2007 Status Reports for the Mākua Implementation Plan and the Draft Oʻahu Implementation Plan

November 2007

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Executive Summary

Current Status of the Mākua Implementation Plan

The Mākua Implementation Plan (MIP) was finalized in May 2003. In January 2005, the Army completed an Addendum which emphasized management of three population units (PUs) per plant taxon in the most intact habitat. Over the past two years, management has been based on the priority actions set 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-3 actions that have occurred between 1 September 2006 and 31 August 2007.

The Army has been implementing the MIP addendum for three years. This year, the Army received a new Biological Opinion (BO) from the U.S. Fish and Wildlife Service (USFWS) regarding the Army's reinitiated Section 7 Consultation for the preferred alternative of the Draft Environmental Impact for Mākua Military Reservation. The most recent BO has resulted in a new Action Area (AA) based on fire modeling and Surface Danger Zones for additional weaponry proposed for training. The new AA, shown in Figure I, includes all of the endangered species included in the MIP plus one additional plant species that requires stabilization, *Gouania vitifolia*. Therefore, the Army is now responsible for the stabilization of 28 plant species, 1 snail species, and all O'ahu 'Elepaio pairs within the new AA. Highlights from the new Mākua BO include more specific fire prevention measures such grass and fuel control, helicopter staffing guidelines based on weather conditions, and the expansion of firebreaks. The BO also takes a tiered approach for the more fire causing weaponry requiring certain species most at risk from fire to be stabilized (termed "expedited stabilization") prior to these weapons use. For example, there are three species that require expedited stabilization before the Army may use tracers in the Valley. There are a total of 12 plant species that will require expedited stabilization. NRS estimates that it will take approximately five years to reach numerical stability for the three species required for tracer use and ten years to reach numerical stability for the remaining nine species. Expedited stabilization will also require an addition $1M of funding above what is already required for the MIP. The NRS will not begin expedited stabilization action until the Army funds this extra $1M pursuant to the requirements laid out in the BO. The 12 target taxa identified for expedited stabilization are (*species identified for five year stabilization):

Chamaesyce herbstii
Cyanea grimesiana subsp. *obatae*
Cyanea longiflora
Cyanea superba subsp. *superba**
Delissea subcordata
Gouania vitifolia
Hibiscus brackenridgei subsp. *mokuleianus*
Neraudia angulata
Phyllostegia kaalaensis
Sanicula mariversa
*Schiedea nuttallii**
*Schiedea obovata**

The current status of each MIP species is summarized in Table I. For detailed explanations of the status of each MIP species refer to Chapters 2, 3, and 4.

Current Status of the Oahu Implementation Plan

The Army produced a Draft Oahu Implementation Plan (OIP) in June 2005 following completion of the USFWS O'ahu BO, covering training at all O'ahu training areas except Mākua. The Draft OIP was created by the O'ahu Natural Resource Program (OANRP) with the help of Hawai'i

Biodiversity and Mapping Program using the basic premises developed during the MIP process. This document was distributed to the Mākua IT to act as an advisory group to this plan via comments. To date, there have not been any significant comments received on the draft document. However, since the USFWS has completed the Makua BO, they have agreed to review the document by the end of 2007. The Army plans on finalizing the document in the spring of 2008.

Since the OIP is still in draft form, OANRP treated FY07 as an OIP urgent action year, focusing on specific actions called out in the BO. NRS is in the process of acquiring additional staff and anticipates beginning year 1 of the OIP in this coming year.

2007 Reporting Highlights

This year the OANRP is reporting on Year 3 of the MIP and urgent actions year 1 of the OIP. This report is organized into five chapters:

1. Ecosystem Management
2. Rare Plant Management
3. *Achatinella* Management
4. O'ahu 'Elepaio Management
5. Research Activities

Chapter 1: Ecosystem Management, was created to help provide a broad look at the major issues facing each region in which OANRP conducts natural resource management. This chapter reports on both weed and ungulate control over the past year. Major highlights include the completion of the approximately 100 acre Mākaha Subunit I fence and the beginning of the 'Ēkahanui subunit II, Palikea Subunit I and Kapuna subunit III fences.

Chapter 2: Rare Plant Management, is organized by Implementation Plan. Thus MIP species are reported on first, followed by a subset of OIP species. Important issues from this year include:

- The addition of *Gouania vitifolia* as a stabilization species, the expedited stabilization of some MIP species (see Table I)
- The effect of the large Waialua fire on the largest *Hibiscus brackenrigei* ssp. *mokuleianus* population
- Near completion of the Nike Site Army Greenhouse
- Pollination efforts that resulted in large amounts of viable seed from, *Fluggea neowarwrea* and *Hesperomannia arbuscula*

Chapter 3: *Achatinella* Management, is also organized by implementation plan. *Achatinella mustelina*, a MIP species, is discussed first and the OIP *Achatinella* species are discussed in the following section. Highlights from this year include:

- NRS developed a Snail Database that makes data tracking easier. Tables generated from this database are utilized in this report.
- NRS installed six new monitoring ground shell plots (GSPs). This makes 14 GSPs that provide threat monitoring in six of the eight managed areas.
- A new design for a *Euglandina rosea* exclosure was tested by an UH Hawaiian Intern Program student. This design will be utilized on an exclosure in the coming year.

- NRS have continued conducting rat control within parts of seven of the eight evolutionarily significant units (ESUs) and have been supporting the UH Snail Propagation Lab in the maintenance of *ex situ* populations from each ESU.

Chapter 4: O‘ahu ‘Elepaio Management is also organized with the MIP efforts discussed first, followed by OIP efforts. This year, NRS were able to conduct threat control for 79 breeding pairs on O‘ahu. All management of these pairs were conducted in one of the following elepaio management units: MMR, SBMR, Honouliuli, Mākaha Valley, Moanalua Valley, Waikāne Valley, and Pālehua.

The last chapter, Chapter 5: Research Activities, is a summary of the data and findings of research activities conducted over the past year. This year, the Army's Research Specialist focused on researching black twig borer control around *Fluggea neowarwrea* and on slug control methods. Results from recent *Drosophila* surveys are also presented here.

Landowner/Agency Communications

The Army continues to work cooperatively under a Memorandum of Understanding (MOU) with both the Board of Water Supply (BWS) and The Nature Conservancy of Hawai‘i (TNCH) for work in Mākaha Valley and TNCH's Honouliuli Preserve.

This year, the 100 acre Mākaha subunit I fence was completed with the help of the OANRP fence crew. The OANRP worked with the contractor to complete the last 10% of fence that was not covered in the contract costs. The Army hopes to be able to begin the Makaha subunit II fence construction this coming year.

There are also several fencing projects that have been approved within Honouliuli Preserve. The Army has worked with TNCH to begin construction on the Pu‘u Palikea and ‘Ēkahanui subunit II fencelines. However, progress has been slow due vandalism to the partially constructed ‘Ēkahanui fenceline.

The Nature Conservancy of Hawai‘i continues to look for a suitable land manager to purchase the Honouliuli Preserve parcel from the James Campbell Company. The latest proposal is for either the State Department of Land and Natural Resources (DLNR) or the Office of Hawaiian Affairs (OHA) to become the land manager for this area. The Army will continue to serve as a member of the Honouliuli Advisory Group for TNCH in the interim and will continue to pursue this area as an Army Compatible Use Buffer (ACUB). The ACUB program allows the Army to help a land manager buy property that will assist with encroachment on training lands owned by the Army. To date, the Army has helped purchase properties such as Moanalua Valley, Pupukea Paumalu, and Waimea Valley.

This year the Army finalized an MOU with the Navy for natural resource management on O‘ahu. The Army has been working with the Navy managing rare plant species within Lualualei and Nānākuli over the last several years. This MOU will enable the Army to continue this important relationship.

The Army currently, has a renewable six month Right of Entry (ROE) with the Waikāne Investment Corp. to conduct ‘Elepaio predator control within Waikāne Valley. This ROE allows the Army to protect one of the only known populations of ‘Elepaio on the windward side of the O‘ahu.

The OANRP will receive a three year license agreement with Kamehameha Schools (KS) in the next few months that will cover all natural resource management work on KS lands on O‘ahu. Once this three year agreement is finalized, the Army will seek an extended ten year agreement that will enable the OANRP to construct ungulate fences for conservation on KS land.

Finally, the Army continues to work toward an agreement to continue conservation work on State land. The Army and the State DLNR legal teams are currently working on an MOU for the Army to access and work on State land on O‘ahu. Once completed, the OANRP will continue to work closely with DLNR staff on all projects and decision making regarding natural resource management on these lands. A major priority for completion of this agreement is the construction of ungulate free management units on State land. The Army would like to work with the state to complete the proposed East Makaleha, West Makaleha, Kapuna subunit IV, and Manuwai MU fences within the next two years. In addition, several more MU fences are proposed on State lands; that would be able to be constructed once a formal agreement is reached.

Status of Fire Management

The Army’s Wildland Fire Management Crew is currently funded for 10 field personnel and a crew boss. This fire crew assisted in several fires this summer including the August 10th, 2007 Punapohaku Fire and the August 12-17th, 2007 Kaukonahua Fire. Additionally, this year the Army Natural Resources Program re-certified 11 personnel to Fire Fighter Type 2 level.

In the early morning of August 10th of this year, a fire started in the northern end of Mākua Military Reservation (MMR). This fire swept from the road up to the Punapohaku area of the MMR range. It was attended to by Honolulu Fire Department (HFD) and the Army Wildland Fire Crew. It was contained within the day and only two individuals of akoko (*Chamaesyce celastroides* var. *kaenana*) were affected. See Appendix I for a full report.

Three days following the Puaakanoa fire, a fire began along the Kaukonahua road and quickly spread to the lower reaches of the gulches above Mokule’ia from Kihakapu all the way to Ka‘awa. See Appendix II for a full report. This fire had a large impact on populations of *Hibiscus brackenridgei* spp. *Mokuleianus*, destroying approximately 90% of the wild individuals left on Oahu. The catastrophic nature of the Kaukonahua fire highlights the susceptibility of MIP and OIP MUs to wildfires and the overwhelming need for an Oahu Wildland Fire Working Group to plan fuel breaks and suppression approaches for wildland areas in the Waianae Mountains. Other lessons learned this fire season include the importance of good communication and cooperation with DLNR Protection Foresters and with HFD about Army Natural Resource Protection interests in these wildland areas. On a positive note, lines of communication were opened as a result of the Kaukonahua fire. The Army was able to assist on the Kaukonahua fire by hiring contract helicopters for water drops and by helping direct these water drops to protect

areas with sensitive species. In addition, NRS provided daily maps of the fire's extent and sensitive resources to help the Incident Commander plan containment efforts.

During the Kaukonahua fire another fire was reported from Ka‘ena point. This fire was monitored by NRS. Once the western front of the fire was out, NRS assisted DLNR in mop up efforts to prevent flare ups near an endangered *C. celastroides* population. The fire destroyed a DLNR reintroduction of rare species but no wild plants were affected. See Appendix III for more information.

Funding and staffing levels

There are currently a total of 34 staff throughout three field crews, one fence crew, and various support staff. This year, the OANRP hired two environmental outreach/ volunteer coordinators, an office associate, a horticulturalist, and several additional field crew technicians. The OANRP is also seeking additional field crew technicians, a fence crew boss, and a horticultural assistant.

In addition to the regular field crew, the OANRP has contracted Pono Pacific for the monitoring and predator control of the O‘ahu ‘Elepaio in Moanalua, Mākaha, and ‘Ēkahanui. The program also has a couple of on-call field experts. Dr. Eric VanderWerf has been assisting the Army in monitoring of O‘ahu ‘Elepaio. Dr. Steven Montgomery was hired to conduct surveys for any listed species of *Drosophila* within the Army ranges. Over the next year, the program plants on contracting Dr. Jim Jacobi of the US Geological Survey to help develop monitoring protocols for the program. The Army is also supporting the research of three University of Hawai‘i graduate students for *Euglandina rosea,* rat density on O‘ahu, and dispersal genetic variation of *Achatinella*. Their work is discussed in detail in Chapter 3.

Cost estimates for Year 3 of the MIP were $3.328 M and the program received $3.2 M in MIP funds. This was the second year that the OANRP received close to the requested amount in funding. The program also received $1.9 M for management associated with the Draft OIP. This money has not been spent in full as the program is still ramping up the amount of staff, equipment, and space required to fully implement this plan.

The OANRP has outgrown its current office space and has moved the fence crew and one field crew to TNCH's Kunia baseyard. This year, the Army offered a large space within Schofield Barracks to house the Natural Resources Program but it requires significant renovation and construction to house all the field crews. This year, the program received $1M towards the first round of renovations. This space will be able to house part of the program sometime in the next year, with final renovations and construction to be completed within the next two years.

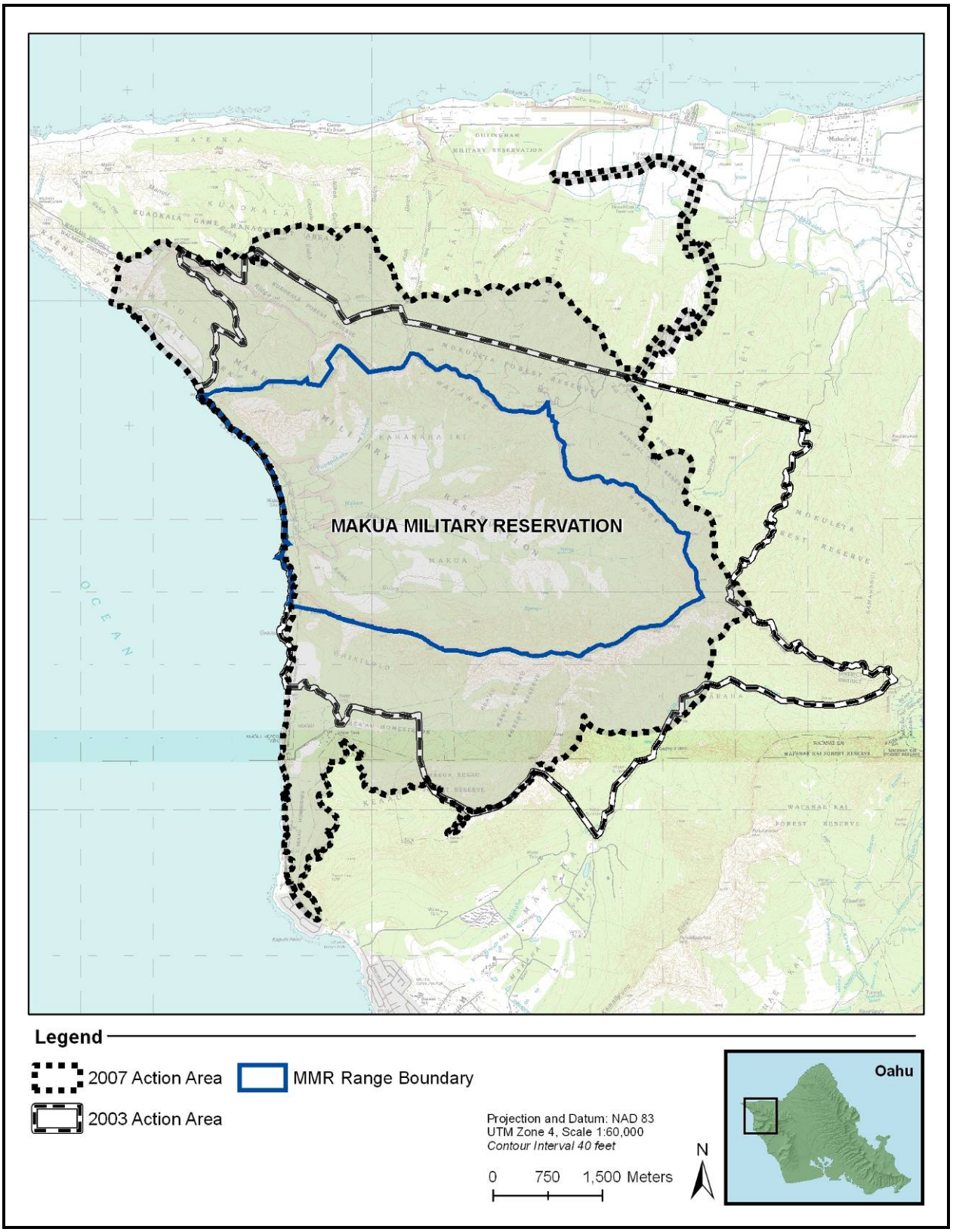

Figure I. 2007 and 2003 Mākua Military Reservation Action Areas.

Table I. Status summary of MIP species for 2007. *species with expedited stabilization within 10 years; **species with expedited stabilization within 5 years; **Bold** = reached target

Makua Implementation Plan				
Species	**PU**	**Status (stability #)**	**Genetic Storage (> 50 seeds, 3 clones in propagation, or)**	**Ungulate free**
Alemacmac	Kahanahaiki to West Makaleha	37/4 (50)	0	no
	Makua	33/0/0 (50)	1 (clones? seed?)	no
	Central Kaluaa to Central Waieli	**52/1/1 (50)**	0	partial
	Makaha	**63/5/2 (50)**	0	partial
Cenagragr	Kahanahaiki to Pahole	**81/11/7 (50)**	27 (50)	**yes**
	Central Ekahanui	30/3/16 (50)	4 (50)	partial
	Makaha and Waianae Kai	12/0/0 (50)	5 (50)	partial
Chacelkae	Makua	**89/45/20 (25)**	46 (50)	**yes**
	Kaena to Keawaula	**300 (25)**	32 (50)	**yes**
	Kaena East of Alau	21/4/20 (50)	10 (50)	**yes**
	Waianae Kai or Puaakanoa	33 or **160/10** (50)	2 (50)	**yes**
Chaher*	Kapuna to Pahole	**67/57/0 (25)**	8 (50)	**yes**
	Makaha (reintro)	0/22/0 (25)	n/a	**yes**
	West Makaleha (reintro)	0	n/a	no
Cyagrioba*	Pahole to W Makaleha	25/8/9 (100)	8 (50)	**yes**
	Central Kaluaa	28/38/0 (100)	1 (50)	**yes**
	Puu Palikea	51/29/10 (100)	12 (50)	**yes**
	Makaha	1/0/0 (100)	1 (50)	no
Cyalon*	Kapuna to W Makaleha	23/35/4 (75)	14 (50)	partial
	Pahole	50/63/4 (75)	27 (50)	**yes**
	Makaha and Waianae Kai	3/5/2 (75)	2 (50)	partial
Cyasupsup**	Kahanahaiki (reintro)	19/92/0 (50)	3 of 4 available founders	**yes**
	Central and East Makaleha (reintro)	0	n/a	no
	Makaha (reintro)	0	n/a	**yes**
	Pahole to Kapuna (reintro)	**72/68/0 (50)**	n/a	**yes**
Cyrden	Pahole to Kapuna and West (central?) Makaleha	**534/520/171 (50)**	**50 (50)**	partial
	Kawaiiki	15/31/39 (50)	0	no
	Opaeula	16/12/0 (50)	0	no
	Kahanahaiki	**156/57/27 (50)**	21 (50)	**yes**
Delsub*	Kahanahaiki to Keawapilau	20/112/0 (100)	12 (50)	partial
	Ekahanui	**113/0/0 (100)**	6 (50)	**yes**
	Kaluaa	25/6/7 (100)	1 (50)	**yes**

	Manuwai (reintro-Palikea gulch stock)	0	6 (50)	no
Dubher	Ohikilolo Makai	**358/0/0 (50)**	6 (50)	**yes**
	Ohikilolo Mauka	**382/6/0 (50)**	6 (50)	**yes**
	Makaha	36/1/0 (50)	1 (50)	**yes**
Fluneo	Kahanahaiki to Kapuna	7/72/0 (50)	0	partial
	Central and East Makaleha	5/0/0 (50)	1 (50)	no
	Makaha	9/0/0 (50)	1 (0)	partial
	Manuwai	3/0/0 (50)	1 (0)	no
Gouvit*	Keaau	**60/0/0 (50)**	0	no
	Makaha (reintro-Waianae Kai stock)	0 (2 in waianae kai)	0	**yes**
	Makaleha or Manuwai	0	n/a	no
Heddegdeg	Kahanahaiki to Pahole	**243/9/8 (50)**	16 (50)	partial
	Alaiheihe and Manuwai	31/6/1 (50)	5 (50)	no
	Central Makaleha and West branch of East Makaleha	25/10/17 (50)	18 (50)	no
Hedpar	Ohikilolo	**120/28/40 (50)**	**102 (50)**	**yes**
	East Makaleha (reintro?)	0	0	no
	Halona	**97/35/19 (50)**	**62 (50)**	no
Hesarb	Waianae Kai	2/1/0 (75)	3 (3 clones)	**yes**
	Makaha	4/8/0 (75)	0	**yes**
	North Palawai	3/0/0 (75)	1 (3 clones)	**yes**
Hibbramok*	Makua	10/4/18 (50)	20 (50)	**yes**
	Haili to Kealia	34/6/9 (50)	3 (50)	no
	Kaimuhole to Palikea Gulch (Kaawa) (reintro)	1/8/0 (50)	11 (50)	no
	Keaau (reintro)	0	n/a	no
Melten	Ohikilolo	**1242/1/0 (50)**	14 (50)	**yes**
	Kamaileunu and Waianae Kai	**881/269/297 (50)**	0	no
	Mt. Kaala NAR	**300/0/0 (50)**	0	no
Nerang*	Makua	37/5/6 (100)	2 (50)	partial
	Manuwai	0	1 (3 clones)	no
	Waianae Kai Mauka	57/29/54 (100)	3 (3 clones)	no
	Kaluakauila (reintro)	53/0/0 (100)	1 (3 clones)	**yes**
Nothum	Kaluakauila	**198/35/0 (25)**	4 (3 clones)	**yes**
	Makua (south side)	**71/1/0 (25)**	0	no
	Kaimuhole and Palikea Gulch (Kihakapu)	**51/4/0 (25)**	12 (3 clones)	no
	Waianae Kai	**224/5/0 (25)**	4 (3 clones)	no
Phykaa*	Keawapilau (reintro)	17/0/0 (50)	1 (3 clones)	**yes**
	Makaha (reintro)	4/20/0 (50)	2 (3 clones; waianae kai)	**yes**
	Manuwai (reintro)	0	2 (3 clones; palikea gulch)	no

	Pahole (reintro)	0/30/0 (50)	2 (3 clones)	**yes**
Plapripri	Ohikilolo	12/14/0 (50)	9 (50)	**yes**
	Ekahanui	29/39/7 (50)	37 (50)	partial
	North Mohiakea	10/16/2 (50)	12 (50)	partial
	Halona	10/17/11 (50)	4 (50)	partial
Prikaa	Ohikilolo	**75/1006/19 (25)**	28 (50)	**yes**
	Ohikilolo East and West Makaleha (reintro)	0/75/0 (25)	n/a	**yes**
	Makaleha to Manuwai	**68/3/0 (25)**	2 (50)	no
Sanmar*	Ohikilolo	3/112/0 (100)	15 (50)	**yes**
	Keaau	11/359/5 (100)	40 (50)	no
	Kamaileunu	5/188/13 (100)	39 (50)	no
Schkaa	Pahole	41/9/0 (50)	2 (50)	**yes**
	Maakua	16/0/0 (50)	3 (50)	no
	South Ekahanui	**69/0/0 (50)**	13 (50)	**yes**
	Kaluaa and Waieli (reintro)	**89/53/0 (50)**	n/a	**yes**
Schnut**	K-iki to Pahole	**61/7/4 (50)**	21 (50)	**yes**
	Kapuna-Keawapilau ridge	0	0 (no founders available?)	no
	Makaha (reintro)	7/0/0 (50)	n/a	**yes**
Schobo**	Kahanahaiki to Pahole	**177/119/7 (100)**	5 (50)	**yes**
	Keawapilau to West Makaleha	63/64/11 (100)	**60 (50)**	partial
	Makaha (reintro)	0	n/a	**yes**
Tetfil	Kalena	9/0/6 (50)	7 (50)	**yes**
	Ohikilolo	**2442/552/1 (50)**	42 (50)	**yes**
	Puhawai	7/2/3 (50)	4 (50)	no
	Waianae Kai	30/2/3 (50)	0	**yes**
Viochacah	Ohikilolo	**433/10/0 (50)**	2 (50)	yes
	Puu Kumakalii	44/0/0 (50)	11 (50)	no
	Halona	41/3/0 (50)	1 (50)	**yes**
	Makaha	17/2/0 (50)	0	**yes**
Species	**PU**	***in situ* #s**	***ex situ* #s (# of pops represented)**	**Ungulate free**
Achmus	ESU A (Kahanahaiki/Pahole)	240/139/61 (300)	0/9/2 (1)	partial
	ESU B1 (Ohikilolo)	286/40/36 (300)	1/21/2 (2)	**yes**
	ESU B2 (East/Central Makaleha)	263/135/66 (300)	0/4/1 (1)	no
	ESU C (SBW/Alaiheihe/Palikea)	49/15/5 (300)	10/65/2 (3)	no
	ESU D1 (North Kaluaa to SBS, Kaala)	**338/204/84 (300)**	1/45/3 (2)	partial
	ESU D2 (Makaha)	41/9/10 (+32) (300)	5/17/0 (1)	yes
	ESU E (Puu Kaua/Ekahanui)	**314/71/77 (300)**	2/9/1 (1)	**yes**

	ESU F (Puu Palikea/Mauna Kapu)	62/30/14 (300)	1/15/0 (1)	no

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Chapter 1 Ecosystem Management

Introduced species threaten endangered species and native ecosystems by altering habitat and disrupting community structure. Invasive vertebrates alter plant community structure and directly impact endangered plants, birds, snails and arthropods. Weedy plant species out-compete native plants for light, space and nutrients. NRS has been conducting ecosystem management on Army land for twelve years. The level of management has increased dramatically over the years, especially with the execution of the MIP and parts of the OIP. In general, this year NRS expanded the scope of weed control projects across all Management Units (MUs) and increased overall acreage protected from ungulates by fencing.

1.1 Introduction

Chapter Organization

Reporting format was revised to better reflect IP requirements and to present ecosystem management actions in a more unified manner. In previous years, ungulate control efforts and weed control efforts were discussed in separate chapters. This year, all ecosystem-level management is grouped together. Chapter 1 is divided into several sections. First, MIP/OIP requirements are discussed for ungulates, then weeds. Following this is the Weed Survey Report, which details results from LZ and road surveys. Next is the Incipient Weed Report, which discusses the results of incipient invasive species control. Lastly, the Ecosystem Management Report discusses ungulate control, ecosystem-level weed control (organized by Weed Control Areas, or WCAs), and any other issues affecting a particular region. The Ecosystem Management Report is organized into twelve geographical Regions, with each Region divided again into IP Management Units. Issues pertaining to all MUs in a Region are discussed within the Region introduction. Information specific to an MU is presented in the MU section. MU sections include an introduction, ungulate discussion, and weed control discussion. Only results from the past reporting year, Sept. 1, 2006 to Aug. 31, 2007 are discussed.

NRS Partnerships

The scope of the IPs necessitates NRS coordination with other agencies. Weed and ungulate 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 of Hawaii (TNCH), Plant Extinction Prevention (PEP) staff, Kamehameha Schools (KS), the Board of Water Supply (BWS), Bishop Museum, Oahu Invasive Species Committee (OISC), and various State of Hawaii agencies, including the Natural Area Reserves System (NARS), State Forest Reserves, and State Parks. NRS rely on partner agencies for guidance on the location and prioritization of weed control areas, as well as types of weed control projects. Many ungulate control projects are joint efforts between NRS and a variety of partners, particularly fence construction, hunting, and snaring. NRS participates in the Feral Goat Working Group, which looks at goat issues island-wide. In particular, NRS works closely with the NARS Specialist to direct actions in the NARS, and with TNC to supplement on-going efforts in Honouliuli.

MIP and OIP Ungulate Management Requirements

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 impacts from these feral

animals on endangered species and native habitats by excluding them from the MIP and OIP 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 and OIP 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 1.1.1 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. 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 breached the fence through a small hole. NRS have removed 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. A 10-15 year license agreement still has to be obtained prior to construction of the fence.	Pigs
‘Ōhikilolo	Partial	‘Ōhikilolo ridge fence is complete along with six smaller PU fences and all are ungulate free. 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 had been ungulate free. Four pigs breached the fence and a sow had a litter this past season. Four adults and five piglets have been eliminated so far. At this time, it appears that all of the pigs have been removed but NRS and NARS will continue to monitor the MU for confirmation	Pigs
Upper Kapuna	Partial		Pigs
Wai‘anae Kai	Partial	One PU fence has been completed and three others are proposed.	Pigs Goats
West Makaleha	Partial	Two PU fences are completed. 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. Subunit II is partially completed but there has been some vandalism to this portion of the fence. NRS are awaiting the arrival of more materials to complete the fence. 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 has been ungulate free. Unfortunately, there was a breach in the fence and twelve pigs were removed from within. 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 has begun. NRS are awaiting the arrival of more materials to complete the fence.	Pigs
BOARD OF WATER SUPPLY			
Kamaile‘unu	Partial	One of the PU fences encompassing two populations of *Sanicula mariversa* has been completed. NRS is awaiting the arrival of more fencing materials to complete the second.	Pigs Goats
Mākaha	Partial	Subunit I has been completed. Several community/staff hunts have been completed and one pig has been taken. Subunits II and III are slated for construction in Year 5. NRS has completed a small PU fence around a population of *Cyanea longiflora* located with Subunit II.	Pigs Goats
DOLE FOOD COMPANY, INC.			
Kaimuhole	No	Dole is willing to give permission for construction of this MU fence if the State can come up with a conservation easement. The Army will not purchase the land for conservation purposes but would work there if the State owns an easement for 10 or 20 years	Goats Pigs
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.

Table 1.1.2 OIP Management Unit Status

Management Unit	Fenced	Ungulate Control	Threat
ARMY MANAGED LANDS			
East of Oio	Yes	There is a small 1 acre fence proposed to be constructed around a population of *Eugenia koolauensis*.	Pigs
Ka‘ala	Yes	The Army controlled side of the MU is fenced. It is unclear as to whether all of the pigs have been eradicated from the fence and whether any animals can get up into the the MU from the Waianae/ Mākaha side. Five pigs have been removed this year.	Pigs
Kaunala	Yes	A small 4.9 acre fence has been constructed around a population of *Eugenia koolauensis*.	Pigs
Oio	Yes	A small 3.3 acre fence has been constructed around a population of *Eugenia koolauensis*.	Pigs
‘Ōpae‘ula / Helemano	Yes	The Helemano portion of this combined fence unit was completed in May 2007 and is about 150 acres. This makes the combined size about 300 acres. Twelve pigs have been removed so far and NRS will continue to monitor until no more remain.	Pigs
Pahipahialua	Yes	A small 1.5 acre fence has been constructed around a population of *Eugenia koolauensis*.	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES			
Kaleleiki	Yes	A small 1.9 acre fence has been constructed by the State around a population of *Eugenia koolauensis*.	Pigs
THE NATURE CONSERVANCY OF HAWAII			
Puali‘i	Yes		
HAWAII RESERVES INC.			
Koloa	No		Goats

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.

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.

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 2006-2007, a total of 170 staff hours were spent checking and resetting snares which resulted in the removal of 31 pigs. This equals about three 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 2006-2007, a total of 5 hunts were conducted, resulting in the removal of 33 goats. This equaled roughly 306 staff hours and 6.6 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, Mākaha 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. Seven hunts have been conducted in Mākaha since May with local community hunters and seven pigs were caught.

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.

MIP and OIP Weed Management Requirements

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, the Oahu BA, and the Oahu BO. 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.

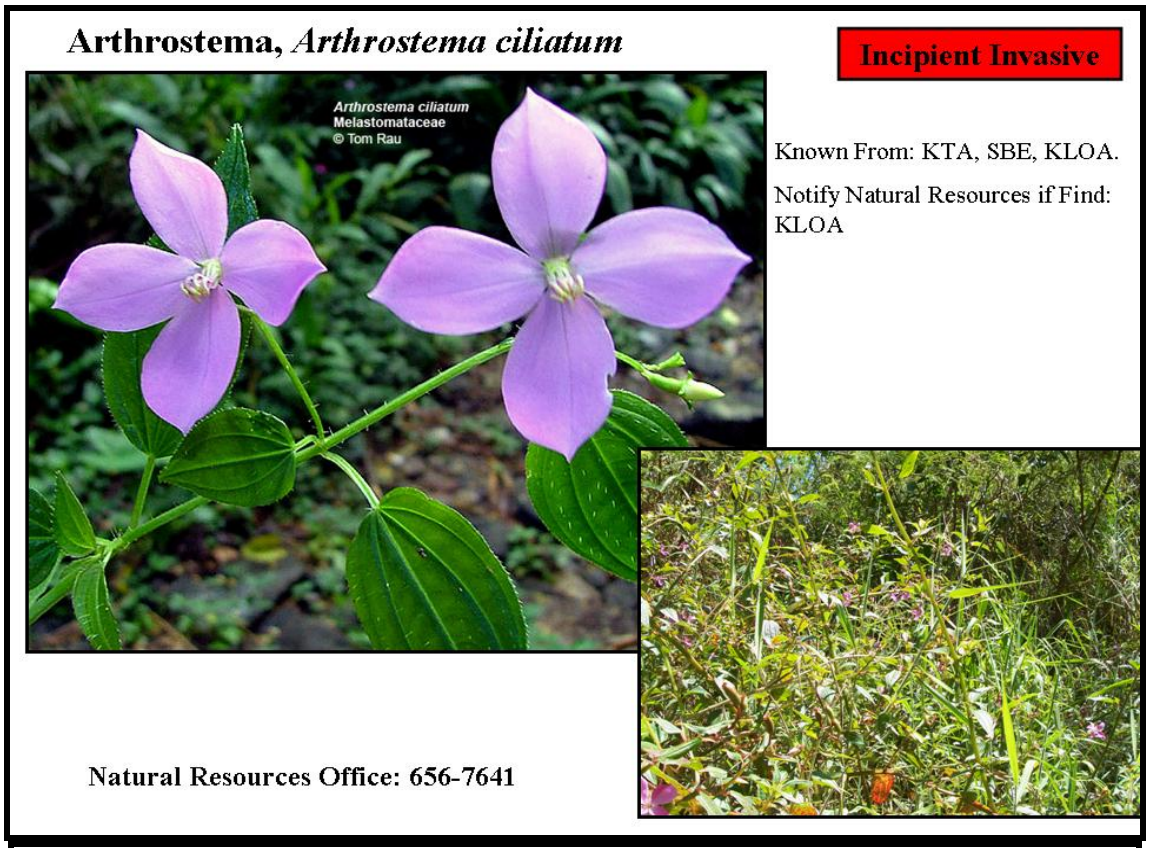
1. Prevention of Weed Spread

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. NRS also worked with Garrison support staff, in particular 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. Figure 1.1.2 is an example of media used in briefings for military units. NRS hope to build on these past efforts. This year, two Public Outreach Specialists were hired. These staff will seek to reestablish reliable connections to the Garrison, continue educational briefings for road crews, improve training media, and seek out other educational avenues for troops. In November 2007, the Public Outreach Specialists will conduct trainings with the Environmental Compliance Officers (ECO) associated with each unit. These ECO trainings, held once a month by the Garrison, are an ideal opportunity to educate soldiers about natural resource threats posed by training.

Mākua related section 7 documents also emphasized gear cleaning infrastructure and procedures for military personnel. This area of the program needs improvement. NRS 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. However, clean vehicles leaving PTA must drive miles through land infested with highly invasive species

such as *Pennisetum setaceum* and *Senecio madagascariensis* to reach Kawaihae Harbor, negating the efficacy of the PTA wash rack. There is no similar wash rack at Kawiahae Harbor. NRS support finding solutions to this discrepancy in the coming year. There is a Standard Operating Procedure (SOP) dictating sanitation protocols that the troops are required to follow. Last 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 (Figure 1.1.1) and created posters for the wash racks outlining incipient weed concerns. This past year, due to high turnover at ITAM, the environmental awareness component of their program was inactive. NRS will seek to reestablish communication with ITAM and continue to improve media products in the coming year.

Figure 1.1.1 ITAM training card cover



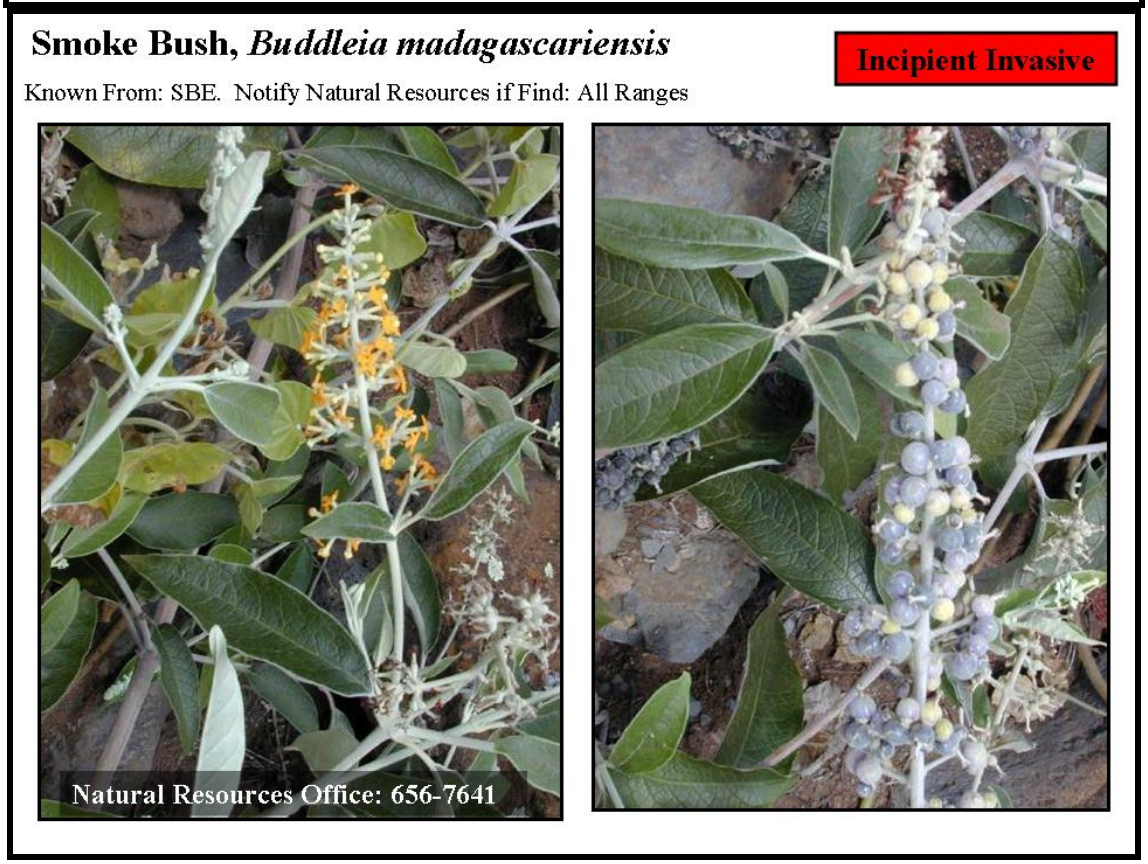


Figure 1.1.2 Invasive species identification cards

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 Waiʻanae and one for Koʻolau 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 ʻŌhikilolo, 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. Surveys are conducted yearly. 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 six 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. When Transformation occurs, road survey frequency will be re-evaluated.

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 yearly and at all small NRS LZs whenever they are 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 high-priority 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. The staff of the Oahu Early Detection (OED) program, located at Bishop, assisted NRS greatly with timely identification of many samples this year. 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 less concerning taxa 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 IP 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 infestation, severity of the weed's potential impact if established, and control possibilities in terms of staff time required and control techniques. Weed Risk Assessments (WRA) conducted by the Pacific Islands Ecosystem at Risk (PIER) program are consulted to determine threats posed by weedy species. These risk assessments are available online at www.hear.org/PIER/index.html, along with a full explanation of how the assessments are conducted, and what each WRA score means. Table 1.1.3 outlines the recommendations associated with WRA scores. In general, the higher the score, the more invasive the species, and the greater the threat it poses to Hawaii's ecosystems.

Table 1.1.3 Weed Risk Assessment Score Interpretation

WRA Score, X	Score Interpretation
X<1	Low risk, low potential of becoming an invasive weed.
1<X<6	More study required, must pass through a second screening process.
X>6	High risk, great potential of becoming an invasive weed.

The IP 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. Achieving eradication can take many years and specific management objectives are needed for each ICA to guide control efforts. In general, preventing any individuals from maturing, setting seed, dispersing, and contributing to the seed bank is the first goal in ICA management. For each taxon, eradication criteria, based on seed longevity and time elapsed since plants seen, need to be established. NRS will work to do this for appropriate taxa in the coming year.

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 (Table1.1.4). 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 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 1.3, NRS already target several incipient weed species, mostly on Army controlled land. Please refer to the Incipient Weed Report for detailed control discussion.

Table 1.1.4 Summary of Incipient Taxa in MUs from Appendix 3.1 Final MIP

Management Unit	Incipient Taxa	Comments
ʻĒkahanui	*Dicliptera chinensis*	Investigate locations. Will evaluate and consider control.
	Heliocarpus popayanensis	Locations known. Will evaluate and consider control.
	Melaleuca quinquenervia	1 tree known from upper water tank. Will treat in the coming year.
	Schefflera actinophylla	Locations known. Will seek more info from Joel Lau, HBMPB.
	Sphaeropteris cooperi	No known locations. Will control within fence if found.
Haili to Keālia	*Schefflera actinophylla*	Some individuals found. Will control in MU.
Kaʻena	*Agave sisalana*	Current target within MU boundary.
Kaluakauila	*Casuarina glauca*	Currently targeted along fenceline only.
ʻŌhikilolo	*Aracauria columnaris*	Currently targeted. See Incipient Weed Report
	Morella faya	Treated in the past. Will monitor known sites.
Upper Kapuna	*Ehrharta stipoides*	Locations known. Will target in coming year.
	Rubus argutus	One location 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. See Incipient Weed Report.
	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	*Ficus macrophylla*	Locations known. Will monitor movement.
	Juniperus bermudiana	Locations unknown. TNC feels it is not present within the MU.
	Montanoa hibiscifolia	Locations known. Will consider control options.
	Schefflera actinophylla	Locations unknown. TNC feels it is not present within the MU
	Sphaeropteris cooperi	Locations known. Will monitor quarterly, and treat in managed areas.
	Toona ciliata	Locations unknown. Will investigate.
West Makaleha	*Sphaeropteris cooperi*	Locations unknown. Work with State to determine level of control
Waiʻanae Kai	*Chrysophyllum oliviforme*	Locations unknown. Will target if deemed necessary
Kaluaa and Waieli	*Angiopteris evecta*	Known from South Central Kaluaʻā. See Incipient Weed Report.
	Ardisia elliptica	Locally common. See Incipient Weed Report
	Mallotus philippensis	Found in Gulch 3 site C. Will map/control as deemed appropriate.
	Schefflera actinophylla	Locations known. Will treat where found.
Pahole	*Acacia mearnsii*	Currently targeted. See Incipient Weed Report.
	Angiopteris evecta	Same as Upper Kapuna site.
	Axonopus compressus	Same site as Kahanahāiki location
	Ehrharta stipoides	Targeted at known sites. See Incipient Weed Report.
	Glycine wightii	Locations unknown. Possibly same as Upper Kapuna site.
	Passiflora suberosa	Will target in course of regular management, esp in Gulch 4.
	Rubus argutus	Locations unknown. Possibly same as Upper Kapuna site.
	Setaria palmifolia	Same as Upper Kapuna site.
	Sphaeropteris cooperi	Targeted by Kay Lynch of Oʻahu Trail and Mountain Club
	Toona ciliata	Some locations known. Will target in coming year.

During conversations with TNCH staff, some species not included in Appendix 3.1 were recognized as possible threats. They are listed in Table 1.1.5 below. These species and sites will be evaluated and ICAs established if deemed necessary.

Table 1.1.5 Additional Incipient Taxa In Honouliuli

Management Unit	Incipient Taxa	Comments
Ekahanui	*Montanoa hibiscifolia*	2 locations known in subunits 1 and 2. Target.
Palikea	*Erigeron karvinskianus*	Control in managed areas.
	Eriobotrya japonica	Localized, half acre population. Target.
	Crocosmia x crocosmiiflora	Localized, focus on containment.
Kaluaʻā and Waiʻeli	*Dicliptera chinensis*	Focus on keeping off trail
	Setaria palmifolia	Focus on keeping off trail
Pualii	*Angiopteris evecta*	One plant seen and killed. Survey for additional plants.
	Trema orientalis	Target in managed areas.

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 IP PU locations and reintroduction sites, and the feasibility of the control project. NRS have broken up the MUs into smaller units, or Weed Control Areas (WCA). In most cases WCAs contain managed PUs and the native habitat surrounding those PUs and focus on ecosystem level weed control. 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 Ecosystem Management Report. 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 IP 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 IP taxa is fruit production, rather than 'Manage for Stability'. The Weed Control Summary Tables in the Ecosystem Management 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 1-1.

Figure 1.1.3 NRS conducting weed control with Garlon 4

Table 1.1.6 summarizes the MU weed control efforts. Combining both MIP and OIP MUs, there are approximately 45 MUs; NRS conducted weed control in 22 of them this year. Eighty-two % of person hours were spent in eight of the 22 weeded MUs. These eight MUs are the largest, include many resources, and are the highest priority for weed control work at this time. While additional staff were hired this year, NRS are still not yet fully staffed. 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 IP management actions. Formal permission has not been granted for a number of sites which therefore are not weeded regularly.

Table 1.1.6 IP Management Units: Weed Effort Summary from 9-1-2006 to 8-31-2007

	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	# of Visits	Effort (Person Hrs)
IP MU: Ekahanui	8.84	3.40	38.47%	12	77.50
IP MU: Haili to Kealia	1.79	0.57	31.72%	4	20.50
IP MU: Kaala	41.76	9.81	23.50%	18	370.85
IP MU: Kaena	1.60	1.40	87.54%	5	64.50
IP MU: Kaena East of Alau	0.14	0.05	38.68%	1	5.00
IP MU: Kahanahaiki	19.41	6.16	31.74%	31	352.75
IP MU: Kaleleiki	0.80	0.03	3.79%	1	24.00
IP MU: Kaluaa and Waieli	12.04	2.76	22.88%	25	128.50
IP MU: Kaluakauila	2.94	2.94	100.00%	2	25.00
IP MU: Lower Ohikilolo	7.81	7.81	100.00%	34	455.50
IP MU: Makaha	21.26	3.13	14.72%	26	266.50
IP MU: MMR No MU	1.45	0.11	7.63%	1	5.00
IP MU: Ohikilolo	63.67	9.34	14.67%	17	226.50
IP MU: Oio	1.33	0.21	15.70%	1	21.00
IP MU: Opaeula/Helemano	49.12	10.63	21.65%	7	78.00
IP MU: Pahole	29.02	8.24	28.41%	29	251.50
IP MU: Palikea	11.71	2.52	21.51%	12	43.70
IP MU: SBE No MU	3.95	2.40	60.82%	1	5.00
IP MU: SBS No MU	1.57	0.35	22.63%	3	30.00
IP MU: SBW No MU	0.21	0.21	100.00%	1	11.00
IP MU: South Haleauau	0.53	0.30	56.92%	2	3.00
IP MU: Upper Kapuna	8.66	1.56	18.01%	17	134.25
IP MU: West Makaleha	2.68	1.14	42.77%	8	111.00
Total for all IP MU:	292.31	75.10		258	2710.55

4. Monitoring of IP related weed control

No ecosystem monitoring was conducted over the past year, due to a vacancy in the Monitoring Program Manager position. Starting in September 2007, Jim Jacobi, PhD, USGS BRD, will be contracted to help develop monitoring protocols for NRS. One of his priorities will be developing vegetation monitoring methods to evaluate management efficacy. Previous monitoring efforts are detailed in OANRP 2006.

5. Research

While there are many weed-related research issues NRS are interested in, little work has been done on them thus far. In the coming year, NRS will work with J. Jacobi to define goals and strategies for monitoring the success of weed management over time. NRS will also develop new, more effective weed control techniques as needed. NRS will also work with the Propagule Management Specialist to look at the longevity of seed viability for invasive species. NRS drafted a priority list of weed species which will guide this effort in the coming year. This information will assist NRS in strategizing how best to plan management at both ICAs and WCAs. 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.

1.2 Incipient Weed Report

All incipient species and their general locations are summarized in the two tables below. Table 1.2.1 lists all regions and MUs where an incipient taxa is controlled, summarizing the data by species. This table gives an idea of the distribution of the species, and of where each poses a significant threat to native areas. The second table, Table 1.2.2, presents the same data, but groups it by region and MU. This table gives a better idea of the number of invasive species affecting each MU. Figures 1.2.1-7 show the 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 1.2.1 Overview of Incipient Taxa Distribution, Organized by Species

Incipient Target	Region	Management Unit (MU)	Number of ICAs
Acacia mangium	KTA	Not in MU	4
Acacia mearnsii	MMR	Kahanahāiki	2
	Mokuleia Forest Reserve	Not in MU	1
Achyranthes aspera	MMR	Kahanahāiki	3
Angiopteris evecta	Honouliuli	Kaluaʻā and Waiʻeli	1
	Pahole NAR	Upper Kapuna	1
Araucaria columnaris	MMR	ʻŌhikilolo	1
Ardesia elliptica	Honouliuli	Not in MU	1
Arthrostema ciliatum	KLOA	Not in MU	2
	SBE	Not in MU	3
Buddleia madagascariensis	SBE	Not in MU	2
Casuarina glauca	MMR	Kahanahāiki	1
	Honouliuli	Not in MU	1
Cirsium vulgare	MMR	ʻŌhikilolo	1
	MMR	Kaluakauila	1
Desmodium intortum	MMR	Not in MU	1
	Pahole NAR	Upper Kapuna	2
Ehrharta stipoides	MMR	ʻŌhikilolo	1
	Pahole NAR	Pahole	4
	Pahole NAR	Upper Kapuna	2
Festuca arundacea	SBW	Kaʻala	1
Fraxinus uhdei	Pahole NAR	Upper Kapuna	1
	MMR	ʻŌhikilolo	1
Grevillea robusta	Pahole NAR	Upper Kapuna	1
Hedychium gardnerianum	KLOA	Koloa	1
	KLOA	Not in MU	1
Ilex cassine	SBW	Not in MU	1
Juncus effuses	SBW	Kaʻala	3
Leptospermum scoparium	KLOA	Poamoho, in and out of MU	2
	KLOA	Not in MU	1
Melochia umbellata	KTA	Not in MU	5
Montanoa hibiscifolia	Pahole NAR	Pahole	1

	Pahole NAR	Not in MU	1
Morella faya	Honouliuli	Not in MU	1
Neonotonia wightii	Pahole NAR	Upper Kapuna	2
Pennisetum setaceum	KTA	Not in MU	1
	MMR	Lower ʻŌhikilolo	1
	SBE	Not in MU	1
	DMR	Not in MU	1
Panicum maximum	Honouliuli	Kaluaʻā and Waiʻeli	1
Pterolepis glomerata	Pahole NAR	Pahole	1
Rhodomyrtus tomentosa	KTA	Not in MU	1
	SBE	Not in MU	1
Rubus argutus	MMR	Kahanahāiki	2
	MMR	ʻŌhikilolo	2
	Pahole NAR	Upper Kapuna	1
	MMR	Not in MU	1
	Mokuleia Forest Reserve	Not in MU	1
Senecio madagascariensis	SBS	Not in MU	1
Setaria palmifolia	KLOA	Opaeula/Helemano	14
	Honouliuli	Kaluaʻā and Waiʻeli	1
Smilax sp.	SBE	Not in MU	1
Sphaeropteris cooperi	Pahole NAR	Upper Kapuna	1
Syzigium jambos	MMR	Kaluakauila	1
Tecoma capensis	Pahole NAR	Pahole	1
Tibouchina urvilleana	KLOA	Whitmore Village, not in MU	1
Trema orientalis	Honouliuli	Kaluaʻā and Waiʻeli	1
	Waiʻanae Kai	Not in MU	1
Triumfetta semitriloba	MMR	Kahanahāiki	5
	Pahole NAR	Pahole	1
	Pahole NAR	Upper Kapuna	1
Vitex trifolia	SBE	Not in MU	1

Table 1.2.2 Overview of Incipient Taxa Distribution, Organized by Region and MU

Region	Management Unit (MU)	Incipient Target	Number of ICAs
Waiʻanae Kai	Not in MU	*Trema orientalis*	1
DMR	Not in MU	*Pennisetum setaceum*	1
MMR	Kaluakauila	*Cirsium vulgare*	1
		Syzigium jambos	1
	Kahanahāiki	*Acacia mearnsii*	2
		Achyranthes aspera	3
		Casuarina glauca	1
		Rubus argutus	2
		Triumfetta semitriloba	5
	ʻŌhikilolo	*Araucaria columnaris*	1
		Cirsium vulgare	1
		Ehrharta stipoides	1
		Fraxinus uhdei	1
		Rubus argutus	2
	Lower ʻŌhikilolo	*Pennisetum setaceum*	1

	Not in MU	*Desmodium intortum*	1
		Rubus argutus	1
Pahole NAR	Pahole	*Ehrharta stipoides*	4
		Montanoa hibiscifolia	1
		Pterolepis glomerata	1
		Tecoma capensis	1
		Triumfetta semitriloba	1
	Upper Kapuna	*Angiopteris evecta*	1
		Desmodium intortum	2
		Ehrharta stipoides	2
		Fraxinus uhdei	1
		Grevillea robusta	1
		Neonotonia wightii	2
		Sphaeropteris cooperi	1
		Rubus argutus	1
	Pahole, not in MU	*Montanoa hibiscifolia*	1
Mokuleia Forest Reserve	Kuaokala, not in MU	*Rubus argutus*	1
		Acacia mearnsii	1
SBW	Ka‘ala	*Festuca arundacea*	1
		Juncus effuses	3
	Not in MU	*Ilex cassine*	1
SBS	Not in MU	*Senecio madagascariensis*	1
Honouliuli	Kalua‘ā and Wai‘eli	*Angiopteris evecta*	1
		Setaria palmifolia	1
		Panicum maximum	1
		Trema orientalis	1
	Not in MU	*Ardesia elliptica*	1
		Casuarina glauca	1
		Morella faya	1
KTA	Not in MU	*Acacia mangium*	4
		Melochia umbellata	5
		Pennisetum setaceum	1
		Rhodomyrtus tomentosa	1
KLOA	Koloa	*Hedychium gardnerianum*	1
	Poamoho, in and out of MU	*Leptospermum scoparium*	2
	Opaeula/Helemano	*Setaria palmifolia*	14
	Not in MU	*Arthrostema ciliatum*	2
		Hedychium gardnerianum	1
		Leptospermum scoparium	1
		Tibouchina urvilleana	1
SBE	Not in MU	*Arthrostema ciliatum*	3
		Buddleia madagascariensis	2
		Pennisetum setaceum	1
		Rhodomyrtus tomentus	1
		Smilax sp.	1
		Vitex trifolia	1

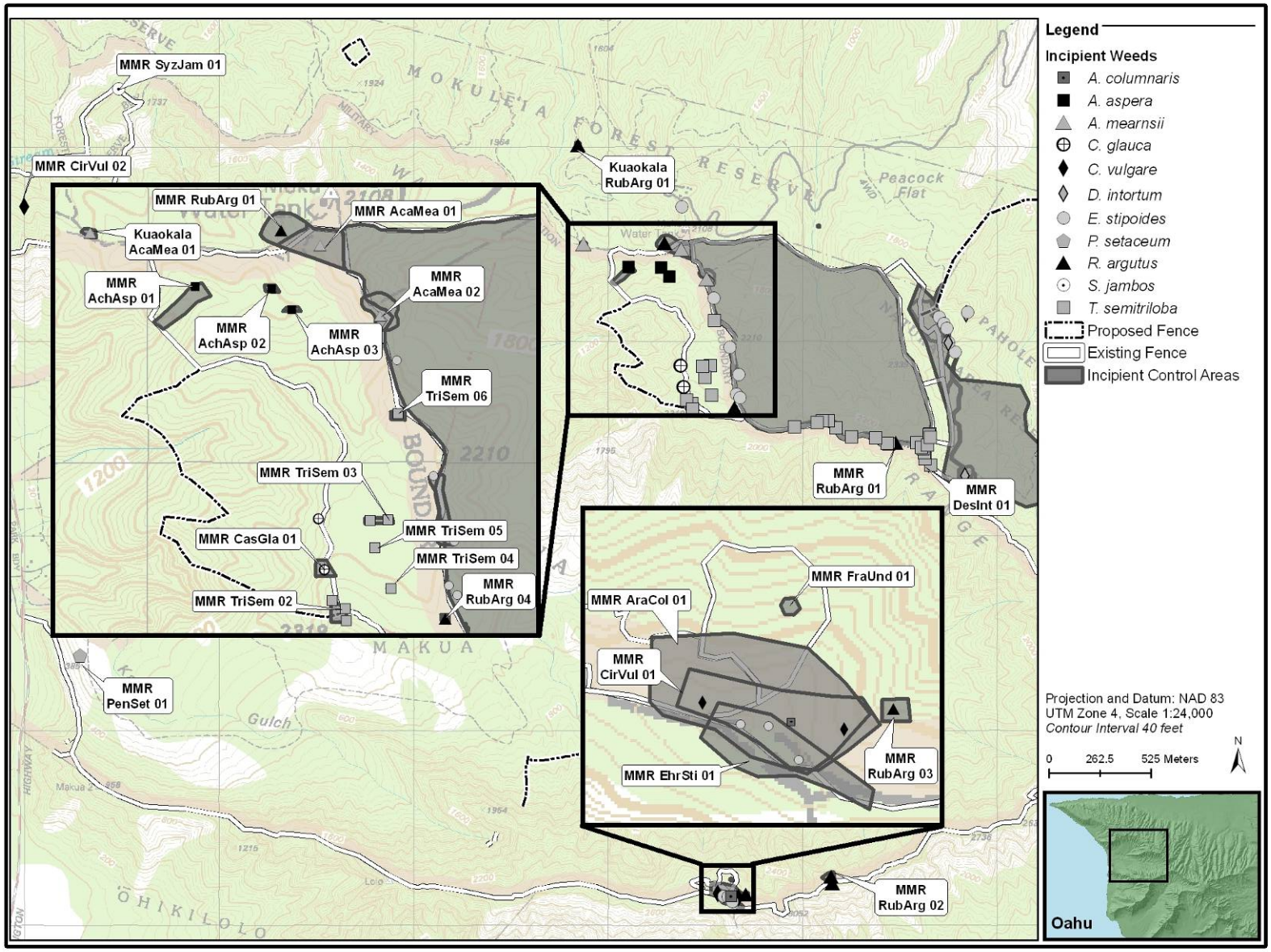


Figure 1.2.1 MMR: Locations of Incipient Weed Species

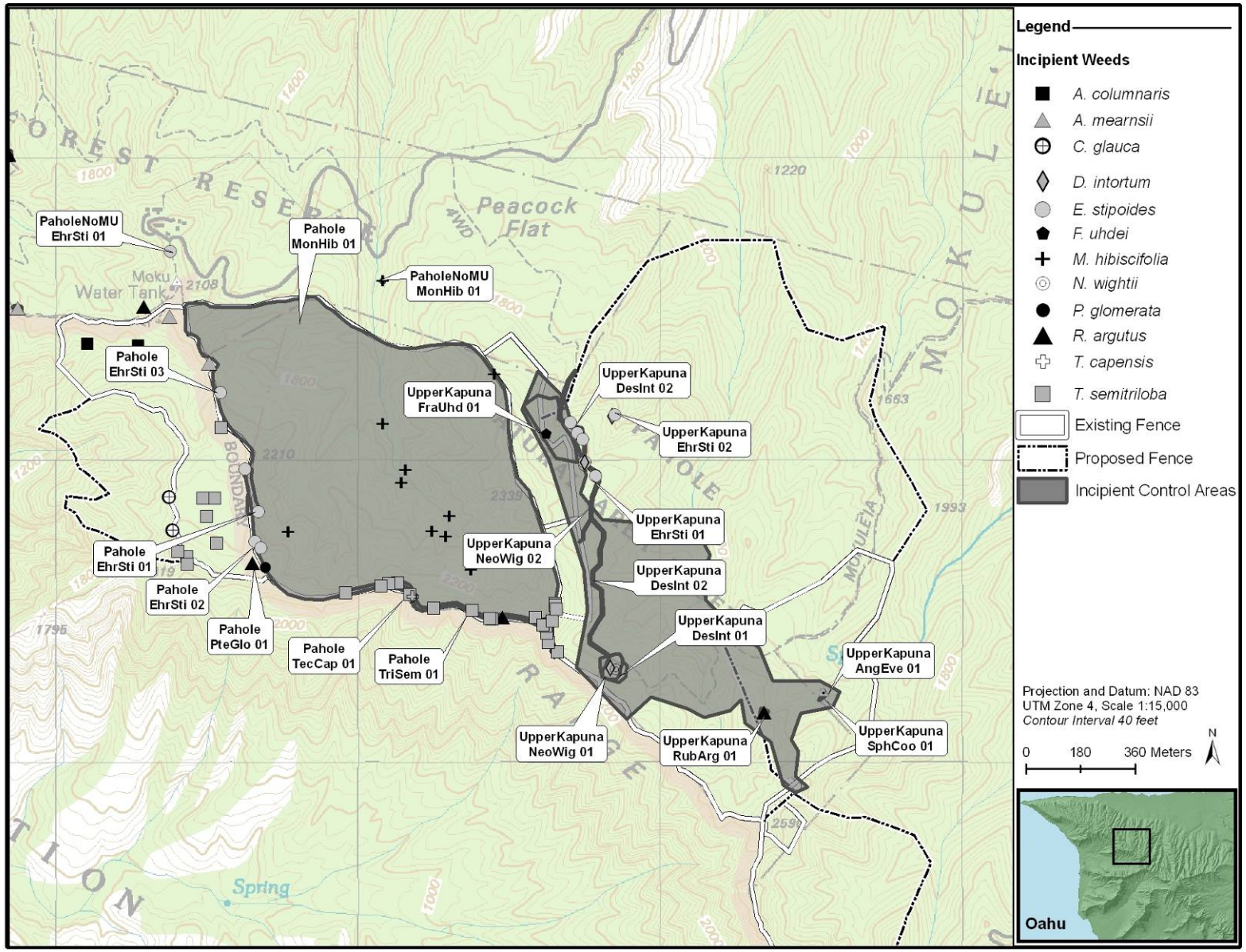


Figure 1.2.2 Pahole NAR: Location of Incipient Weed Species

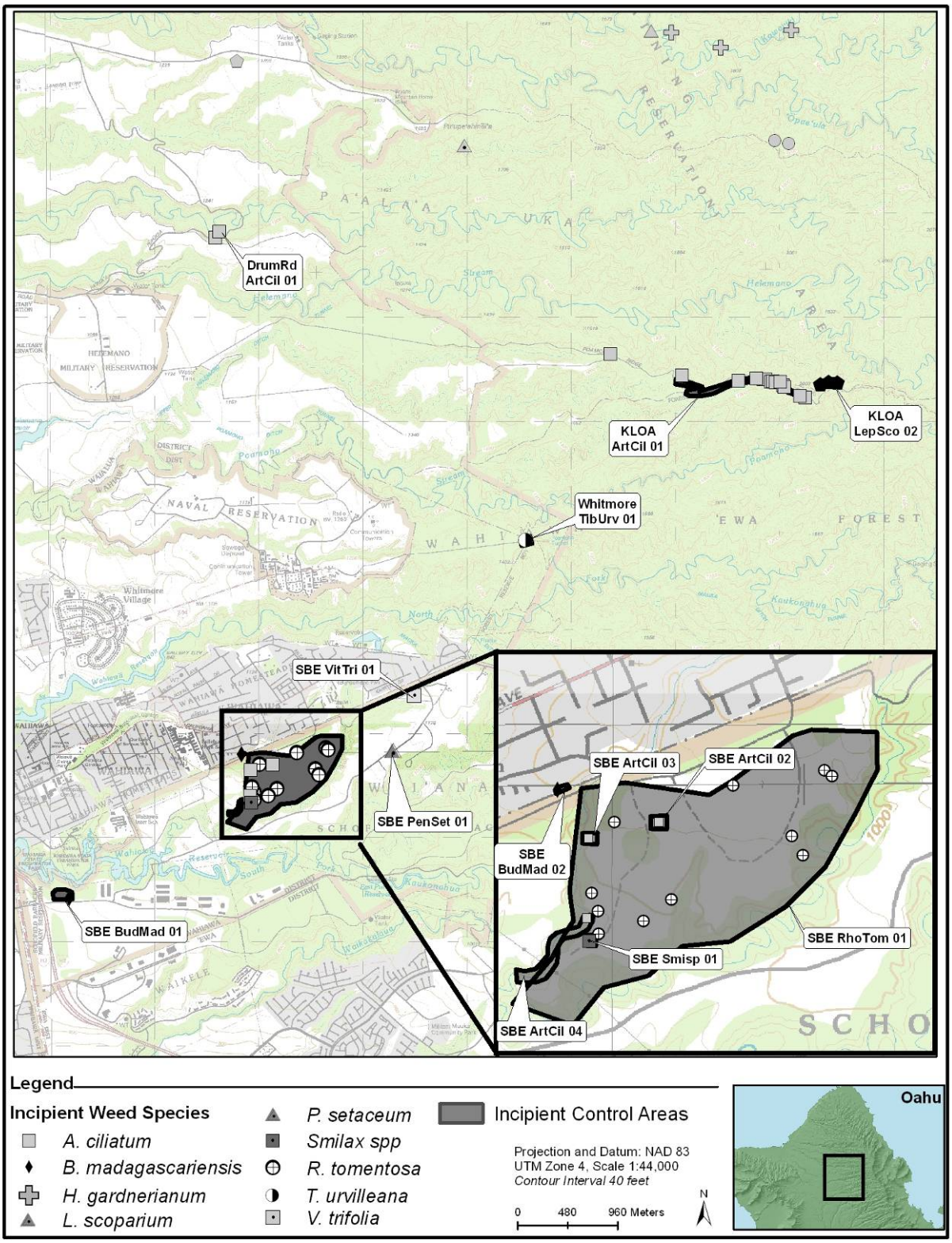


Figure 1.2.3 KLOA and SBE: Location of Incipient Weed Species

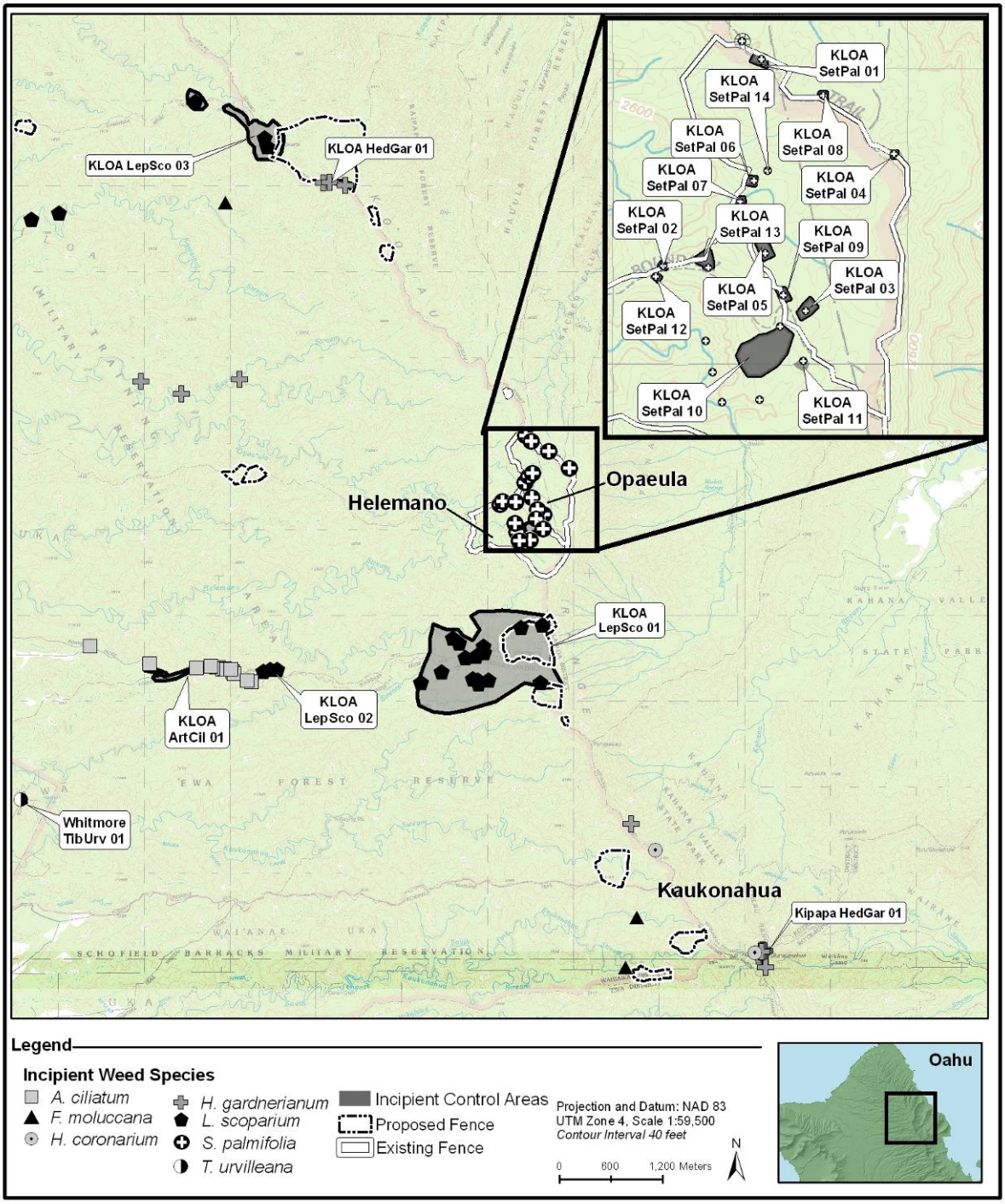


Figure 1.2.4 KLOA: Location of Incipient Weed Species

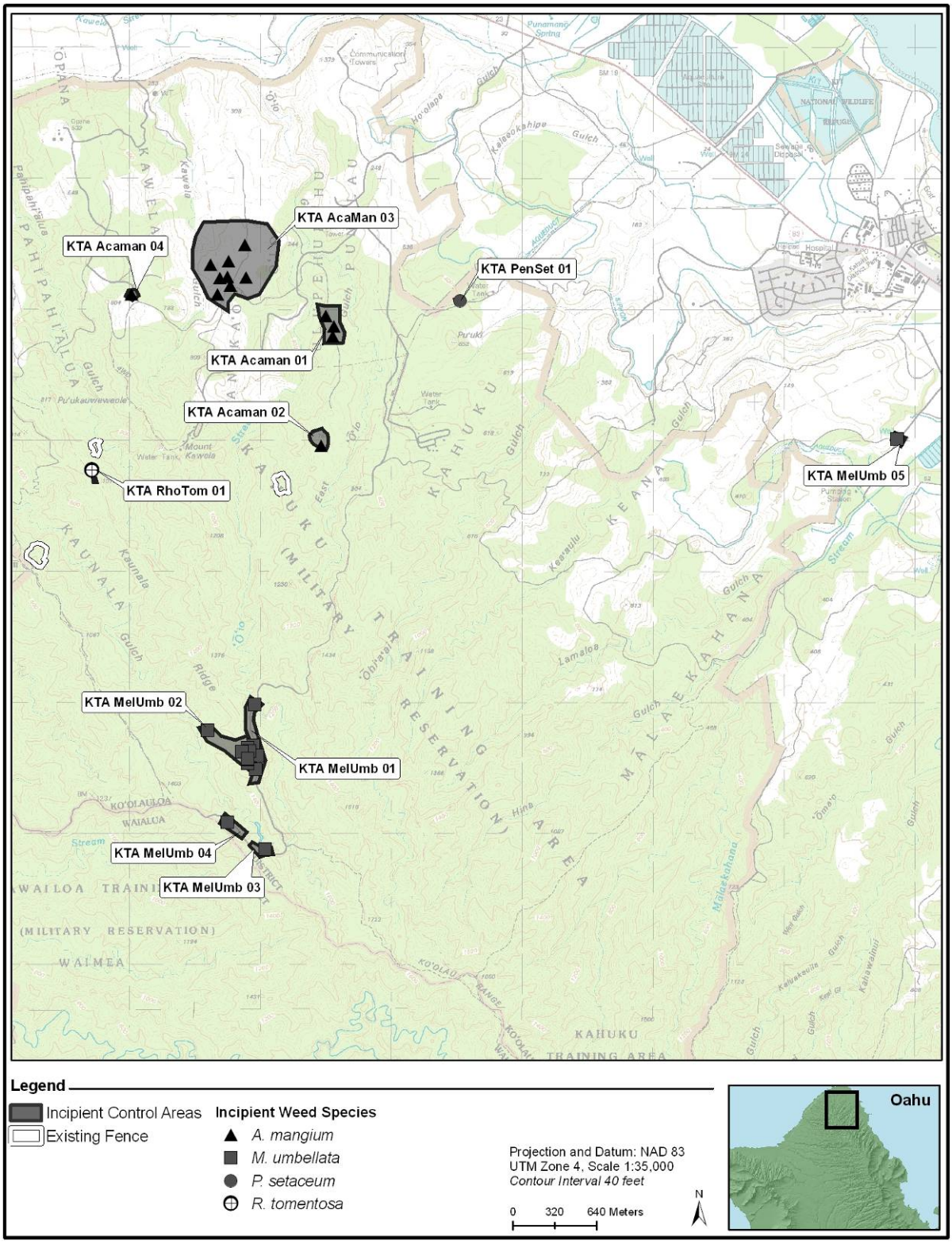


Figure 1.2.5 KTA: Location of Incipient Weed Species

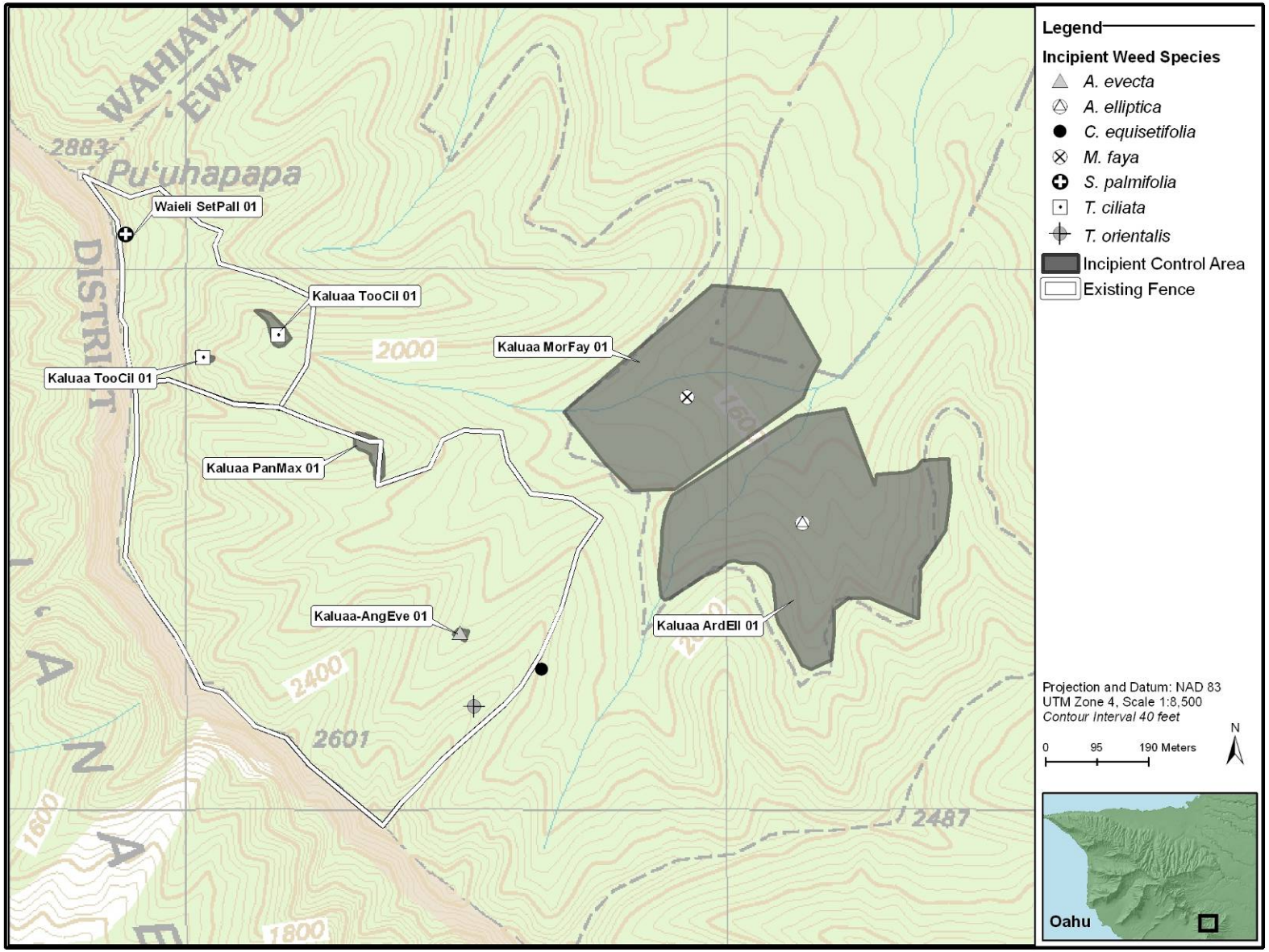


Figure 1.2.6 Kalua'ā and Wai'eli: Locations of Incipient Species

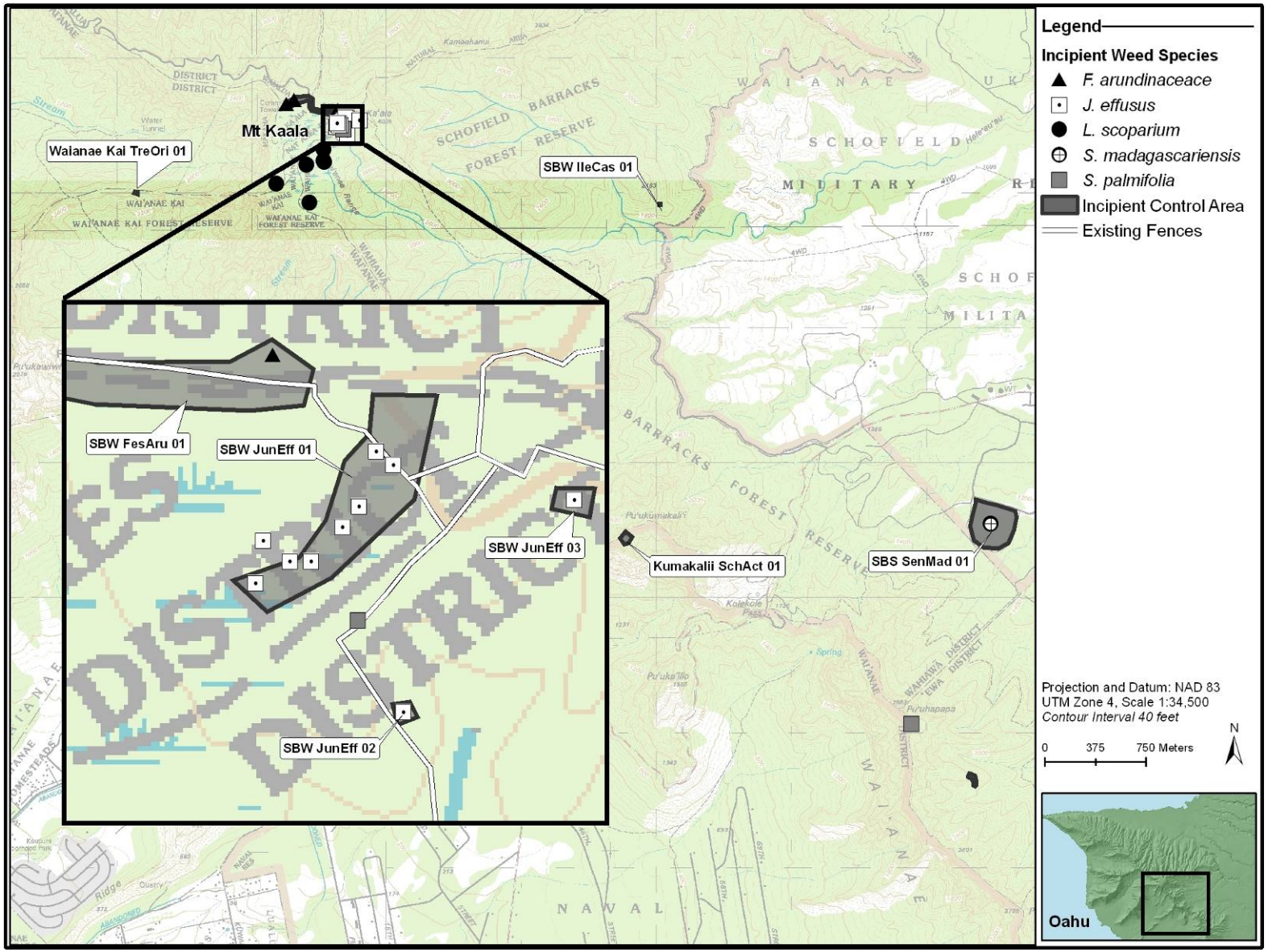


Figure 1.2.7 SBW, SBS, Wai‘anae Kai: Locations of Incipient

Incipient Control Discussion

Acacia mangium

Silk Leaf Acacia is the common name. It is native to northern Australia, Papua New Guinea, and eastern Indonesia. Its ability to rapidly colonize roadsides, abandoned, degraded or open areas and marginal lands is well known. It has a high weed risk assessment (WRA) score of 8, and therefore is regarded as an undesirable weed. In addition to the WRA score, NRS is controlling this species because there is a possibility that it may hybridize with *Acacia koa*. NRS treats this species by cutting the base of the trunk and applying Garlon 4 at a 20% concentration in Forestry Crop Oil. *Acacia mangium* is not tolerant of shade, but is very fast growing. NRS was short staffed and was not able to visit the four ICAs designated for this species this year. All are located in KTA (Figure 1.2.5). In the coming year, NRS will prioritize the Canes Complex ICA, KTA-AcaMan-03, which has been deemed the most important site to monitor due to the high number of seedlings in this area. It is a difficult site because the grass is tall making it hard to get 100% coverage on every trip. Other sites will be surveyed to ensure that at a minimum all the mature trees are removed. NRS will strive to visit all four ICAs quarterly.

Acacia mearnsii

The common name for this species is Black Wattle. The Pacific Islands Ecosystems at Risk (PIER) website 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 stopped the spread of this species throughout their MUs by containing the known populations to the outer edges of the MUs that they are found near/in. All ICAs designated for this species are located in the greater Mākua region, see Figure 1.2.1. Control efforts for all ICAs are summarized in Table 1.2.3.

Figure 1.2.8 *Acacia mearnsii* seedlings

<u>MMR-AcaMea-01; Kahanahaiki AcaMea</u>

Acacia mearnsii is now nearly non-existent 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, formerly a large stand of mature trees. NRS have been returning to this site for the past six years and pulling new seedlings. NRS visited this site five times last year. In the coming year, NRS will re-visit the site quarterly to survey for and eradicate all new seedlings 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. NRS have begun to supplement their weeding efforts this

year by outplanting common natives in weeded areas. Two volunteer groups (Halau Mohala Ilima and Davianna McGregors Hawaiian Ethnic Studies class) helped outplant 50 Palapalai (*Microlepia strigosa*) ferns throughout this ICA. This area will be visited quarterly over the next year for weeding efforts.

MMR-AcaMea-02; Black Wattle by Schwepps trail/Pahole crossover
This ICA is made up of two outlier sites each with large mature trees. This site was weeded three times last year and each time only 1 plant was found. Since this site is located partially on a regularly hiked trail, it is checked at least once a week. 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.

Kuaokalā-AcaMea-01; Easternmost Kuaokalā AcaMea
Two mature trees were cut, treated and dragged off the re-vegetation road. NRS was driving this road to carry outplantings into Kahanahāiki. It is not an area NRS usually drive. NRS will monitor this site on the way to Kaluakauila at least once per year. This site is an isolated spot away from the main infestation on Kuaokalā road.

Table 1.2.3 Summary of *Acacia mearnsii* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: AcaMea	**Acacia mearnsii**				
Kuaokala-AcaMea-01	Mokuleia FR No MU	1	2.00	10/3/2006	
MMR-AcaMea-01	Kahanahaiki	5	26.50	4/30/2007	4/30/2007
MMR-AcaMea-02	Kahanahaiki	3	0.61	10/16/2006	4/16/2007

Achyranthes aspera

A common name for this species is Devil's Horsewhip. *Achyranthes aspera* is widespread across the entire island of O'ahu, but is a species 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 (Figure 1.2.1). 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 have been found.

MMR-AchAsp-01; Kahanahāiki AchAsp Lowest
This year only one seedling was found at this site (Table 1.2.4). This is much improved compared to previous years. Last year two adults, five immatures and four seedlings were found, and the year before that one adult, four immatures, and 120 seedlings were found. The seed bank is slowly being exhausted by NRS efforts. NRS only visited this site twice this year, but next year will try and visit this site quarterly.

MMR-AchAsp-02; Kahanahāiki AchAsp Middle
No plants have been observed at this site since April 2006. The last mature plant was seen in May 2002. We only visited this site once this year (Table 1.2.4), but NRS will continue to try and 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.

MMR-AchAsp-03; Kahanahāiki AchAsp Upper
No plants have been observed at this site since June 2003. The original site was only 0.08 acres so NRS is confident that this area has been thoroughly searched. We only visited this site once this year (Table 1.2.4), but NRS will continue to try and 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.

Table 1.2.4 Summary of *Achyranthes aspera* Control Efforts

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	2	3.00	4/25/2006	10/3/2006
MMR-AchAsp-02	Kahanahaiki	1	1.00	5/13/2002	4/25/2006
MMR-AchAsp-03	Kahanahaiki	1	1.00	5/13/2002	6/24/2003

Angiopteris evecta

Commonly known as mule's-foot fern, *Angiopteris evecta* scores 7 on the PIER weed risk assessment, designating it an undesirable invasive. This giant fern can form thick, dense, very shady stands, and is itself shade-tolerant. It prefers wet gulches, and is very effective at crowding out native species. It produces thousands of wind dispersed spores. It is well established in many areas of Oahu, including both Mānoa and Poamoho. However, it is not common on NRS managed lands and is a priority target for areas where it is incipient. NRS experimented with a variety of treatment methods for *A. evecta* this year. See the UpperKapuna-AngEve-01 ICA discussion below for more detailed information. In general, Garlon 4 is effective at killing this species when either applied foliarly or to a cut/smashed base.

Kaluaʻā-AngEve-01; South Central Gulch
This site was treated in 2005-2006 by TNCH. In 2006-2007, a total of 8 matures, 25 immatures and 30 seedlings were killed (Table 1.2.5). One adult may need to be chainsawed to prevent resprouting. NRS will conduct control at this site once per year. This is the only known site in Kaluaʻā (Figure 1.2.6). It is two small patches separated by about 10m. The sites are both in a gulch bottom with seedlings and immatures on both sides. The mature plant treated is on the north facing slope. The area looks similar to those pictured in Figure 1.2.9 for Upper Kapuna. With regular monitoring twice per year, it is possible that this site can be extirpated within three years. It is likely that there are more sites probably hidden in thick alien habitat in areas exposed to northern trade rainfall. NRS will do surveys of these areas as staff members increase.

UpperKapuna-AngEve-01; Kapuna *Angiopteris*
This ICA was created in October of 2006, when NRS noted it during rare plant surveys. After talking with the NARS Specialist, NRS began control. The 230m² infestation is confined to one

gulch in Keawapilau (Figure 1.2.2). Over three control trips, NRS effectively treated all plants (Table 1.2.5). Giant mature plants with 3m fronds thickly shaded the gulch bottom, while hundreds of immature plants dotted the gulch walls. The NARS Specialist suggested that a 5% spray of Garlon 4 in water would be an effective control method. In order to reduce non-target effects on the surrounding area, which included some native ferns as well as the endangered *Cyrtandra dentata*, NRS first cut and stacked all large fronds prior to basal spraying. While this initial effort was effective in killing some plants, many started to grow new croziers within four months. NRS think that cutting fronds prior to spraying resulted in low herbicide absorption. A second control trip in February 2007 tested the efficacy of 10% and 20% Garlon 4 in water. Also, the few fronds and croziers present were not cut prior to spraying and both leaf and basal material were sprayed. Both concentrations were effective at killing *A. evecta*. On a third control trip in May 2007, sporelings and immatures were treated with 20% Garlon 4 in Forestry Crop Oil (FCO), again without cutting fronds. This method, standard for all NRS weed control, was also very effective. Given the success of these control efforts in reducing the population from hundreds to tens of plants, large scale spray operations are no longer needed, see Figure 1.2.9. Future efforts will focus on thoroughly surveying the ICA twice a year, treating any plants with 20% Garlon 4 in FCO. Eradication of *A. evecta* at this site appears achievable. However, there were three very large mature plants at this ICA, and NRS need to research how long spores can remain viable, and how long gametophytes persist in order to better determine a long-term monitoring strategy. NRS will thoroughly survey the perimeter of the infestation for outliers in the coming year. Discussions with the NARS Biologist suggest that there are two other distinct *A. evecta* sites in Keawapilau. NRS will investigate these other sites and create new ICAs if needed.

Figure 1.2.9 On the left, the *Angeopteris evecta* infestation after one treatment. On the right, the same site from a different angle, showing no *Angeopteris evecta* after multiple treatments. Unfortunately no photos were taken prior to treatment.

Table 1.2.5 Summary of *Angiopteris evecta* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: AngEve	**Angiopteris evecta**				
Kaluaa-AngEve-01	Kaluaa and Waieli	1	1.00	2007-05-29	2007-05-29
UpperKapuna-AngEve-01	Upper Kapuna	3	8.50	2006-10-03	2007-05-02

Araucaria columnaris

Frequently used as a forestry planting by the state in the past, *A. columnaris*, or Cook Pine, received a Weed Risk Assessment of -5 by the PIER project. This score suggests that this species is not an invasive threat. However, NRS decided to target this species within MMR because it is incipient at ‘Ōhikilolo and has begun to naturalize. While common elsewhere on the island, it is not well-established on the ‘Ōhikilolo ridgeline. *A. columnaris* often forms dense monocultures, with little understory persisting beneath it. It can produce copious amounts of wind dispersed fruit, and is fire tolerant. According to the PIER website, *A. columnaris* seeds are do not store well, and only remain viable up to 24 months. *A. columnaris* responds well to treatment with 20% Garlon 4 in FCO, although very large trees may require multiple treatments. Seedlings can usually be controlled with handpulling.

<u>MMR-AraCol-01; Norfolk Control at ‘Ōhikilolo Campsite</u>

The origin of this infestation was one large mature tree, planted many years ago (Figure 1.2.10). This tree was killed September 2001. Multiple treatments were required to kill this giant, and it finally fell to the ground in early 2004. NRS are attempting to eradicate this taxon from ‘Ōhikilolo and hope to eradicate all seedlings before they reach maturity. Given the slow growth of this species, this can be accomplished with yearly sweeps. Since the seed of this species is wind dispersed, it is difficult to predict how far seed may have spread. The infestation area includes the ridge and gulches immediately adjacent to the former location of the mature plant, as well as both the Forest Patch and *Pritchardia kaalae* MMR-A exclosures (Figure 1.2.1). This year, NRS conducted one control trip (Table 1.2.6). Thirty plants were found in the region closest to the mature tree, and one was found in the makai end of the Forest Patch exclosure. This is slightly lower than quantities found in previous years. Given the short seed life of *Araucaria*, NRS hope the existing seedbank will continue to be depleted. The prognosis for eradication is very good for this ICA. Next year, NRS will thoroughly sweep this ICA one time, focusing on the region at the top of the *P. kaalae* MMR-A exclosure.

Figure 1.2.10 *Araucaria columnaris* at ‘Ōhikilolo Camp

Table 1.2.6 Summary of *Araucaria columnaris* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: AraCol		**Araucaria columnaris**			
MMR-AraCol-01	Ohikilolo	1	6.00	2001-09-19	2006-12-14

Ardesia elliptica

Commonly refered to as Shoebutton Ardesia, this plant is widely distributed in lower elevation mesic sites throughout the Wai‘anae Mountains. However, NRS plan to target this species in select native areas where it is not yet established. This species had a PIER high risk score of 11. Bird dispersal and a tolerance to a wide range of soils makes the control of this species more difficult. The possibility of eradicating *A. elliptica* is possible considering the seed bank lasts only 6 months. However, the population needs to be reduced and monitored because regrowth happens quickly.

Kalua‘ā-ArdEll-01

NRS spent 16 hours controlling *A. elliptica* on two trips in May. The core population boundary has been scoped and flagged (Figure 1.2.6). Most of the half acre area was treated this year (Table 1.2.7). The ICA where the plant is seen is still large at nearly 26.5 acres. NRS hopes to reduce at least the majority of the mature plants in certain gulches for this species. NRS plan to return to this site quarterly. Analyzing control efforts for this area will give NRS a better understanding of whether *A. ellitica* spread can be mitigated.

Table 1.2.7 Summary of *Ardesia elliptica* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: ArdEll		**Ardisia elliptica**			
Kaluaa-Ardell-01	Kaluaa and Waieli	2	16.00	5/31/2007	5/31/2007

Arthrostemma ciliatum

Arthrostemma ciliatum is a member of the *Melasomataceae* family, along with two other 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 (Figures 1.2.3-4). NRS is currently controlling *A. ciliatum* at five locations.

Figure 1.2.11 *Arthrostemma ciliatum*

SBE-ArtCil-02; East Range Eucalyptus Patch ArtCil Control Area

The *A. ciliatum* at this site has the potential to be spread by military personnel, via foot and/or vehicle traffic within the East Range land navigation area. This area was roped off at the beginning of the year to restrict

vehicle and personnel access. NRS visited this site four times this year (Table 1.2.8). Forty-three plants (mature 1, immature 16, seedling 26) were controlled during site visits by hand pulling and/or spraying. NRS will continue to deplete the seed bank during quarterly site visits.

SBE-ArtCil-03; East Range Mid Gulch ArtCil Control Area

The *A. ciliatum* at this site does not have the potential to be spread by military personnel or vehicles. This patch of A. cliliatum is located about mid-slope on a steep bank of a gulch. This site was visited two times this year, in which 11 immature plants were hand pulled (Table 1.2.8). This site is on a steep slope making both hand pulling and spraying difficult. NRS will continue to spray immature and seedlings in this area during quarterly site visits.

SBE-ArtCil-04; East Range Army Navigation Trail ArtCil Control Area

The *A. ciliatum* at this site has the potential to be spread by military personnel, via foot traffic. This patch is the largest of the three located in Schofield Barracks East Range. The patch is located in a gulch bottom with a preexisting navigation trail cutting through the patch. During scoping of the navigation trail at the beginning of 2006, it was found that this patch was much larger then first known. NRS made four site visits to this area and controlled 466 plants (mature 105, immature 129, seedling 232) by hand pulling and spraying (Table 1.2.8). NRS will continue to visit this site to reduce the number of mature plants.

KLOA-ArtCil-01; ArtCil along Poamoho Road

This 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. This site occurs along the Poamoho road, which makes spraying them easy. This ICA was weeded once last year using a backpack sprayer and an estimated 38 plants were killed (Table 1.2.8). Two trips will be made to this area next year to treat any regrowth. 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 2 times this year for a total of 2 hours (Table 1.2.8). We found 50 plants, but none of them were mature. Since there was still quite a bit of recruitment from the seed bank, NRS will visit this area quarterly next year.

Table 1.2.8 Summary of *Arthrostemma ciliatum* Control Efforts

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	2	2.00	5/29/2006	4/24/2007
KLOA-ArtCil-01	KLOA No MU	1	2.00	4/12/2007	4/12/2007
SBE-ArtCil-02	SBE No MU	4	4.25	10/9/2006	5/30/2007
SBE-ArtCil-03	SBE No MU	2	0.95	7/20/2006	4/25/2007
SBE-ArtCil-04	SBE No MU	4	11.00	5/30/2007	5/30/2007

Buddleia madagascariensis

Buddleia 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. It received a risk assessment score of 7 from PIER. It produces viable, bird dispersed seed, is a host for other pathogens and pests, and has a climbing, smothering habit. NRS feels it is important to control and eradicate this plant before it becomes established on this island. NRS currently controls this weed at two sites, both in Schofield Barracks East Range (Figure 1.2.3).

SBE-BudMad-01; East Range BudMad along Higgins Road

The mature plant found at this site appears to be dead and no seedlings were found in the surrounding area (Table 1.2.9). OISC also did not find any seedlings this year. NRS will continue to monitor this site every six months.

SBE-BudMad-02; East Range BudMad at Coqui site

No plants have been observed at this site since 2004 (Table 1.2.9). NRS will continue to monitor this site once a year during its annual road survey.

Table 1.2.9 Summary of *Buddleia madagascariensis* Control Efforts

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	1	0.10	3/15/2004	6/22/2006
SBE-BudMad-02	SBE No MU	1	0.10	11/8/2004	6/14/2004

Casuarina equisetifolia/ Casuarina glauca

There are two weedy *Casuarina* species naturalized on Oahu, *equisetifolia* (Ironwood) and *glauca* (Longleaf Ironwood). Both are highly invasive, and pose serious threats to the native habitats which they invade. They look very similar and share similar habitats. *Casuarina* stands are scattered across the Wai‘anae range, and are locally well-established. NRS target small stands within IP MUs. Two ICAs have been designated for *Casuarina* control by NRS, each for a different species of *Casuarina*. NRS plan to key out plants from each site to determine whether one site was misidentified as the wrong species. Both species respond well to herbicide control.

Casuarina equisetifolia can grow 5-10 feet per year, producing dense shade and a thick blanket of leaves that completely covers the ground. Chemicals in its leaves may inhibit the growth of other plants. It also fixes nitrogen, further altering soil chemistry. It has a PIER risk score of 15, making it a highly invasive species. It tolerates and may benefit from mutilation, cultivation, and fire. It creates a fire hazard in natural ecosystems. Its prolific seed production (>1000/m2), seeds adapted to wind dispersal, and tolerance of a wide range of soil conditions help this species migrate quickly to other areas. It also can reproduce vegetatively. *Casuarina equisetifolia* can cause allergies or is otherwise toxic to humans. Smith (1985) states of *C. glauca*: “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 for fire.

Kaluaʻā-CasEqu-01; Kaluaʻā South Fenceline

A total of 10 mature and 10 immature plants were killed this year. The area is about 50m² and is very controllable (Table 1.2.10). The infestation is located along the southern fence ridgeline, primarily outside the fence (Figure 1.2.6). There are no other *C. equisetifoia* populations anywhere in Kaluaʻā. NRS will visit this site once per year and monitor for seedlings/resprouts. This site is on the way to the site of the rare *S. kanehoana*, so periodic quick visual checks are possible.

MMR-CasGla-01; Kahanahāiki Ironwood Removal

This ICA is located along the Mākua rim within Kahanahāiki MU and covers approximately ¼ acre (Figure 1.2.1). It stretches from the edge of the exclosure, down a ridge into MMR. The ridge portion of the infestation is very steep, in some sections vertical. The *Casuarina* population poses both an ecosystem and fire threat to populations of *Cenchrus agrimonioides* and *Achatinella mustelia* which it abuts. NRS have been working at this site since 2002. All easily reachable plants were killed in previous years. This taxon spreads and matures slowly, and NRS did not conduct control this year (Table 1.2.10). Instead, the site was scoped and it was determined that rapelling gear is needed to reach the remaining plants. Very few resprouts and seedlings were seen. NRS plan to treat the cliff plants and sweep the area for resprouts once in the coming year.

Table 1.2.10 Summary of *Casuarina* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: CasEqu	**Casuarina equisitifolia**				
Kaluaa-CasEqu-01	Kaluaa and Waieli	1	0.50	2007-01-04	2007-01-04
MMR-CasGla-01	Kahanahaiki	1	0.25	2005-08-08	2005-08-08

Cirsium vulgare

This species received a PIER score of 21, which suggests it is a highly undesirable and invasive taxon. It is well-established on Hawaii, but is less well-known from Oʻahu. Also known as Bull Thistle, it is considered highly invasive for several reasons. It produces copious amounts of seed which are widely dispersed by both wind and animals, particularly birds (Figure 1.2.12). There is evidence that a persistent propagule bank is formed. It grows in a number of climates and habitats, thriving particularly well in disturbed, dry to mesic habitats. Fortunately, it is not shade tolerant, and competes poorly with other pioneer species. It is also a host for recognized pests and pathogens. On Hawaii, it thrives in high-elevation pastures; fortunately this habitat type doesn't really exist on Oʻahu. *Cirsium vulgare* is not common in any MU, and is a prime candidate for eradication. In the coming year, NRS will research seed longevity to better determine what is needed to attain eradication.

Figure 1.2.12 *Cirsium vulgare*. Note the seeds adapted for wind dispersal

MMR CirVul-01; ‘Ōhikilolo CirVul Area

On Army land, the largest known population of this weed is located on ‘Ōhikilolo Ridge, see Figure 1.2.1. The infestation covers approximately 1.5 acres of open, scrubby slope. NRS line up and sweep across the known infestation area, treating all plants found with a basal application of Garlon 4 or via hand pulling. Particular attention is paid to former sites of flowering plants. This year, the ICA was treated one time in December 2006; one immature plant was found at the former site of a mature plant (Table 1.2.11). The previous reporting year, no plants were found during surveys in January 2006. Numbers of plants found have been steadily decreasing over time, which is very encouraging for achieving eradication. In the coming year, NRS plan to re-visit this ICA one to two times, focusing effort during the rainy season.

MMR CirVul-02; Kaluakauila CirVul at Veg Plots

This ICA is located in Kaluakauila Gulch on the far side of Mākua Valley (see Figure 1.2.1). *Cirsium vulgare* was first discovered in this area in May 2006, when one immature individual was observed and removed. This year, one immature plant was found (Table 1.2.11). While it is promising that no mature plants were ever seen at this site, the mode of introduction of this light- and disturbance-loving plant to the area is unknown, and thus, a concern. If the introduction of *C. vulgare* was an isolated event, there is a good prognosis for achieving eradication. NRS will focus on preventing any new plants which may germinate from reaching setting fruit. This ICA will be monitored twice a year.

Table 1.2.11 Summary of *Cirsium vulgare* Control Efforts

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	1	6.00	6/15/2005	12/14/2006
MMR-CirVul-02	Kaluakauila	1	0.25		12/20/2006

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 ICA.

MMR-DesInt-01; Makua East Rim DesInt

Located on the Makua rim, this site is relatively small and covers approximately 0.05 acres (Figure 1.2.1). NRS visited this site twice last year and found a total of five plants (Table 1.2.12). NRS plan to visit this area quarterly in the coming year.

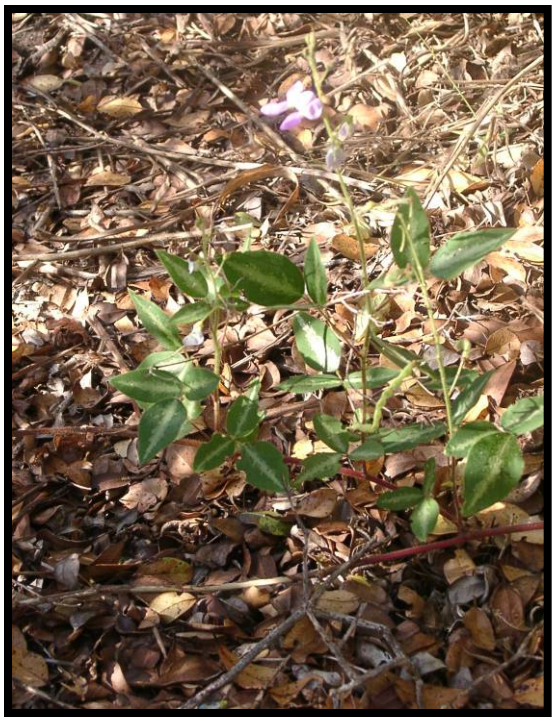


Figure 1.2.13 *Desmodium intortum*

UpperKapuna-DesInt-01
NRS established this ICA last year with the recommendation of NAR Specialist Talbert Takahama. It is an area that is frequently traversed, which is why it was weeded six times last year (Table 1.2.12). A camping area, emergency LZ, and rest spot (Hunter Cabin) is located within this ICA making it a highly visited area not only by NRS but also the public (Figure 1.2.2). NRS hope to prevent the spread of this weed throughout the MU by eradicating it from highly used areas. This site will be revisited quarterly over the next year.

UpperKapuna-DesInt-02
NAR Specialist Talbert Takahama consulted with NRS to establish this ICA. This ICA was designated along the Mokuleia trail to stop its spread throughout the MU (Figure 1.2.2). This site was visited three times last year and NRS treated five plants, none of which were mature (Table 1.2.12). NRS plan to visit this site quarterly next year in continuation of their weeding efforts.

Table 1.2.12 Summary of *Desmodium intortum* 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	2	0.35	10/11/2005	6/18/2007
UpperKapuna-DesInt-01	Upper Kapuna	6	6.00		8/22/2007
UpperKapuna-DesInt-02	Upper Kapuna	3	3.00		6/14/2007

Ehrharta stipoides

Ehrharta stipoides, or Meadow Rice Grass, has the potential to drastically alter environments by creating a thick mat of vegetation in which it is difficult for native species to regenerate. It is not rated by the PIER program. It is known to respond well to fire. *E. stipoides* seeds are easily dispersed by awns that attach to clothing, see Figure 1.2.14. It is unknown how long the seeds remain viable in the soil. 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. Of the seven ICAs designated for *E. stipoides*, six are on state land, see Figures 1.2.1-2. NRS work with the NARS Specialist at these sites. *Ehrharta stipoides* responds well to foliar sprays of 5-10% Roundup. To better direct management, NRS will research seed viability for this taxon. Unfortunately, *E. stipoides* is easily confused with a very similar species, *Vulpia bromoides*. NRS will strive to confirm positive identification of *E. stipoides* at all ICAs and become more familiar with both species.

Figure 1.2.14: *Ehrharta stipoides* fruit

MMR-EhrSti-01; ʻŌhikilolo EhrSti Areas

This ICA covers 1.1 acres of the primary ʻŌhikilolo campground, and areas along the fence both above and below camp. NRS have continued to struggle somewhat with correct identification of *E. stipoides* at ʻŌhikilolo, given its similarity to another, less invasive species, *V. bromoides*. While field identification has improved, NRS treat the ICA conservatively, treating all weedy grasses which may be *E. stipoides*. NRS treated the ICA three times this year on regular quarterly visits to ʻŌhikilolo (Table 1.2.13). In December 2006, dozens of mature and approximately 100 immature plants were treated. In March 2007, three mature clumps were found, and dozens of immature plants. In July 2007, two mature and 20 immature plants were found. This decreasing trend is probably due to both treatment and increasing dryness in summer months. It will be interesting to see if *E. stipoides* levels spike in the upcoming rainy season. NRS feel this infestation can be controlled and will continue to treat this site quarterly. If the 3-4 month gap between treatments dictated by the quarterly visitation schedule allows plants to reach maturity between visits, NRS will consider more aggressive control options.

Pahole-EhrSti-01; Pahole EhrSti along Kahanahāiki Fenceline

This ICA occurs along the Kahanahāiki/Pahole fenceline, and was likely introduced via hikers coming from the nearby State snail enclosure. There are three sites within this ICA, two of which seem to have been eradicated. This year, some immature plants were found and treated at the third spot along the fenceline (Table 1.2.13). NRS will continue to monitor these sites quarterly. 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 monitoring of the snail site. While the infestation here is sparse, it has been persistent and difficult to eliminate. At last treatment, five matures and many immatures were found within the snail enclosure (Table 1.2.13). The mature plants were found underneath other introduced grasses. Next year NRS will spray all grasses to eliminate any cover. NRS feel this ICA can be controlled, but regular visits are vital to prevent recruiting individuals from maturing. NRS will monitor *E. stipoides* quarterly.

Pahole-EhrSti-03; Pahole EhrSti along Pahole Trail

A new ICA was created this year after a single immature *E. stipoides* was discovered along the trail near the western boundary of Pahole. It was likely introduced by hikers coming from the State snail exclosure. The plant was eliminated (Table 1.2.13) and NRS will continue to monitor this site quarterly for any seedlings or resprouts. NRS feel that this site will be easily eradicated since it was discovered so early.

PaholeNoMU-EhrSti-01; Pahole EhrSti at Trail Head

The presence of *E. stipoides* at the Pahole/Kahanahāiki trail head was brought to the attention of NRS by the NARS Specialist. The NARS Specialist treated this small patch (1m²) in the past and asked us to monitor and treat it in the future (Table 1.2.13). NRS feel this infestation can be controlled due to its small size and will continue to treat this site quarterly.

UpperKapuna-EhrSti-01; EhrSti on Mokulēʻia Trail

Both Upper Kapuna *E. stipoides* ICAs were designated this year, after discussions with the NARS Specialist. Along the Mokulēʻia trail, small clumps of *E. stipoides* are scattered between the trailhead and the hunter's shelter, a portion of the trail covering approximately one kilometer. The clumps are quite cryptic and difficult to see mixed with a variety of other trailside grasses. The NARS Specialist oriented NRS to the site, and conducted an initial control effort. NRS followed up with three maintenance trips, spaced two months apart (Table 1.2.13). As Figure 1.2.15 shows, overall plant numbers were never high, but have steadily decreased with consistent effort. In February 2007, three mature and 22 immature plants were found, but by August 2007, only one immature and two seedlings were found. NRS want to prevent any plants from reaching maturity, and plan to continue to visit the ICA every two to three months. While there is a positive control trend at this site, NRS recognize that the cryptic nature, quick germination, and fast-growing nature of this species will make it difficult to eradicate.

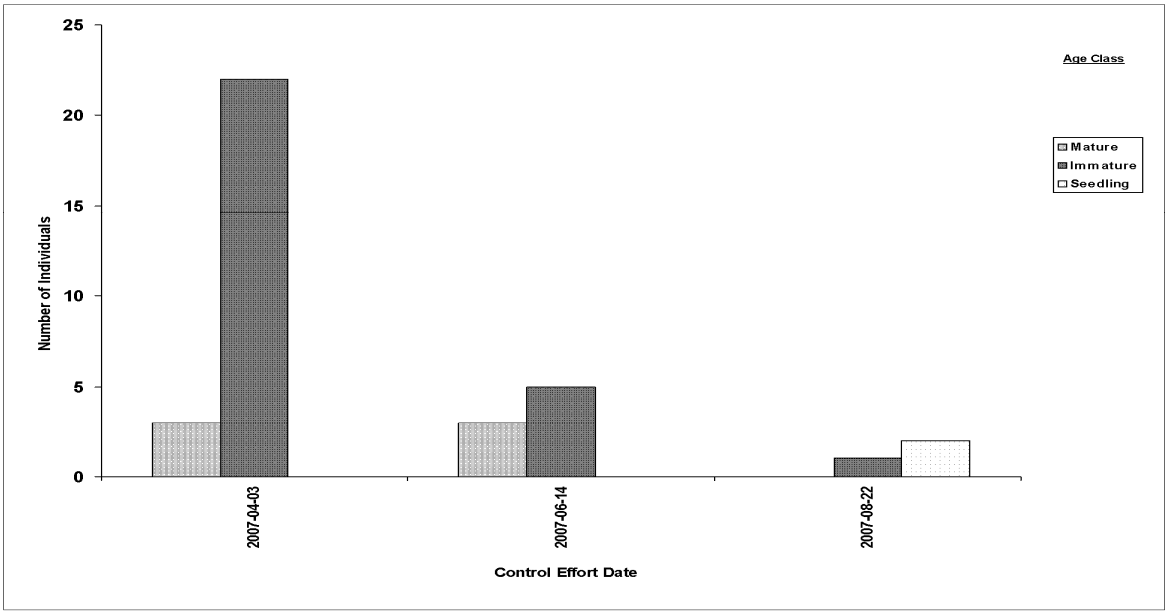


Figure 1.2.15 Number of *Erharta stipoides* Individuals Controlled at UpperKapuna-EhrSti-01

UpperKapuna-EhrSti-02; Talbert's EhrSti Patch below Mokulēʻia Trail

This ICA is located well off the Mokulēʻia trail, in an open gap. The infestation covers some very steep area, including a small dirt cliff. While small in area, this infestation was very dense, consisting of one thick patch and numerous scattered clumps. The small dirt cliff in the site has made control challenging, as it is difficult to thoroughly survey and treat the cliff. Initial control in November 2006 was successful in killing all treated plants. No plants were seen at the site again until February 2007, when 10 each mature and immature plants were seen and treated. Four months later, three mature and 50 immature plants were seen at the site (Table 1.2.13). It is encouraging to see a decreasing number of plants reaching maturity at the site. NRS plan to revisit the site at regular two to three month intervals over the coming year.

Table 1.2.13 Summary of *Ehrharta stipoides* Control Efforts

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	3	4.00	2007-07-19	2007-07-19
Pahole-EhrSti-01	Pahole	2	1.00	2006-05-30	2007-05-14
Pahole-EhrSti-02	Pahole	3	1.75	2006-08-02	2006-08-02
Pahole-Ehrsti-03	Pahole	1	0.10		2007-05-14
PaholeNoMU-Ehrsti-01	Pahole	1	0.25	2007-05-14	
UpperKapuna-EhrSti-01	Upper Kapuna	3	3.25	2007-06-14	2007-08-22
UpperKapuna-EhrSti-02	Upper Kapuna	4	3.50	2007-06-14	2007-06-14

Festuca arundinacea

Festuca arundinacea is a deep rooted perennial grass from Europe. It is a cool-season, long-lived grass that grows in moist forests and grassland, reed swamps, riparian habitats, and seashores. The grass is mostly infected with an endophytic fungus, making it more drought tolerant and increasing its nitrogen utilization efficiency (Weber, 2003; p. 168). It is a persistent grass that strongly competes with native species. It forms dense, monotypic stands, displacing native herbaceous vegetation and reduces species richness.

SBW-FesAru-01

Festuca arundinacea at Ka‘ala (Figure 1.2.7) continues to be a persistent problem. This ICA was aggressively sprayed five times this year (Table 1.2.14), but NRS continue to find mature seeding clumps. Seed heads were bagged and remaining stalks sprayed. NRS will continue to spray the area once per quarter 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.

Table 1.2.14 Summary of *Festuca arundinacea* Control Efforts

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	5	13.00	8/20/2007	8/20/2007

Fraxinus uhdei

This species is widely distributed in lower elevation mesic sites throughout the Waianae Mountains. According to Weber (from the PIER website) “Where invasive, it colonizes disturbed areas in forests and precludes the establishment of native plants. The large canopies shade out most understory species and prevent forest succession" (Weber, 2003; p. 174). NRS plan to target this species in select native areas where it is not yet established. This incipient will be controlled by girdling the bigger trees and basally applying Garlon 4A.

MMR-FraUhd-01; ‘Ōhikilolo Campsite FraUhd
This ICA once contained one large mature and several small individuals within the ‘Ōhikilolo PriKaa A fence (Figure 1.2.1). NRS visited this area once last year and controlled all known individuals (Table 1.2.15). NRS will visit this ICA every six months to confirm the mature tree died and to treat any seedlings.

UpperKapuna-FraUhd-01
NRS established this ICA with the help of NAR Specialist Talbert Takahama (Figure 1.2.2). This area was visited twice last year and weeding efforts were mainly focused on trees no greater than 8” in diameter (Table 1.2.15). This was the dominant canopy species in some of the areas that were weeded. Focusing on the selective weeding of smaller trees is important to prevent the opening up of huge light gaps that are highly favorable to weedy species. This area will be visited quarterly next year with weeding efforts focused on smaller trees beneath the canopy.

Table 1.2.15 Summary of *Fraxinus uhdei* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: FraUhd	**Fraxinus uhdei**				
MMR-FraUhd-01	Ohikilolo	1	0.50	2006-12-13	
UpperKapuna-FraUhd-01	Upper Kapuna	2	49.75	2007-06-25	2007-06-25

Grevillea robusta

This tree, native to Eastern Australia, may reach heights of 30m and produces seeds that are dispersed in the wind (Figure 1.2.16). In newly disturbed areas this tree may become established and prevent the regeneration of native plants due to allelopathic properties found in its leaves. This is a cultivated, introduced, and invasive plant that has naturalized on the island of O‘ahu. It is mainly a threat to management in the Waianae Mountain Range because it prefers drier habitats. Mature trees are found in low numbers throughout its established areas, making eradication from certain MUs an achievable goal.

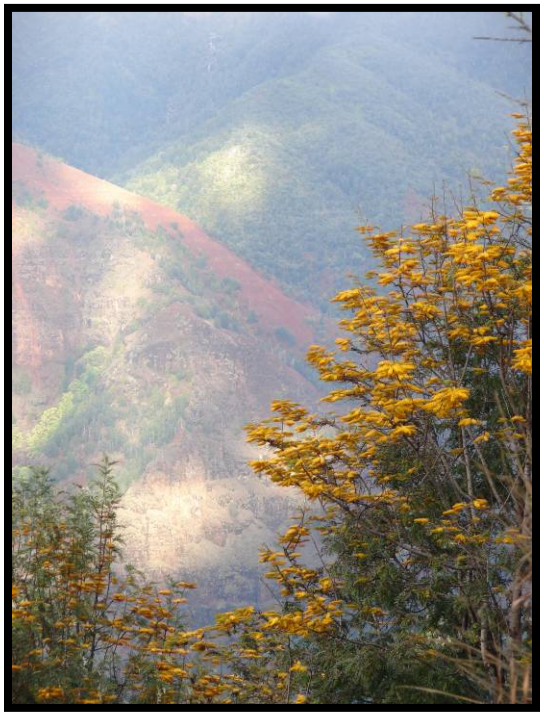


Figure 1.2.16 Flowering *Grevillea robusta*

UpperKapuna-GreRob-01
This ICA was established this past year by NRS under the direction of NAR Specialist Talbert Takahama. It includes most of the Upper Kapuna MU (Figure 1.2.2). NRS visited this ICA once last year and killed three mature trees using a chainsaw (Table 1.2.16). NRS used a chainsaw to girdle the trees, which were then treated with a 20% Garlon 4A in Forestry Crop Oil. NRS plan to visit this MU quarterly next year and will focus their efforts on killing trees that will not open up large light gaps.

Table 1.2.16 Summary of *Grevillea robusta* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: GreRob	**Grevillea robusta**				
UpperKapuna-GreRob-01	Upper Kapuna	1	1.00	2007-05-02	

Hedychium gardnerianum/coronarium

Hedychium 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. This species received a score of 16 from the PIER Weed Risk Assessment and is considered a very high risk for becoming invasive. It is less common on O‘ahu than other islands, and control of this weed in its known locations in Ka‘ala bog and the Ko‘olau summit is a high priority for NRS. *H. gardnerianum* control on Mount Ka‘ala is discussed in the MU WCA Report; this taxa is so widespread at Ka‘ala that it is no longer treated as an incipient.

Hedychium coronarium, or White ginger, is another widespread, naturalized ginger which threatens native ecosystems. With a Weed Risk Assessment score of 10, it is not as dangerous a pest as *H. gardnerianum*, but still is highly undesirable. Like *H. gardnerianum*, it is shade-tolerant, forms dense stands, produces viable seed, and is adapted for moist environments. Unlike *H. gardnerianum*, it is not thought to be bird-dispersed. *Hedychium coronarium* is widespread in low elevation valleys, particularly on the windward side of O‘ahu.

<u>Kipapa-HedCor-01; HedGar at Puu Kaaumakua</u>
The goal of this eradication effort is to keep *H. coronarium* off the summit and limit it to the windward side (Figure 1.2.4). This year NRS was not able to visit the site due to logistical problems, but NRS will continue to kill large patches on the windward side near the summit and continue to monitor one to two times per year.

<u>Koloa-HedGar-01; Kawailoa Kahuku Cabin</u>
Only two seedlings were found this year (Table 1.2.17). 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 1.2.4). NRS will survey the area thoroughly next year. Because plants were removed before seeds are produced, the identification of this population still needs to be confirmed, although it is suspected to be *H. gardnerianum*, based on the widespread *H. gardnerianum* patches found in low elevations in the region.

Table 1.2.17 Summary of *Hedychium gardnerianum* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: HedGar	**Hedychium gardnerianum**				
Koloa-HedGar-01	Koloa	1	2.50	3/17/2005	2/15/2007

Ilex cassine

Ilex cassine is a member of the holly family (Aquifoliaceae) and is native to the Eastern United States. It received a score of 3 from the PIER Weed Risk Assessment, but is not considered invasive yet, because the score is listed as needing re-evaluation. It is unclear as to the invasiveness of this species, but it has already naturalized at an old low elevation botanical site in Helemano, where it is a common component of the alien-dominated forest. NRS does not want new populations to get established in management areas. The only other place on the island that this plant is known is Schofield West Range (SBW). One mature plant was found in June 2006 during a fire survey (Figure 1.2.7) and NRS hopes to eradicate it from this MU.

SBW-IleCas-01; Haleauau/Pulee Ridge Fire Area

NRS visited this site once in Septemer 2006 (Table 1.2.18) and retreated the one mature plant since it had resprouted. NRS will try to monitor this plant at least once a year. Access into SBW is often very limited.

Table 1.2.18 Summary of *Ilex cassine* Control Efforts

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	0.25	9/19/2006	

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 1.2.7). It forms dense aggregations that may inhibit natural regeneration of native bog flora. The current control technique for *J. effusus* 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.

SBW-JunEff-01; Ka’ala Bog JunEff Core

This year two volunteer groups spent 86 hours manually removing *J. effusus* around the beginning portion of the Ka‘ala boardwalk (Table 1.2.19). There are still some large clumps left and other species of introduced grasses are starting to fill in. Next year, this area has been designated as a target for volunteer groups. They will continue to manually remove clumps of *J. effusus* and there are also plans to outplant native plants in an effort to rehabilitate this area. NRS will continue to monitor the area and try to develop an effective control strategy.

SBW-JunEff-02;Ka’ala Bog JunEff South

No *J. effusus* was found at this site when NRS check in September 2007 (Table 1.2.19). It is very likely that it has been eradicated from this location. NRS will continue to monitor this site when we are in the area.

SBW-JunEff-03; Ka’ala Bog JunEff Northeast

The population at this location is not that dense. In one ten hour trip NRS were able to remove all of the *J. effusus* from the area (Table 1.2.19). NRS have not had much time to dedicate to this problem in past years, but in the next reporting period we are expecting to have volunteer groups work this area more frequently.

Table 1.2.19 Summary of *Juncus effusus* Control Efforts

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	2	86.00	4/22/2006	11/18/2006
SBW-JunEff-02	Kaala	1	0.10		
SBW-JunEff-03	Kaala	1	10.00	8/30/2007	8/30/2007

Leptospermum scoparium

Leptospermum scoparium received a PIER 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 O‘ahu. This species is known from the extreme northern end of KLOA, Poamoho, and KTA. While it is very well established in the northern Ko‘olau Mountains, 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 Pu‘uka‘inapua‘a region of northern KLOA, the frontline of *L. scoparium* expansion in the northern Ko‘olaus (Figure 1.2.4).

Figure 1.2.17 *Leptospermum scoparium*

KLOA-LepSco-01; LepSco Poamoho

Despite a relatively low population in Poamoho, *L. scoparium* is distributed across a large are including the Poamoho trail ridge and both bordering valleys. Reaching all plants is difficult. The terrain is steep and the native vegetation is thick. This year NRS visited this site twice and killed hundreds of mature and immature plants (Table 1.2.20). Next year NRS will visit this site quarterly and perform weed sweeps expanding out from the trail towards the waterfall. NRS will also do an aerial survey to seek out any outliers.

KLOA-LepSco-02; LepSco Poamoho Trailhead

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

KLOA-LepSco-03; Pu‘uka‘inapua‘a

This year NRS revisited an older *L. scoparium* site in KLOA that has not been controlled since 2002. There were large mature trees scattered throughout this area, but it was not as abundant as

it once was. NRS was able to hit the most of the core area, but more time is needed to sweep the surrounding areas thoroughly (Table 1.2.20). NRS will visit this area two times next year.

Table 1.2.20 Summary of *Leptospermum scoparium* Control Efforts

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	34.00	2007-04-11	2007-04-11
KLOA-LepSco-03	KLOA No MU	1	8.00	2007-02-15	2007-02-15

Melochia umbellata

M. umbellate, also called Gunpowder Tree, 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 KTA (Figure 1.2.5). *M. umbellata* has not been ranked by PIER yet. 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 ICAs 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. NRS remove this species by hand-pulling seedlings. For larger tress that can not be pulled a cut stump or frill treatment with Garlon 4 20% concentration is used. Control efforts for all ICAs are summarized in Table 1.2.21. NRS has done a literature search to find information on the longeivity of the seed bank. NRS will pursue this research in the future.

<u>KTA MelUmb-01; Kahuku MelUmb Along Road</u>

This ICA is one of the highest priority incipient sites that NRS manage. This is the core site for *M. umbellata* in KTA. A total of 11 immatures were found in October 2006 and 6 were found in January 2007. NRS will plan to visit this site at least twice in the next year to insure that any new plants are removed before maturity. Figure 1.2.18 shows that there has been a steady decline in the number of immatures and seedlings found over the years. This suggests that the seed bank is being exhausted and that the goal of eradication is being approached. The graph does not show the removal of matures that happened prior to 2004.

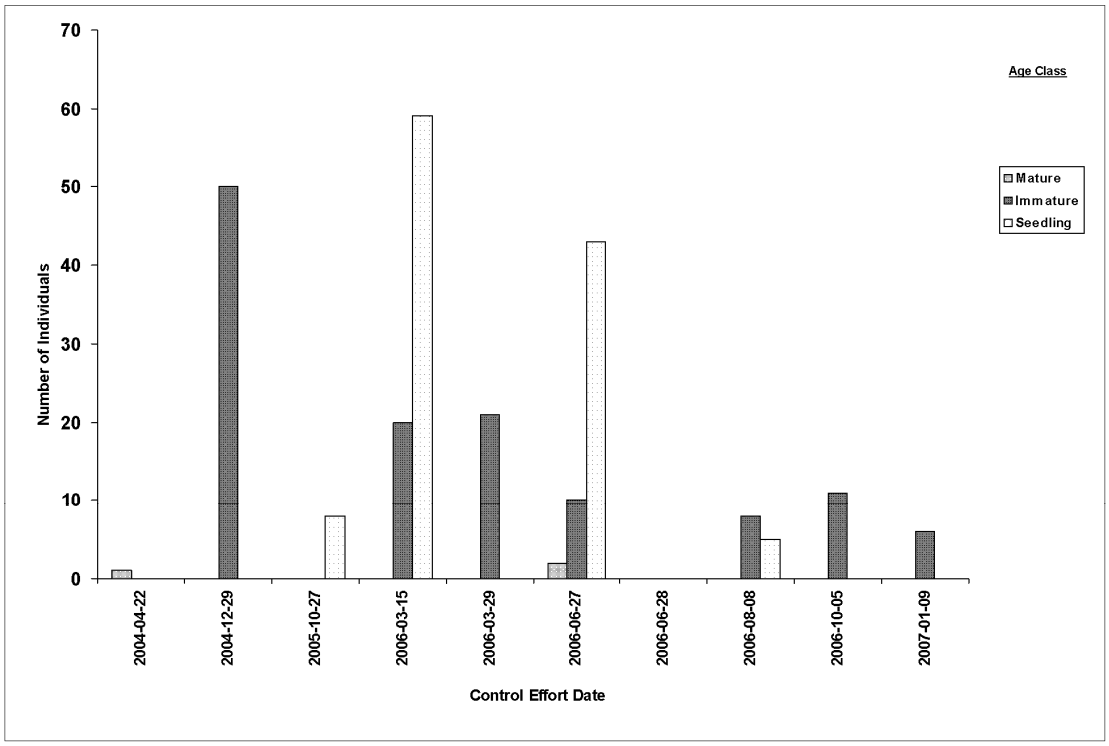


Figure 1.2.18 Number of *M. umbellata* Individuals Controlled in KTA-MelUmb-01

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 cattleianum* and other non-native trees, making it unfavorable for *M. umbellata*, which prefers full sunlight. In the 2005-2006 report year, NRS found a large mature tree from the air. This year, NRS navigated to the site and removed the tree and in addition found nine immatures and two seedlings. NRS will revist this area at least once in the coming year to remove any additional plants. As there were no aerial surveys done this year, NRS will also conduct a survey in the next year. This survey will be conducted during the flowering season in March.

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 in 2006 and no plants have been seen since. NRS will monitor the site at least once in the coming year. This frequency should be sufficient to control any seedlings that come up before they become mature. When the aerial survey is conducted at KTA Mel Umb-02, NRS will also survey this 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 of 2006. The tree was killed, and like the previous ICA, no plants have been seen since. NRS plans to re-visit the site and sweep for seedlings at least once a year. A yearly aerial survey in conjunction with the other sites is recommended for the following report year.

KTA MelUmb-05; Kahuku MelUmb Delta Gate
NRS has not surveyed this site in two years due to the closure of Delta Road. NRS believe the road repair was completed and that it is passable. NRS will make it a high priority to survey this area in the next year. It will also be considered as a site for aerial survey pending the results of ground survey.

Table 1.2.21 Summary of *Melochia umbellata* Control Efforts

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	2	3.10	6/27/2006	1/9/2007
KTA-MelUmb-02	KTA No MU	1	10.00	10/5/2006	10/5/2006
KTA-MelUmb-03	KTA No MU	1	0.50	6/27/2006	
KTA-MelUmb-04	KTA No MU	1	0.50	6/27/2006	

Montanoa hibiscifolia

The common name of *Montanoa hibiscifolia* is Tree Daisy. According to the PIER Weed Risk Assessment, *M. hibiscifolia* is given a score of 13, and is deemed a high risk. It is also listed on the Noxious Weed List for the State of Hawai‘i. It occurs in mesic to dry areas and is able to form dense stands. This species is widely distributed in lower elevation mesic sites throughout the Wai‘anae Mountains. Prolific seed production (>1000/m^2) and shade tolerance make the spread of this plant in native areas a threat. NRS hopes to control the spread into sensitive native areas that are managed.

Kalua‘ā-Monhib-01; Airplane gulch
A large patch was found and treated, however, further scoping uphill found a patch probably too large to attack (Figure 1.2.6). A 200 square meter area in the portion closest to the gulch was treated (Table 1.2.22). This area is right above the *A. elliptica* site. NRS will no longer manage for *M. hibiscifolia* at this site.

Pahole-MonHib-01; Pahole MonHib
Montanoa hibiscifolia is found along the rim and throughout the interior gulches of Pahole. It will be difficult to eradicate it from the NAR, but in cooperation with the state NARS Specialist, NRS has designated the entire Pahole MU as an ICA for *M. hibiscifolia* (Figure 1.2.2). There are records of NRS controlling patches of *M. hibiscifolia* in Pahole since 2004. NRS has revisited and retreated all of these sites and have documented several more this year (Table 1.2.22). NRS will try to conduct an aerial survey next spring while they are flowering to determine the full extent of *M. hibiscifolia* in the valley.

PaholeNoMU-MonHib-01; Pahole MonHib Outside the Fence
NRS controlled a 100m^2 patch of *M. hibiscifolia* that was just outside the exclosure (Figure 1.2.2). All plants were killed and the surrounding area was also surveyed for additional plants (Table 1.2.22). This site needs to be checked three to four times next year for seedling or resprouts.

Table 1.2.22 Summary of *Montanoa hibiscifolia* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: MonHib	**Montanoa hibiscifolia**				
Kaluaa-Monhib-01	Kaluaa and Waieli	1	1.50	2007-05-31	
Pahole-MonHib-01	Pahole	3	29.75	2007-05-16	2007-01-11
PaholeNoMU-MonHib-01	Pahole No MU	1	6.00	2007-04-18	2007-04-18

Morella faya

The PIER risk assessment gave this species a score of 8, meaning that it should be rejected for importation. This species, commonly known as the Firetree, is common in the Southern Wai‘anae Mountains from Palikea to Puali‘i. NRS will control any *M. faya* north of Puali‘i. Problems of this plant include prolific seed production (>1000/m2) and evidence that a persistent propagule bank is formed (>1 yr). *M. faya* often forms dense thickets and propagules can be bird and pig dispersed. The fact that it is a nitrogen-fixing woody plant makes it possible for other weeds such as *Ehrharta stipioides* to grow in the understory. NRS plan to target this species in select native areas where it is not yet established.

Kalua‘ā-MorFay-01

A small population of *M. faya* was treated in the Kalua‘ā area (Figure 1.2.6). The area containing mature *M. faya* measured a little more than 9 acres (Table 1.2.23). NRS hopes that early treatment will prevent the spread uphill into the native patches. All trees had multiple trunks so chainsaws were useful for girdling the plants before treating them with 40% Garlon4. NRS will survey this area again to see if any mature trees still exist.

Table 1.2.23 Summary of *Morella faya* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: MorFay	**Morella faya**				
Kaluaa-Morfay-01	Kaluaa and Waieli	1	68.00	7/12/2007	

Neonotonia wightii

This plant was given a risk assessment score of 7, which means it has a high risk of becoming invasive. It grows as a vine that may reach lengths of 4.5m. It smothers native plants by forming dense mats on the ground; it may even creep up trees. It produces seeds that cling easily to anything that brushes up against it. These plants are widely distributed in lower elevation mesic sites throughout the Wai‘anae Mountains. In Upper Kapuna it is mainly found along the trail and in a rest spot that is frequently used by the public. NRS plan to target this species

Figure 1.2.19 *Neonotonia wightii*

in select native areas that are regularly used to stop it from being transported throughout the MU. ICA locations are shown in Figure 1.2.2. NRS began targeting this species in the Pahole NAR this year at the request of the NARS Biologist. Control efforts are summarized in Table 1.2.24.

UpperKapuna-NeoWig-01; NeoWig at the Hunters Shelter
NRS visited this site six times this past year and treated the plants with Round Up that was applied using a hand-pump sprayer. Although the dilution rates varied each time, from 4% to 10%, all treatments resulted in success. NRS will weed this area quarterly next year in efforts to exhaust this plant from the seed bank.

UpperKapuna-NeoWig-02; NeoWig at Mokuleia trailside clearing
NRS began controlling this species at a clearing along the Mokulēʻia trail within this past year. Several plants were treated although just two were observed to be mature. Most of the plants treated were seedlings and were concealed in the grass. NRS will revisit this area quarterly to keep this weed from spreading onto the trail.

Table 1.2.24 Summary of *Neonotonia wightii* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: NeoWig	**Neonotonia wightii**				
UpperKapuna-NeoWig-01	Upper Kapuna	6	5.50		2007-08-22
UpperKapuna-NeoWig-02	Upper Kapuna	6	2.90	2007-05-15	2007-08-22

Panicum maximum

Although this species is very wide spread throughout lower elevation areas on Oʻahu, NRS would like to prevent its spread in sites near or adjacent to particular MUs. This species got a 17 PIER rating, defining it as a highly invasive grass. Prolific seed production (>1000/m2), propagules adapted to wind dispersal, and high toleration of a wide range of soil conditions makes it a dominant invader. It is allelopathic and forms dense thickets, creating a major fire hazard in natural ecosystems. *Panicum maximum* has a very high burn index and was the major fuel source in all fires which affected NRS projects this year. This grass is relatively easy to kill, and responds well to foliar sprays of as low as 0.5-1% Roundup.

Kaluaʼā-PanMax-01
Two small populations of *P. maximum* were treated near the fenceline to prevent the development of a larger unmanageable population (Table 1.2.25). This opportunistic treatment was facilitated by a helicopter drop carrying fence maintenance supplies and water necessary for conducting spray operations. This site is of low priority to NRS and will be monitored infrequently. In the future, with more staff, NRS will manage this site while conducting other ecosystem management work in the area.

Table 1.2.25 Summary of *Panicum maximum* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: PanMax		**Panicum maximum**			
Kaluaa-PanMax-01	Kaluaa and Waieli	1	1.00	4/4/2007	

Pennisetum setaceum

Pennisetum setaceum or Fountain grass, received a PIER Weed Risk Assessment score of 26, making it highly invasive and undesirable. It is easily dispersed and is apomictic, meaning it can produce lots of clonal seed, giving it the ability to spread very quickly. It is a fire-stimulated grass which can carry intense fires throughout its range; extirpating any infestations is crucial. There are three well established population of *P. setaceum* in the Koʻolau Mountains: Diamond Head crater, Lanikai and Pālolo valley. It is a high priority to keep this species out of the Waiʻanae Mountains and off all Army lands. Given that eradication efforts have been very successful at all designated ICAs, NRS will research seed bank viability for this taxon and create guidelines for determining when an infestation can be deemed extirpated.

KTA-PenSet-01; Kahuku PenSet

The area is thick with weedy vegetation, dominated by tall *P. maximum,* making surveys of this site difficult (Figure 1.2.5). No plants were found this year 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. If the area proves difficult to survey due to thick vegetation, NRS will consider spraying the area with herbicide to kill any hidden plants.

DMR-PenSet-01; Dillingham Gate PenSet

This site is monitored during the annual Road survey and spot checked upon each DMR visit. No plants were found this year (Table 1.2.26). No plants have been seen since 2001, suggesting the taxon may be extirpated. NRS will monitor this site again next year. If there are no plants found again next year NRS will remove this site as an ICA.

MMR-PenSet-01; Lower ʻŌhikilolo PenSet

NRS found and eliminated one flowering plant in 2006 in a frequently visited WCA, Lower ʻŌhikilolo 01 (Figure 1.2.1). NRS visited the lower patch several times this year and no *P. setaceum* was noticed (Table 1.2.26). NRS will continue to monitor the area once a quarter.

SBE-PenSet-01; East Range PenSet

NRS and OISC found one plant with a flowering head in 2004 on Centerline Road (Figure 1.2.3). It was pulled and disposed of. The area has been monitored during road surveys since 2005 and no regrowth has occurred (Table 1.2.26). NRS will continue to monitor this area during the annual road survey.

Table 1.2.26 Summary of *Pennisetum setaceum* Control Efforts

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	Haili to Kealia	2	0.50	8/30/2001	8/30/2001
MMR-PenSet-01	Lower Ohikilolo	4	0.40		3/13/2006
SBE-PenSet-01	SBE No MU	1	0.10	9/21/2004	

Pterolepis glomerata

Pterolepis glomerata is a member of the *Melasomataceae* family, along with two other well known invasive species *Miconia calvescens,* and *Clidemia hirta.* It is native to tropical regions of eastern South America. In Hawai‘i, this weed has naturalized in wet to mesic disturbed sites and trail margins, primarily in the Ko‘olau Mountains. In an attempt to keep it from establishing in the Wai‘anae Mountains, NRS will target any small incipient populations found (Figure 1.2.2).

Pahole-PteGlo-01; Pahole Pteglo Near the Mākua Overlook

In May of 2007, an 84m² patch of *Pterolepis glomerata* was discovered on a trail in Pahole right before the Mākua overlook, most likely brought in by hikers with contaminated gear. It was treated by NRS staff a week later, and after three subsequent retreats the population was killed (Table 1.2.27). The seed bank is expected to be substantial and seedlings will very likely appear after the next big rain in Pahole. NRS will check this spot at least once a quarter and more frequently during the winter months.

Table 1.2.27 Summary of *Pterolepis glomerata* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: PteGlo	**Pterolepis glomerata**				
Pahole-PteGlo-01	Pahole	6	3.75	5/10/2007	7/9/2007

Rhodomyrtus tomentosa

This species is a member of the Myrtaceae family, and was probably introduced to Hawai’i intentionally as an ornamental plant. It received a score of 8, meaning high risk, from the PIER Weed Risk Assessment. 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’olau Mountains, 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 1.2.3 and 1.2.5). It is important that NRS keep this weed out of management areas in KTA and SBE.

KTA-RhoTom-01; Kahuku RhoTom at Puu 1010

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 (Table 1.2.28). 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. NRS will use its Outreach Program to educate motorcross riders about the importance of cleaning their bikes to eliminate weed dispersal.

SBE-RhoTom-01; East Range RhoTom Control

This year NRS swept through the core *R. tomentosa* area twice. A total of nine matures, 46 immatures and 23 seedlings were controlled. A third day was spent surveying surrounding areas and no plants were found (Table 1.2.28). The number of matures found is less than last year (27 matures) but the number of immatures and seedlings are about the same (41 immatures and 20 seedlings). NRS will continue to visit the area three times a year, focusing on killing seedlings near areas where mature plants were found. NRS will also continue to complete surveys of surrounding areas to ensure that all mature plants were found. NRS is still considering using a pre-emergent herbicide to kill seeds in the soil to reduce seedling recruitment.

Table 1.2.28 Summary of *Rhodomyrtus tomentosa* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: RhoTom		**Rhodomyrtus tomentosa**			
SBE-RhoTom-01	SBE No MU	3	40.64	4/25/2007	4/25/2007

Rubus argutus

Rubus argutus, or Blackberry, is a thorny shrub belonging to the Rosaceae family. It received a score of 21.5 on the PIER weed risk assessment, making it highly invasive and undesirable. It is native to the central and eastern United States and is a naturalized, highly invasive weed in Hawai‘i. It grows in a variety of climate, habitat, and soil types, from wet bogs to dry ridges. It is moderately shade tolerant and creates dense thickets. This brambling shrub produces edible fruit that is black when ripe, and is dispersed by birds (Foster and Robinson 2007). Seeds are not affected by passing through the gut. There is evidence *R. argutus* forms a persistent seed bank. It can also reproduce vegetatively and tolerates pruning well. It may host other pests and pathogens. 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 north of West Makaleha. NRS would like to keep it out of the Pahole NAR and all areas north to the north. *Rubus 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 (40%) have been somewhat more effective, but NRS have achieved greater success by digging up runner plants and treating as much of the roots/runner as possible. This method, while time consuming, is effective for small infestations. All control efforts for this taxon are summarized by ICA in Table 1.2.30. All ICA locations are mapped in Figures 1.2.1-2.

Kuaokalā-RubArg-01; RubArg Kuaokalā Road

This roadside site was treated once this year. Only four immature plants were found. As the Figure 1.2.20 shows, there is a decreasing population trend at this site. NRS feel that eradication is achievable, as very few mature plants were ever found at the site, and it is unlikely there is

much of a seed bank. However, to achieve this, more frequent monitoring is needed and NRS will strive to treat this ICA quarterly in the coming year. Also, NRS will strive to implement the digging/herbicide application method at this site.

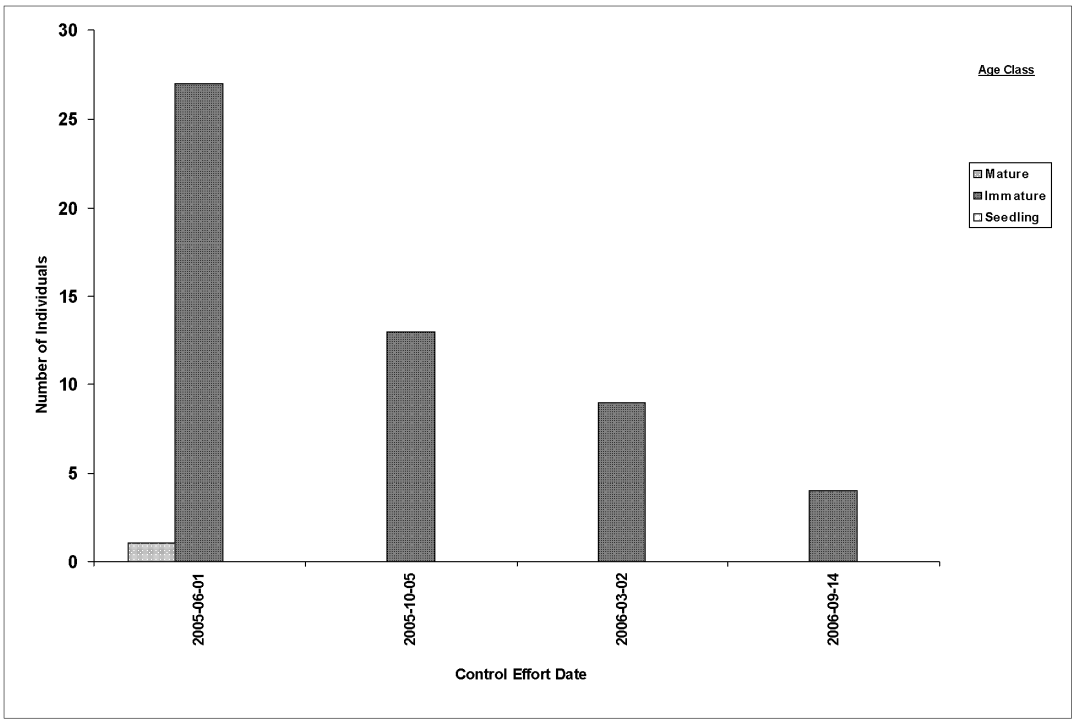


Figure 1.2.20: Numbers of *Rubus argutus* Individuals Controlled at Kuaokala-RubArg-01

MMR-RubArg-01; Kahanahāiki RubArg at Black Wattle

This ICA is located just outside of the Kahanahāiki exclosure. *Rubus argutus* was discovered during surveys at the *A. mearnsii* ICA in Kahanahāiki and was first controlled in May 2003. Part of the infestation is located on a small steep cliff; webbing is needed to treat plants in this area. NRS visited this ICA three times last year. Two trips in October 2006 were within days of each other; four mature, four immature, and one seedling were found during these trips. Sixty-three immature plants were found in April 2007. Population numbers seem to fluctuate greatly at this ICA; to counteract this, NRS plan on treating the site quarterly in the coming year and consistently using the dig/herbicide control method.

MMR-RubArg-02; ʻŌhikilolo 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 in December 2006, three plants were found, one of each size class. However, the second trip in July 2007 resulted in five seedlings and 60 large plants. While none of these 60 were fruiting, they were large enough to have reproduced. Last year, very few plants were seen at the site. This year's flush may have been in response to winter rains, or the artifact of a pulse in the seed bank, or some unknown factor. In order to prevent more plants from reaching maturity, NRS will monitor this site three times in the coming year, and will implement the digging/herbicide control method.

MMR-RubArg-03; ʻŌhikilolo RubArg in Lancam Gulch
Three immature plants were discovered and treated in November 2005. Since that time, no seedings/resprouts have been seen. NRS visited the site once in the past year. No mature plants have ever been found in this area. This population was controlled before it could reproduce, which increases the chance of eradication at this ICA. This area will be monitored yearly.

MMR-RubArg-04; Kahanahāiki RubArg at SE Quad
NRS visited this ICA once this year and did not find any *R. argutus* (Table 1.2.30). 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. NRS need to determine guidelines for extirpation for this species. 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; Mākua East Rim RubArg
Three immature *R. argutus* were found and treated on the east rim on Mākua in 2004. After three years of post-treatment monitoring, no plants have been found (Table 1.2.30). Though it has very likely been eradicated, given no mature plants were known from the site, NRS will continue to monitor this area yearly for any regrowth until guidelines for determining whether a site has been extirpation are developed.

UpperKapuna-RubArg-01; Kapuna RubArg Above PhyKaa Fences
This infestation lies within a WCA in Keawapilau, close to *Cyanea longiflora* PIL-B. While small in area (5x5m), the site is relatively dense, with upwards of 70 plants found when it was first treated in September 2005. While no mature plants have been seen on site by NRS, given the population size, it is likely that some kind of seed bank is present. This year, NRS monitored the site twice. No plants were found in January 2007, but 60 immature canes were found in August 2007. As Figure 1.2.21 shows, there is no consistent pattern for this ICA. This may be due to seasonality; this year no monitoring was done directly after the winter rains. In future, NRS will visit the site quarterly and implement the digging/herbicide treatment method.

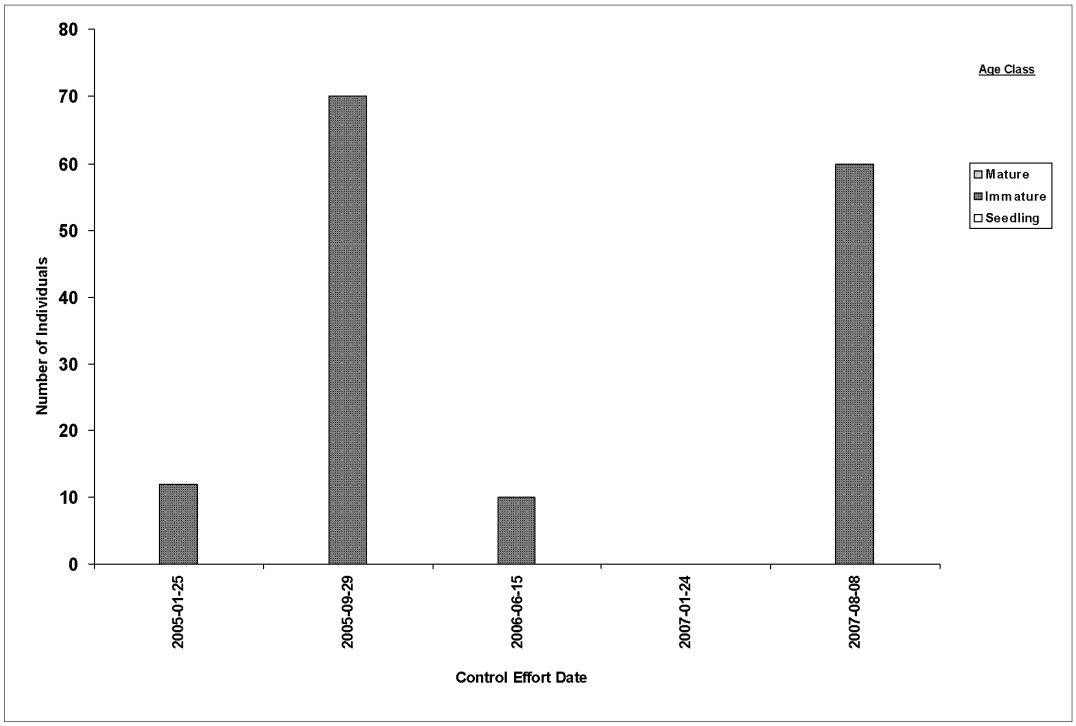


Figure 1.2.21 Number of *Rubus argutus* Individuals killed at UpperKapuna-RubArg-01

Table 1.2.29 Summary of *Rubus argutus* Control Efforts

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	1	0.50	6/1/2005	9/14/2006
MMR-RubArg-01	MMR No MU	3	6.75	10/24/2006	4/30/2007
MMR-RubArg-02	Ohikilolo	2	4.50	7/19/2007	7/19/2007
MMR-RubArg-03	Ohikilolo	1	1.00		11/8/2005
MMR-RubArg-04	Kahanahaiki	1	0.25	6/6/1999	8/19/2003
MMR-RubArg-05	MMR No MU	2	0.60		9/13/2004
UpperKapuna-RubArg-01	Upper Kapuna	2	2.50		8/8/2007

Senecio madagascariensis

It is probable that *S. madagascariensis*, or Fireweed, was introduced to O‘ahu by the accidental transportation of contaminated soil by military personnel or vehicles coming from Hawai‘i or Maui. It had a PIER score of 15. Prolific seed production (>1000/m2) and evidence that a persistent propagule bank is formed (>1 yr) make quick elimination of this population difficult. It is also spread by wind, birds, animals and man. It can spread locally by rooting from nodes. It can quickly spread in disturbed areas. However, it is susceptible to control via herbicide.

<u>SBS-SenMad-01; South Range SenMad at FP Halo</u>

Located on an actively used training site in SBS, *S. madagascariensis* is found at only site on military land (Figure 1.2.7). The infestation included both Firing Point (FP) and Observation

Point (OP) Halo, which are contiguous. The core of the infestation was centered at FP Halo; however, a training structure was built on FP Halo, effectively eliminating all possible habitat. Some outlying plants may persist just above the training facility, at OP Halo. NRS will monitor this ICA once or twice in the coming year.

Setaria palmifolia

Setaria palmifolia, or Palm grass, 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, although it can become established in disturbed areas. Controlling this weed in higher elevation MUs of KLOA and the Wai‘eli MU is a high priority for NRS.

Figure 1.2.22 Fruiting *Setaria palmifolia*

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, 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 summit.

This species received a PIER score of 7 and is therefore deemed an undesirable weed . The seeds are very small, which make it easily dispersed (Figure 1.2.22). 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 control 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>Wai‘eli-SetPal-01</u>
This site is located on the trail from the Hāpapa Bench to the Summit LZ (Figure 1.2.6). Two mature plants were killed in November of 2006 at this site and one immature was pulled in August of 2007 (Table 1.2.31).

<u>KLOA-Set Pal- ICAs 1-14; ‘Ōpae‘ula sites</u>
As mentioned above, NRS consider this species incipient in the higher elevations of KLOA. NRS have targeted this species as an incipient species within the ‘Ōpae‘ula-Helemano MU and there are 14 ICAs (see Figure 1.2.23 below). New sites have recently appeared along the fence, emphasizing how easily spread this species can be. Overall NRS feel that this species can be

eradicated from within the fenced MU if there are enough revisits and surveys, especially in ‘Ōpae‘ula. There are large populations in the Helemano fence that maybe too extensive to manage. Control efforts are summarized in Table 1.2.31.

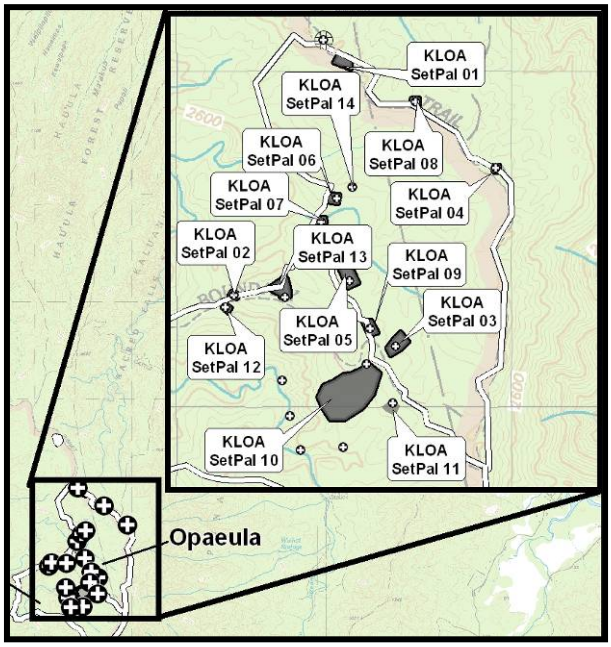


Figure 1.2.23 *Setaria palmifolia* Sites in ‘Ōpae‘ula

KLOA SetPal-01; ‘Ōpae‘ula SetPal along northern fenceline
One seedling was found here last year and no plants were seen this year.

KLOA SetPal-02; ‘Ōpae‘ula SetPal along Peahinaia Trail
This population was found prior to 2002 and was the largest of the five original *S. palmifolia* sites. In that year, 90 mature plants and many seedlings were found. In 2006, it appeared the population was declining when four matures and three juveniles were found and pulled. However, this year NRS found a few matures, over 20 immature, and over 50 seedlings over the last 2 visits. NRS will need to revisit this site frequently to eradicate this population effectively.

KLOA SetPal-03; ‘Ōpae‘ula SetPal at 260 Transect 12
Nine mature and two immature plants were originally removed from this spot in 2005. Three immature plants were removed last year and six immature plants were removed this year. NRS hope that as long as plants are removed before they mature, the soil seed bank will be reduced over time.

KLOA SetPal-04; ‘Ōpae‘ula SetPal on Transect 14 Station 290
One individual was removed here in 2006 and no plants were observed this year. More surveys are needed to confirm there are no additional plants in this area.

KLOA SetPal-05; ‘Ōpae‘ula SetPal at 370
One mature and one immature plant were seen in 2004 and 2005 respectively. No additional individuals have been observed here since that time.

KLOA SetPal-06; ‘Ōpae‘ula SetPal at Goosehead
No plants have been observed here since the one mature and five immature individuals seen here in 2005.

KLOA SetPal-07; ‘Ōpae‘ula SetPal at Hypalon
No plants have been observed here since the one immature was removed from this site in 2003.

KLOA SetPal-08; ‘Ōpae‘ula SetPal at Shaka
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; ‘Ōpae‘ula SetPal on Transect 12 Station 290
This ICA was visited once last year and no plants were found. NRS will visit this site once again next year to search for seedlings.

KLOA SetPal-10; SetPal Helemano bowl down to stream
This ICA contains the largest treated 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. No weeding was done in 2006-2007. Scouting surveys within the Helemano fence one gulch away from this site show extensive *S. palmifolia* populations in steep terrain. NRS will formalize a weed plan for *S. palmifolia* in this area for next year.

KLOA SetPal-11; Above Peahinaia Trail/Helemano fence
This population was not revisited in the past year as ungulate control was the priority. NRS will conduct *S. Palmifolia* control here as well as in other Helemano areas next year.

KLOA SetPal-12; North Helemano fenceline, west of LZ 66
This population was not revisited in the last year, however, on last visit, there were no individuals observed. 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 Trail SetPal
Six mature individuals were removed from this site in July 2006. NRS did not revisit this site in the past year, although, surveys are planned for the coming year.

KLOA SetPal-14; Hypalon bowl site
Two mature individuals were discovered and removed from this new site this year.

Table 1.2.30 Summary of *Setaria palmifolia* Control Efforts

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		7/18/2006
KLOA-SetPal-02	Opaeula/Helemano	2	1.25	4/2/2007	4/2/2007
KLOA-SetPal-03	Opaeula/Helemano	1	0.50	10/20/2005	5/17/2007
KLOA-SetPal-04	Opaeula/Helemano	1	0.50		7/18/2006
KLOA-SetPal-05	Opaeula/Helemano	1	0.33	10/19/2004	5/3/2005
KLOA-SetPal-06	Opaeula/Helemano	1	0.08	10/20/2005	10/20/2005
KLOA-SetPal-07	Opaeula/Helemano	2	0.18		1/13/2003
KLOA-SetPal-08	Opaeula/Helemano	1	0.50		
KLOA-SetPal-09	Opaeula/Helemano	1	0.08		
KLOA-SetPal-12	Opaeula/Helemano	1	0.25	3/20/2006	3/20/2006
KLOA-SetPal-14	Opaeula/Helemano	1	0.25	8/2/2007	
Waieli-SetPal-01	Kaluaa and Waieli	2	0.75	11/29/2006	

Smilax sp.

This genus is a group of species with woody climbing vines, tendrils and thorny stems originating from the Eastern United States. NRS found an introduced species of *Smilax* in Schofield Barracks East Range (Figure 1.2.3). Formal identification of this species would require flower and/or fruit, neither of which has been seen by NRS. It appears that this *Smilax* sp. can invade an area quickly with runners and seeds. NRS is monitoring this site closely. Rather than risking this species from spreading to multiple sites, NRS will continue eradication efforts.

SBE-Smisp.-01

The *Smilax* site in East Range has been visited three times this year (Table 1.2.32). Spraying with Glyphosate twice a year for three years has not been effective at killing this persistent taxon. In April 2007, NRS attempted to dig up the *Smilax* tubers and Triclopyr was applied to the cut ends that remained in the ground. NRS will go back next year to monitor if this method was more effective in eradicating this target pest. NRS will continue to check on this site twice per year, trying different control techniques.

Table 1.2.31 Summary of *Smilax* sp. Control Efforts

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	3	5.00		11/14/2006

Sphaeropteris cooperi

Known as Australian tree fern and previously known as *Cyathea cooperi*, this species received a Weed Risk Assessment score of 8 from the PIER website. This score designates it as an undesirable invasive species. A versatile species, *S. cooperi* thrives in a variety of climates. On

O‘ahu, it is widely distributed across both the Ko‘olau and Wai‘anae ranges, particularly mid-elevation mesic to wet sites. It is shade tolerant, prolifically produces wind dispersed spores, and matures to reproductive stage quickly. *Sphaeropteris cooperi* is relatively easy to kill via cut stump and Garlon application. NRS targets this species in high priority areas. Due to the scattered distribution typical of the species, treatment effort will be focused in WCAs or incidental to other management effort. Thus far, only one ICA has been designated for *S. cooperi*.

UpperKapuna-SphCoo-01; Kapuna *Sphaeropteris*
During the course of weed control in the *A. evecta* ICA in Upper Kapuna, NRS discovered one large mature *S. cooperi* (Figure 1.2.2). The tree was cut and treated with 5% Garlon 4 in water, which was effective in killing it. Subsequent trips to the site for *A. evecta* control did not reveal any seedlings or resprouts (Table 1.2.33). While this species is relatively widespread throughout the Waianaes, it is not well known from the Upper Kapuna MU. Whenever it is found during the course of other management work, NRS will treat and track this species.

Table 1.2.32 Summary of *Sphaeropteris cooperi* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: SphCoo	**Sphaeropteris cooperi**				
UpperKapuna-SphCoo-01	Upper Kapuna	1	0.50	10/3/2006	10/3/2006

Syzygium jambos

Native to continental Southeast Asia, *S. jambos,* commonly known as Rose Apple, 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 ‘Ōhi‘a 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. NRS did note a large population of *S. jambos* in Mākaha that was devastated by the rust.

MMR-SyzJam-01; Kaluakauila Upper Transect SyzJam
This ICA was created when one immature *S. jambos* was found along a weed transect in 2005 (Figure 1.2.1). 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. *S. jambos* was not observed in 2006-2007 when the ungulate transect was read. No *S. jambos* were seen on all trips for baiting and rare plant re-introductions for Kaluakauila last year. NRS will monitor the transect site at least once next year.

Tecoma capensis

Tecoma capensis or Cape honeysuckle, is a vine-like shrub that is native to South Africa. It is widely cultivated in the tropics and subtropics for its bright orange flowers and attractive leaves (Figure 1.2.24). It can flower continuously throughout the year and its fruits contain many winged seeds. It received a score of 6 from the PIER Weed Risk Assessment and has been given the designation of 'L' which means that it is not currently recognized as invasive in Hawai'i. Though it is not considered to be invasive, NRS has decided to target any plants found before it becomes a problem.

Figure 1.2.24 Flowering *Tecoma capensis*

Pahole-TecCap-01; Pahole TecCap South Rim

Tecomaria capensis was discovered on the south rim of Pahole by the NARS Specialist in 2004 (Figure 1.2.2). Since it does not seem to be reproducing by seed, it is thought that it was likely planted there by someone. The patch was first treated in 2004, but was not revisited until May 2007. It now covers 261m², five times bigger from when it was first discovered. With renewed effort NRS has targeted *T. capensis* for eradication. NRS has visited the area three times this year (Table 1.2.34), and will continue to go back until the entire patch has been treated. Once that is completed, NRS will monitor it quarterly for resprouts.

Table 1.2.33Summary of *Tecomaria capensis* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: TecCap		**Tecomaria Capensis**			
Pahole-TecCap-01	Pahole	3	14.00	6/18/2007	

Tibouchina urvilleana

Tibouchina urvilleana is a shrub native to Brazil. It forms dense thickets in wet disturbed areas and apparently is not spread by seed, but easily roots from stem fragments. It is currently listed on the HDOA noxious weed list and is considered highly invasive by the PIER Weed Risk Assessment System (Score 10). This species is currently found in only four spots on O'ahu.

Whitmore-TibUrv-01; Whitmore *Tibouchina*

In 1998, a large population of *T. urvilleana* was found on Navy lands in Whitmore Village (Figure 1.2.3). It was planted as a part of a botanical garden, which is no longer in operation. NRS has been monitoring this population ever since the initial treatment in 1999. NRS visited the Whitmore site once this year and found only seven plants (Table 1.2.35). There was one mature hidden beneath thick brush, but since it does not reproduce from seed it is not such a big concern, numbers are still quite low. NRS will continue to monitor this site once a year.

Table 1.2.34 Summary of *Tibouchina urvilleana* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: TibUrv	**Tibouchina urvilleana**				
Whitmore-TibUrv-01	KLOA No MU	1	2.30	5/30/2007	5/30/2007

Trema orientalis

This species is widely distributed in lower elevation sites across both mountain ranges. However, NRS plan to target this species in select native areas where it is not yet established. There is no rating from PIER yet. Common names for this plant are Gunpowder or Charcoal tree. It spreads well in disturbed areas and birds spread it into new areas. It prefers sites on well-drained, exposed soils without leaf litter, demonstrating an ability to become established on poor or disturbed soil. *T. orientalis* produces 370,000 seeds per kilogram of fruit. The germination rate is 75%. Germination length is 10-30 days. Seeds have been shown to be stored effectively for 6 months. Seedlings show rapid growth in a nursery, and will reach 1 m within 6 weeks of germination. It flowers throughout the year and generally lives only 8 to 10 years (PIER website).

Kaluaʻā-TreOri-01

One mature tree was found along the southern Central Kaluaʻā fenceline (Figure 1.2.6). The ICA is just 1 meter at this point. Scoping a larger area would be difficult as the area drops off steeply. Control efforts are summarized in Table 1.2.36. NRS will be able to monitor this site at least once next year while checking the *S. kanehoana* re-introductions just above this site. It is likely that this was an isolated bird dispersed individual tree and no other individuals will be found.

WaiʻanaeKai-TreOri-01

A total of 4 mature trees were killed near the landing zone (Figure 1.2.7). The ICA area is 5 X 20 meters. Control efforts are summarized in Table 1.2.36. NRS will be able to monitor this site while visiting nearby sites in Mākaha at least twice in the upcoming year. NRS would like to contain this species because the large disturbed burn area nearby could easily become infested with seeds spread by birds.

Table 1.2.35 Summary of *Trema orientalis* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: TreOri	**Trema orientalis**				
Kaluaa-Treori-01	Kaluaa and Waieli	1	0.50	7/19/2007	
Waianaekai-Treori-01	Waianae Kai	1	3.00	7/11/2007	

Triumfetta semitriloba

Sacramento bur is common in dry disturbed sites on O‘ahu, however, NRS would like to eradicate this species from areas where it is still considered incipient and keep it out of MUs. PIER has not ranked this species yet. This plant produces copious amounts of seed burrs (Figure 1.2.25), 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. Control in areas of high traffic such as trails and along fence lines will also help to prevent dispersal and keep weeding effort down. This will allow NRS to eventually eliminate the main source of spread. Control efforts are summarized in Table 1.2.37. More research needs to be done on seedbank longevity for this species.

Figure 1.2.25 *Triumfetta semitriloba* seed burrs

MMR-TriSem-01; Makua East Rim TriSem

This site was found just inside the Pahole fence, on the east rim of Mākua (Figure 1.2.1). 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 Kahanahā‘iki (all sites listed below; MMR-TriSem-02 to MMR-TriSem-06) that NRS check with regularity (Figure 1.2.1). No new sites in Kahanahā‘iki 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 Kahanahā‘iki sites twice per quarter.

MMR-TriSem-03; Pisonia patch

NRS have been treating this site since 2003. In 2004, NRS removed several mature plants and over 200 seedlings. Since this time, there have been a low number of individuals observed. NRS try to revisit this site often to prevent any seedlings from becoming mature. Three immature plants were removed this year.

MMR-TriSem-04; SE Quad

NRS have been treating this site since 2005. NRS revisited this site five times this year and several mature plants and a handful of seedlings were removed.

MMR-TriSem-05; Orange Trail

NRS have been treating this site since 2005, when one mature and four seedlings were removed. No plants were observed in 2006; however, this year NRS removed one immature individual.

MMR-TriSem-06; Top of Switchback
NRS have been treating this site since 2005 when 10 immature plants were removed. No plants were observed last year. However, this year one mature and approximately 30 seedlings were removed this year.

Pahole-TriSem-01; Pahole TriSem along South Rim Fence Line
Mature *T. semitriloba* plants were found along almost the entire south fence line in Pahole (Figure 1.2.2). It was probably spread by people or ungulates walking along the fence. NRS established a new 8941m² ICA to control this population. This year 47 mature plants were removed in two visits (Table 1.2.37). NRS observed a lot of seeds on the ground under these mature plants. NRS will visit this area quarterly to treat all seedlings and resprouts.

Table 1.2.36 Summary of *Triumfetta semitriloba* Control Efforts

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	4	7.75	1/2/2007	3/12/2007
MMR-TriSem-03	Kahanahaiki	4	2.75	8/1/2006	3/12/2007
MMR-TriSem-04	Kahanahaiki	5	1.75	3/23/2007	3/12/2007
MMR-TriSem-05	Kahanahaiki	3	1.00	1/9/2005	3/12/2007
MMR-TriSem-06	Kahanahaiki	5	2.75	6/26/2007	5/15/2007
Pahole-TriSem-01	Pahole	2	3.00	6/20/2007	6/20/2007

Vitex trifolia

Vitex trifolia is a large coastal shrub that is native to parts of Africa, Asia, and Australia. It is commonly planted as an ornamental and is currently not recorded as naturalized in Hawai‘i. Though this plant is not particularly invasive, NRS targeted it to prevent it from becoming naturalized.

SBE-VitTri-01; East Range *Vitex trifolia*
NRS spotted a small patch of the non-native *Vitex* in East Range (Figure 1.2.3). A sample was submitted to Bishop Museum for identification and NRS was informed that there was no previous record of *V. trifolia* being naturalized in Hawai‘i. In response to that NRS decided to control the patch in East Range (Table 1.2.38). There were only few plants to kill, so it was very likely planted there. It did not seem to be reproducing by seed, so very little follow-up is anticipated. NRS will check this spot yearly during other East Range ICA control efforts.

Table 1.2.37 Summary of *Vitex trifolia* Control Efforts

ICACode	IPManagementUnit	# of Visits	Effort (Person Hrs)	Date Last Mature Plant Found	Date Last Non-Mature Plant Found
IncipientTaxon: VitTri	**Vitex trifolia**				
SBE-VitTri-01	SBE No MU	1	0.50	5/30/2007	

1.3 Weed Survey Report

Surveys are conducted both on Army land and partner agency land (see Figures 1.3.3 - 6). Three types of surveys are conducted by NRS: road, landing zone, and transect. Transect survey results are discussed in the relevant IP MU sections of the Ecosystem Management Report. Road and landing zone survey results are summarized in Tables 1.3.1 and 1.3.2, respectively, and discussed below.

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 six letter codes; refer to Appendix 1-1 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.

Figure 1.3.1 NRS conducting a road survey in KTA

Figure 1.3.2 NRS conducting an LZ survey at a military LZ in KLOA

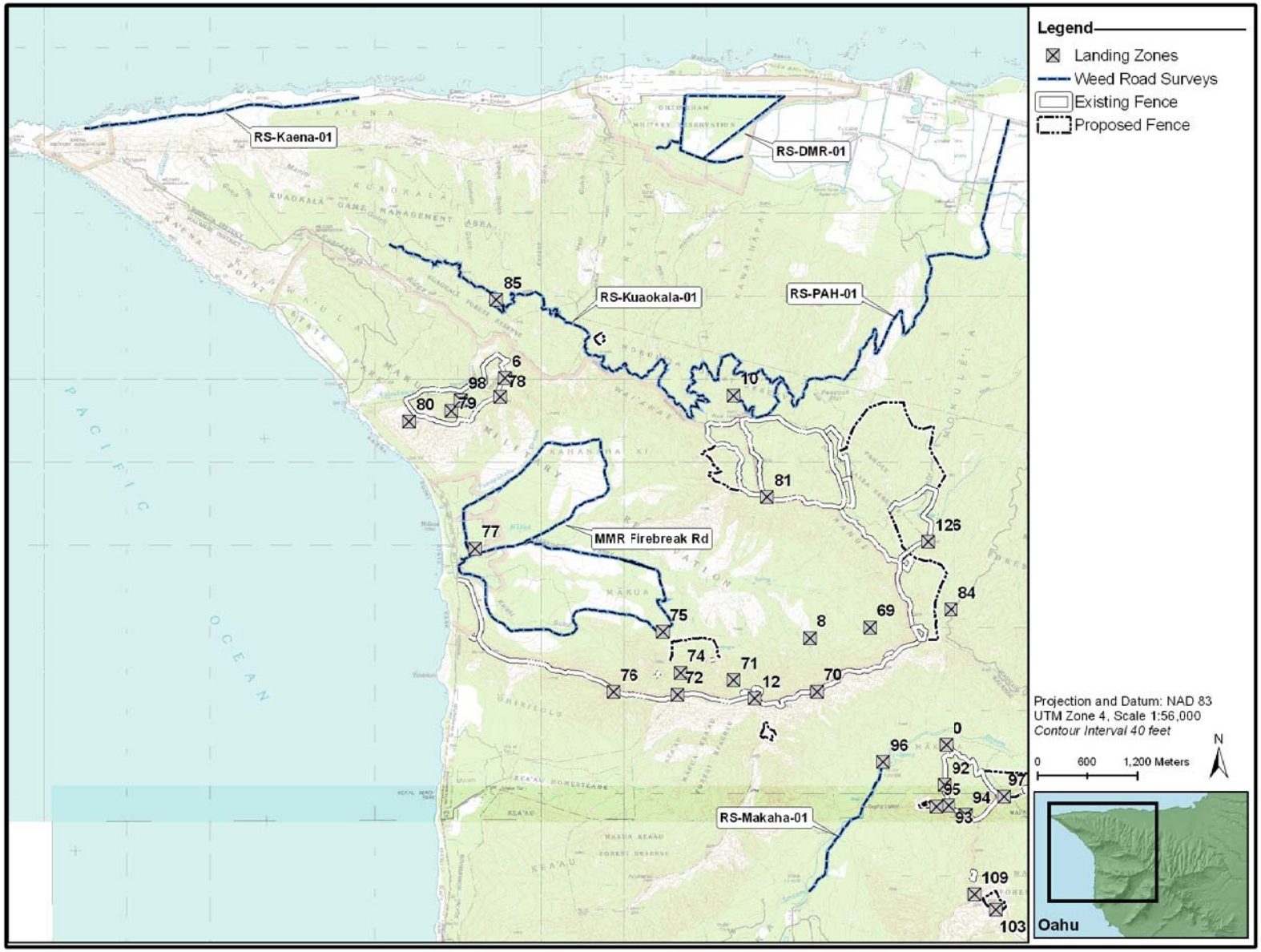


Figure 1.3.3 Northern Wai‘anae

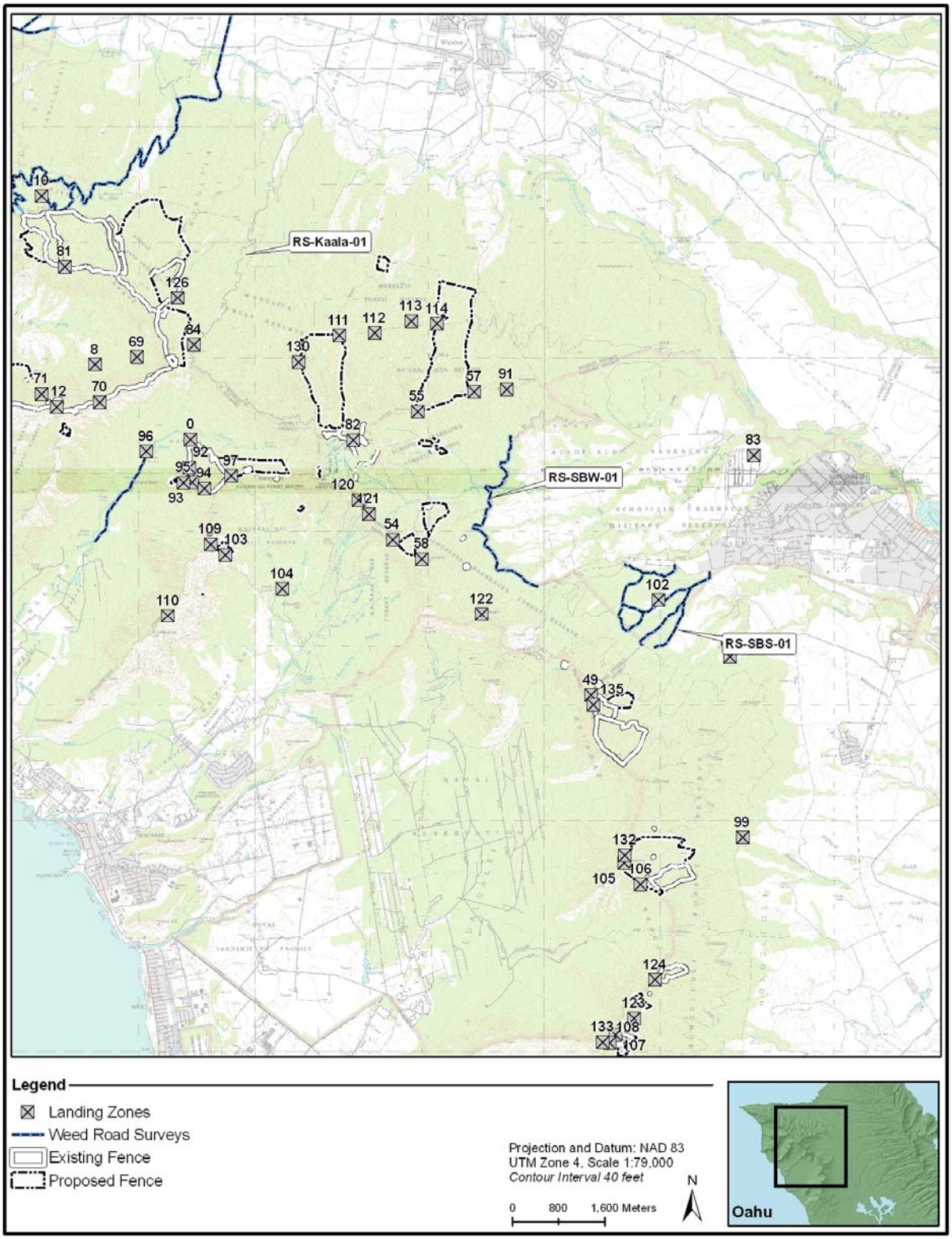


Figure 1.3.4 Southern Wai‘anae Surveys

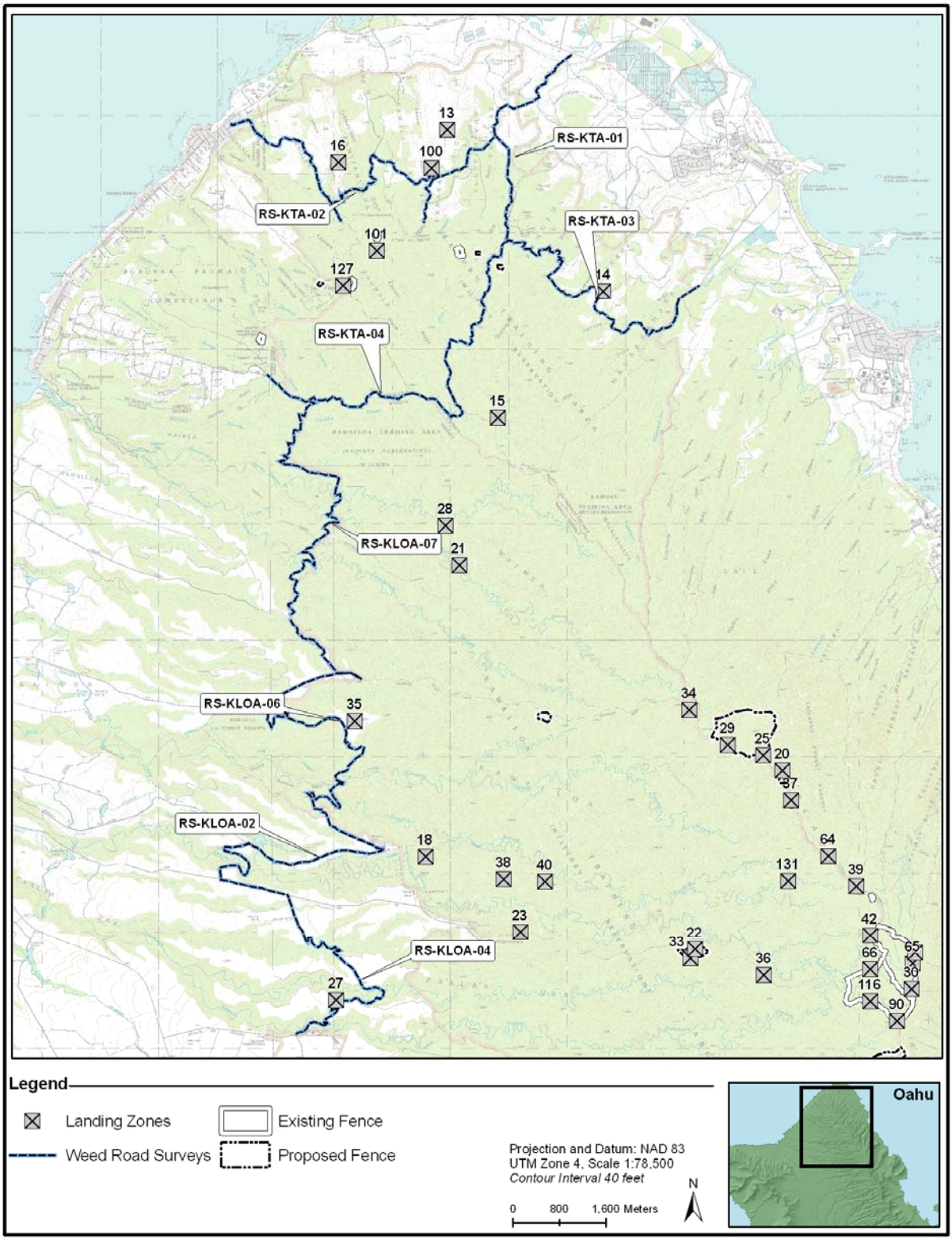


Figure 1.3.5 Landing Zone & Road Surveys, Kahuku and Kawailoa Military Training Areas

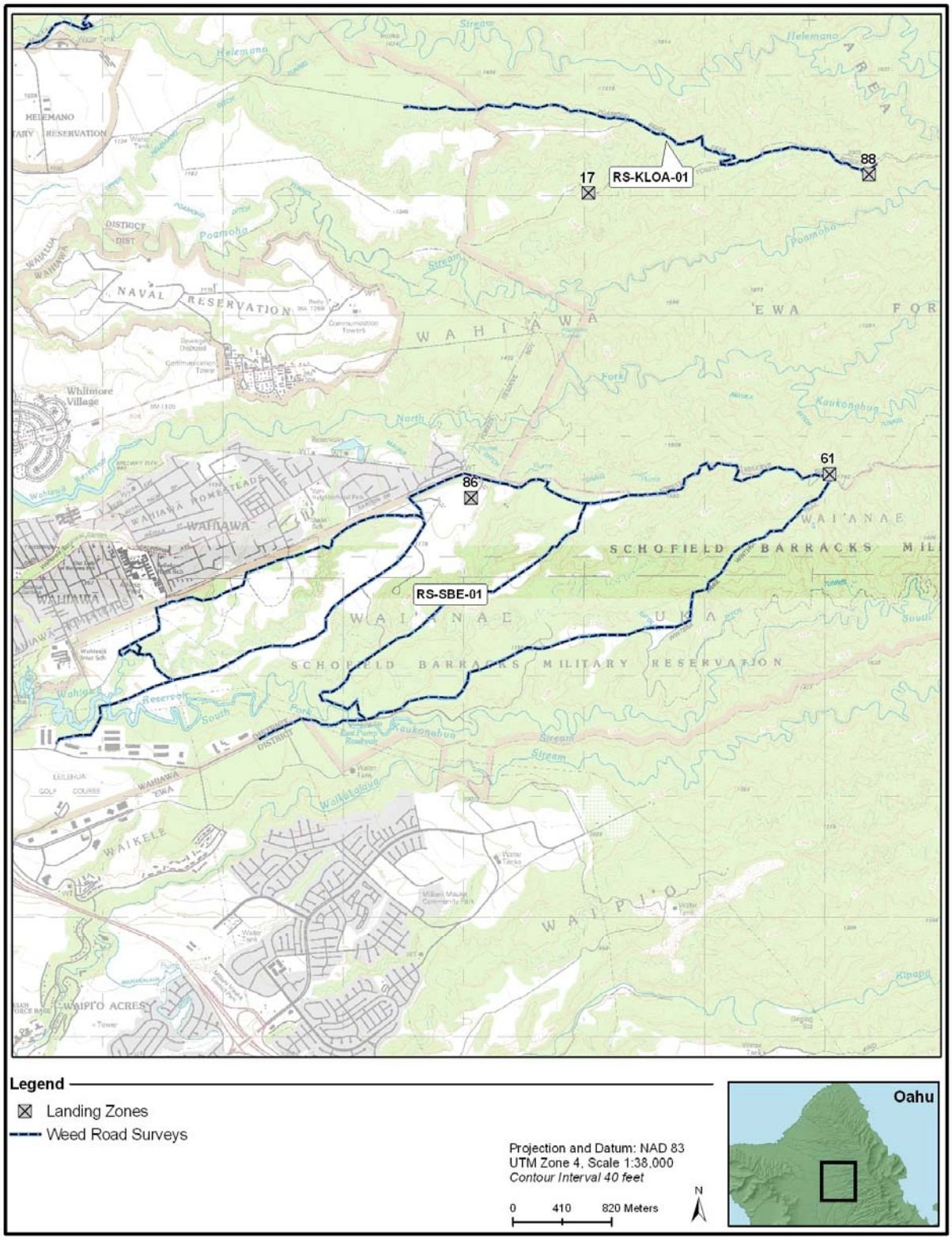


Figure 1.3.6 Landing Zone & Road Surveys, Poamoho to Schofield Barracks East Range

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. Three road surveys were not conducted this year. RS-KLOA-03 was not surveyed because the road was in disrepair and was not drivable; also, it appears that the Army has discontinued use of this road. If Army use changes, NRS will resume survey efforts. RS-SBW-01 was not surveyed due to access limitations to this high-use live-fire training area. When SBW training temporarily ceases during September and October 2007, NRS plan to complete the survey. RS-Makaha-01 was not surveyed due to organizational changes in the allocation of management areas between field crews. However, this area appears to have a relatively stable weed population and is not used by the military. NRS will continue this survey next year.

Next year, Stryker operations are scheduled to commence. When they do, NRS will begin surveying roads used by Strykers several times a year. Surveys will be conducted as needed, generally quarterly. Frequency of surveys will depend on whether roads were used by Strykers during a given quarter. During the dry, summer quarter, when many roadside weeds die back, surveys may not be conducted. Roads used by Strykers will include those in KTA, SBS, KLOA, and SBE.

No new potentially significant pests were found on any road surveys this year. Table 1.3.1 lists all road surveys completed. Some potentially significant species identified in last year's report are still extant, and NRS will continue to monitor them for any changes, such as sudden spread, which would trigger control. These include *Casuraina equisitifolia* and *Agave sisalana* at Ka‘ena, *Sideroxylon persimile* at Makaha, *Caesalpinia decapetala* at KTA-02 and SBW, and *Callitris sp.* at SBW. When RS-SBW-01 is completed in September-October, NRS will map the perimeter of the *Callitris* infestation. It is unclear whether this infestation is expanding, as access to this area is so limited. This population occurs on both sides of the firebreak road, in high-density UXO areas. Due to possible high UXO hazard, conducting control may not be an option below the firebreak road. Creating an accurate picture of the current distribution will aid NRS decision-making. *Schefflera actinophylla*, previously noted as a potentially significant weed, was observed across almost all KLOA and KTA road surveys. While its spread is distressing, it appears to be too widespread to merit control. *Solanum mauritianum*, tree tobacco, is colonizing many of the fallow agricultural fields in Wahiawa, Kunia, and Waialua. It is a noxious weed in New Zealand, Australia, Tonga, and Rarotonga. As of yet, it has not been seen on any road surveys or near to any significant resources, although it is thought to be present in SBE. This species is bird-dispersed, widespread, and thus unlikely to be a candidate for control in the future. However, it is interesting to note it's exceptional rate of spread.

In the coming year, NRS plan to survey one additional road. The access road to the Palikea MU runs through the small, remote housing community of Palehua. Given the variety of ornamental plants in this area and greatly increased NRS use, NRS feel it would be prudent to monitor the portion of this road above Camp Timberline for invasive species.

The Army recently acquired a portion of Kalua‘ā, termed the SBS Acquisition Area. Training has not yet begun on this parcel, but once it does, NRS plan to survey all roads. In addition, the

Army is ramping up for Stryker use both in SBS and KLOA. When this training begins, NRS will establish appropriate new road surveys and evaluate whether surveys in these areas should continue to be conducted yearly, or increased to quarterly.

Table 1.3.1: Road Survey Summary

SurveySiteCode	SurveySiteName	SiteLength (km)	SurveySiteType	First Survey Date
Property Name: Dillingham Military Reservation				
RS-DMR-01	Dillingham Roads	2.692	Road Survey	2004-02-23
Property Name: Kaena Natural Area Reserve				
RS-KAENA-01	Kaena Point Road	3.477	Road Survey	2006-02-08
Property Name: Kahuku Training Area				
RS-KTA-01	Charlie 1 Gate to Foxtrot Gate	5.81	Road Survey	2003-01-28
RS-KTA-02	Charlie 2 Gate to Alpha Gate	7.24	Road Survey	2003-01-29
RS-KTA-03	Hill 904 Junction to Delta Gates	4.143	Road Survey	2004-06-22
RS-KTA-04	Pupukea Gate to Foxtrot Gate	1.891	Road Survey	2004-02-10
Property Name: Kawailoa Training Area				
RS-KLOA-01	Poamoho Road	2.871	Road Survey	1997-12-19
RS-KLOA-02	Kawaiiki Ditch Trail to Brian's Mtn House Road Jnc.	3.469	Road Survey	2004-02-09
RS-KLOA-04	Brian's Mtn House Road Jnc to Helemano Gate	3.439	Road Survey	2004-02-09
RS-KLOA-06	Ashley Gate to Kawaiiki Ditch Trail	6.583	Road Survey	2004-02-09
RS-KLOA-07	McCormick Gate to Ashley Gate	4.327	Road Survey	2004-02-09
Property Name: Kuaokala Forest Reserve				
RS-KUAOKA-01	Kuaokala Road	9.954	Road Survey	2002-01-01
Property Name: Makua Military Reservation				
RS-MMR-01	Makua Firebreak Roads	12.118	Road Survey	2005-01-25
Property Name: Mokuleia Forest Reserve				
RS-KAALA-01	Kaala Road	10.353	Road Survey	2006-01-24
Property Name: Pahole Natural Area Reserve				
RS-PAH-01	Pahole Road	8.081	Road Survey	2005-02-01
Property Name: Schofield Barracks East Range				
RS-SBE-01	East Range Road to Sch-Wai Trailhead	13.938	Road Survey	2004-02-09
Property Name: Schofield Barracks South Range				
RS-SBS-01	South Range Roads		Road Survey	2004-02-12

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. Army LZs are surveyed once a year. However, some Army LZs in KTA and KLOA were not surveyed this year due to organizational changes in the allocation of management areas between field crews. NRS will strive to develop a complete list of Army LZs to aid in efficient monitoring. If NRS LZs are not used in a given year, no surveys are conducted at them. There are over 50 LZs each associated with MIP and OIP actions; 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. Table 1.3.2 lists new weed species found on LZs during the 2006-2007 report year.

Table 1.3.2: Landing Zone Survey Summary

SurveySiteCode	SurveySiteName	SiteLength (km)	SurveySiteType	First Survey Date	Significant New Pest Species
Property Name: Honouliuli Preserve					
LZ-HON-1	Kaluaa Field LZ-QTR2		Landing Zone	2006-11-30	
LZ-HON-2	Waiʻeli Ridge		Landing Zone	2006-11-29	
Property Name: Kawailoa Training Area					
LZ-KLOA-18	Black		Landing Zone	2001-08-14	
LZ-KLOA-20	Crispa		Landing Zone	2004-05-18	
LZ-KLOA-25	Kahuku Cabin		Landing Zone	2004-05-18	
LZ-KLOA-29	Northern LZ		Landing Zone	2004-05-18	
LZ-KLOA-30	Peahinaia Summit LZ		Landing Zone	1999-02-09	BleApp, Rhycad
LZ-KLOA-34	Puu Kainapuaa LZ		Landing Zone	2001-03-06	
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	Rhycad
LZ-KLOA-66	Helemano Near SetPal Bowl		Landing Zone	2007-02-05	
LZ-KLOA-90	Southern Helemano Summit		Landing Zone	2005-08-17	
Property Name: Makua Military Reservation					
LZ-MMR -72	Koiahi LZ		Landing Zone	2005-06-14	
LZ-MMR-12	Ohikilolo Camp LZ		Landing Zone	1997-04-13	
LZ-MMR-70	Red Dirt LZ		Landing Zone	2005-11-19	
LZ-MMR-8	Lower Makua LZ		Landing Zone	2003-03-27	
Property Name: Schofield Barracks South Range					
LZ-SBS-49	Puu Hapapa		Landing Zone	2006-11-29	AcaAus

Potentially significant new weeds were found at three LZs. *Rhyncospora caduca* was found at two LZs at the Opaeula summit: Weatherport Opaeula and Peahinaia Summit. Unrated by the PIER website, this invasive species is widely naturalized throughout the state. While *R. caduca* is not an ecosystem-altering weed, it is not known from this portion of the summit. *Blechnum appendiculatum* was found at the Peahinaia Summit. This LZ was a staging area for flying fencing materials to the new Helemano fence; it is likely that these new species were introduced via NRS use. *Blechnum* is unlikely to thrive in the wet summit environment, but *Rhyncosporum* could adapt well to such rainy conditions. Typically, the set of weed species at the summit has been very stable, making these two introductions significant. NRS will designate ICAs and work to eliminate these weeds from these LZs in the coming year. *Acanthospermum australe* was noted at the Puu Hapapa LZ. It is not a highly invasive pest, but is previously unknown from the area. However, it is widespread at the Kaluaʻā trailhead, the LZ often used to fly to Puu Hapapa. NRS removed the *Acanthospermum* from Puu Hapapa. These three species highlight the need for vigilant sanitation during field operations.

1.4 Ecosystem Management Report

Ecosystem scale management is reported by IP MU. The MUs are arranged geographically, from the northern Waiʻanae Mountains, to the southern Waiʻanae Mountains, and across to the Koʻolau 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, ungulate control efforts and transect survey results are discussed. For some IP MUs, other sections relating to predator control (specifically, coquí in SBE) are included. 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.

Region: *Waiʻanae Kai Forest Reserve*

Two MUs have been designated in Waiʻanae Kai, both around *Neraudia angulata* populations (Figure 1.4.1). They are Waiʻanae Kai (*Neraudia angulata* Slot Gulch), and Waiʻanae Kai *Neraudia angulata* Mauka. Neither one is fenced. NRS has not worked extensively in the Waiʻanae Kai Forest Reserve. This reflects a conscious decision to focus weed management efforts within fenced MUs and ungulate management in areas that are manageable. The Waiʻanae Kai area is designated as a State Game Management Area (GMA) and is actively utilized by the community for pig and goat hunting. Although NRS have proposed MU fences, none have been built other than the small *Hesperomannia arbuscula* fence completed in 2006 by Plant Extinction Prevention (PEP) and NRS (OANRP 2006). NRS have proposed to build two small MU fences and one PU protection fence here in the near future. Until fences are built, NRS will continue managing this area on a minimal level for rare species protection and collection. Effort in Waiʻanae Kai will intensify as management goals are defined, logistical considerations resolved, and NRS staffing levels increase.

The area is accessed through numerous well maintained trails and a BWS road. Several of the MIP plant populations do require helicopter transport and rappelling for monitoring and collection work.

Fire remains a huge threat to this area with numerous wildland fires occurring annually near farming and residential areas. The lower portion of the MU is predominantly vegetated with *Panicum maximum* and *Leucaena leucocephala*. A large fire in 2003 started near the Kūmaipō saddle area and numerous other fires have regularly burned up to the forest edge in the lowlands. Importantly, the State continues to maintain a large fuel/fire break near the lower forest edge as a fire pre-suppression measure.

The short-term weed management goals for the Waiʻanae Kai Forest Reserve MU are:

1) Develop weed management plans for the MU following more intensive rare plant surveys, collection, and monitoring efforts in the area.
2) Control incipient, habitat modifying weeds in areas around MIP and OIP plant populations.
3) Participate in an interagency effort to control *Rubus argutus* in a roughly two acre area at the Kūmaipō burn site.

4) Assist PEP in weed control efforts at *H. arbuscula* fence.
5) Manage fire threats as necessary.

A small population of *Trema orientalis* was treated in the Wai‘anae Kai region. No other weeding was done in the 2007 report year. Future weed efforts will continue primarily around important *Neraudia angulata*, *Nototrichium humile, and H. arbuscula* plant populations. Fire planning and coordination will be better for any future fires in this area after discussions following the 2007 Kaukonahua/Waialua fire. NRS will assist BWS with replanting of common natives in the 2003 burn site in the upcoming year. Weed species to be controlled at the burn site include *B. asiatica* and *R. argutus.* Control of these species is needed to release regenerating koa trees from weed competition and prevent the further spread of blackberry in the area. Naturally recruited *A. koa* is already ten feet tall in the burn area as reported by the Board of Water Supply Biologist.

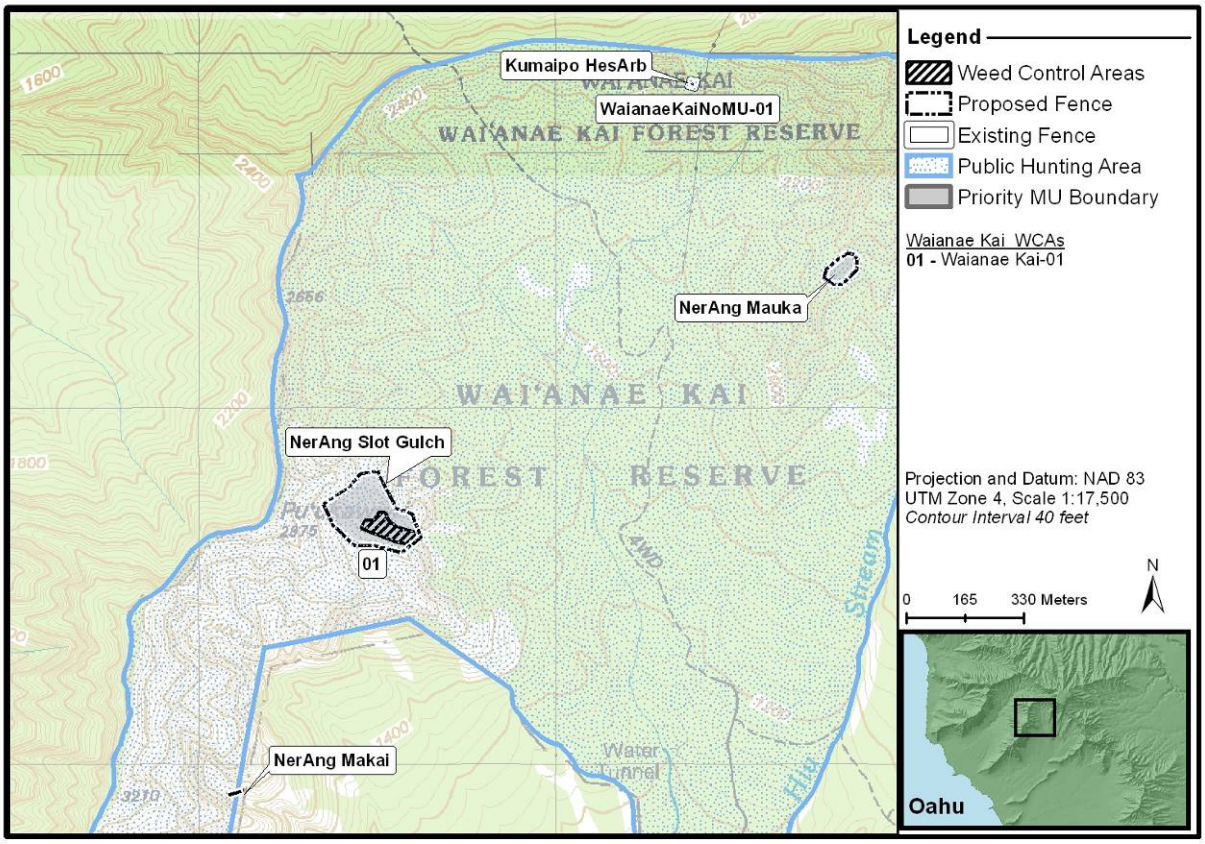


Figure 1.4.1 Ecosystem Management in Wai‘anae Kai

<u>Ungulate Control Efforts</u>

NRS assisted staff from PEP in erecting a small PU fence around a population of *H. arbuscula* in April 2006. No new fences have been constructed and no new ungulate control measures have been taken in the Wai‘anae Kai MU in 2006-2007.

The scale of the proposed fences for these MUs has been reduced significantly from what was proposed in the MIP. NRS feel the best approach to fencing issues here is to start off small with PU sized fences rather than MU fences. Three main reasons for this opinion are:

- The proximity of these plant populations to a very popular hunting area.
- The fact that the surrounding habitat is heavily degraded by feral goats, considerably impacted by introduced weeds.
- The difficulties and safety issues arising from working in such steep terrains.

NRS feel that in the short-term, constructing PU fences would protect the immediate habitat surrounding the populations from further degradation by ungulates. Weed control will also be potentially more effective and beneficial when concentrated in small, discrete areas. At this time, it is unclear whether the proposed PU fences will be large enough to ensure adequate habitat management for the various species to remain viable and reach stability but this is a reasonable first step in management of the populations.

IP MU: Wai‘anae Kai

This MU, labeled in Figure 1.4.1 as “NerAng Slot Gulch”, includes several IP taxa, including *N. angulata*, *Nototrichium humile*, *Tetramolopium filiforme*, and *Abutilon sandwichensis*. As fence construction, as discussed above, has not yet occurred in this MU, management has been limited. One WCA has been defined in the MU, and another was designated outside any MUs. Both are centered around rare plant populations. No weeding was done in the 2006-2007 Report Year.

WCA Discussion

Wai‘anae Kai-01; Nerang Slot Gulch

In the next two years, visit quarterly to maintain greater than 75% native cover on *N. angulata* cliff and reduce guinea grass and other non-native elements along 1/2 acre gulch bottom area (beneath *N. angulata* cliff to less than 25% cover.

This WCA is located in a slot gulch with very high cliff walls. The gulch houses important populations of *N. angulata* and *N. humile*. *Tetramolopium filiforme* also occurs in this area but mainly at the top of the cliffs. The vegetation in the gulch is mixed with some native elements, and large amounts of *L. leucocephala*. The cliff face with the largest concentration of *N. angulata* and *N. humile* is largely intact, although non-native elements are increasing. This cliff face offers an important reference site for high quality *N. angulata* and *N. humile* cliff habitat. Managing the weeds on this cliff is problematic given the lack of accessible anchor points for ropes. While the gulch is surrounded by grass, there is very little *P. maximum* in the WCA itself. In the future, NRS will target *L. leucocephala*, continue to treat other weedy trees and control grass as necessary to reduce fire threat and encourage rare species recruitment along the gulch bottom. This topographically isolated WCA is expected to respond well to weed control; once woody weeds have been removed and guinea grass knocked down the site may only require maintenance once or twice a year. As with any slot gulch, rock fall is a serious safety concern, and NRS staff will need to limit the time spent in the gulch bottom area to minimize exposure to falling rocks.

Wai‘anae Kai NoMU-01; Kūmaipō HesArb

In the next two years, continue to weed all habitat modifying understory weeds from the *H. arbuscula* fence with minimal disturbance to root zone of remaining *H. arbuscula* individuals on at least an annual basis.

PEP staff built a fence protecting *H. 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 any intensive weeding. The vegetation at the site is mixed, with a variety of native mesic canopy and understory species as well as many weed species. NRS will maintain a low level of effort at this site, and will continue to assist PEP management efforts to weed alien understory such as *C. hirta* and *R. argutus*.

Region: *Mākaha*

This region includes Mākaha Valley and the ridges that encompass it. This area is owned by BWS. The region includes several MUs, including Mākaha, Kamaileunu, and Kea‘au and Mākaha. With the cooperation of BWS, there has been considerable work done in this area over the last year, including the completion of the 85 acre Mākaha Subunit I fence, the completion of the approximately one acre Pu‘u Kawiwi fence, weed control, and ungulate removal within the fences. A half acre fence surrounding a *Cyanea longiflora* population was completed in the 2006 reporting year. Over the next year, NRS plan to construct two fences: the 66 acre Subunit II fence and the 5 acre Kamaile‘unu fences. Vandalism is a serious problem in the area as the new Subunit I fence was repeatedly vandalized soon after the start of fence construction. Several large, mature *Cyanea longiflora* plants were also vandalized early in 2007. Fence construction at the Kea‘au and Makaha MU, centered around a population of *Sanicula mariversa* is not scheduled to begin next year. NRS will focus on monitoring the *S. mariversa* for goat damage until the fence is constructed.

Large goat populations exist along the back of Mākaha along the northern and western walls.

The short-term goals for the Mākaha MU are as follows:

1) Control weedy tree species in and around rare plant populations and reintroduction sites.
2) Expand weed control efforts as related to rare plant reintroduction sites.
3) Control all ungulates within fenced areas using community and staff.
4) Maintain fence integrity through periodic fence monitoring.
5) Continue and expand outreach with Wai‘anae community to educate about conservation.

NRS has seen evidence of old camp fires in the Mākaha Subunit I fence and more regularly along the access trail at the bottom of the main gulch. Continued education with volunteer hunters and Wai‘anae High School students who access this area on NRS work trips will hopefully spread the word of concern on this issue. A fire on Kūmaipō ridge in 2003 was believed to have been started by an abandoned camp fire.

IP MU: Mākaha

Mākaha Valley has many desirable elements for rare plant population management and reintroduction efforts. Weed control in Mākaha MU Subunit I focused around more intact mesic forest habitat, rare plant populations and adjacent areas where weed influx would originate. WCAs were created to capture such weed control efforts. Only WCAs in which control has been conducted this year are discussed below.

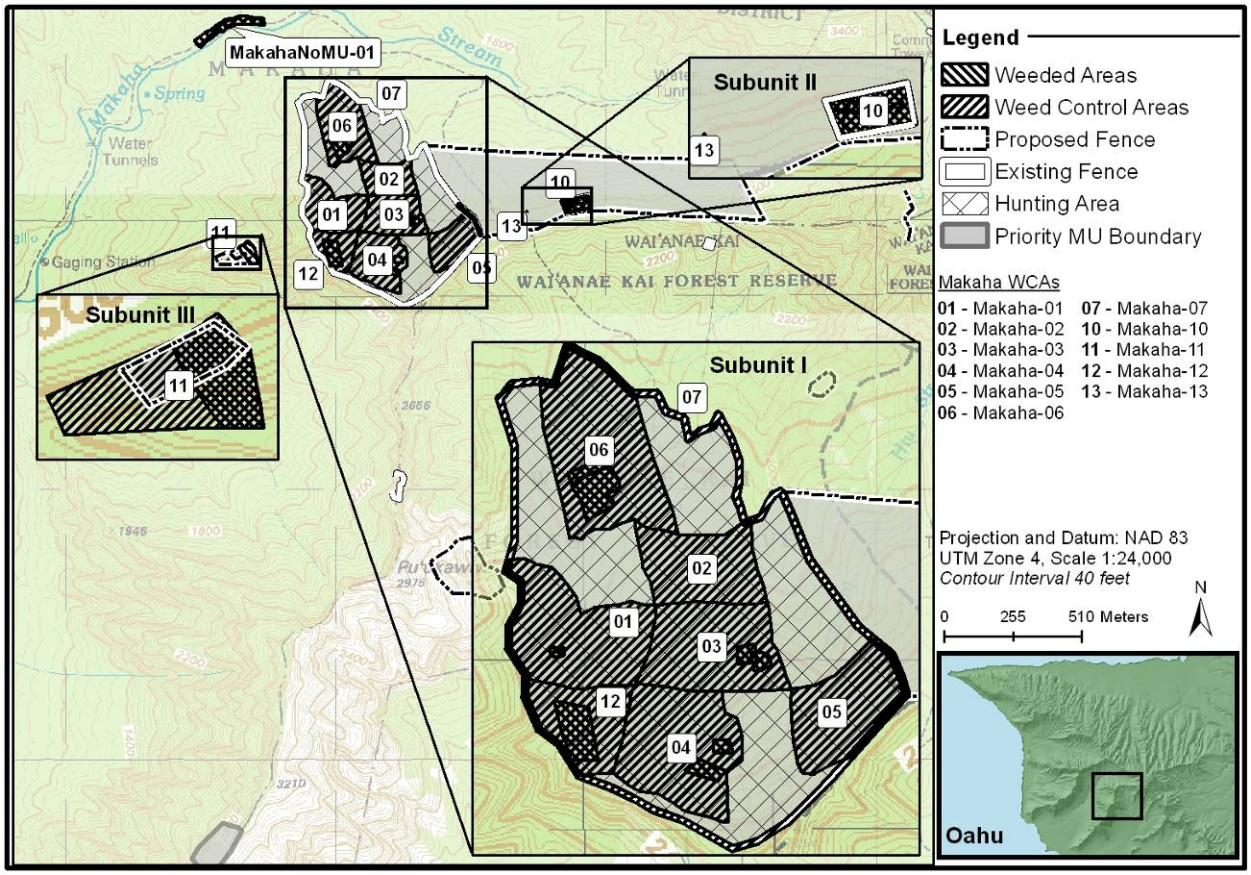


Figure 1.4.2 Ecosystem Management in Mākaha

Ungulate Control Efforts

A small-scale PU fence (0.5 acre) was erected to protect a population of *Cyanea longiflora* within subunit II and was completed October 2006. The fence was checked recently and found to still be pig-free and structurally sound. Larger fences for subunits II and III are slated for construction in Year 5 of the MIP (see Figure 1.4.2).

An 85-acre fence for Subunit I of the Mākaha MU protecting 21 threatened and endangered species was completed August 2007. The EA was approved in early 2005 but unforeseen delays with processing the CDUA forced the contractor to postpone construction and apply for continuances on the contract. The unanticipated lapse of time required using a subcontractor to build and complete the fence. During construction, there were a 3 incidences of vandalism where the fence had been cut or partially dismantled and propped open to allow access in and out of the area. The fence has since been repaired and reinforced by NRS. Periodic fence checks

will continue to be conducted to ensure fence integrity. Step-over crossings in strategic areas are also being built to allow hiking access where the fence crosses hiking trails.

NRS is currently in partnership with BWS, Mauna ʻOlu Estates, Kaʻala Farms, DLNR, and community hunters to implement a volunteer hunter program for ungulate control within the newly constructed fence. Community meetings were held to inform the public of the fence project and gain support by local hunters. As a popular hunting area, Mākaha Valley is frequented by many hunters and educating them on our efforts may minimize human impacts to the fence. BWS rules do not allow the use of firearms on any of their lands and so volunteer hunters must utilize knife-and-dog hunting methods to control pigs within the fenced area. Prior to the August 2007 fence completion, 7 community hunters and 4 NRS participated on 4 outings for a total of 76 person hours, removing 2 pigs. Unauthorized hunting continues to occur in the area so the 2 ungulates removed only includes confirmed removals. With the completion of the fence, more outings with community hunters are planned for complete removal of ungulates within the fenced area. As pigs re-enter the fence area in the future following fence breaks or other means, NRS will again utilize community hunters to re-clear the fence area.

WCA Discussion

Mākaha-01; Makai Ridge

In the next two years, visit at least quarterly to

1) Frill/chainsaw treat all *T. ciliata* greater than 20cm diameter at breast height (dbh) in a five acre area.
2) Basal or frill treat all *S. terebinthifolius, B. asiatica, P. guajava* and *P. cattleianum* in the core two acre mixed native area.
3) Foliar treat *T. ciliata* and other understory seedlings/saplings in the two acre core native area as needed on a bi-annual basis.

In the past, NRS have focused management efforts in Mākaha-01 around an individual of *F. neowawraea*. Management efforts included removal of one habitat altering species of tree, *Toona ciliata*. This is one site within the fence with a sizable population of *T. ciliata* and the most likely seed source in this area. In 2006-2007, NRS spent 7.5 hours primarily focusing on continued reduction of *Toona ciliata* canopy. The strategy NRS is using to manage this weed tree species is to control the large mature individuals to eliminate the seed source thus reducing the seed bank. With a maturity age of 6-8 years old, most *T. ciliata* will be controlled before reaching seed production capability. Continued weed sweeps of the area focusing first on matures and then on immatures are planned with ongoing management of the area.
In preparation for reintroduction of *Phyllostegia kaalaensis,* a 40 m^2 area was weeded of all *T. ciliata, S. terebinthifolius,* and *Coffee arabica*.

Mākaha-02; Lower Flag

In the next year, determine weed management objectives (if any for this area).
No weeding has been done in this WCA. Some understory native emergence was observed such as *Microlepia strigosa.* While it is not necessary to schedule major weed effort in this area, NRS recommends small scale strategic weeding to expand these native understory areas.

Table 1.4.1 Summary of Mākaha Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Makaha						
Makaha-01	Habitat	3.54	0.04	1.00%		FluNeo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	17.50	CofAra, PsiCat, PsiGua, SchTer, TooCil
Totals	3	17.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Makaha-03	Habitat	3.09	0.16	5.13%		AleMacMac, FluNeo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	16.00	BudAsi, CofAra, Lancam, PsiCat, PsiGua, RubArg, RubRos, SchTer, TooCil, TriSem
Totals	4	16.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Makaha-04	Habitat	3.51	0.20	5.71%	CyaMem, DieFal, GouMey, PteMac, SicLan, StrRub, ZanDipDip	AleMacMac, MelTen, VioChaCha

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	26.00	BudAsi, PsiCat, PsiGua, RicCom, Rubarg, RubRos, SchTer, TooCil
Totals	2	26.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Makaha-06	Habitat	4.54	0.55	12.18%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	5	151.00	CofAra, LanCam, PsiCat, SchTer
Totals	5	151.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Makaha-07	Fenceline Clearing	2.57	0.13	5.22%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	22.00	CliHir, CofAra, PsiCat, rubros
Totals	3	22.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Makaha-10	Habitat	0.45	0.45	100.00%		CyaLon

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	19.25	BleOcc, BudAsi, CliHir, LanCam, PsiCat
Totals	4	19.25	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Makaha-11	Habitat	0.86	0.34	39.94%		AbuSan, MelTen, NerAng, NotHum

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

Makaha-12	Habitat	1.91	0.48	100.00%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	9.00	TooCil
Totals	1	9.00	

Makaha-13	Habitat	0.00	0.00	100.00%		CyaGriOba

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	0.25	BleOcc, CliHir, PsiCat
Totals	1	0.25	

MakahaNoMU-01	Trail	0.79	0.77	97.59%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	2.50	TriSem
Totals	2	2.50	

Total IPMU: Makaha						
		21.26	3.13	14.72%	26	266.50

Mākaha-03; Upper Flag

In the next two years, treat all canopy weed trees in a two acre area and treat all habitat modifying understory weeds on at least a bi-annual basis. Continue treating all weeds in a five meter radius around all large, mature *A. macrococcus* trees.

Weeding was done to prepare reintroduction sites for *C. herbstii* reintroduction. Some *A. macrococcus* in the area were also liberated from encroaching weed trees. The area seems to respond well to weeding with no regeneration of weeds in the understory. NRS recommends continued removal of canopy weed species.

Mākaha-04; AleMac

In the next two years, treat all canopy weed trees in a two acre area and treat all habitat modifying understory weeds on at least a bi-annual basis in preparation for future reintroductions. Continue treating all weeds in a five meter radius around all large, mature *A. macrococcus* trees.

A total of 10 hours were spent targeting canopy and understory weeds. More weeding can be done uphill and to either side of this treated area. This area could eventually sustain other reintroduction sites.

Mākaha -06; Camp Ridge

In the next two years, 1) Continue treating all mature *P. cattleianum* surrounding mature koa trees at a rate of 2 acres each year through annual visits with larger work groups. 2) Continue 4 trips each year by Waianae High School to treat *C. arabica* and *P. cattleianum* in 20x20 m plots with minimal impacts to Elepaio pair breeding efforts.

A total of 94 hours were spent re-weeding plot areas treated in the previous report year and extending weed control to include areas under *Acacia koa* trees. *Acacia koa* seedlings have been observed recruiting in treated areas. The emergence of *M. strigosa* has been observed in the Wai‘anae High School (WHS) plots. *Coffee arabica* regrowth from their plots is slow and controllable. WHS has multiple work trips scheduled in this area for 2007-2008. Trials of small diameter coffee stands weed whacked with a blade and sprayed with a lower dose 5% G4 show initial signs of success. Future trials will hopefully speed up the effectiveness of reducing this species in areas near native plants. NRS recommends continued efforts of *C. arabica* and *P. cattleianum* removal.

Mākaha -07; Fenceline

In the next two years continue treating all *P. cattleianum, S. terbinthifolius,* and *C. hirta* along two kilometers of fenceline in order to maintain the fence corridor for ease of fence and ungulate monitoring.

One hour was spent spraying *P . cattleianum* and *C. hirta* on the East fenceline. Weed control along the fence assists in keeping the fenceline corridor unobstructed for ease of walking and maintenance checks. NRS is planning weed control for the entire fence perimeter.

Mākaha-10; Cya Lon

In the next two years, visit the half acre fence area quarterly and

1) Continue treating all weeds in a two meter radius around all *C. longiflora* plants,
2) Treating all mature habitat modifying understory weeds (especially *Clidemia hirta*), and
3) Reducing *P. cattleianum* canopy cover by no greater than 40% each year.

A total of 19 hours was spent controlling weeds in this newly established WCA inside the small *C. longiflora* PU fence. Most weed control took place around the *C. longiflora* plants and on the fenceline perimeter. A large aggregate of *P. cattleianum* will be cleared in progressive stages from in and around the fenced area.

Mākaha-11; Ner Ang (unfenced)

In the next two years, visit the 2 acre core area quarterly and:

1) Continue removing all understory weeds in a minimum two meter radius around all accessible rare plants (targeting *Rivina humilis* in particular).
2) Treat all *S. terebinthifolius* in a 10 m radius around all accessible *Abutilon sandwicensis* and *Neraudia angulata* plants to provide sufficient sunlight.
3) Assess feasibility of conducting weed control along the cliff face to facilitate *N. angulata* and *A. sandwicensis* recruitment by conducting one trial weeding effort in the next year. Trial weeding effort to focus on small ledges below mature *N. angulata* plants.

This WCA is unfenced. A total of three hours was spent in this newly established WCA. *S. terebinthifolius* removal will minimize competition for light by *Abutilon sandwicensis* and *Neraudia angulata*. NRS recommends more weed control to assist native plant recruitment and growth.

Mākaha-12; Upper makai

In the next two years, conduct quarterly trips to continue treating all *T. ciliata* tree greater than 20 cm dbh in a five acre area. If no trees found greater than 20 cm dbh after next trip, begin treatment of all trees between 5 and 20 cm dbh across same five acre area. This WCA was started to reduce *T. ciliata* seedling spread in the gulch below. Large mature trees were targeted for control to reduce the seed source. There are still some large trees to be controlled. NRS recommends continued *T. ciliata* weed efforts and control of resprouts as light gaps opens up.

Mākaha-13; *C. grimesiana*

This WCA was started to support recruitment of seedlings from the wild *C. grimesiana*. Management plans include conducting annual weeding in a 2m radius around base of the plant with minimal disturbance to the root zone. In 2008, this WCA will be in the fence boundary and weeding will be done on a larger scale. The area has mixed native canopy and understory and will be suitable for reintroduction sites.

Mākaha-No MU-01; Trail Trisem

The trail leading to the Mākaha fence passes through some weedy areas infested with *T. semitriloba*. This species is not incipient in the region, but NRS conducts periodic control of this infestation in hopes of limiting the spread of this plant into the fenced MU, where it is not well established. NRS handpulled over 100 mature *T. semitriloba* at one site, near a rain gauge. A total of 200 immature *T. semitriloba* and 120 seedlings on the trail from the parking lot up to the rain gauge site were handpulled as well. Continued weed control along this trail may help minimize the spread of *T. semitriloba* throughout the management area by hikers, hunters, and NRS. In the next two years, NRS will conduct an annual *T. semitriloba* control trip along a two mile by 20 foot corridor from the trailhead to the Kūmaipō trail juncture. During weed control visits to WCA units in the Subunit I fence, any *T. semitriloba* individuals found will be controlled and the results reported in the appropriate WCA discussion.

IP MU: Kamaile‘unu

NRS efforts in this area have been to collect seed and monitor *Sanicula mariversa*. The area is steep and only accessed by helicopter. Invasive plant species and goats are immediate threats. No weeding has been done here yet but may include controlling *Schinus terebinthifolius*. The construction of the Kamaile‘unu fence to protect *S. mariversa* will be started in October 2007.

The short-term objectives for this MU are:

1) Build remaining fence for *S. mariversa*.
2) Assess weed control needs of both populations of *S. mariversa* and implement weed management plan.

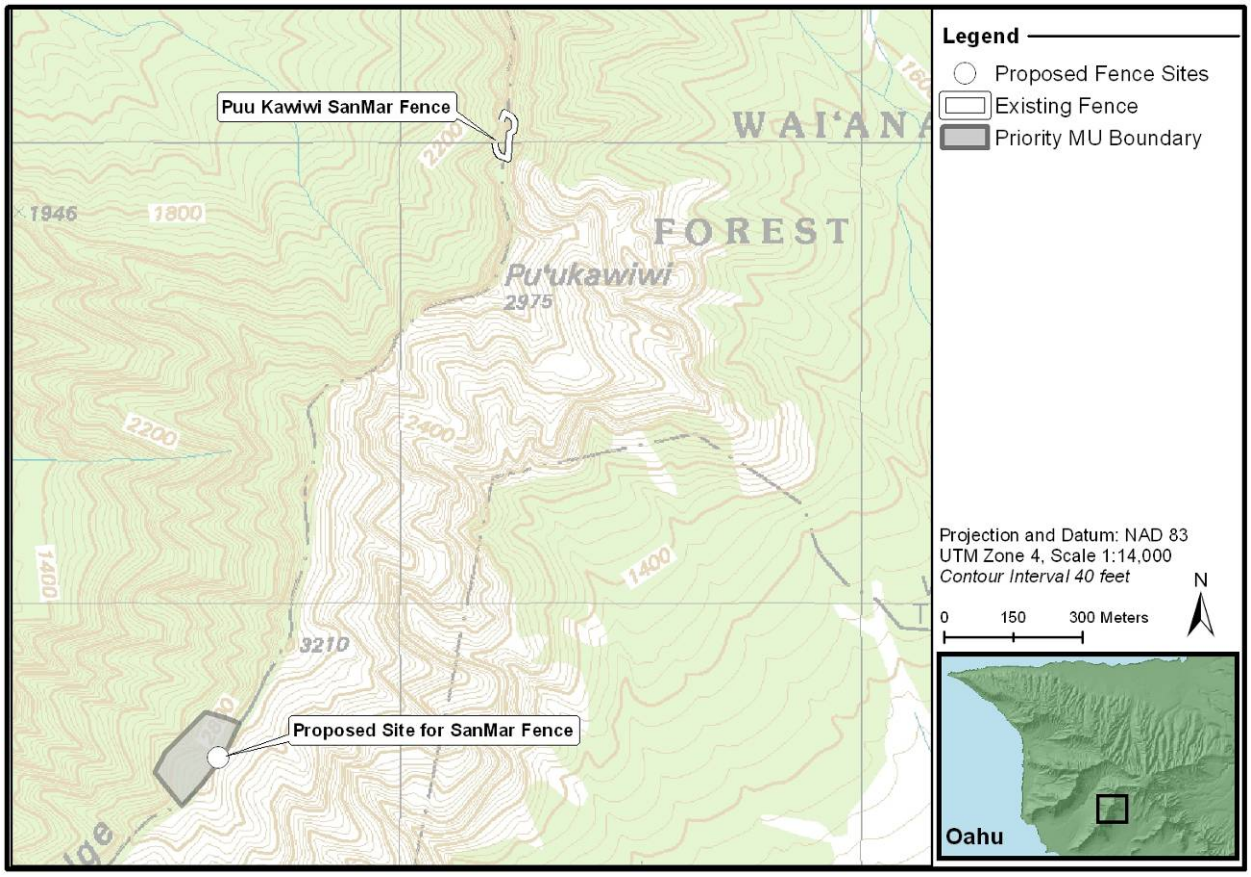


Figure 1.4.3 Ecosystem Management in Kamaile'unu

Ungulate Control Efforts

One of two small-scale fences has been built to protect *S. mariversa* (Figure 1.4.3). The fence near Pu'u Kawiwi is roughly a half an acre in size. The other proposed PU fence, near Pu'u Kēpau'ula, is about 4.5 acres in size. Construction of this fence is planned for October 2007. NRS have been awaiting the arrival of materials and tools to complete the job. 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.

Region: *Ka'ena Point*

This region includes two IP MUs Ka'ena and East of Alau which are both within the State's Ka'ena Point NAR (see Figure 1.4.4). NRS focuses management around the rare plant species *Chamaesyce celastroides* var. *kaenana*. Ungulates are generally not a problem in this area so NRS do not have any fenced units proposed. However, the State is currently working with the Xcluder fence company to build a rodent proof exclosure at the point to protect native seabird populations. The actual fence route is not final and may not include the portion of the NAR that is actively weeded by NRS. Monitoring transects will be installed both inside and outside of the

proposed fence by U.H. to determine the effect of removing rodents from this dry costal habitat. A wildland fire consumed approximately 74 acres near the East of Alau MU. The fire burned within the boundaries of this MU and approximately 35m from the WCA. See Appendix III, Ka‘ena Fire Report.

IP MU: Ka‘ena

NRS coordinate with state NARS staff on management of the KAE-B *C. celastroides* var. *kaenana* population located within the MU. This population is designated as MFS. Weed control efforts are focused around the *C. celastroides* var. *kaenana* population, and there is one WCA defined in this MU, Ka‘ena-01 (see Figure). If the predator proof fence is built to include this WCA, access issues will have to be worked out with the state. The population is surrounded by grassy slopes, which is comprised predominantly of *Chloris barbata*. NRS is working towards increasing the native vegetation population by outplanting Kawelu (*Eragrostis variables*) and ‘Aweoweo (*Chenopodium oahuensis*).

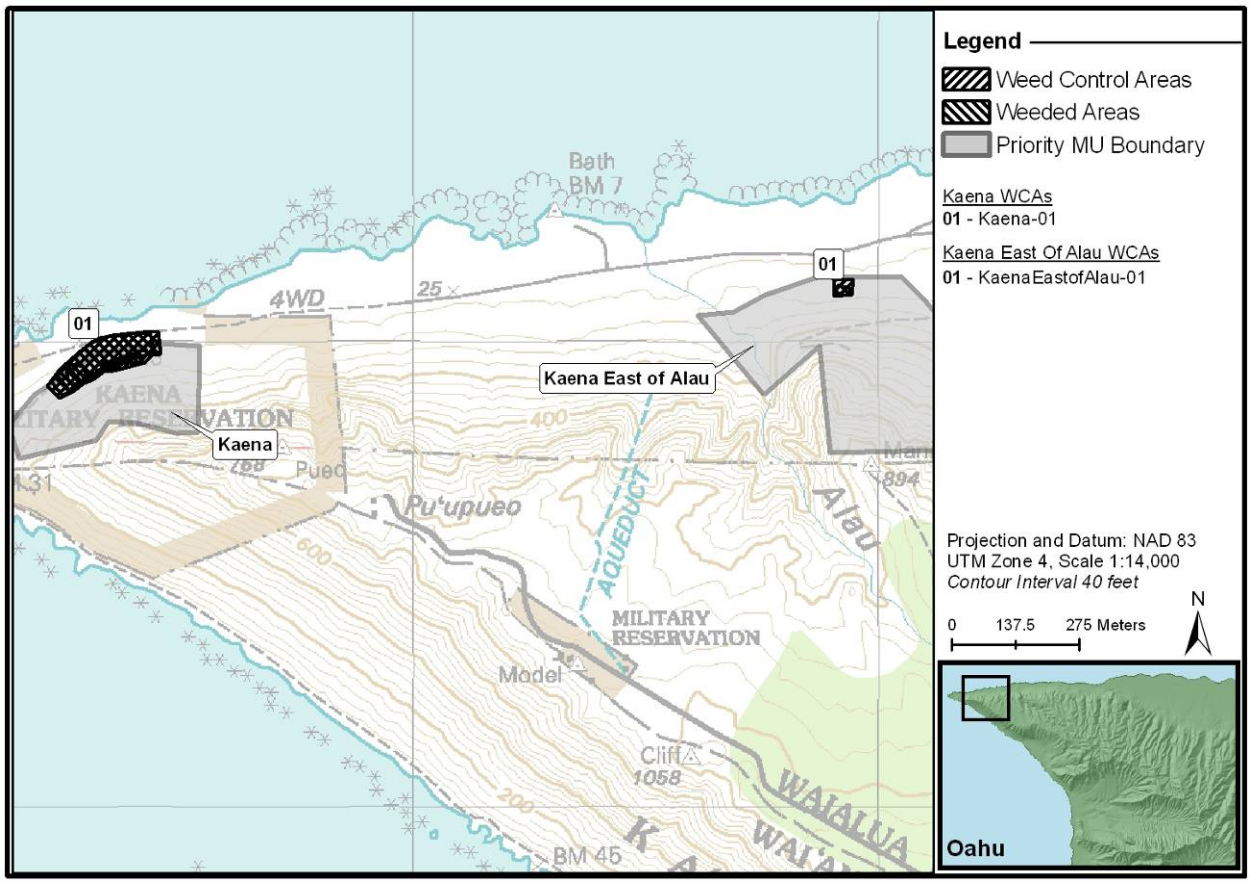


Figure 1.4.4 Ecosystem Management in Ka’ena Point

Canine Control Efforts

In early November dogs were found to have killed 700 shearwater chicks. DLNR staff quickly responded by hunting the dogs. NRS will continue to monitor the area for any dog sign when they work at this site, and will report their findings to DLNR staff. Currently, the state is developing a plan to install an excluder fence that will keep out all terrestrial animals.

Table 1.4.2 Summary of Ka'ena Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Kaena						
Kaena-01	Habitat	1.60	1.40	87.54%		ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	5	64.50	AcaFar, AchAsp, AgaSis, AtrSem, ChlSp., DesVir, Ipoind, LanCam, LeuLeu, MacLat, PanMax, PluInd, PluSp., PluSym, SchTer, SolSp., SyzCum
Totals	5	64.50	

Total IPMU: Kaena						
		1.60	1.40	87.54%	5	64.50

WCA Discussion

Kaena-01; NAR *C. celastroides* var. *kaenana*

NRS weeded in this area six times over the past year and noticed a major decline in the weed species *Leucaena leucocephela* (see Table). In the past, this weed was widely spread throughout this WCA and weed control efforts for this species took up a majority of the time spent. Past weeding efforts required NRS staff to carry equipment such as loppers and hatchets to treat this weed throughout the WCA. Over the past year, only immature plants were found which can be treated with clippers or simply hand-pulling. This has resulted in a decline on the amount of time needed to do weed sweeps. While this weedy tree species has diminished, NRS focused more effort on the ground creeping weed *Atriplex sembicatta.* This weed has been seen to smother the endangered *C. celastroides* var. *kaenana*, especially younger, immature plants which are often hidden under this sprawling weed.

C. barbata has been a troublesome weed to control; past weeding efforts included using the grass specific herbicide Fusilade® that was applied with backpack sprayers. Over the past year, NRS has begun to take a different approach for attacking this weed. NRS combined outplanting efforts with the state to help battle this weed. During an outplanting trip with state worker Greg Mansker, NRS helped outplant 'Ohai (*Sesbania tomentosa*) and *Capris sandwichiana* outside the WCA in native bird habitat. After those plants were in the ground 200 Kawelu and one 'Aweoweo was planted throughout the WCA in a trial effort to battle the *C. barbata* (see Figure). This was paired with hand-pulling *C. barbata* to create outplanting sites for the Kawelu. Last monitoring records in September showed that 45% of the outplanted Kawelu are still alive and the lone 'Aweoweo had perished. Seed sowing trials have also begun in this area but it is too early to report any results.

Figure 1.4.5 Outplanted Kawelu

NRS plan to visit this WCA quarterly over the next year and will focus on weeding efforts further upslope from the road. NRS will also continue to sweep through the area for *L. leucocephela* and *A. sembicatta*. NRS will work with NARS Specialist to develop a common reintro plan for this area that will include species such as Kawelu, Naio, and ‘Aweoweo.

IP MU: Ka‘ena East of Alau

NRS work with NARS staff to protect the *C. celastroides* var. *kaenana* population found within this MU (see Figure). There is one WCA found in this MU that includes the *C. celastroides* var. *kaenana* population and the area directly surrounding it. This WCA is found in a rocky area that is mainly made up of *L. leucocephela*.

Table 1.4.3 Summary of Kaena East of Alau Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Kaena East of Alau						
KaenaEastofAlau-01	Habitat	0.14	0.05	38.68%		ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	5.00	AcaFar, LanCam, LeuLeu, PluSp.
Totals	1	5.00	

Total IPMU: Kaena East of Alau					
		0.14	0.05	38.68%	1	5.00

WCA Discussion

KaenaEastofAlau-01; East of Alau *C. celastroides* var. *kaenana*

NRS visited this WCA once last year and mainly weeded *L. leucocephela* (see Table). The area where the *C. celastroides* var. *kaenana* are growing is not that weedy, so most of NRS weeding efforts have been directed to the area bordering this plant population. NRS plan to visit this site two times next year and will work on keeping a weeded buffer zone surrounding these rare plants.

Region: *Dillingham Military Reservation, DMR*

This region covers one IP MU that is split into two units and contains a highly degraded lowland dry forest/dry shrubland community. The Western unit is on State land along the Keālia Trail and the Eastern unit occurs mainly on Dillingham Military Reservation (DMR). Fire is the primary threat to this MU because of its proximity to roads as well as being dominated by *Panicum maximum* and *Leucaena leucocephala*, two fire-adapted species. Access is granted through coordination with the Army. The Army does some training in the area and NRS works around their training schedule.

IP MU: Haili to Keālia

Two WCAs are defined for this MU (Figure 1.4.6). There are no ungulate exclosures currently planned for this MU as pig activity is generally low. This decision may be re-evaluated if pig activity increases and affects reintroduction and management efforts. NRS conducts weed control only in the Eastern unit. Without fencing, weed control objectives will continue to be moderate given the level of disturbance to this area. The irreversibly degraded state of this region also warrants a lower level of weed control. Weed control needs of the Western unit of this MU have yet to be determined.

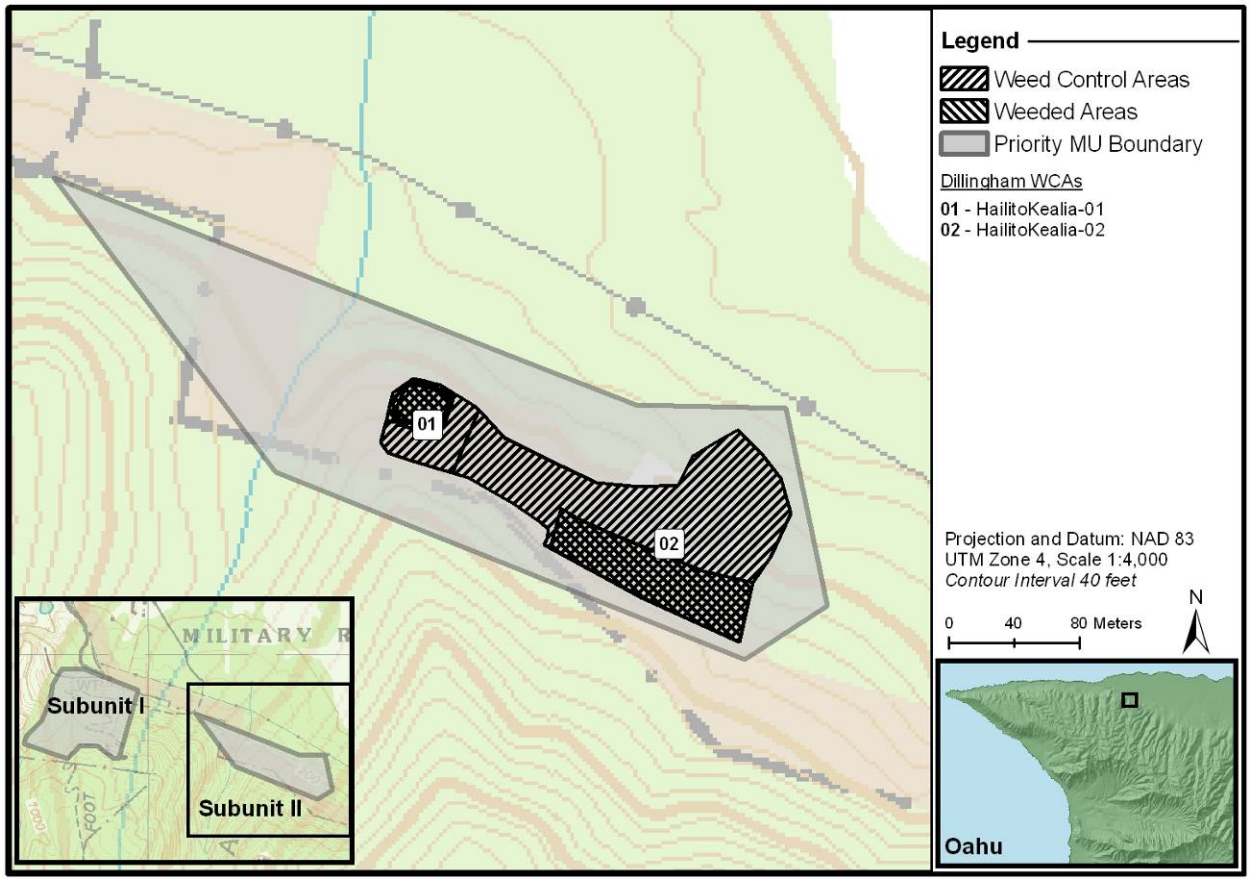


Figure 1.4.6 Ecosystem Management in Haili to Keālia, Dillingham Military Reservation

Ungulate Control Efforts

There was no NRS ungulate control efforts conducted in this area. Poaching appears sporadic. Pigs are regularly present in the area and are utilizing seeps in the *Sapindus oahuensis* stand and adjacent areas. Pigs occasionally disturb the *Hibiscus brakenridgei* reintroduction area by crossing through, but since the area is filled with talus only minimal disturbances to the outplantings have been noted.

Table 1.4.4 Summary of Haili to Kealia Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Haili to Kealia						
HailitoKealia-01	Habitat	0.47	0.20	41.89%		HibBraMok
HailitoKealia-02	Habitat	1.32	0.37	28.10%	HibKokKok	
Total IPMU: Haili to Kealia		1.79	0.57	31.72%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	6.50	PanMax
Ecosystem Weed Control	1	8.00	Cocgra, LeuLeu, PasEdu
Totals	3	14.50	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	6.00	
Totals	1	6.00	

Total IPMU: Haili to Kealia	4	20.50	

WCA Discussion

Haili to Keālia-01; Hibiscus Outplanting

The long term objective of weed management for this area is to maintain the 0.5 acre *H. brackenridgei* reintroduction site. The short-term objectives for weed control in this WCA are:

1) Continue weed removal in a two meter area around each reintroduced plant at the 0.5 acre reintroduction site.
2) In a three-year period, create a ten meter *P. maximum* free buffer around the *H. brackenridgei* reintroduction area.
3) Control all *Syzygium cuminii* in WCA.

This area is dominated by *P. maximum* and *L. leucocephala* with some remnant *Erythrina sandwicensis* trees and other native shrubs. The reintroduction site is currently about 900m^2. NRS make roughly four trips a year to prepare for more outplantings of *H. brackenridgei* and to conduct follow-up maintenance. *Panicum maximum* was controlled by spray and hand-pulling around *H. brackenridgei*. NRS will continue fire threat management by limiting *L. leucocephala* and *P. maximum.* NRS observed native regeneration of *Psydrax odorata*, *Dodanaea viscosa,* and *E. sandwicensis* in this WCA. Continued weed control will allow more native recruitment. NRS may consider some level 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 WCA encompasses a fairly intact *S. oahuensis* dominated forest. The long-term objective of weed management in this WCA is to maintain native forest cover in this two acre remnant *S. oahuensis* stand. The short term objectives are:

1) Control all non-native canopy tree species larger than two meters in the two acre *S. oahuensis* stand.
2) Control incipient understory weed species.

A total of six hours was spent in the upper east end of this WCA, focusing on incipient weed species and *Schinus terebinthifolius*. Work in this area requires difficult talus and boulder walking. In the past, NRS made use of volunteers to conduct weed control in this area. NRS would like to continue community stewardship of this area with experienced volunteers capable of working in difficult terrain.

Region: *Mākua Military Reservation, MMR*

This region covers the entire Mākua Valley and is leased by the Army. There are four major MUs within the valley where NRS conduct management: Kaluakauila, Kahanahāʻiki, ʻŌhikilolo, and Lower ʻŌhikilolo. Of these, Kaluakauila and Kahanahāiki are fenced, while ʻŌhikilolo and Lower ʻŌhikilolo are partially fenced. These MUS effectively identify the areas of the valley containing the highest numbers of IP taxa, highest species diversity and largest sections of native forest. NRS conduct weed control across these MUs and have some ungulate control in the unfenced portions of the valley. Most of the valley perimeter is surrounded by ungulate fencing however there is approximately 3,200 m along the northern end that is not fenced. If fenced completely, this would be the largest fenced area and first ungulate-free valley on Oʻahu. Such a project would provide many interesting research opportunities. NRS are excited about the possibility of removing ungulates from such a large area while acknowledging that removing animals from such a large area will be extremely challenging.

A wild fire occurred on the northern end of the valley this year at Puaʻakanoa (see MMR fire report in Appendix). This fire was started along the public road and spread onto the military reservation. Fire will always be a threat in Puaʻakanoa, given its proximity to Mākua training and to the public road.

IP MU: Kaluakauila

A 110 acre pig-free exclosure was completed in June 2002 protecting rare plant species and native dry forest (Figure 1.4.7). 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.

There are three WCAs drawn in Kaluakauila (Figure1.4.7). Two are 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.

NRS current weed control strategies include weeding areas around rare plants to reduce competition for resources. Oftentimes, the results are large light gaps where other opportunistic weedy species can quickly germinate and occupy. NRS will attempt to utilize this available

sunlight by translocating seedlings of common native species from surrounding areas into these light gaps. Successful plantings will be able to compete for light and shade out weeds. This strategy could also be used near the forest edges to essentially expand native forest cover.

The objectives for this MU for the next two years are:

1) Continue treating all weeds in a two meter radius around the base of all rare plants (five meter radius for large, mature female *Euphorbia haeleeleana* trees)
2) Conduct quarterly control trips of *Panicum maximum* and *Leucaena leucocephala* across the six acre core native areas.
3) Conduct biannual removals of other canopy weed trees in 50 x 50 m plots (one plot each in Upper and Lower patches).
4) Conduct trial outplantings of transplanted native seedlings as well as nursery stock in same 50 x 50 m plots located around reintroductions.

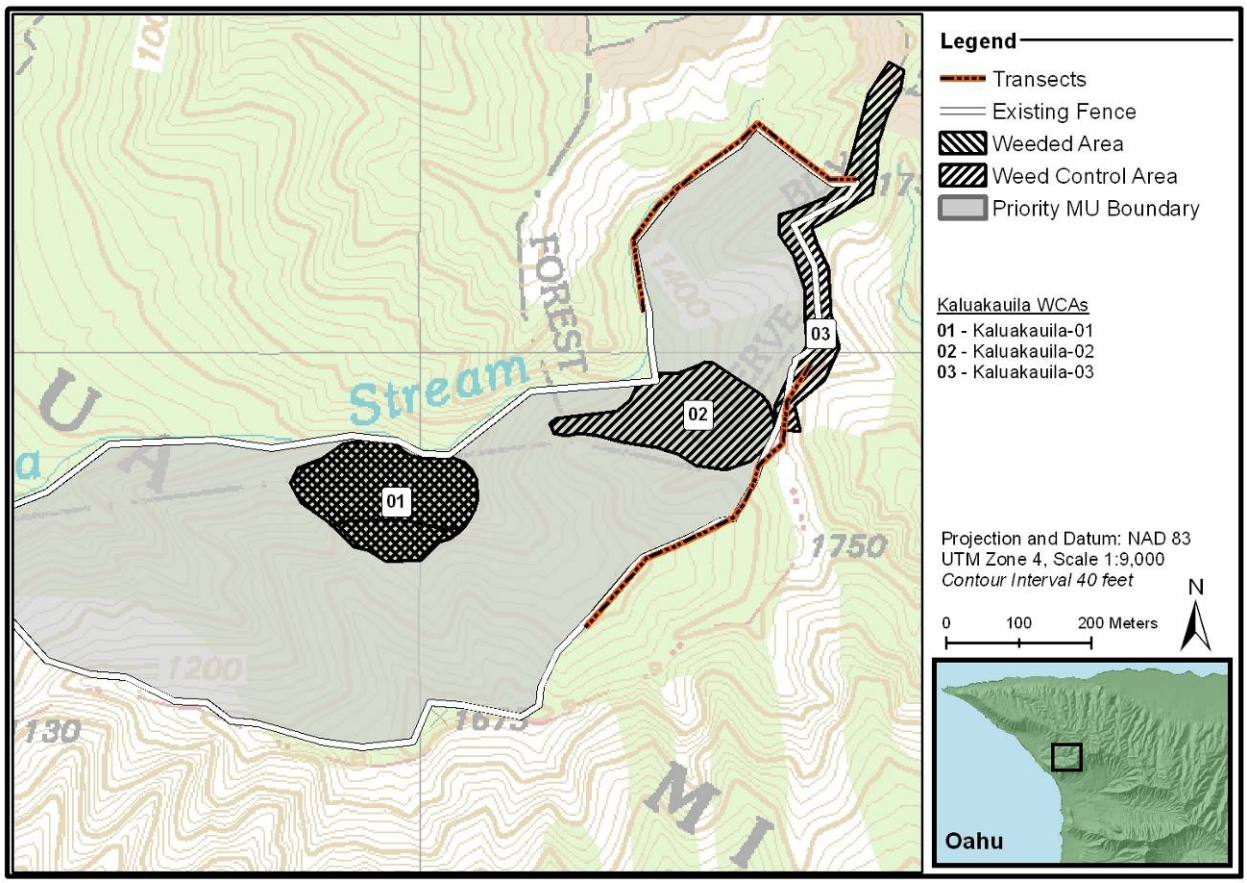


Figure 1.4.7 Ecosystem Management in Kaluakauila

Ungulate Control Efforts

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 conducted periodic fence checks to monitor ungulate activity and fence integrity. The results of recent visits found the fence to be structurally intact, functional as an ungulate barrier, and still ungulate-free.

Transect discussion

There are two vegetation transects in this MU. No transect readings were done this year.

Table 1.4.5 Summary of Kaluakauila Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Kaluakauila						
Kaluakauila-01	Habitat	2.94	2.94	100.00%	BobSan, BonMen, EupHae	AbuSan, HibBraMok, NerAng, NotHum

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	25.00	PanMax
Totals	2	25.00	

Total IPMU: Kaluakauila						
		2.94	2.94	100.00%	2	25.00

WCA Discussion

Kaluakauila-01; Lower Patch

For a number of years, NRS has been working in the Kaluakauila-01 WCA to restore native habitat for protected species by focusing mainly on *P. maximum* and *L. leucocephala* removal. The Kaluakauila-01 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.

To ensure that *P. maximum* is sufficiently suppressed to allow native plant regeneration, NRS will continue monitoring and grass spraying if necessary throughout the Kaluakauila-01 WCA every quarter for the 2007-2008 year. If done at this frequency, grass levels should be kept low enough so that grass control does 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, Schinus terebinthifolius,* and *Grevillea robusta* in higher priority areas.

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 *E. haeleeleana* and outplanted populations. This year NRS will experiment with translocation of common native seedlings from overcrowded nearby areas to places recently cleared of weeds. It is important to combine weeding with native outplanting to discourage alien plant re-growth into the weeded area. Also, by transplanting seedlings from dense patches to open areas, we may be utilizing many plants that might not do as

well because of competition with cohorts. Using wild germinated seedlings may increase survival rates by using plants adapted to that specific microclimate.

A total of nine hours was spent surveying grass. Previous grass control with Roundup® seems to have been successful because there were only sparse populations of waist high *P. maximum* in the WCA. NRS suggests spraying in January or February to keep re-growth down.

NRS did *P. maximum* trials with Oust® XP herbicide in heavily infested areas. Oust® XP is a broad spectrum herbicide that works through preemergence and postemergence activity. The results of the trials showed that Oust® XP was not effective. NRS will continue control using Roundup® in strategic spots.

Kaluakauila-02; Upper Patch

The Kaluakauila-02 WCA is more uniform than the Kaluakauila-01 WCA, and has a larger area of 75% or more native canopy. Weeding effort in the Kaluakauila-02 WCA has focused mainly on grass and broadleaf canopy control around the three reintroduced and four wild populations of rare plant species. Grass control throughout the area occurred in 2005-2006. As NRS was short staffed this year efforts were focused on grass control in the Kaluakauila-01 WCA and did not conduct weed control in this WCA. NRS will visit the WCA at least twice in the next year for weed control. NRS will focus efforts on removing grass and reducing *G. robusta* and *L. leucocephala* in this WCA. Habitat restoration techniques discussed above will be implemented in the Kaluakauila-02 WCA if found to be successful and feasible in the Kaluakauila-01 WCA.

IP MU: Kahanahāiki

This MU was fence in 1996 and is currently ungulate free. Numerous WCAs were established in this MU 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, however, 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.

Ungulate Control Efforts

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 has scoped out the route and have determined the best route of the fence line 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 operational since 1999. These groups have been very effective, removing 210 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).

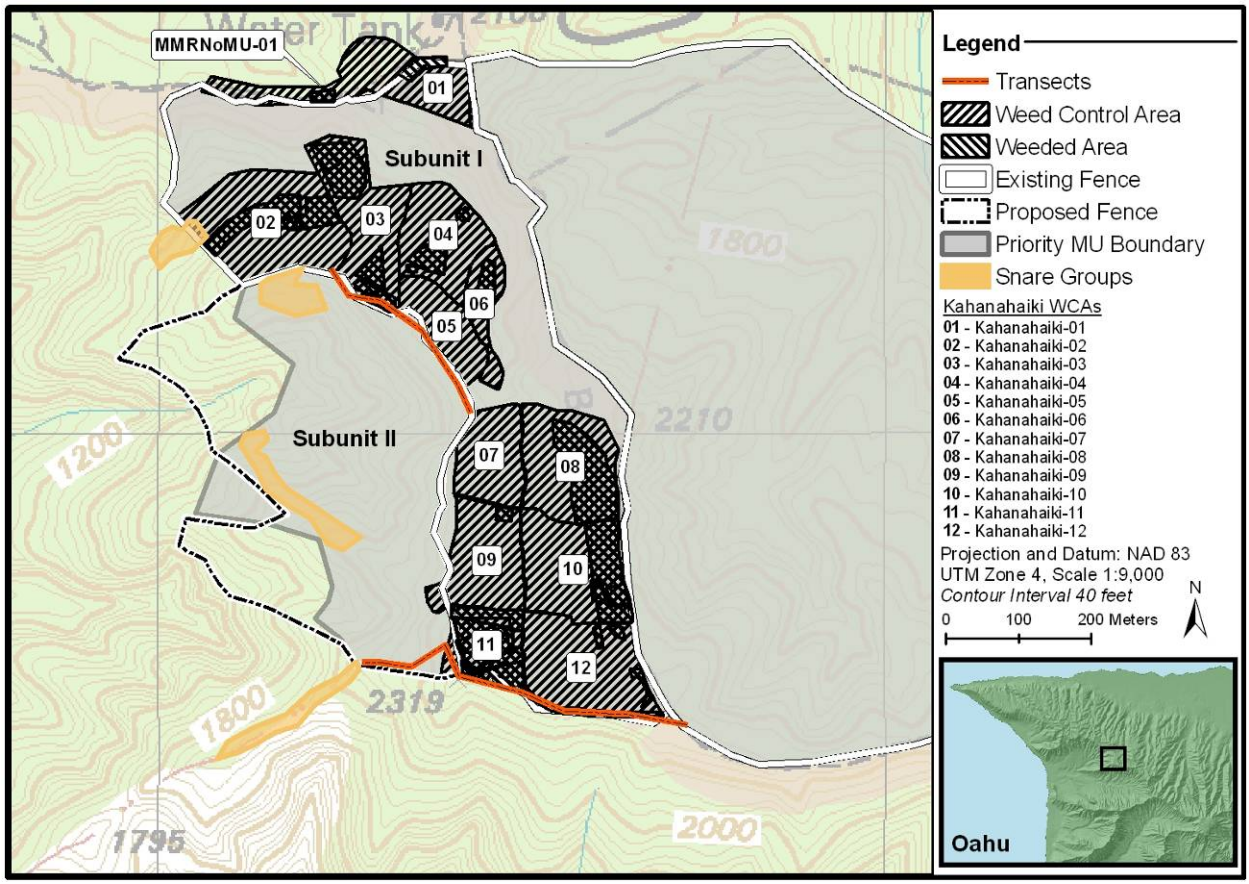


Figure 1.4.8 Ecosystem Management in Kahanahāiki, Makua Military Reservation

Transect Discussion

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

WCA Discussion

Kahanahāiki-01; Black Wattle

This WCA is easily accessible to NRS because it is near the trail head. Last year, NRS weeded this area targeting Molasses grass (*Melinis minutiflora*) that has been trying to outcompete the native seedlings and outplanted Koa in the area. Volunteer groups help with the outplanting of 50 Palapalai (*Microlepia strigosa*) in this area to compliment NRS weeding efforts. Ninety-two percent of the outplanted native ferns have survived and are looking healthy. NRS plan on revisiting this area two times next year to continue efforts of killing the invasive grasses and continue common reintros.

Kahanahāiki-02; Ptemac/Generals

For fiscal year 2007, NRS conducted weed sweeps through 0.59ha or 22.5% of this WCA (Table 1.4.6). There are two important outplanting sites in this area, one for *Cyanea superba* subsp. *superba* and *Delissea subcordata* and the other for *F. neowawraea* and *A. macrococcus* var. *macrococcus.* Most of the weed control effort this year was focused on outplanting site maintenance and weeding surrounding areas to increase the buffer zone. Any additional time

was spent weeding forest with fairly intact native canopy on the western portion of the WCA. Next year, NRS will continue to hit the priority sites first and if there is time, expand weed sweeps in the northern portion of the WCA.

Table 1.4.6 Summary of Kahanahāiki Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Kahanahaiki						
Kahanahaiki-01	Habitat	0.68	0.11	16.08%		
Kahanahaiki-02	Habitat	2.63	0.59	22.50%	LepArb, PteMac	AleMacMac, CyaSupSup, DelSub, FluNeo, SchObo
Kahanahaiki-03	Habitat	3.65	1.46	39.88%	AlpPon	CyaSupSup, DelSub, FluNeo, SchObo
Kahanahaiki-04	Habitat	1.40	0.19	13.59%	DieFal	CenAgrAgr, CyrDen, FluNeo, SchNut
Kahanahaiki-06	Habitat	0.58	0.14	24.96%		CyaSupSup, CyrDen
Kahanahaiki-08	Habitat	1.86	0.76	40.83%		CenAgrAgr, SchNut, SchObo

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

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	37.75	AgeRip, BudAsi, ChrPar, CliHir, CorFru, GreRob, LanCam, PsiCat, PsiGua, RubRos, SchTer, SyzJam
Totals	3	37.75	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	5.00	MelMin, OplHir
Ecosystem Weed Control	4	40.00	BudAsi, CliHir, PsiCat, RubRos, SchTer
Totals	6	45.00	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	0.50	MelMin
Totals	1	0.50	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	6.00	BudAsi, CliHir, PsiCat, RubArg
Totals	1	6.00	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	6.00	GreRob
Totals	1	6.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Kahanahaiki-09	Habitat	1.41	0.27	19.50%		CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	32.00	PsiCat, PsiGua, SchTer
Totals	3	32.00	

Kahanahaiki-10	Habitat	1.90	0.86	45.28%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	31.00	BudAsi, CliHir, GreRob, PsiCat, RubRos
Totals	3	31.00	

Kahanahaiki-11	Habitat	1.04	0.97	93.50%		CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	5	103.00	BudMad, ChrPar, CliHir, GreRob, LanCam, PsiCat, RubRos, SchTer, StaDic
Totals	5	103.00	

Kahanahaiki-12	Habitat	2.12	0.22	10.50%		CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	85.50	BudAsi, CliHir, LanCam, PsiCat, RubRos, SchTer, SpaCam, StaDic, SyzCum
Totals	4	85.50	

MMRNoMU-01	Habitat	2.15	0.59	51.19%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	3.00	MelMin, PanMax, PasCon
Ecosystem Weed Control	1	2.00	AcaMea
Totals	3	5.00	

Total IPMU: Kahanahaiki						
		19.41	6.16	31.74%	31	352.75

Kahanahāiki-03; Ethans Gulch

NRS weeded this WCA seven times this past year; on three of those visits they focused their efforts on spraying the invasive grasses. One volunteer group assisted in the weeding efforts of this area which contains a wide diversity of outplanted native plants. NRS plan on weeding this area quarterly next year and hope to compliment their weeding efforts with the outplanting of more common native plants.

Kahanahāiki-04; Aunty Barbs

This WCA contains a variety of endangered species and all weeding efforts are performed in close proximity to these plants. NRS visited this area two times last year; one of those visits was to spray *M. minutiflora*. Two volunteer groups assisted in the outplanting of *M. strigosa* in this

WCA last year. Ninety-eight percent of those plants have survived this past year and appear healthy. NRS plan on weeding this WCA quarterly next year. NRS will focus their efforts on controlling the weeds that have become established in the light gaps. This is mainly the result of killing the weedy tree canopy species in the past.

Kahanahāiki-05; Schwepps/Pink Trail

NRS visited this site once last year which coincides with the prior years weeding efforts. The prior years weeding efforts focused on spraying Molasses grass while this past year's efforts focused on weeding mainly weedy tree canopy species. NRS will visit this WCA two times next year and will focus their efforts on the weedy grasses and shrubs in close vicinity to the outplanted endangered plants.

Kahanahāiki-06; Upper Gulch

This WCA was visited once last year and focused mainly along the gulch bottom where a majority of the Ha'iwale (*Cyrtandra dentata*) is located. NRS plan on revisiting this WCA two times next year. They will focus their efforts in the gulch bottom in efforts to increase *C. dentata* habitat.

Kahanahāiki-07; North Western Quadrant

This WCA was not visited this past year but NRS plan on revisiting this WCA quarterly next year. NRS will mainly be targeting the weeds in the gulch where most of the native vegetation is found.

Kahanahāiki-08; North Eastern Quadrant

The eastern side of the Kahanahāiki exclosure is dominated by introduced weeds. NRS weed control efforts are focused on the remnant patches of native forest found in the central portion of the WCA and around the wild *C. agrimonioides* var. *agrimonioides* population. This year the only activity that occurred in this WCA was a *Grevillea robusta* sweep over 40% of the total area (Table 1.4.6). Next year, NRS plans to continue sweeping the area for *G. robusta* and to maintain priority areas if needed.

Kahanahāiki-09; Middle Western Quadrant

This site was weeded three times last year and volunteers were involved in all of those trips. There is a noticeable increase in the native understory such as Maile (*Alyxia olivaformis*). NRS has refined it's techniques by sparing the larger trees and concentrating weeding effort on the understory, which consist of immature *Psidium cattleianum* and *Clidemia Hirta*. This technique is done to minimize large scale disturbance in the form of light gaps which in the past has led to insurmountable *P. cattleianum* resprouts. Within the past year, NRS has attempted to fly in a chipper to facilitate slash disposal. Unfortunately, there were load complications and the helicopter was unable to fly in the chipper. Additionally, *M. strigosa* was later outplanted in these areas to aid in the reestablishment of native groundcover. To date, 80% of the ferns outplanted are still alive and slowly beginning to spread. NRS will visit this site quarterly next year to continue their efforts in clearing invasive understory and out-planting more common native flora.

Kahanahāiki-10; Middle Eastern Quadrant

This WCA is primarily dominated by introduced weeds. Though there are a few patches of native forest along the one gulch that runs down the eastern portion of the WCA, there are many thick stands of *P. cattleianum*. In recent years, volunteer groups were utilized in an effort to remove these stands of *P. cattleianum*. This year, most of NRS effort was spent retreating some of these *P. cattleianum* removal areas, and conducting a *G. robusta* sweep down the eastern side of the WCA (Table 1.4.6). Next year, NRS plans to conduct weed sweeps in the more native areas, hopefully with the help of volunteer groups. NRS will also be exploring the possibility of outplanting native canopy species to rehabilitate the area and reduce weed recruitment.

Kahanahāiki-11; South Western Quadrant

This area was swept five times within the last year. Additionally, *Triumfetta semitriloba* was found in this WCA in the past and monitoring for germination has been conducted with each weed sweep. Only two plants were found in the past year and NRS will continue to monitor the WCA for any other seedlings. Spreading native seeds from common native plants such as, *Diospyros sandwichensis*, and *Hedyotis terminalis* was also implemented to supplement weeding sweeps. The results have been moderate to successful with once monotypic stands of *P. cattleianum* giving way to native recruitment of *A. olivaformous* and *M. strigosa*. NRS will visit this site quarterly next year in efforts of increasing native plant diversity.

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 four times this year (Table 1.4.6). During one trip, the south fence line was cleared of weeds by a big volunteer group. The rest of NRS activities focused mainly on weeding the nice forest patches. The entire WCA was swept for all weeds in March 2005, and is scheduled for retreatment again in the coming reporting year.

MMRNoMU-01; Black Wattle Outside the MU

This WCA was weeded three times last year and efforts focused on spraying the grass along the fence (Table 1.4.6). The fence was not visible and vehicles were hitting it. This WCA will be visited quarterly next year to keep the grass from covering up the fence again.

IP MU ‘Ōhikilolo

The ‘Ōhikilolo MU lies between Mākua and Mākaha valleys (Figures 1.4.8-12). 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*. The entire MU is threatened by fire originating from live firing training within MMR as well as from roadside fires started on Farrington Highway.

This MU is divided into two separate regions, ‘Ōhikilolo Ridge and Lower Mākua. Most of the ‘Ōhikilolo Ridge WCAs (Ohikilolo-3, 4, 6, 8, 9, 10, 11, 13, 14, 17 and 19,) are centered around

IP taxa and native forest patches. Figure 1.4.11 is a close up of several of these WCAs. On ‘Ōhikilolo Ridge there is much variation among WCAs in the level of weeding effort they receive. Some WCAs, like ‘Ōhikilolo-10, are predominantly 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 Lower Mākua WCAs (‘Ōhikilolo-05, 07, 12, 15, 16 and 18) are comprised of a montage of predominantly native to weedy patches of forest (Figures 1.4.9 and 1.4.10). NRS felt that the best approach was to begin weeding operations in the native patches first, then spread out to the more weedy areas. This method of landscape level weeding should allow the native patches time to regenerate and spread. NRS believe that a two year re-visitation frequency should be appropriate for this but also realize that it is a very long process.

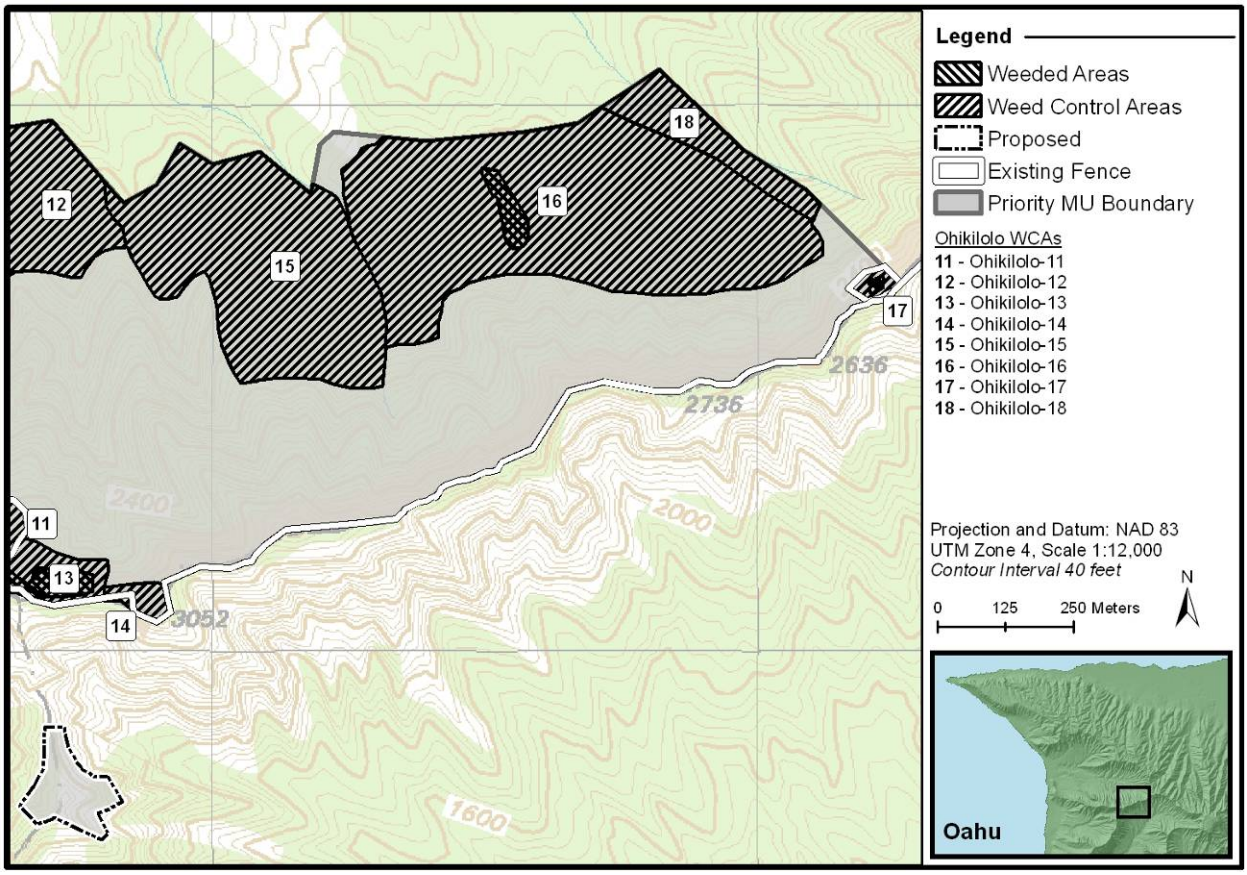


Figure 1.4.9 Ecosystem Management in ‘Ōhikilolo – Eastern Section, MMR

A perimeter fence was completed in 2000 that separates the MU from the adjoining ‘Ōhikilolo Ranch and Kea‘au Game Management Area (GMA) to the south, which have large populations of feral goats (Figures 1.4.9, 10, 12). Six PU enclosures and one small ecosystem management enclosure have also been constructed within the MU. All of these enclosures have remained ungulate free and are checked quarterly. All of Mākua Valley has been free of feral goats since 2001. Breaches in the perimeter fence have been known to occur since its completion in 2000. NRS were able to repair the breaches and the goats were removed. Monitoring for ungulate activity in the ‘Ōhikilolo MU coincides with quarterly inspections of the perimeter fence.

NRS was able to regain permission to camp at the Lower Mākua portions of the ‘Ōhikilolo MU this year. There is a 1,200 m strategic fence is slated for construction in Year 7 of the MIP within this portion of the MU. At this time, it is getting more difficult to construct fences within impact areas due to safety issues. NRS would like to look at an alternative to building the strategic fence and see if it will still be necessary to construct. This would entail completing the perimeter fence on the North side of the valley from the Kahanahāiki MU fence to the Kaluakauila MU fence. Once this was completed, NRS would then try to eradicate all of the pigs left within using as many resources as possible. If this is successful, this would create an ungulate free valley. If this is unsuccessful, then NRS would continue with the strategic fence plan and try to work out any safety concerns.

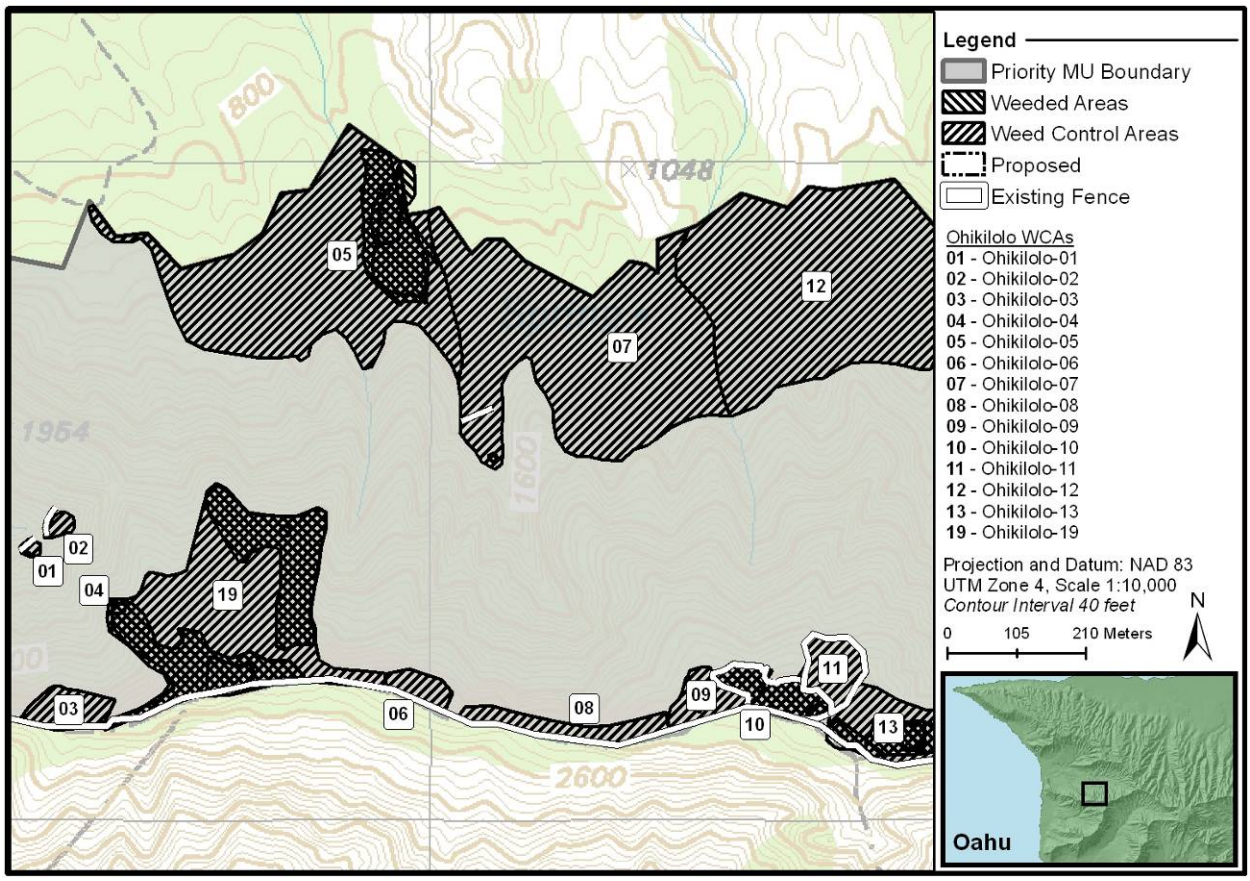


Figure 1.4.10 Ecosystem Management in ‘Ōhikilolo – Western Section, MMR

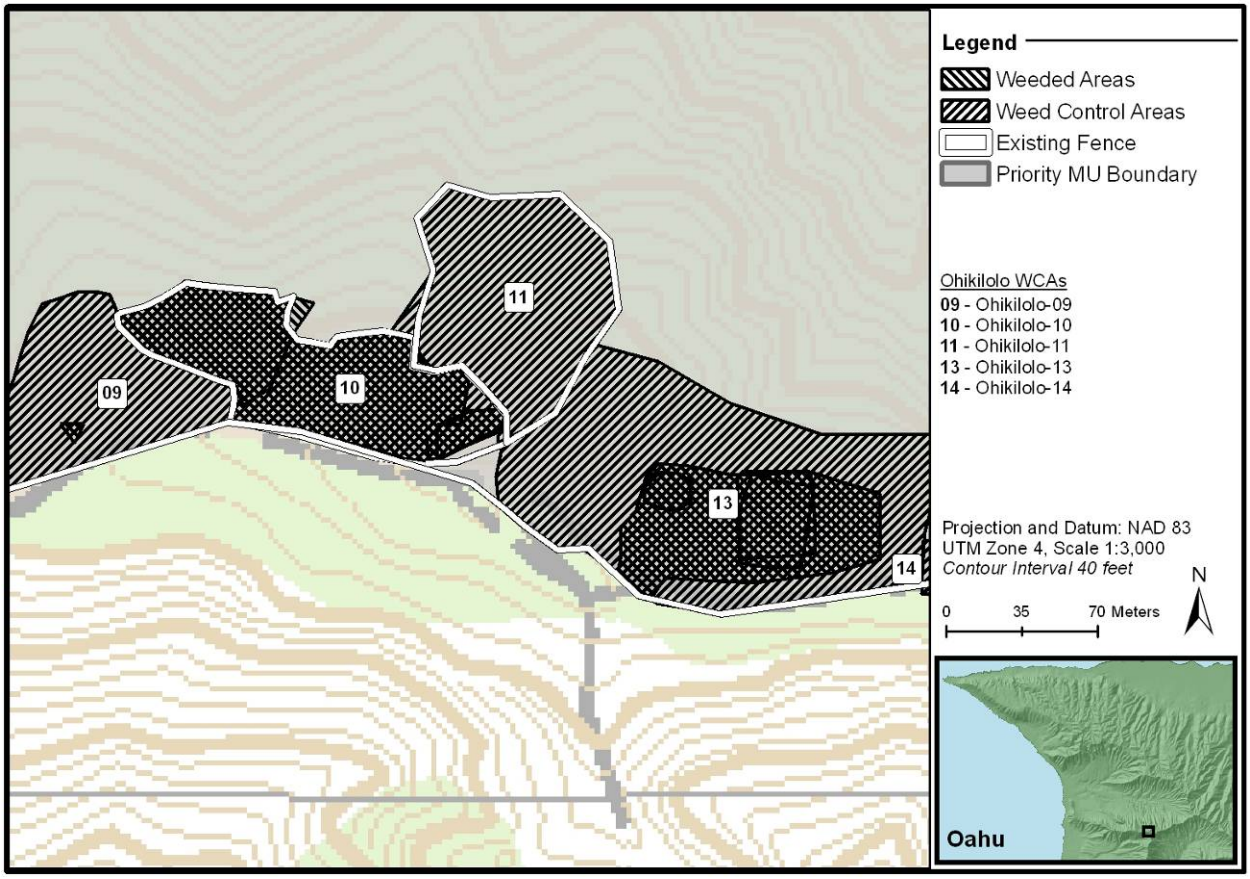


Figure 1.4.11 Ecosystem Management in ‘Ōhikilolo – Fence Exclosures Section, MMR

Ungulate Control Efforts

Monitoring of ungulate activity in the ‘Ōhikilolo MU coincides with quarterly inspections of the ridge fence. In September 2006, four small goats breached the ‘Ōhikilolo ridge fence from Kea‘au. Fortunately, the breach was detected early enough for the goats to stay within proximity of the fence. All four goats were removed via snares. Figure 1.4.12 shows where the snares were put up (shaded area) and the goats were caught in the circled areas (goat sign). Later visits revealed an absence of goat sign. This fence will continue to be pressured by goats from the neighboring Kea‘au GMA. NRS will work this year to re-enforce the areas of the fence undermined by erosion.

The two PU fences protecting *Neraudia angulata* in ‘Ōhikilolo-01 and 02 were damaged by rock-fall this year (Figure 1.4.10). NRS completed general maintenance for the damage when discovered but more comprehensive repairs are needed on the next visit. NRS will also evaluate the need to reinforce the fences.

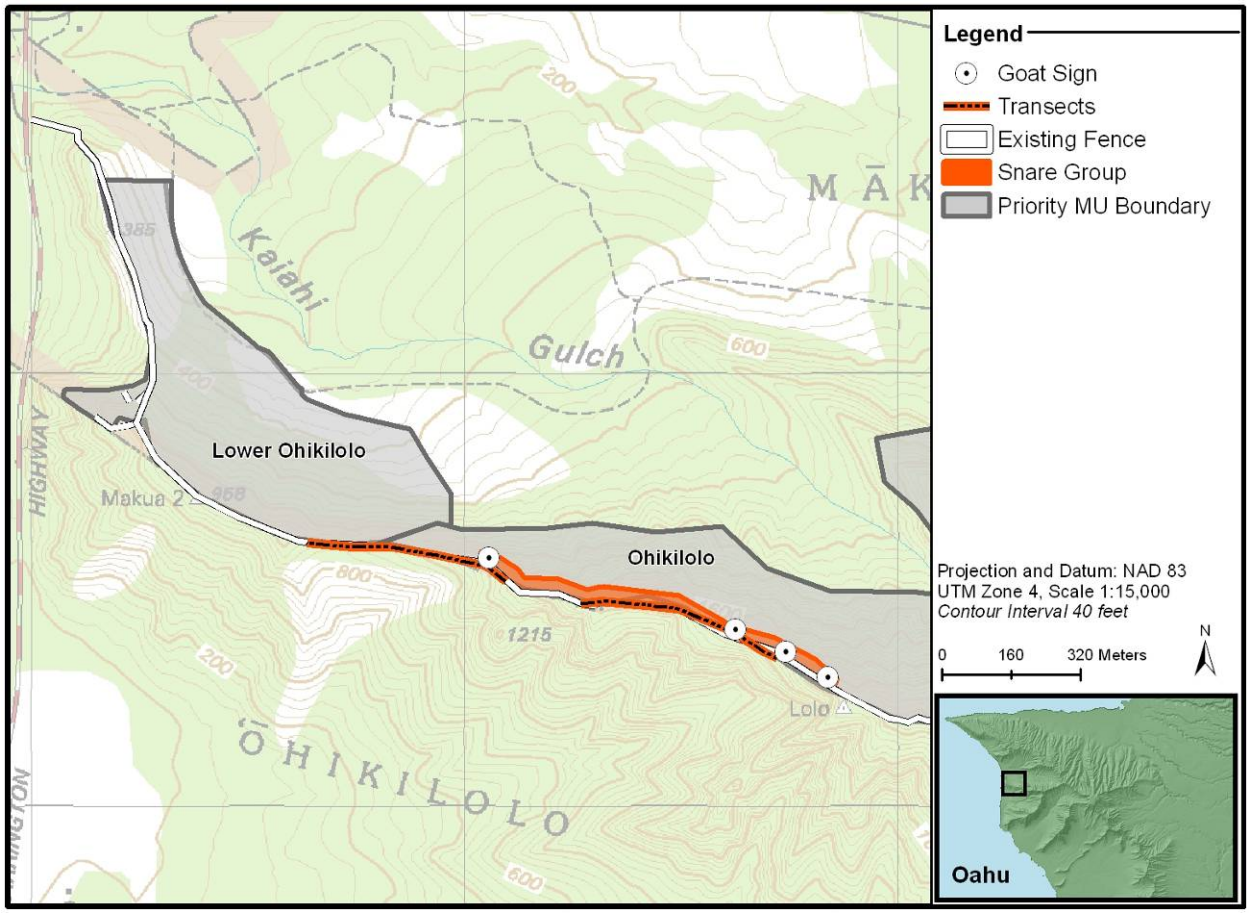


Figure 1.4.12 Ungulate Activity in Western Portion of ‘Ōhikilolo

Transect Discussion

There are two transects along the ridge fence in this MU. These transects only detect the presence or absence of ungulates within the MU and serve as an instrument to detect new weed invasions. No new significant weeds were identified.

Table 1.4.7 Summary of ʻŌhikilolo Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Ohikilolo						
Ohikilolo-01	Habitat	0.06	0.01	8.40%		MelTen, NerAng

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.00	AgeAde, AgeRip, BudAsi, ChrDen, SchTer, SpaCam
Totals	1	3.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-05	Habitat	18.57	3.30	17.77%	BobSan	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	6.00	DigIns, PanMax, RhyRep
Ecosystem Weed Control	2	21.00	BudAsi, LeuLeu, MelAze, MonHib, PasEdu, PasSub, PluCar, PsiCat, PsiGua, SchTer, SyzCum, TooCil, TriSem
Totals	3	27.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-07	Habitat	10.07	0.01	0.10%	BobSan, BonMen, LobNii, NesPol	DubHer, MelTen, NerAng, NotHum

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	15.00	AgeAde, AgeRip, BleApp, HelPop, KalPin, MonHib, TriSem
Totals	1	15.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-09	Habitat	0.63	0.00	0.76%		AleMacMac, DubHer

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	1.00	GreRob, SchTer
Totals	1	1.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-10	Habitat	0.75	0.74	97.86%		PriKaa, SanMar

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	96.00	AgeAde, AgeRip, BleApp, BudAsi, EriKar, RubRos, SchTer, StaDic
Totals	2	96.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-13	Habitat	3.30	1.12	33.97%	MelMak, NotLon, PteMac	PriKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.50	MelMin, PasCon, SetGra
Ecosystem Weed Control	3	28.00	AgeAde, AgeCon, AgeRip, BleApp, BudAsi, ChrPar, KalPin, LanCam, RubRos, SchTer, StaDic
Totals	4	29.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-16	Habitat	22.65	0.56	2.46%	BobSan, PteMac	AleMacMac, MelTen

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	28.00	CliHir, GreRob, LanCam, PsiCat, PsiGua, SchTer, SyzCum, TooCil
Totals	1	28.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-17	Habitat	0.36	0.06	16.28%		PriKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	7.00	AgeAde, AgeRip, ChrPar, GreRob, PsiCat, RubRos, SchTer
Totals	2	7.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ohikilolo-19	Habitat	7.28	3.55	48.71%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	20.00	GreRob, SchTer
Totals	2	20.00	

Total IPMU: Ohikilolo						
		63.67	9.34	14.67%	17	226.50

WCA Discussion

‘Ōhikilolo-01; NerAng South Fork

‘Ōhikilolo-01 is located in the south fork of Ko‘iahi Gulch (Figure 1.4.10). This WCA is dominated by weeds and NRS intends to conduct weeding operations once a year to encourage *N. angulata* recruitment. NRS visited this WCA one time this year (3 person hours) to conduct weeding operations (Table 1.4.7). Two staff were able to cover about 9% of the WCA, focusing weeding efforts around the wild population of *N. angulata*. So far, it seems that the combination of ungulate removal and weeding has been beneficial to the population. There are more plants at the base of the cliff than previously known. Only a small percentage of the WCA was covered as NRS spent a majority of the time conducting fence repairs.

‘Ōhikilolo-02; NerAng North Fork

‘Ōhikilolo-02 is located in the north fork of Ko’iahi Gulch (Figure 1.4.10). NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year but will conduct weeding when monitoring this year.

‘Ōhikilolo-03; ‘Ōhikilolo Ko‘iahi Prikaa-I

This WCA is home to an outplanted population of *P. kaalae* and a handful of other rare species (Figure 1.4.10). The habitat it contains is patchy, with some very nice native stands of understory species, but it is almost completely dominated by *S. terebinthifolius* in the overstory. No weed control was conducted at this site this year, but during other work, NRS noted that last year’s *Grevillea robusta* treatment was very effective. Limited weed control is necessary at this time. At present, it is felt that removal of the overstory would be detrimental to shade-loving native understory plants. 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.

‘Ōhikilolo-04; ‘Ōhikilolo Prikaa-B

This tiny WCA contains a small population of wild *P. kaalae*. The population is made up of three mature trees at the edge of a steep cliff (Figure 1.4.10). Since this PU is not designated MFS, NRS spend minimal time here. No weed control effort was conducted this year. It is unclear how NRS will manage this population in the future; 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. NRS will visit this WCA once in the coming year and target any small herbaceous plants and grass directly affecting the *P. kaalae*.

‘Ōhikilolo-05; Road to Nerang Gulch

‘Ōhikilolo-05 is located in Lower Mākua starting from the fire break road spanning across to Nerang gulch (Figure 1.4.10). NRS visited this WCA three times this year (27 person hours) to conduct weeding operations (Table 1.4.7). Nine staff were able to spend to cover about 18% of the WCA conducting ecosystem weed and grass control. Most of the area covered had been weeded prior but needed some clean-up of both new and re-sprouts and for encroaching grass. Overall, it seems that the weeding operations have been beneficial for the ecosystem. It appears that the weed populations in this area have diminished quite a bit without a great deal of re-colonization being observed.

‘Ōhikilolo-06; ‘Ōhikilolo Sanmar-A

This WCA surrounds a population of *Sanicula mariversa* found on a steep cliff (Figure 1.4.10). 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. Cliff weeding of grasses and weedy trees will be considered. NRS will also monitor the possible influx of *Stachytarpheta dichotoma* to the site, and treat it and other common fenceline weeds as necessary.

‘Ōhikilolo-07; Nerang to Past Well Ridge

‘Ōhikilolo-07 is in Lower Mākua along the blue trail from the Nerang gulch to the other side of the Well Ridge (Figure 1.4.10). NRS visited this WCA once this year (15 person hours) and focused the weeding operation within a fenced site of wild and reintroduced populations of *N. angulata* and *Nototrichium humile* (Table 1.4.7). This fenced area comprises a very small percentage of the entire WCA but is to be the site for additional outplantings. Five staff were able to cover about 50% of the fenced area conducting ecosystem weed control. Anecdotally,

NRS have noticed an increase in native fern cover in the gulch bottom likely due to the removal of feral ungulates and weeds such as *Ageratina riperia, A. adenophora* and *R. rosifolius*.

‘Ōhikilolo-08; ‘Ōhikilolo Transect 9 Ridgeline

Located along the top of the ‘Ōhikilolo ridgeline, the WCA encompasses some very weedy zones, as well as some patches of native scrub (Figure 1.4.10). NRS expended no weeding effort in this WCA during the 2006-07 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*.

‘Ōhikilolo-09; ‘Ōhikilolo Makai of Exclosure

Just below the intensively managed Forest Patch Exclosure, little effort has been expended in the WCA thus far (Figure 1.4.11). It contains some lush patches of native forest and ferns. As little weeding has been conducted here, it is an ideal site to set up a monitoring plot inside to document and measure the effects of weeding on habitat structure and composition. NRS will pursue this option when the new monitoring program is initiated. Until then, very little effort will be expended in the WCA. This year, NRS treated canopy weeds *S. terebinthifolius* and *G. robusta* in a small area.

‘Ōhikilolo-10; ‘Ōhikilolo Forest Patch Exclosure

Surrounded by a fence, the Forest Patch has been goat-free and managed for weeds for almost 10 years (Figure 1.4.11). Almost 100% native, this area is thick with native ferns, *A. mustelina*, and reintroduced *P. kaalae*. The only weed-dominated portions of this WCA remaining include portions of the fenceline, a 10x10m open gap home to a *Sanicula mariversa* reintroduction, and a 30x30m slope in the far eastern corner of the exclosure.

Generally, the control strategy for this WCA is to thoroughly sweep across it once or twice a year, treating any understory weeds found. *Rubus rosifolius* is the most common understory weed; it thrives in light gaps but also can become established in semi-shade. Control efforts are summarized in Table 1.4.7. NRS swept all of the WCA except the weedy eastern corner once this year. Part of the western portion was swept twice. Sweeping the WCA more often results in less time needed per sweep, but weed control necessarily results in the trampling of some native ferns; NRS must balance these two factors in determining control frequency. NRS strive to reduce understory impacts. Weeding effort has decreased over time as natives gradually colonized open areas. Overall, this WCA is doing spectacularly. No grass control was required at all this year. NRS have noted that native ferns seem to be responding well, and are filling in understory areas.

The weedy eastern slope of the WCA was partially weeded once in the last year. Koa trees outplanted in previous years now reach five meters in height and are providing some much needed shade. *Stachytarpheta dichotoma* and *A. adenophora* were cleared from around the koa this year. NRS hope to expand on the success of these common reintroductions in the coming year by planting more koa into the area, as well as palapalai. Weed control will continue to focus around these reintroductions.

‘Ōhikilolo-11; ‘Ōhikilolo Prikaa-A Fence

Encompassing the largest wild population of *P. kaalae* on ‘Ōhikilolo ridge, this WCA is defined by a 1.9 acre fence (Figure 1.4.11). The site is dominated by *S. terebinthifolius* and a weedy understory. Previous weed control efforts focused on clearing *S. terebinthifolius* to create more light for *P. kaalae*. NRS expended no weeding effort here during the 2006-2007 reporting year. NRS plan to conduct understory and limited canopy control once in the next year.

‘Ōhikilolo-12; Rons Rock to Dividing Ridge

‘Ōhikilolo-12 is located in Lower Mākua along the blue trail from Ron’s Rock on the Well Ridge to the Dividing Ridge (Figure 1.4.9). NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year but will do so this year.

‘Ōhikilolo 13; ‘Ōhikilolo Mauka Patch

This WCA encompasses three small gulches located just mauka of the camp LZ (Figure 1.4.11). The habitat is patchy, with some portions of the area dominated by native canopy, some by *Cibotium glaucum*, and some by weedy *S. terebinthifolius*. Understory species are similarly patchy; almost half of the area is covered by *Blechnum appendiculatum*, but some regions are thick with native ferns. Typically, weed control across this WCA has focused on grasses (*M. minutiflora*) and understory weeds, especially *Rubus rosifolius*, *S. dichotoma*, and both *Ageratina* species. Limited canopy control is conducted, since areas dominated by *S. terebinthifolius* tend to also be dominated by *B. appendiculatum*. NRS spend a significant amount of time and effort in this WCA as it includes several resources, including a large *P. kaalae* reintroduction, *Achatinella mustelina*, and *Pteralyxia macrocarpus*. Control efforts are summarized in Table 1.4.7.

Generally, weed control has focused in the middle of the three gulches, *Pteralyxia* gulch. Last year, NRS swept this area twice. *Rubus rosifolius* was much less plentiful than in previous years, suggesting past efforts are paying off. Fewer trips and less time were needed to cover the same amount of area. NRS will monitor this gulch quarterly and sweep it 2-3 times in the next year. NRS also plan to begin palapalai reintroductions to the area to jumpstart native colonization of open, weedy, eroding spots in this gulch.

The westernmost of the gulches, nicknamed Lantana gulch, is very patchy. One slope is dominated by native species, the gulch bottom is dominated by weeds, and the other slope is dominated by grasses and *S. terebinthifolius*. Koa planted into the gulch bottom in previous years are now reaching four to five meters in height. The area was treated once this year; NRS focused on clearing weeds from around the koas and from the margins of the native dominated slope. Some native ferns appear to be colonizing the gulch bottom. In the coming year, NRS plan to expand common native reintroductions and weed the area twice.

The easternmost of the gulches, *Myrsine* gulch, is almost completely covered by *B. appendiculatum*. NRS do not currently have a viable method for treating this fern, and no large scale weeding occurred in this gulch this year. Previous treatment trials of *B. appendiculatum* have been unsuccessful. This year, NRS installed a new trial, testing a technique which appeared effective in Kahanahāiki. Two plots were installed. The boundaries of the plots were dug out with a pick; all stolons and roots were cleared from the 8-10cm wide borders to a depth of 5-

8cms. Then the plots were sprayed with 5% Garlon 4 in water. The only difference between the two plots is size: Plot 1 is 4x4m, and Plot 2 is 2x2m. Results from this trial are pending. If successful, NRS will strategize how best to use this new technique.

Melinus minutiflora is found across this WCA. This grass forms dense mats which may inhibit seedling germination and growth. All three gulches were treated on one trip this year. NRS will continue grass control as needed, twice a year.

‘Ōhikilolo-14; ‘Ōhikilolo Tetramolopium Peak

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 *Tetramolopium filiforme* (Figure 1.4.9). When grasses again threaten the *T. filiforme*, NRS will resume control.

‘Ōhikilolo-15; Dividing Ridge to Campsite

‘Ōhikilolo-15 is located in Lower Mākua along the blue trail going from the Dividing Ridge to the campsite (Figure 1.4.9). NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year but will do so this year.

‘Ōhikilolo-16; Campsite to Arch Site

‘Ōhikilolo-16 is located in Lower Mākua along the blue trail going from the campsite to the archeological site in the back (Figure 1.4.9). NRS visited this WCA once this year (28 person hours) and focused the weeding operation within a large, continuous patch of predominantly native forest that had been previously weeded (Table 1.4.7). Four staff were only able to cover about 3% of the entire WCA conducting ecosystem weed control. This patch is a very small percentage of the entire WCA but NRS is considering placing MIP taxa outplantings here in the future. The most dominant weed in the area is large *P. cattleianum* trees, but individuals are few and far between. The native canopy and understory are healthy with little room left for invasive weeds. Overall, it seems that the weeding operations have been beneficial for the ecosystem. It appears that the weed populations in this area have diminished quite a bit without a great deal of re-colonization being observed.

‘Ōhikilolo-17; ‘Ōhikilolo Ctesqu Ridge Prikaa-G

This WCA is defined by a small fence erected to protect a reintroduction of *P. kaalae* (Figure 1.4.9). The overstory in this steeply graded habitat is largely native-dominated with some aliens, primarily *S. terebinthifolius*. The largely open understory is dominated by herbaceous alien species such as *B. appendiculatum* and *A. adenophora*. The outplanting has been swept twice this year. Understory weeding is a priority in this WCA. Previous weeding efforts have made a significant impact on *A. adenophora*, but it remains common. NRS targeted it and other understory weeds this year (Table 1.4.7). A few canopy species, in particular *G. robusta*, were also targeted. Efforts focused on clearing around the reintroduced plants and clumps of native ferns. In the coming year, NRS plan to expand understory weed control during bi-annual sweeps through the outplanting site, possibly remove some of the non-native canopy trees to ensure optimal habitat for the outplanted *P. kaalae*, and consider common reintroduction options.

‘Ōhikilolo-18; CteSqu Ridge to FluNeo

‘Ōhikilolo-18 is located in Lower Mākua along the blue trail going from the Ctesqu ridge above the Arch site to the Fluneo ridge area (Figure 1.4.9). NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year but will do so in the future.

‘Ōhikilolo-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* (Figure 1.4.10). This year, NRS expanded the boundary of this WCA to include the region between WCAs 3 and 6, reaching from the fence down several walkable ridges to a hanging gulch home to a large patch of native *Pisonia* (Figure 1.4.14). Over the course of two trips, almost half of this large WCA was swept (Table 1.4.7). In the treated areas, all *G. robusta* reachable without ropes were killed. In addition to targeting *G. robusta*, NRS also weeded directly around the *Pisonia* patch. Before goats were eradicated from the area, the hanging gulch was a popular resting spot, and thus was highly degraded. Goats have been absent from the area for several years. Encouragingly, hundreds of seedlings sprung up around the two mature *Pisonia*. See photo below. A few *S. terebinthifolius* directly around the seedlings were treated to create more favorable growing conditions for the seedlings. Next year, NRS plan to sweep the rest of the WCA for *G. robusta*. Once an initial sweep is complete, retreatment may not be necessary for several years. NRS will also monitor the *Pisonia* patch and conduct minimal weeding as needed.

Figure 1.4.13 *Pisonia* seedlings recruiting in goat-free habitat at ‘Ōhikilolo

IP MU: Lower ‘Ōhikilolo

According to the 2007 BO (USFWS 2007), OANRP is required to remove all standing live and dead grass from within two meters of all MIP stabilization plants in the MU. NRS not only maintains this two meter area, but removes all grass from with the seven hectares of the first three WCAs (Figure 1.4.15). Other contractors maintain the required, 60m strip along the south lobe of the firebreak road (grass has to be kept at a height of 30cm or less).

Maintenance weed control at Lower ‘Ōhikilolo continued this year as in previous years. There are four WCAs in the MU. 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 *Chamaesyce celastroidies* var *kaenana* 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 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. *Leucaena 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.

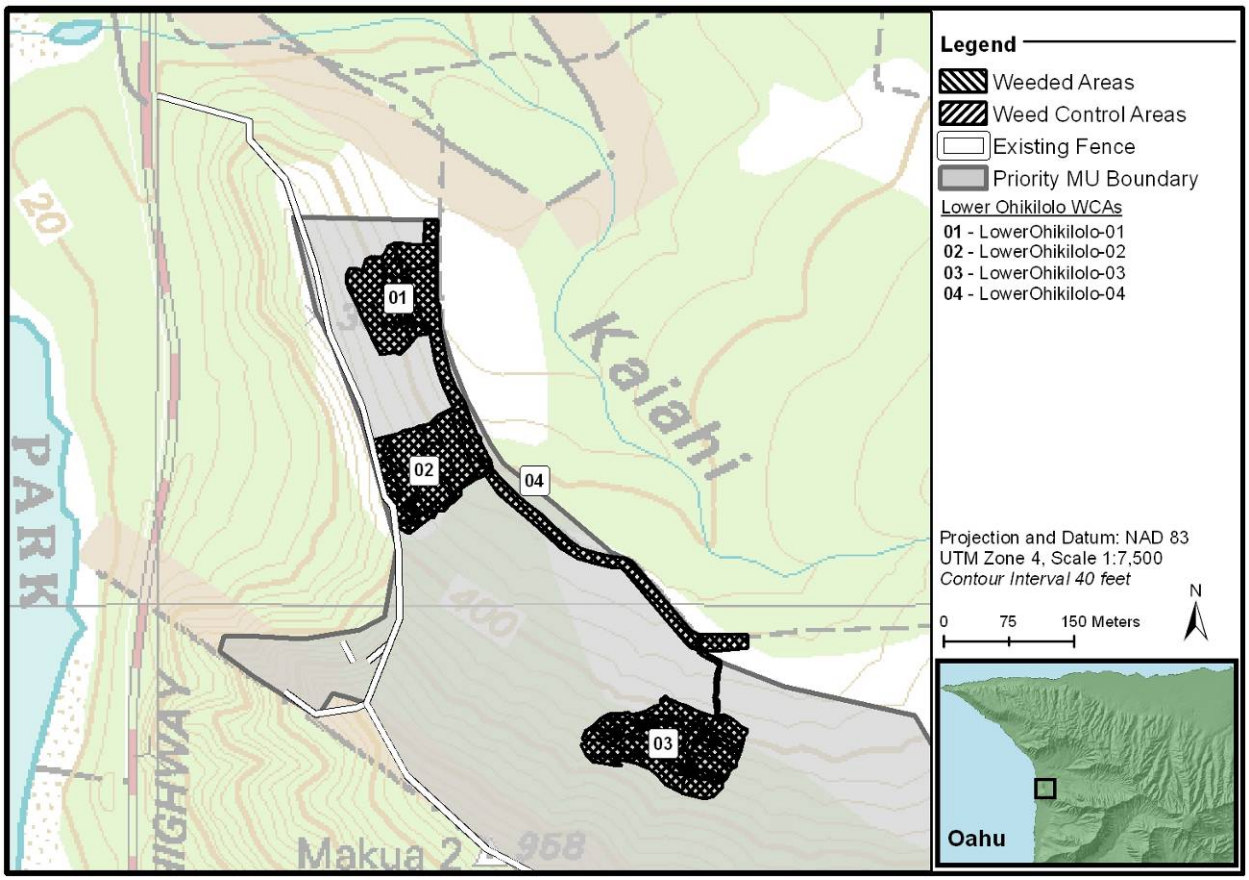


Figure 1.4.14 Ecosystem Management in Lower ʻŌhikilolo

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.
There is a perimeter fence ,completed in 1998, that separates the MU from the adjoining ‘Ōhikilolo Ranch to the south, which has large populations of feral goats (Figure 1.4.15). A strategic fence protecting an endangered population of *Melanthera tenuifolia* was erected in June 2002. No breaches have been observed since 2002.

Ungulate Control Efforts

In February 2006 a small hole was discovered along the perimeter ridge fence and goat sign was reported inside the fence (Figure 1.4.15). On a subsequent scoping trip, four goats were observed uphill of the *Hibiscus brackenridgei* ssp. *mokuleianus* population. NRS has since eradicated five goats and there have been no further breaches.

Figure 1.4.15 NRS conducting grass control at Lower ‘Ōhikilolo

Table 1.4.8 Summary of Lower ʻŌhikilolo Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Lower Ohikilolo						
LowerOhikilolo-01	Habitat	2.01	2.01	100.00%		ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	4	46.00	ChlSp., HypPec, LeoNep, LeuLeu, PanMax, RhyRep
Ecosystem Weed Control	6	74.00	AcaFar, BidPil, ChlBar, ChlSp., HypPec, LeoNep, LeuLeu, PanMax, RhyRep
Totals	10	120.00	

LowerOhikilolo-02	Habitat	2.39	2.39	100.00%		ChaCelKae

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	5	51.00	BraSub, ChlSp., PanMax, RhyRep
Ecosystem Weed Control	6	86.00	AcaFar, BidAlb, HypPec, LeoNep, LeuLeu, MacLat, PanMax
Totals	11	137.00	

LowerOhikilolo-03	Habitat	2.74	2.74	100.00%		HibBraMok

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	3	19.00	LeuLeu, PanMax, RhyRep
Ecosystem Weed Control	9	175.50	AcaFar, BidAlb, BidPil, ChlBar, HypPec, LanCam, LeoNep, LeuLeu, PanMax, PluSym, RhyRep
Totals	12	194.50	

LowerOhikilolo-04	Trail	0.68	0.68	100.00%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	4.00	PanMax, RhyRep
Totals	1	4.00	

Total IPMU: Lower Ohikilolo						
		7.81	7.81	100.00%	34	455.50

WCA Discussion

Lower ʻŌhikilolo-01 Lower *C. celastroides* patch

Fire is the primary threat to the *C. celastroides* patches at Lower ʻŌhikilolo. NRS has spent 120 person hours this year doing fire pre-suppression by controlling higher fuel content weed species such as introduced grasses and woody shrubs (Table 1.4.8). This included activities such as weedwhacking, *L. leucocephala* removal and grass spraying. While NRS was very successful at keeping the grass population to very low levels, and in removing the larger woody species, the broadleaf herbaceous weeds such as *Leonotis nepetifolia* and *Bidens pilosa* formed very thick monotypic patches over a good portion of the WCA. NRS tried to spray them as seedlings with Glyphosate, but at the end of the rainy season most plants had matured and seeded. These species are less of a fire hazard, but we are concerned about their affect on *C. celastroides*

seedling recruitment. Next year, we will continue grass control efforts, but we will also explore using other alternatives such as shade cloth, outplanting native species to rehabilitate the area, and we are also considering using pre-emergent herbicide on the lower roadside portions of the WCA.

Lower‘Ōhikilolo-02 Upper *C. celastroides* patch

The Upper *C. celastroides* patch is subject to all the same challenges that we are dealing with in the LowerOhikilolo-01 WCA. NRS spent 137 person hours this year (Table 1.4.8), reducing fire hazards in the upper patch by weedwhacking, removing *L. leucocephala* and by spraying the introduced grasses. Next year, we will continue with grass control efforts, but we will also explore other alternatives (listed above) to deal with the broadleaf weeds.

Lower‘Ōhikilolo-03 *H. brackenridgii*

The *H. brackenridgii* patch is subject to all the same challenges that we are dealing with in the LowerOhikilolo-01 WCA. NRS has spent 194 person hours doing fire pre-suppression activities this year (Table 1.4.8). Grass populations were kept to low levels, but for fiscal year 2008 we will explore alternatives to help control the weedy broadleaf plants that have established themselves in the three patches.

Lower‘Ōhikilolo-04; Lower ‘Ōhikilolo Roadside

Occasionally, NRS will use a power sprayer to herbicide the low portions of the three WCA at Lower ‘Ōhikilolo. At the end of the day, any excess herbicide is used to spray the road below and between the three patches. A new WCA was established to account for this roadside activity. This year, NRS spent four person hours spraying 100% of this WCA (Table 1.4.8).

Region: *Pahole Natural Area Reserve*

This region includes two IP MUs: Pahole and Upper Kapuna. These fenced and proposed fenced MUs are within the State’s Pahole NAR and access and weeding and ungulate projects here are done in coordination with the State NARS Specialist. The Pahole Gulch fence encompasses 215 acres of mixed native and alien mesic forest. Once completed, the combined Upper Kapuna subunits will encompass an additional 220 acres. Because these MUs are adjacent to the Kahanahāiki MU to the west and the proposed West Makaleha MU to the east, once all the fences are complete, this will essentially be 600 acres of mixed native and alien mesic forest in the Wai‘anae Mountains that will be ungulate free.

IP MU: Pahole Gulch

Pahole Gulch lies between Kapuna and Kahanahāiki Valleys in the Northern Wai‘anae Mountains (Figure 1.4.16). There are a total of ten WCAs within this MU, most of which are established around wild and outplanted populations of rare and protected plant species. Weed actions conducted in the gulch are based on objectives established through discussion between NRS and the NARS Specialist. These objectives include focusing weeding actions around wild and outplanted populations of rare and protected plant species, within areas that are largely native and require only occasional understory weeding, and on eradicating incipient species that are suggested by the NARS Specialist. At this time, NRS and NARS staff are still in the process

of developing an over-all weed control plan for the gulch. Goals will be established for the long-term objective for weed eradication within the MU.

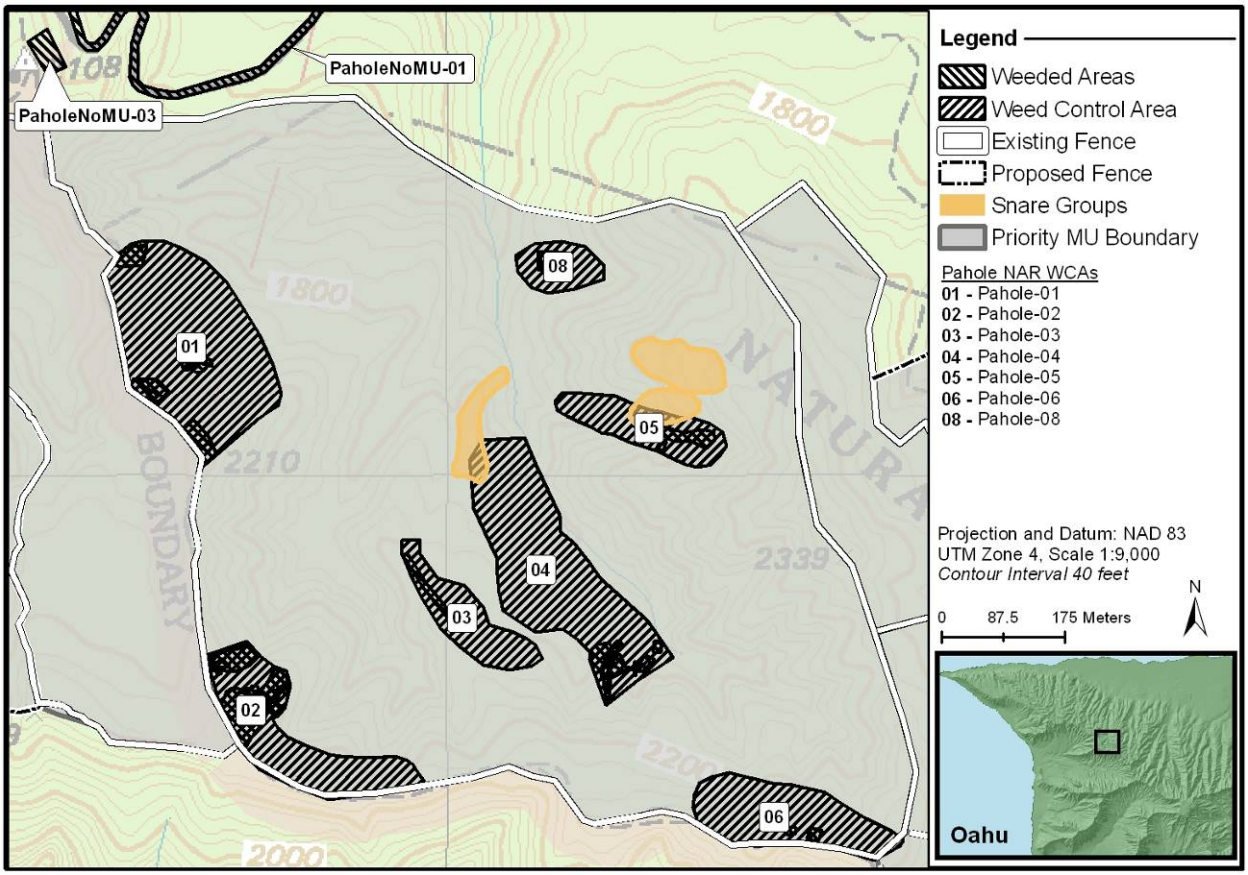


Figure 1.4.16 Ecosystem Management in Pahole

Ungulate Control Efforts

The Pahole Gulch MU has been fenced since 1997 and all of the ungulates were removed shortly after. In previous years, there have been a couple of breaches in the fence since but all animals were removed. NRS and NARS staff documented ungulate sign within the MU in February 2007. It is believed that four or five pigs breached the fence when they were very small and went undetected for several months. Action was taken by NARS staff to install a couple of snare groups to eliminate the animals (Figure 1.4.16). To date, four adults (three male and one female) and five piglets have been removed. NRS and NARS staff believe there are still a few more pigs within the fence but anticipate removing them within the next few months. It is still unclear how exactly these pigs did get in, whether they were small enough to fit through the bottom of the fence or if they were maliciously released. Inspection of the fence did not reveal any holes or damage that would allow a larger pig access.

Table 1.4.9 Summary of Pahole Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Pahole						
Pahole-01	Habitat	4.90	0.42	8.49%		CenAgrAgr, CyaSupSup, SchNut, SchObo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	16.50	ChrDen, ChrPar, LanCam, PsiCat, PsiGua, SchTer, SpaCam, SyzJam
Totals	3	16.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Pahole-02	Habitat	4.94	1.38	27.89%		CenAgrAgr, CyaLon, HedDegDeg, PlaPriPri

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	3	6.00	EhrSti, MelMin, PanMax, PasCon
Ecosystem Weed Control	6	51.50	BudAsi, CliHir, FraUhd, LanCam, PluCar, PsiCat, RubRos, SchTer, StaDic
Totals	9	57.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Pahole-03	Habitat	1.23	0.08	6.24%	DieFal	CenAgrAgr

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	29.00	CliHir, GreRob, LanCam, MelMin, PsiCat, SchTer
Totals	2	29.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Pahole-04	Habitat	4.32	0.27	6.24%	LabKaa	AleMacMac, ChaHer, CyaSupSup, CyrDen

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	6	61.50	CliHir, GreRob, LanCam, MonHib, PsiCat, PsiGua, RubRos, SchTer, SpaCam, SyzCum
Totals	6	61.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Pahole-05	Habitat	2.52	0.38	15.19%		CyrDen, PhyKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.50	MelMin, OplHir, PasCon
Ecosystem Weed Control	1	20.00	BudAsi, ChrPar, PsiCat, RubRos, SchTer
Totals	2	21.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Pahole-06	Habitat	2.14	0.04	1.92%		CyaLon, CyrDen, SchNut, SchObo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	28.00	CliHir, GreRob, PsiCat
Totals	1	28.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered
Pahole-08	Habitat	0.69	0.09	13.60%

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	20.00	AleMol, CliHir, PsiCat, PsiGua, SchTer, SpaCam
Totals	2	20.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered
PaholeNoMU-01	Trail	7.76	5.18	66.77%

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	12.00	LeuLeu, PanMax
Totals	2	12.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered
PaholeNoMU-02	Habitat	0.27	0.23	84.03%

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	4.00	BidAlb, ChaNic, LeuLeu, MelMin, NeoWig, PanMax, SchTer, WedTri
Totals	1	4.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered
PaholeNoMU-03	Habitat	0.26	0.18	69.00%

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	1.50	LanCam, PsiCat, SchTer
Totals	1	1.50	

Total IPMU: Pahole						
	29.02	8.24	28.41%	29	251.50	

WCA Discussion

Pahole-01; Switchbacks, SchNut Reintro

Pahole-01 is located on the North East facing slopes of Pahole about a third of the way out to the overlook (Figure 1.4.16). It includes the reintroduction site for *Schiedea nuttallii* at the switchback site and reintroduction sites that where established this year for *C. agrimonioides* and *S. obovatum*. The WCA also contains a mix of native dominated and alien dominated areas. NRS conducted three weeding trips (16.5 person hours) to the WCA this year. Seven staff covered about 9 % of this large WCA, weeding focused directly around the reintroductions (Table 1.4.9). Weeds do not appear to be reestablishing in large numbers and the reintroductions are doing well. Many of the reintroduced plants are producing seeds and NRS hope that intermittent weeding will be sufficient. 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. Grass control also needs to be conducted in this WCA during winter months when *Melinus minutiflora* begins to invade.

Pahole-02; Cenagr PAH-A

WCA Pahole-02 spans the flat area above the Pahole snail enclosure between the Pahole and Mākua rim (Figure 1.4.16). There are nice patches of native forest separated by dense stands of *P. cattleianum*. *Dicranopteris linearis* dominates the area near the Pahole rim. There are also outplantings of *C. agrimonioides*, *Cyanea grimesiana* and *Schiedea obovata* within the WCA. NRS made nine weeding trips (57.5 person hours) to the area this year. Nine staff covered about 28% of the entire WCA (Table 1.4.9). Seven of the trips were concentrated in and around the area of the State snail exclosure and the *C. agrimonioides*. There was a lot of focus on this area in preparation for introducing a large number of common natives this outplanting season and to follow up previous weeding efforts. Some of the *P. cattleianum* that had been hit before were not killed. Two other trips concentrated weeding efforts in the *C. agrimonioides* outplanting site. NRS will continue to attempt to extend weeding operations to other areas within the WCA.

Pahole-03; Cenagr PAH-B

WCA Pahole-03 is centered upon a wild *C. agrimonioides* population (Figure 1.4.16). The highest priority action is to control *M. minituflora* that grows along the open ridge crest, in the past it smothered *C. agrimonioides*. These patches must be manually cleared away from the *C. agrimonioides*. Then once at a safe distance of at least more than 3 m, they can be sprayed. Down slope from the *C. agrimonioides*, the native forest is being invaded by *P. cattleianum*. NRS conducted weed control in the WCA twice this year (29 person hours). Five staff covered only about 7% of the WCA (Table 1.4.9). Effort was focused on opening up the *P. cattleianum* canopy in and around the *C. agrimonioides* population, hand-pulling *M. minituflora*, and eradicating the few *Grevillea robusta* in the area. NRS will continue to attempt to extend the weeding operations to other areas within the WCA.

Pahole-04; Gulch 3 Cyasup Reintro/Chaher

WCA Pahole-04 is centered upon reintroductions of *Cyanea superba* and *Chamaesyce herbstii* (Figure 1.4.16). NRS conducted weed control in the WCA six times (61.5 person hours) this year. Nine staff covered only about 7 % of this large WCA (Table 1.4.9). Effort was focused around site preparations for a *C. herbstii* augmentation and the surrounding *C. herbstii* wild populations. At this time, the area that surrounds the *C. superba* reintroduction is more problematic. This species was reintroduced along the gulch bottom which is dominated by introduced species such as *R. rosifolius, Christella parasitica* and *Paspalum conjugatum*. The presence of these species in the understory does not appear to impact the *C. superba*. The reintroduced plants do exhibit vigorous growth; however, seedling germination could possibly be inhibited by the dense cover. 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 *Phyllostegia kaalaensis* was outplanted by NRS (Figure 1.4.16). Unfortunately, the outplantings have not done well. NRS has done extensive weed control in the area in the past and went to the area twice (21.5 person hours) this year. Five

staff covered about 16% of the WCA performing maintenance and preparing new areas for further reintroduction (Table 1.4.9). Over time, this weed control has changed the regime of weeds in the area. *Buddleia asiatica* replaced *Ageratum adenophora* when it was removed. The *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 Southeastern corner of the fence and is one of the most intact areas remaining in Pahole (Figure 1.4.16). This WCA contains wild populations of *C. longiflora* and *S. nutallii*. The NARS Specialist has suggested that NRS pair weeding trips with collection trips to minimize impacts. NRS strongly agree with this strategy as the habitat is very sensitive to disturbance. One trip (28 person hours) was made this year. Ten staff covered about 2% of the entire WCA (Table 1.4.9). Effort was focused on *P. cattleianum* and *C. hirta* seedlings and immatures. In past years, NRS swept through this predominantly native area removing sparse canopy weeds. This site will be visited, at most, two times year and care will always be taken to minimize impacts.

Pahole-08; Gulch 5

WCA Pahole-08 encompasses an area in Gulch 5 that is being utilized as an augmentation site for *Schiedea kaalae* (Figure 1.4.16). NRS conducted weed control in the WCA two times (20 person hours) this year. Four staff covered about 14% of the entire WCA (Table 1.4.9). Weeding was conducted in the area around the last remaining wild plant in preparation for augmenting the population. NRS is optimistic that this rehabilitation of the habitat will be beneficial for the population as a whole. It is too early to make any assumptions on the success of the weeding actions.

PaholeNo MU-01; Pahole Road

WCA Pahole-No MU-01 covers roadside weed spray along the access road from the Dillingham Ranch gate to the Pahole Mid-elevation Nursery (PMEN). This WCA is partially depicted in Figure 1.4.16. NRS conducts the action in order to keep the access road open for public safety and as a means to minimize the introduction of new weeds from fallow fields below via vehicle traffic. This effort is shared with NARS staff. NRS sprayed the road two times this year and will monitor vegetation over the next year and respond accordingly (Table 1.4.9).

PaholeNoMU-02; Nike Site

WCA Pahole-No MU-02 encompasses the PMEN site upper building-helicopter LZ. This WCA is not noted on a map. NRS conducts control here in order to minimize the transport of weeds from the PMEN via slingloads and/or personnel to various MUs. This effort is shared with NARS staff. NRS sprayed the area one time this year and will monitor vegetation over the next year and respond accordingly (Table. 1.4.9).

Pahole-NoMU-03; Outside the Fence

WCA Pahole-NoMU-03 is located outside the Pahole fence near the PMEN (Figure 1.4.16). NRS weeded in this WCA prior to outplanting *S. obovata*. Two staff spent about an hour cleaning up the site. The area was weeded once this year (Table 1.4.9). The area is relatively

native and NRS feel 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.

IP MU: Upper Kapuna

Upper Kapuna MU includes 11 WCAs, six of which were established over the last year (Figure 1.4.17). All WCAs were established with the assistance of NARS staff. Two of the WCAs are currently within small fences, while the remaining are not protected at this time. However, a system of four staggered fences is being constructed in the area. These fences will protect vital resources wild rare plant PUs, reintroduced rare plant PUs, and snail PUs. Subunit I encloses Upper Kapuna 07 and 09. Subunit III will include Upper Kapuna-03, 04, 06, and 10 and the fourth subunit will encompass Upper Kapuna-01, 02, 08, 11. No WCAs are established in Subunit II. NRS have committed to helping the State complete the units, and construction is pending initiation by the State's fencing contractor, with completion by early 2008.

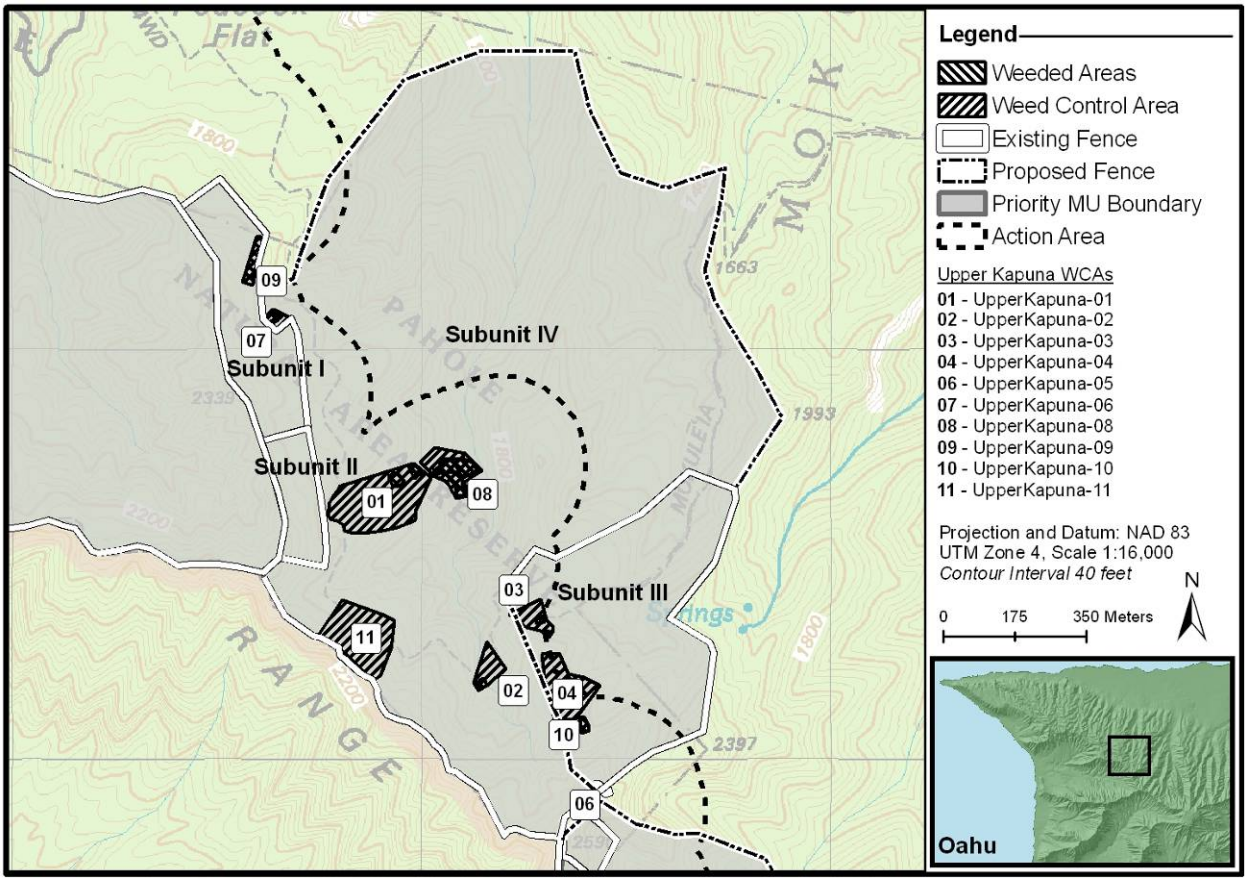


Figure 1.4.17 Ecosystem Management in Upper Kapuna

The MU is threatened by fire, from the north and the south. Fires occurring in the ranch and fallow agriculture fields below of the NAR could impact the area, though the extent of the possible burn area is unclear due to varying fuel types in the MU. Fires from MMR could impact the area as well, as part of the MU falls within the AA.

At the present time, weeding is concentrated in the direct vicinities of the rare plant populations. Control efforts are summarized in Table 1.4.10. 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.

Ungulate Control Efforts

Originally the Upper 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 2.1.15). Subunits I, and II are complete, but have been breached by smaller pigs able to walk through small holes on the bottom of the fence. NARS staff and NRS have been addressing these weak points in the fences and these units should be ungulate free in the near future. NRS have completed their obligations for subunit III, and contractors working for NARS will complete the construction of the subunit. NARS awarded the contract for subunit IV, with construction to begin in fall 2007. NARS staff and NRS have conducted volunteer hunts using dogs within these subunits. In addition, this area remains a public hunting area to keep the pigs from further pressuring the fence.

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 native dominant habitat in the WCA, the maintenance and expansion of which being critical to the survival of the rare plant taxa found therein. Weeding effort (3 visits, 30 person hours) over the past year has been focused on areas around the rare plants, reintroductions, and in areas of healthier native forest. As stated in the introduction, the weeding effort in this WCA is focused mainly on understory weeds. The NARS specialist feels it is necessary to keep overstory control to a minimum (6% per trip) to reduce light gaps which stimulate rapid growth of pioneer weeds. However, a far amount of canopy was removed in the area where the PhyKaa.KAP-B outplanting occurred in order to provide sufficient light levels for healthy growth.

It will be necessary to continue weeding effort in this WCA on a regular basis, as there are aggressive weeds can colonize open areas quickly 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 and reintroductions, as well as increasing the buffer of native dominated habitat around them.

Upper Kapuna-02; Kapuna Stream

This WCA is contained by a PU fence, in which are planted *Cyanea superba* and *Chamaesyce 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; there was only one visit this year with 1.25 person hours of effort. The dominant weed in the area is *R. rosifolius*. 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*, and 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.

Table 1.4.10 Summary of Upper Kapuna Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Upper Kapuna						
UpperKapuna-01	Habitat	2.83	0.16	5.64%		ChaHer, DelSub, HesArbu

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	30.00	AgeRip, BleApp, BudAsi, ChrPar, CliHir, GreRob, PsiCat, PsiGua, RubRos, SpaCam, TooCil
Totals	3	30.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-02	Habitat	0.45	0.05	10.36%		ChaHer, CyaSupSup

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	1.25	ChrPar, CliHir, RubRos
Totals	1	1.25	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-03	Habitat	0.47	0.02	4.22%		CyaLon, SchNut

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	8.50	CliHir, PsiCat, SchTer
Totals	2	8.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-04	Habitat	1.32	0.04	2.79%		CyaLon, PhyKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	28.00	CliHir, PsiCat, RubRos, SchTer
Totals	2	28.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-06	Habitat	0.04	0.04	99.35%		SchObo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	16.50	AndVir, CliHir, GreRob, MelMin, PasCon, PsiCat, RubRos, SchTer, StaDic
Totals	2	16.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-07	Habitat	0.18	0.05	26.09%		CyaSupSup

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	0.75	CliHir, RubRos, SchTer
Totals	1	0.75	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-08	Habitat	0.93	0.44	47.11%		DelSub

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	6.50	CliHir, GreRob, PsiGua, SchAct, SchTer
Totals	2	6.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-09	Habitat	0.27	0.27	100.00%		DelSub

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	17.00	AgeAde, FraUhd, GreRob, LanCam, PasCon, PsiCat, PsiGua, RubRos, SchTer, SyzCum, SyzJam
Totals	2	17.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-10	Habitat	0.07	0.07	100.00%		SchObo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	3.75	CliHir, GreRob, PasCon, PsiCat, RubRos
Totals	1	3.75	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
UpperKapuna-11	Trail	2.09	0.43	20.60%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	22.00	GreRob, PsiGua
Totals	1	22.00	

Total IPMU: Upper Kapuna						
		8.66	1.56	18.01%	17	134.25

Upper Kapuna-03; Keawapilau SchNut/CyaLon.

There are two protected species in this WCA, *Cyanea longiflora* and *Schidea nuttalii*, both of which are designated MFS. 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. Two visits were made totaling 8.5 hours of effort. Weeding is concentrated mainly in the immediate vicinity of the rare taxa. It was noted that the weeding from the previous year was effective. However, the area surrounding the upper CyaLon.PIL-A population was inundated with *C. hirta*, so most of the weeding effort was focused on improving the habitat there. 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.

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 contiguous native habitat through the population. During the two visits this year (totaling 28 hours of effort) some removal of the *Psidium cattleianum* occurred, but within the NARS specialist's 6% limit per trip (see Upper Kapuna-01). NRS plan to revisit this site quarterly in the coming year.

Upper Kapuna-05; Kapuna fenceline

During the previous reporting year a fenceline was cleared in the Kapuna area in preparation for fence construction. No weeding occurred this year and NRS will not maintain this WCA in the future.

Upper Kapuna-06; SchObo PIL-C

This WCA was created this year to clear and maintain the site for the *Schiedea obovatum* PIL-C reintroduction. Currently the population is protected by a temporary plastic fence, but will soon be enclosed by the Subunit III fence. The site was visited twice for a total of 16.5 hours of effort. The habitat is of good quality with sparse understory weeds and only a few *P. cattleianum* within the fence, which were all treated during the two visits. NRS will return twice next year to monitor and maintain the site.

Upper Kapuna-07; 1-Acre Site

This WCA is defined by an old outplanting site within a PU fence, primarily *Cyanea superba*. The plants are healthy and are some of the largest outplanted specimens of their species anywhere. Weeding is focused within the fenced area on understory weeds. There remains a high number of understory weeds, the fern *C. parasitica* in particular, but the overstory is largely native-dominant (large *Metrosideros polymorpha*). Weeding efforts are focused on broadleaf weeds such as *R. rosifolius*. One trip was spent weeding in this WCA. In the coming year NRS plan to re-visit the site at least once to continue to treat understory weeds around the outplantings. The WCA is managed mainly for fruit production, so ecosystem scale weeding here is limited.

Upper Kapuna-08; Delsub KAP-C

This WCA was created this year to improve the habitat for the *Delissea subcordata* KAP-C wild population. The site was visited twice this year with a total of 6.5 hours of effort. The border of the WCA was established to include a newly found immature *D. subcordata*, but the plant has since been extirpated, most likely by a pig. However, the habitat that surrounded the extirpated immature plant is native dominant canopy (*Diospyros* and *Sapindus*) with scattered *Schinus terebinthifolius* in the overstory and minimal weeds in the understory. NRS will continue to weed within it to allow for future natural regeneration of this *D. subcordata* population.

Upper Kapuna-09; Delsub KAP-D

This WCA was established this year to clear and maintain the site for the *Delissea subcordata* KAP-D reintroduction. The site consists of a mix native and alien canopy with an open understory. The WCA was visited twice this year for a total of 17 hours of effort. The WCA is inside the Subunit I fence. Before the outplanting the area was thought to be pig free. However, on a monitoring visit NRS observed pig sign near the plants that was not there during the

planting. NRS, in coordination with NARS staff, did a thorough search of the subunit and did not find any recent pig sign. NARS patched the areas along the fence that could be compromised and NRS will monitor the site when returning to weed the site twice in the next year.

Upper Kapuna-10; SchObo PIL-B

This WCA was created this year to improve the habitat for the *Schiedea obovatum* PIL-B wild population. The site consists of a mix native and alien canopy with relatively open understory on steep terrain, surrounded by a dense *P. cattleianum* stand. The areas immediately around the rare plants are particularly sensitive due to the presence of other rare taxa (Cyalon.PIL-D) and the steep terrain of the site. NRS weed directly around the taxa to maintain their existing microclimates, and try to reduce the *P. cattleianum* canopy at the site within the limits set by the NARS staff (6% per trip). The site was weeded once this year with 3.75 hours of effort. NRS plan to return two times next year to maintain the habitat.

Upper Kapuna-11; Hunter Cabin LZ

This WCA was established to track effort used in helping the NARS staff re-open and maintain this LZ at the Hunter shelter along the Mokulēʻia Trail. The LZ will be used in emergencies only, but is needed as there are currently no LZs in the immediate area. The site was visited once this year with 22 hours of effort. NRS plan to return next year with NARS staff to remove some trees that were treated and are dead.

Region: *Lower Kaʻala Natural Area Reserve to Mokulēʻia Forest Reserve*

The landowner for this region is the State of Hawaii. There are four MUs designated in this region. Within the West Makaleha MU there are two small fences centered around rare plant populations. NRS has plans for two large scale fences in this region but is waiting on a MOU with the state of Hawaii before project plans can be finalized. Within these Units NRS is involved in ongoing vegetation management. Fire is a threat to Lower Ka'ala NAR as was illustrated by the Kaukonahua fire this year (see Appendix II)

Regional Ungulate Control Efforts

The Army's Natural Resource Staff worked with cooperators from the State of Hawaii Natural Area Reserve System and the U. S. Fish and Wildlife Service to conduct a feral goat hunt within the Lower Ka`ala NAR and East Makaleha. The hunt spanned from 24 October to 26 October 2006. Teams of two personnel were inserted by helicopter and camped on three different ridges starting from Dupont Trail and heading East to the Western ridge between Kamoku'iki and Kamokunui.

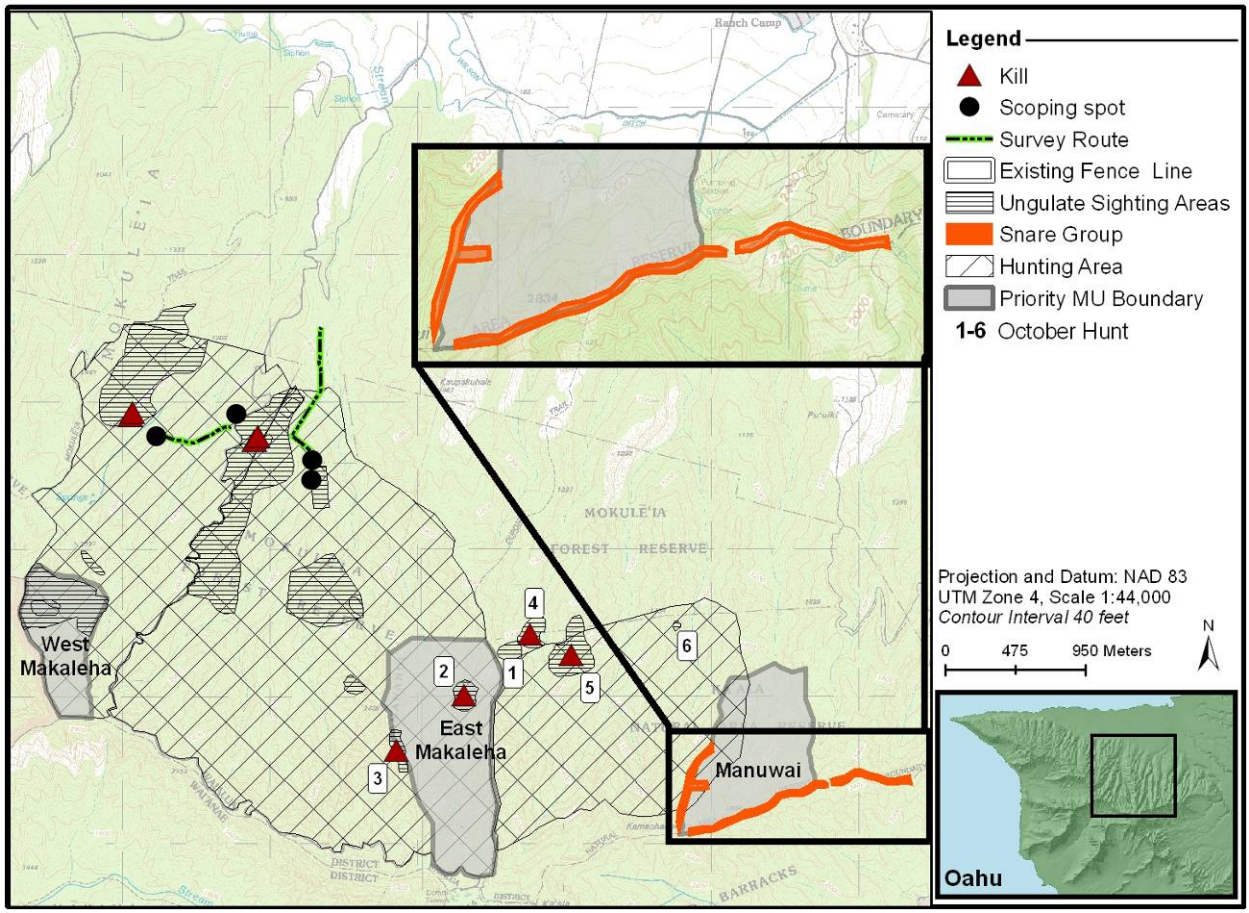


Figure 1.4.18 Goat Management Areas Across the Mokulēʻia Forest Reserve and Lower Kaʻala NAR

Table 1.4.11 Results of October 2006 Hunt

Date	Person Hours	Goats Observed	Confirmed Goats Removed	Unconfirmed Goats Removed
10/24/06	48	24	14	3
10/25/06	60	31	10	1
10/26/06	42	14	5	0

Overall the hunt was quite successful. Table 1.4.11 summarizes results of the hunt. A total of 29 goats were confirmed removed with a possible four others unconfirmed. Most of the animals are concentrated on the western boundary of the NAR and appear to travel between Makaleha and the NAR.

In order to keep the goat population at manageable numbers, future staff hunts should continue to focus efforts along the western boundary of the NAR and make the move into East and Central Makaleha. Population control efforts should also include other methods ie. aerial operations, radio telemetry, and snaring to increase success. A goat management plan needs to be drawn up with the support of all parties involved with management of ungulates in these forest reserves.

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 1.4.19). 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*. The site will also be utilized to continue habitat restoration efforts and expand outplanting sites of *C. longiflora, S. obovata,* and *Pritchardia kaalae*. Fire is a potential threat to the lower elevations of this MU. Access is coordinated with the State.

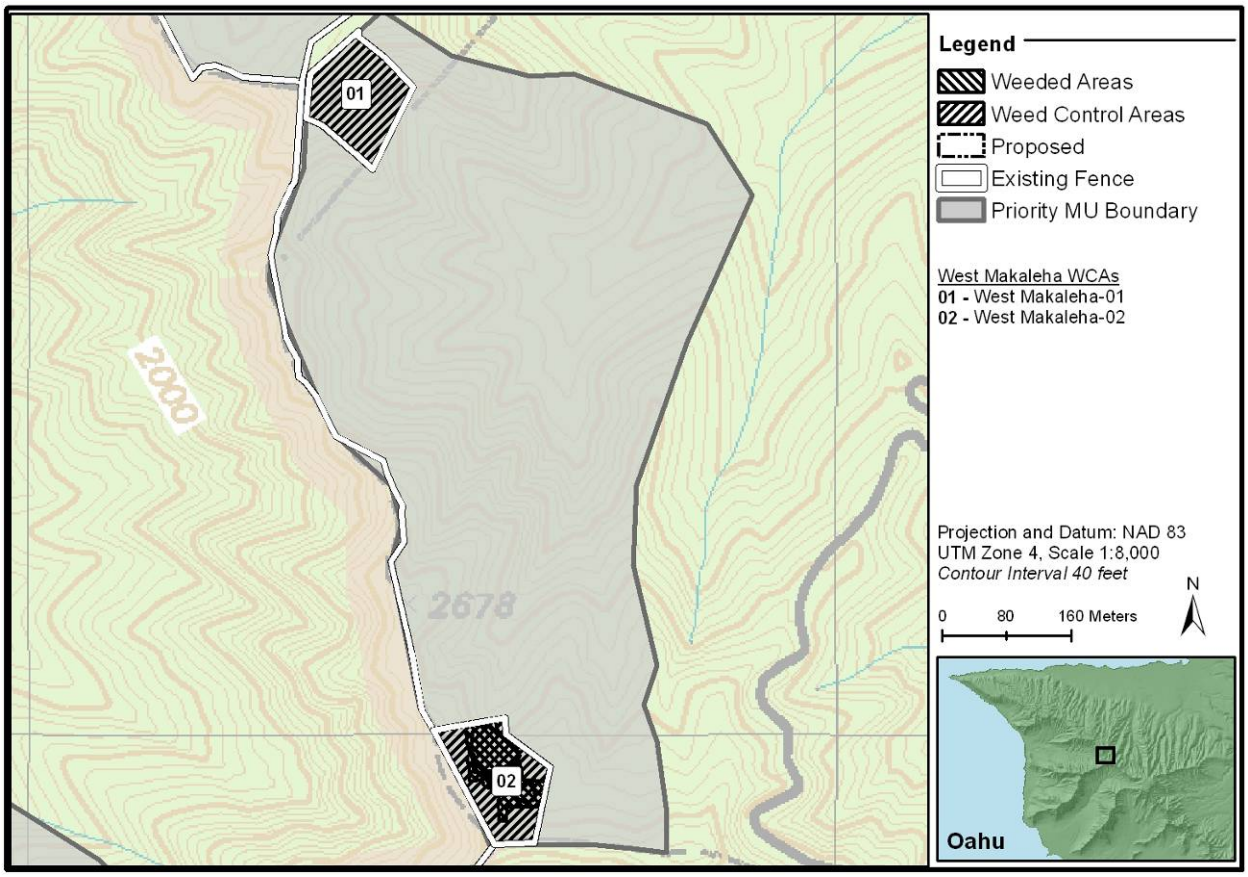


Figure 1.4.19 Ecosystem Management in West Makaleha

Ungulate Control Efforts

There are two PU fences within the MU that are both ungulate-free. Completion of the MU perimeter fence is slated for Year 4 of the MIP, pending a finalized agreement with the State. Currently, NRS and NARS staff minimizes goat damage around the MU by reducing population numbers. From September 2006 – August 2007 NRS worked closely with NARS staff to remove four feral goats from a small resident herd on the boundary ridge of the Pahole NAR (Figure 1.4.18). Close monitoring of this area will continue because the goats have been known to travel back and forth from the forest reserve to neighboring ranch land. In the past year, fewer goats have been observed with minimal NRS and NARS hunting. However, smaller herds are more difficult to track and have been known to join neighboring herds. This goat population

remains critical to eliminate as it poses a serious threat to Pahole NAR. Currently, the Upper Kapuna MU fence material that borders the West Makaleha MU is only 42" which is not tall enough to deter goats from jumping over if stressed. Taller fence materials are currently being sought.

Table 1.4.12 Summary of West Makaleha Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: West Makaleha						
WestMakaleha-02	Habitat	2.68	1.14	42.77%		CyaGriOba, DelSub, PriKaa, SchObo
Total IPMU: West Makaleha		2.68	1.14	42.77%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	3.00	MelMin, PasCon
Ecosystem Weed Control	7	108.00	AgeAde, AgeRip, BudAsi, ChrPar, CliHir, LanCam, PsiCat, RubArg, RubRos, SchTer, StaDic
Totals	8	111.00	
	8	111.00	

WCA Discussion

West Makaleha-01; Schobo Exclosure

NRS have intentionally minimized their presence and impact in the area. Therefore, this WCA is not shown in Table 1.4.12. 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 2005-2007. Follow-up weeding for past canopy removal above the slope is scheduled for next year.

West Makaleha-02; Three Points Exclosure

This WCA is defined by the fence boundary. The upper 2 acre flat area contains reintroduction sites of outplanted *C. superba*, *D. subcordata,* and *S. obovatum*. Weed control efforts focused on the grassy areas (Table 1.4.12). Herbicide spray on *Melinis minutiflora* looked promising, however; *R.argutus* is still problematic. The lower 1 acre slope area is 75% native. The current strategy in this area is to weed around and below *C. grimesiana* with hopes that seeds from fallen fruits will germinate. NRS increased weed efforts in this area focusing mostly on understory weeds including *B. appendiculatum*. NRS will monitor what regenerates from this effort.

In the next two years, NRS will conduct approximatly six visits each year to:

1) Continue weed control in a two meter radius around all rare plants.
2) Treat all mature *B. asiatica, R. argutus,* and *C. hirta* in the 3.3 acre fence area.
3) Continue 100% removal of all weeds in the 1 acre lower portion of the fence with minimal impact to native elements.
4) Continue foliar sprays of grass and other understory weeds in upper 2 acres of the fence.
5) Continue *P. cattleianum* control in upper 2 acres of fence by thinning remaining trees (no greater than 25% loss of canopy cover each year).

6) Transplant a minimum of 50 *Cibotium* sp. each year into the lower 1 acre portion for shade control of weeds.
7) Plant 250 koa saplings/acre each year into thinned *P. cattleianum* stand area in upper portion of fence (assuming 50% mortality of koa saplings planted in dibble tubes).

IP MU: East Makaleha

A 230 acre MU fence is proposed for this area but an MOU with 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. In the past, NARS staff and NRS have focused more effort on observing for ungulates in these areas to monitor movement and composition of the herds. As a result of this monitoring, NRS and NARS staff established proven survey routes and spots that oversee many areas where the goats frequent (Figure 1.4.18). Observations by NRS and NARS staff indicate that goat travel back and forth between these areas in fairly small discrete herds. 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.

Ungulate Control Efforts
All hunting efforts are directed by and done in cooperation with NARS staff. Since 2004, 31 goats were removed from East and the neighboring Central Makaleha gulches. 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 implementing alternative methods of control in this area (radio/GPS collars). The data on goat movements in these areas will help NRS plan hunt’s accordingly.

IP MU: Manuwai

Spanning both the Lower Ka‘ala NAR and Mokulē‘ia Forest Reserve, this MU encompasses the upper elevation portion of Manuwai gulch (Figure 1.4.18). Populations of many endangered plant species are found in this MU, as well an *A. mustelina* site. Management effort thus far has focused on rare plant monitoring and ungulate control. No WCAs are yet established. While the upper section of the MU is well-forested, the lower section is patchy with the fire-carrying grass *Panicum maximum*. Below the MU boundary, Manuwai gulch is dominated by *P. maximum*. The fire threat this grass poses was realized this year when portions of the MU burned in the August 2007 fire; see Appendix II, Waialua Fire Report, for a full discussion of impacts to this MU.

Ungulate Control Efforts
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 (colored in orange) 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 (see regional ungulate). The snares have removed a total of 74 goats total but have not caught any since September 2004. Due to recent fire events NRS believe it is necessary to

survey the area for ungulate presence once again. Since September 2005, only nine goats have been removed through hunting because NRS was waiting for an agreement with the state to continue all management actions in the NARS. Future hunts/surveys are anticipated as the agreement issues has are completed.

Region: *Schofield Barracks West and South Ranges, SBW/SBS*

This region extends from Puʻu Hāpapa, just south of Kolekole Pass, north to the major Kamaʻohanui ridgeline. The region's western boundary is the Mt. Kaʻala Summit. Currently, there is no legal pig hunting permitted within Schofield Barracks West Range (SBW) due to UXO and security issues. This restriction has allowed for proliferation of pig populations within SBW. Schofield Barracks South Range (SBS) is a GMA administered by the Provost Marshal on base.

In order to protect rare resources and specific habitats, five PU enclosures were constructed in SBW and a large-scale strategic fence was installed around the Kaʻala summit (Figure 1.4.21). There is a population of goats in Waiʻanae Valley just over the boundary line from SBW that NRS are working to address. There is one PU enclosure in SBS.

Weed issues vary dramatically across this region. The more mesic portions of the region have established forests of *Schinus terebinthifolius, Heliocarpus popayensis* and *Toona ciliata*. The wetter portions in lower Haleʻauʻau gulch are dominated by *Syzigium jambos*, *Falcataria mollucana* and *Psidium cattleianum*. Habitat conditions improve and native canopy presence increases with elevation. The summit of Mt. Kaʻala is predominately native wet forest with few canopy weeds. Weed control effort centers on rare species locations in lower elevations and intact native habitat in upper elevations along crest lines and summits.

Both SBS and SBW are threatened by fire originating from live firing training. The threat to SBS is less than in SBW due to the types of weapons used there. The Army conducts prescribed burns each year and maintains a fuel break above the impact area as a means to protect the natural resources outside.

IP MU: Kaʻala

Mt. Kaʻala is located in the northern Waiʻanae mountains above SBW, Mākaha, Makaleha, and Waiʻanae valleys (Figure 1.4.21). It is the highest point on Oʻahu at 1227 m in elevation. Natural resource management actions on the summit region of Kaʻala are shared by NRS and NARS staff. At this time, there are six WCAs designated for the MU.

For the Kaʻala MU, NRS presents a *Hedychium gardnerianum* control strategy across all WCAs. In the following WCA discussion, NRS combines the results of all the sweeps conducted throughout the WCAs this year. Figure 1.4.21 presents the WCAs and weeded areas from this reporting period. In addition, Table 1.4.15 shows the summary data for weed control efforts in Kaʻala WCAs for this reporting period. WCA-3 is not included as NRS did not conduct weed control over this year. Of note is the expansion of WCA-6 to encompass some of the Kaʻala

NAR area on the northeast side of the Mt. Ka‘ala access road. In addition, NRS presents an update on efforts to determine control mechanisms for *Sphagnum palustre*.

***Hedychium gardnerianum* Control Strategy**

In last year’s report, NRS presented a strategy for the control of this taxon at Ka‘ala. In summary, the goal for *H. gardnerianum* is to eliminate all mature plants from within the fenced MU. NRS will investigate options for knocking back the core of this taxon located in WCA-3 to reduce the seed sources immediately adjacent to the fenced area. NRS aim to re-treat WCAs on a two-year cycle because it takes just over two years for ginger plants to mature.

In order to more effectively achieve the above goals, NRS conducted an aerial survey of all WCAs within the fence and adjacent NARS and Board of Water Supply lands for mature plants. Figure 1.4.20 displays observations of ginger and other incidental weeds from this survey. These will be discussed in the *Other Survey Observations* section. Of the sites identified, the highest priority for control is the mature plant clusters furthest from the core area in WCA-3. The aerial survey approach to identifying mature plants was very effective and should be employed yearly.

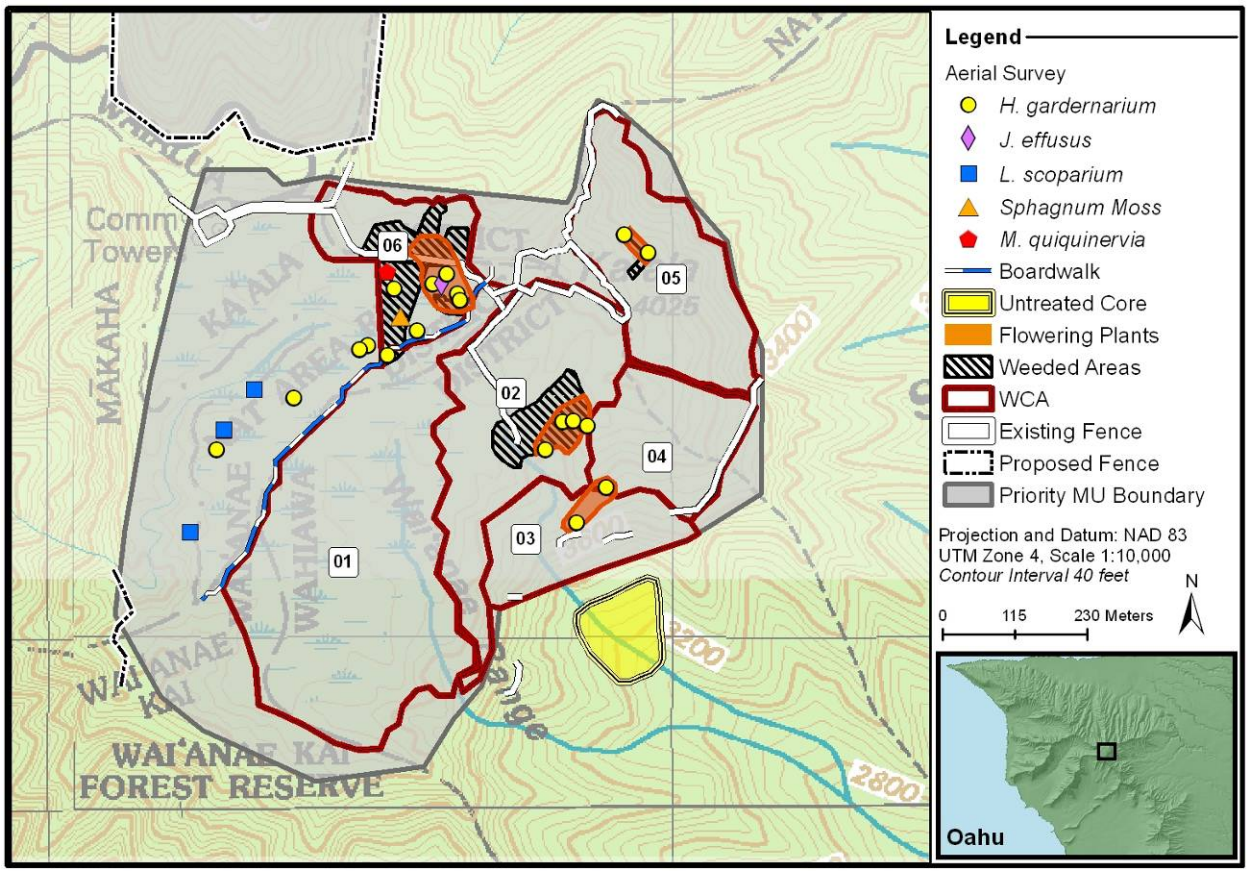


Figure 1.4.20 Aerial *Hedychium gardnerianum* Survey

Other Survey Observations

Other incipient weeds observed while conducting the aerial ginger survey are shown in Figure 1.4.20. NRS will request permission from the NARS Specialist to kill the few *Leptospermum scoparium* and the lone *Melaleuca quinquenervia* observed. NRS have establish a no tolerance policy for both of these taxa atop Ka‘ala. Control of these weeds will be discussed in the ICA section next year. In addition, this survey identified the far western location of *Juncus effusus* which revealed to NRS the true extent of this ICA. One satellite location of *Sphagnum* moss was observed from the air. NRS will follow up with NARS staff to conduct a survey of the location.

Sphagnum palustre Control Research

Sphagnum palustre was introduced to Mt. Ka‘ala from the Kohala Mountains, Hawai‘i Island. It is native to the Kohala Mountains but was never native to the Wai’anae Mountains. *Sphagnum palustre* is abundant along the boardwalk corridor and along the upper reach of the Mākaha stream drainage. In addition, NRS have identified some small satellite populations. *Sphagnum palustre* is easily spread vegetatively; therefore, strict protocols must be employed to eliminate spread.

Table 1.4.13 List of Proposed Mossicides

Trade Name and Synonyms	Chemical Name and Synonyms	Proposed application rate	EPA Reg. No.
Ash Grove Kemilime; Graymont Hydrated Lime	Calcium hydroxide 97.0%	Applied as a 3% solution (see soil drench application on Coqui label)	None
Safer® Brand Moss and Algae Killer; DE-MOSS Concentrate	Potassium Salts of Fatty Acids, Ethyl alcohol, Methyl alcohol	Label specifications	42697-7
St. Gabriel Moss Killer	Clove Oil 12%, Sodium Laurly Sulfate 8%	Label specifications	None
ZeroTol	Hydrogen Dioxide: 27%	Label specifications	None

Since this taxon is impacting the native habitat atop Ka‘ala, it is a high priority to develop a control technique for it. NRS have experimented with hydrated lime as a control agent for *S. palustre*. Based on preliminary observation, the lime appears to affect good control of the moss but it is not registered by the EPA for use in this manner. In the last year, the NRS Research Specialist investigated available registered mossicides via the Hawaii Department of Agriculture (HDOA). Table 1.4.13 is a tentative list of products under consideration for control of *S. palustre* on Army lands at Mount Ka‘ala. Products listed have been tentatively approved by HDOA for inclusion in an Experimental Use Permit (EUP) application. St. Gabriel Moss Killer is currently legal to use at Mt. Ka‘ala as the product contains natural ingredients not regulated by the EPA. All other products would be illegal to use as a mossicide in the bog unless covered under a EUP. Among these, both Safer Moss Killer and ZeroTol would require a label change if used outside of a EUP. Most difficult to register would be lime. This product would require a new registration and label with the EPA. It is included in the EUP for comparison only, not

because it is likely to be approved for general application. The EUP is under preparation and when complete will be submitted to HDOA for approval.

One other subject related to *S. palustre* at Ka‘ala is the planning for the reconstruction of the boardwalk. The boardwalk will be designed considering the need for future access to the moss for control. When a viable control method is available, control may be conducted in the area of the boardwalk in order to reduce inadvertent spread. The re-design of the boardwalk to an elevated design would greatly reduce the spread of *S. palustre* by hikers.

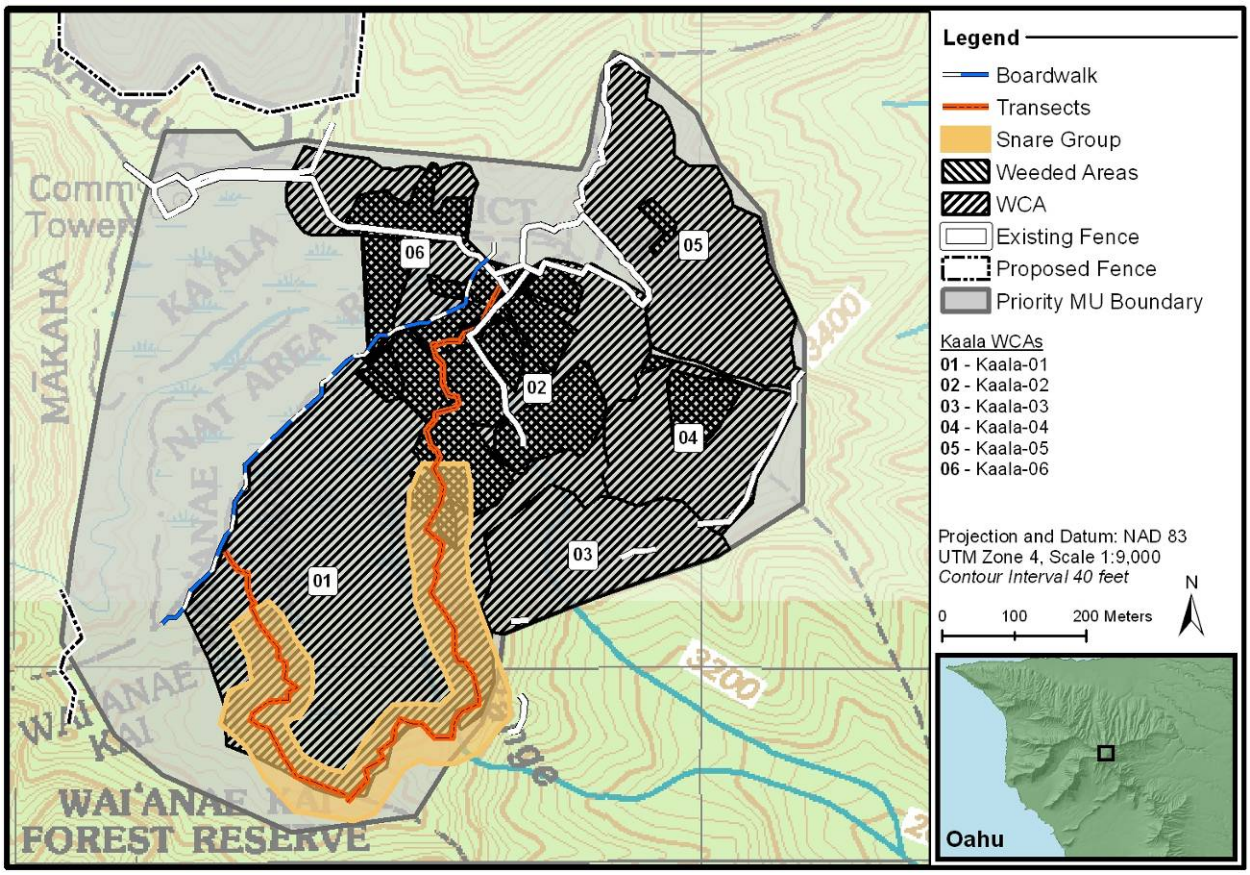


Figure 1.4.21 Ecosystem Management in Ka‘ala

Objectives for Ka‘ala MU

- Survey for points of ingress for pigs, construct additional fencing required to secure Ka‘ala summit as pig free.
- Investigate use of telemetry studies to look at pig movement on the summit.
- Control all locations of *H. gardnerianum* where mature plants were observed during aerial survey.
- Request permission to control *L. scoparium* and *M. quinquenervia* on NARS property.
- Survey the *S. palustre* satellite location with NARS Specialist and determine a course of action.
- Conduct annual aerial surveys for mature *H. gardnerianum*.
- Research aerial control techniques for attacking the core *H. gardnerianum* site in WCA-3.
- Submit EUP application for potential *S. palustre* control products.

- Propose establishing more WCAs on the NARS side of the boardwalk to control *H. gardnerianum*.
- Complete new redesigned boardwalk.

Ungulate Discussion

With the completion of the strategic fencing on the SBW side of the summit, NRS felt that pig ingress would be eliminated. Unfortunately, there are still some pigs left within the fence. It is not entirely clear whether all of the pigs were eradicated, but NRS feel that whatever ingress there may be must be coming from other portions of the protected summit. Initially, NRS tried to use hunting as a means to eliminate the pigs from within the MU. This method has proven feasible but a lot of person hours are required to survey and run the dogs. There is also a problem with the possible increased spread of *S. palustre* throughout the summit region and the sensitivity of the area to disturbance from hunting. Because of this, NRS is looking at other methods as a way to eradicate the last of the pigs. NRS has installed snares along Transect SBW-03 where fresh sign was observed and have since caught five pigs. In the next year, NRS will install baited live traps as another means of capturing the pigs. This should limit the amount of damage that occurs while snaring and NRS would be able to us these pigs for possible telemetry studies. NRS will also run a few ground hunts if fresh sign is observed, and survey for possible pig ingress.

Transect Discussion

There is one ungulate transect at Ka‘ala which is monitored quarterly for pig sign. NRS will continue to use this monitoring as a tool to guide pig control efforts and supplemental fencing. No new weeds have been observed on Transect SBW-03.

WCA Discussion

NRS is consolidating all of the results from the weeding actions in all of the WCAs for the Ka‘ala MU. Most of the weeding consists of conducting sweeps through all of the WCAs looking for *H. gardnerianum*. *Psidium cattleianum* and *C. hirta* are patchily distributed so control of these taxa occurs in conjunction with volunteer trips usually. In the last year, NRS conducted weed control over 9.8 hectares, covering 23.5% of the 41.8 total hectares in WCAs at Ka‘ala (Table 1.4.15). NRS targeted *H. gardnerianum*, *P. cattleianum*, and *Clidemia hirta*.

Table 1.4.14 *Hedychium gardnerianum* Control Summary

Report Year	2006	2007
Mature	27	25
Immature	667	1052
Seedling	368	862
Re-treat	23	8

Table 1.4.14 summarizes the totals of the different age classes of *H. gardnerianum* controlled over the last two years. The increase in the total number of plants treated this year is directly attributed to information gained from NARS staff, the aerial surveys conducted and time spent conducting sweeps in new areas. NARS staff informed NRS about the location of some flowering mature plants on the NAR side of the summit. Upon further inspection NRS found a total of 366 plants. Of the 23 mature plants killed this year, 10 plants were identified during the

aerial reconnaissance and 13 were located within the NAR. In 2006, NRS spent 181 hours covering 7.5 ha. This year 371 hours were spent covering 9.8 ha of which roughly 3 ha had never been covered before. This increase in effort is what this project requires for success. In addition to more staff time working on *H. gardnerianum* control, NRS will engage more volunteer assistance via our expanded public outreach program.

Table 1.4.15 Summary of Ka'ala Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	IP Taxa Present	Effort (Person Hrs)
IP MU: Kaala						
Kaala-01	Habitat	16.84	2.09	12.40%	LabCyr, SchTri	
Kaala-02	Habitat	9.37	4.82	51.41%	LabCyr, SchTri	
Kaala-04	Habitat	4.25	0.82	19.22%	CyaCal, LabCyr, SchTri	
Kaala-05	Habitat	6.85	0.16	2.28%	CyaAcu, CyaCal, LabCyr, SchTri	
Kaala-06	Habitat	4.44	1.93	73.70%		
Total IPMU: Kaala						
		41.76	9.81	23.50%		370.85

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	6	95.50	HedGar, PsiCat
Totals	6	95.50	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	6	180.00	CliHir, CroCro, GreRob, HedGar
Totals	6	180.00	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	3	32.10	BudAsi, CliHir, ElaGra, HedGar, PsiCat, RubArg
Totals	3	32.10	

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

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	51.25	HedGar
Totals	2	51.25	

IP MU: South Haleauau

This MU is located in a sub-gulch on the south side of South Hale‘au‘au (Figure 1.4.23). The MU is a patchwork of mixed native to weedy mesic/wet-mesic forest. There is a large MU fence proposed for construction, however in the meantime, a small PU fence protecting *Stenogyne kanehoana* has been built.

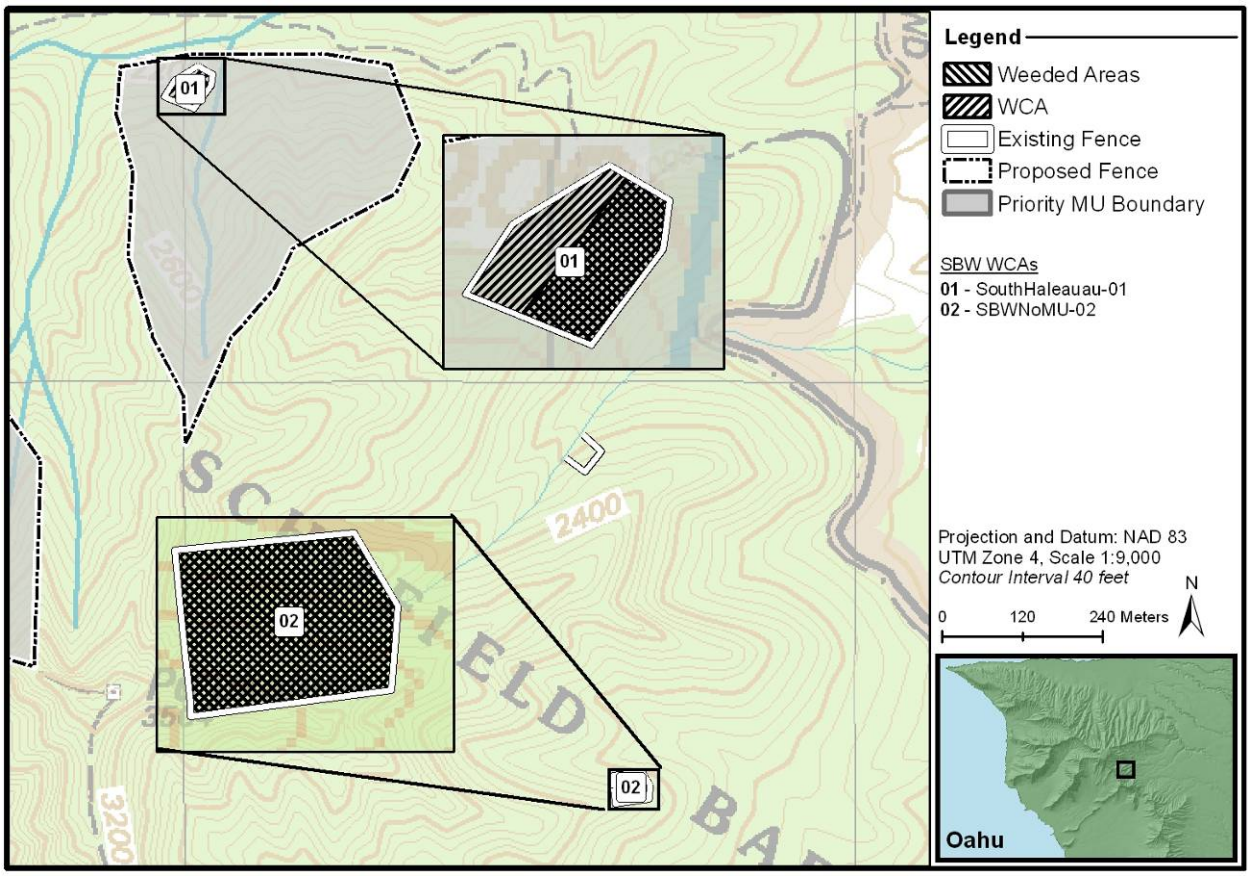


Figure 1.4.22 Weed Control Areas and Fences in SBW–South Hale‘au‘au

Ungulate Control Efforts

NRS did not conduct any ungulate control operations within this WCA during the 2006-2007 reporting year. NRS will monitor fence yearly.

WCA Discussion

South Hale‘au‘au-01; Stekan Exclosure

South Hale‘au‘au-01 is in the mid reaches on the south side of Hale‘au‘au Gulch (Figure 1.4.23). NRS tries to conduct weeding operations in this WCA one to two times a year, depending upon access. The WCA consists of a small fence surrounding a population of *S. kanehoana*. NRS visited the WCA twice this year (3 person hours) to conduct weeding operations. Three staff covered about 57% of the PU fence enclosure for both grass control and ecosystem weed control (Table 1.4.16). To date, NRS is unable to say whether the weeding is having a positive effect on

this population. The population has dwindled considerably since discovery but there may be other factors that NRS are unaware of.

Table 1.4.16 Summary of South Hale‘au‘au Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: South Haleauau						
SouthHaleauau-01	Habitat	0.53	0.30	56.92%		SteKan
Total IPMU: South Haleauau						
		0.53	0.30	56.92%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.00	PasCon
Ecosystem Weed Control	1	2.00	CliHir, LanCam, PsiCat, RubArg, RubRos, TooCil
Totals	2	3.00	

IP MU: SBW No MU

NRS did not conduct any ungulate control operations outside of MUs in this region during the 2006-2007 reporting year. NRS will monitor the Mohiakea fence yearly.

Table 1.4.17 Summary of SBW NoMU Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: SBW No MU						
SBWNoMU-02	3M	0.21	0.21	100.00%		AleMacMac, DelSub, FluNeo, PhyMol
Total IPMU: SBW No MU						
		0.21	0.21	100.00%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	11.00	BudAsi, CliHir, PasSub, SchTer, TreOri
Totals	1	11.00	

WCA Discussion

SBW NoMU-01; North Hale‘au‘au Garman Exclosure

SBW NoMU-01 is located in the mid reaches on the south side of North Hale‘au‘au Gulch (Figure 1.4.23). NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year. NRS will endeavor to conduct weeding operations within this PU enclosure one to two times a year, depending upon access. It is a small area and the rare plant populations contained within are all deemed ‘collect for genetic storage’.

SBW NoMU-02; Mohiākea Delsub Exclosure

SBW NoMU-02 is located in the first sub-gulch on the north side of Mohiākea Gulch (Figure 1.4.23). NRS tries to conduct weeding operations in this WCA one to two times a year, depending upon access. The WCA is a small area and the rare plant populations contained within are all deemed 'collect for genetic storage', making weed control a low priority. NRS visited the WCA once this year (11 person hours) to conduct a weeding operation (Table 1.4.17). Four staff covered the entire PU enclosure and the perimeter was cleaned up. NRS will continue status quo for upcoming year.

IP MU: Kalena – Ka'ala Ridge

Effort in this MU has centered on exploratory surveys. In the last year, substantial discoveries were made within the proposed fence unit. An endangered *Drosophila montgomeryi* fly was possibly observed (see Chapter 5.4). In addition, substantial numbers of *Achatinella mustelina* were discovered. Both observations increase the priority for management within the Kalena-Ka'ala Ridge MU. The construction of the MU fence at this site is not slated until year four of the OIP. Weed control has not been initiated within this MU. In the next year, efforts will continue to focus on rare species surveys.

Ungulate Control Efforts

While there is significant pig impact to this MU, the most critical ungulate issue is the population of feral goats just over the Kalena-Ka'ala ridge on the Waianae side. Goats observed were unafraid of humans, suggesting that the site receives very little to no hunting pressure. NRS have initiated discussions with the Division of Forestry and Wildlife staff about conducting control hunts in the area. This is the top priority action for NRS to perform over the upcoming reporting period.

IP MU: Pu'u Kūmakali'i

This MU is centered around wild and reintroduced *Tetramolopium filiforme*. NRS modified the shape of the boundary for this MU to include Navy property, see Figure 1.4.24. Initially, the wild population of *T. filiforme* had been left out of the MU because there was no signed MOU between the Army and Navy. In the last year, the MOU was signed, therefore there is now an agreement allowing Army management of rare plants in Lualualei. One WCA was designated around the *T. filiforme* reintroduction. IP taxa in this MU are primarily located on cliffs, and little weed control is needed at this time; NRS did not conduct any weed control work within the Pu'u Kūmakali'i WCA this year. NRS will work to develop a weed control plan for this MU. In the coming year, work in this MU will focus on ungulate control and limited weed control.

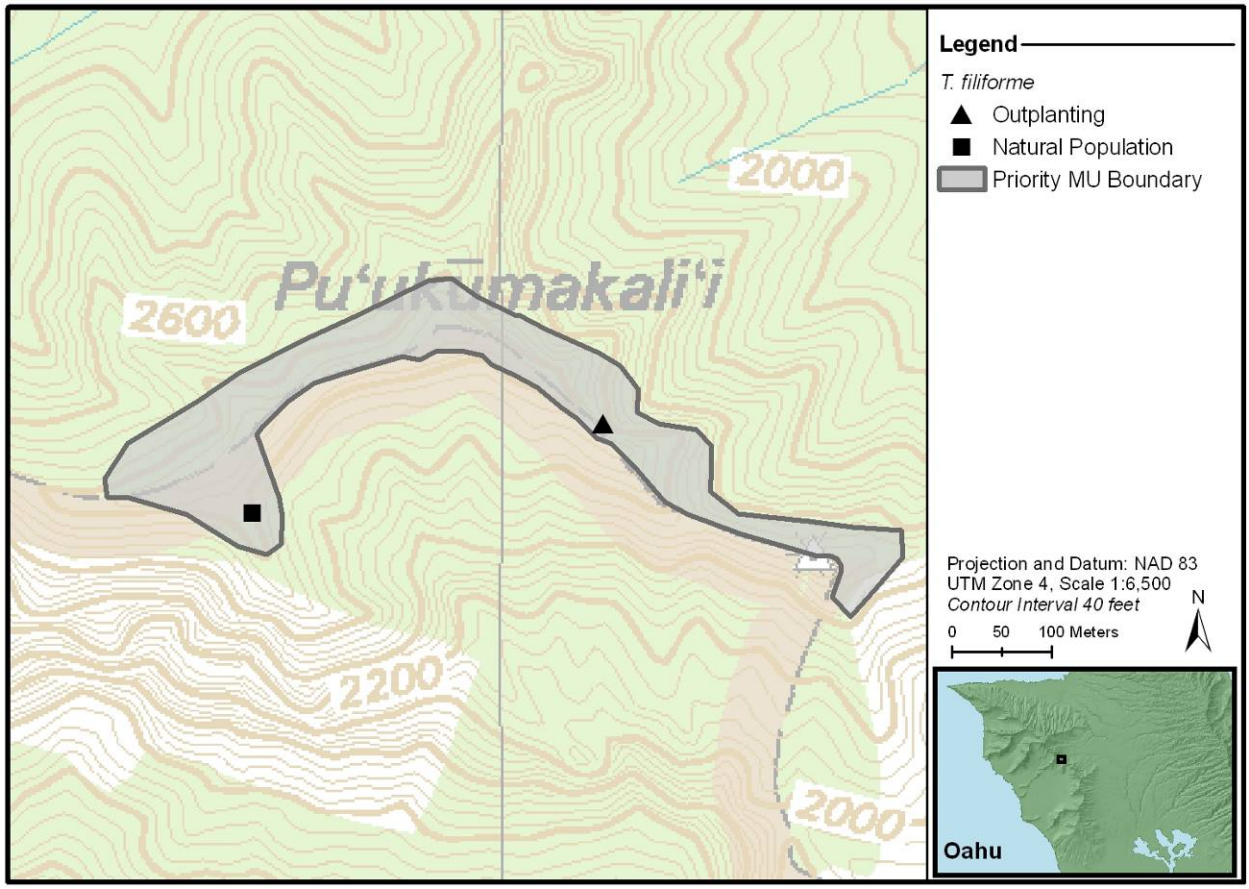


Figure 1.4.23 Weed Control Areas in Pu'u Kūmakali'i

IP MU: SBS, No MU

One of the smaller Army training ranges, SBS is difficult to access as it is heavily used for training. Much of the region is steep, and much of it is heavily degraded. Weeds dominate much of the area, but some diverse mesic components remain in small areas in SBS. No MUs have been designated in this region. Management in SBS is focused in two locations, both designated as WCAs (Figure 1.4.25). The primary weed threats to these sites are *S. terebinthifolia*, *C. hirta*, *E. karvinskianus*, and non-native grasses. Given that regular visitation isn't possible at this time due to poor access, controlling *E. karvinskianus* and weedy grasses is difficult, as both require dependable follow-up. Weed control efforts are summarized in Table 1.4.25. This year, management focused on conducting native *Drosophila* surveys.

The short-term objectives for this MU are:

1) Continue baiting grids for rat control around snail habitats.
2) Weed around rare native plants and in preferred *Drosophila* habitat

<u>Ungulate Control Efforts</u>

A 1.6 acre fence exclosure was constructed to protect reintroduced *Urera kaalae*, habitat of the endangered tree snail *Achatinella mustelina*, and two very rare ground snails, *Laminella*

sanguinea and *Amastra micans*. These snails have not been seen on recent surveys, and may no longer be present. The fenced area was checked and appeared to be ungulate-free.

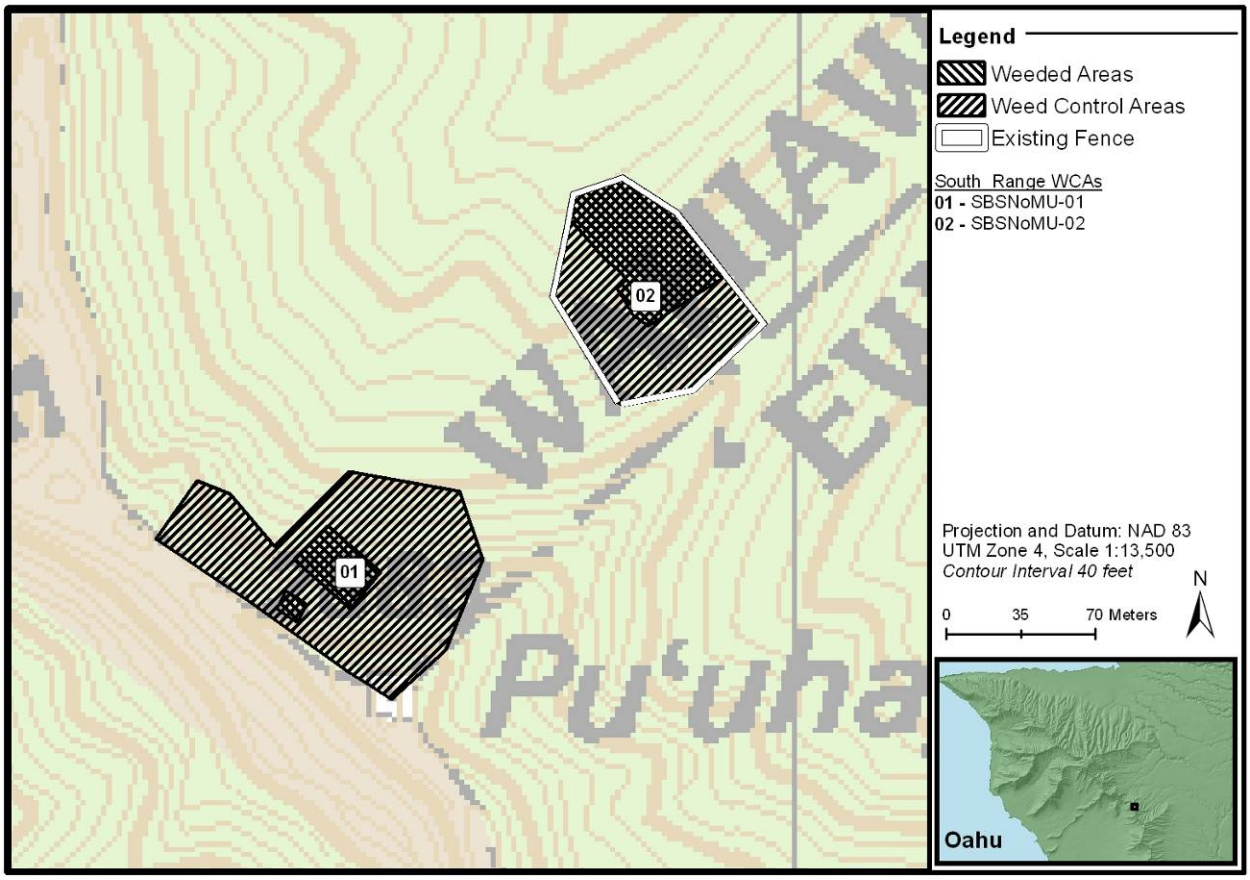


Figure 1.4.24 Ecosystem Management in SBS

WCA Discussion

SBSNoMU-01; Puu Hapapa Snail Zone

This area has a lot of Campanulacea and *Cibotium glaucum* habitat and contains good habitat for *Drosophila* species. Not much weed control has been done since the area is not fenced and pigs may invade open areas. NRS did weed canopy and understory in a small area (Table 1.4.18). NRS noted that weeding in the steep sections seems to help native recruitment but weeds came back after a year. Grass and *E. karvinskianus* need to be controlled, especially if more canopy is removed. *Toona ciliata* and *H. popayanensis* were killed near the bottom of this WCA. NRS is considering construction of strategic fencing to protect this site from pigs.

SBSNoMU-02; Moho Gulch

NRS initially managed this area for *A. micans* and *L. sanguinea*, which are no longer abundant in the area. This WCA contains a unique grouping of native plant species, including *U. kaalae*, *N. latifolium* and *Phyllostegia hirsuta*. NRS monitored this area for *Drosophila* species, but only common taxa were found. Weed control was conducted around *U. kaalae* and *U. glabra* reintroductions, as both are preferred *Dropsophila* habita (Table 1.4.25). If future surveys

reveal endangered *Drosophila* in the area, NRS will conduct more aggressive management. For now, NRS management will be minimized.

Table 1.4.18 Summary of SBS Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: SBS No MU						
SBSNoMU-01	Habitat	0.91	0.09	9.58%		
				Treatment Type	**# of Visits**	**Effort (Person Hrs)**	**Species Controlled**
				Ecosystem Weed Control	2	14.00	BudAsi, CliHir, EriKar, HelPop, LanCam, PasSub, RubRos, SchTer, TooCil
				Totals	2	14.00	
SBSNoMU-02	Habitat	0.66	0.27	40.82%	NotLon, UreKaa	
				Treatment Type	**# of Visits**	**Effort (Person Hrs)**	**Species Controlled**
				Ecosystem Weed Control	1	16.00	BudAsi, CliHir, HelPop, PasSub, RubRos, SchTer
				Totals	1	16.00	
Total IPMU: SBS No MU						
		1.57	0.35	22.63%	3	30.00	

Region: *Honouliuli*

Honouliuli is currently owned by Campbell Estate with a conservation easement held by TNCH. However, Campbell Estate is subdividing and selling the area and the TNCH is phasing out management of the Preserve. NRS continues to be actively involved in management in the area and is also working to secure the land for future management. The region may be purchased in part with Army funds via Army Compatible Use Buffer (ACUB) funds through Trust for Public Lands (TPL) and other partners. Regardless of the land transfer, NRS is vested in the management of the resources of this region. There are four MUs where NRS conduct active management. This includes fenced MUs where NRS is involved with ongoing ungulate management. The ʻĒkahanui fence is being extended by 120 acres. A larger MU fence is being constructed at Palikea. Within these MUs, NRS is involved in ongoing vegetation management. Access to this region has become more difficult over the past year, as the agriculture fields below the preserve are fallow and for sale.

IP MU: Kaluaʻā and Waiʻeli

Within this MU are two fences, SubUnit I, a larger 107 acre fence built in 2001 by TNCH and SubUnit II, a 24 acre fence completed in 2005 by TNCH with the help of NRS. NRS and TNCH collaborate on management of these areas. There are a total of 12 WCAs in this MU, incorporating past TNCH weed control areas into current NRS WCAs (Figure 1.4.26). Weed control efforts for this year are summarized in Table 1.4.19.

The short term goals for this MU are as follows:

1) Maintain pig free fenced areas.
2) Weed two meters around rare plants and re-introduced plants.
3) Reduce large canopy alien species such as *T. ciliata* and *S. terebinthifolius* in areas surrounding re-introduction sites.
4) Survey and control all *T. ciliata* and *S. campanulata* in the central gulch with trees greater than 50 cm diameter at breast height (dbh).
5) Reduce the spread of incipient weeds such as *T. semitriloba* , *P. maximum*, *E. karvinskianus*, and *A. evecta.*
6) Possibly create field nurseries in some of these areas to reintroduce common native canopy and understory species.

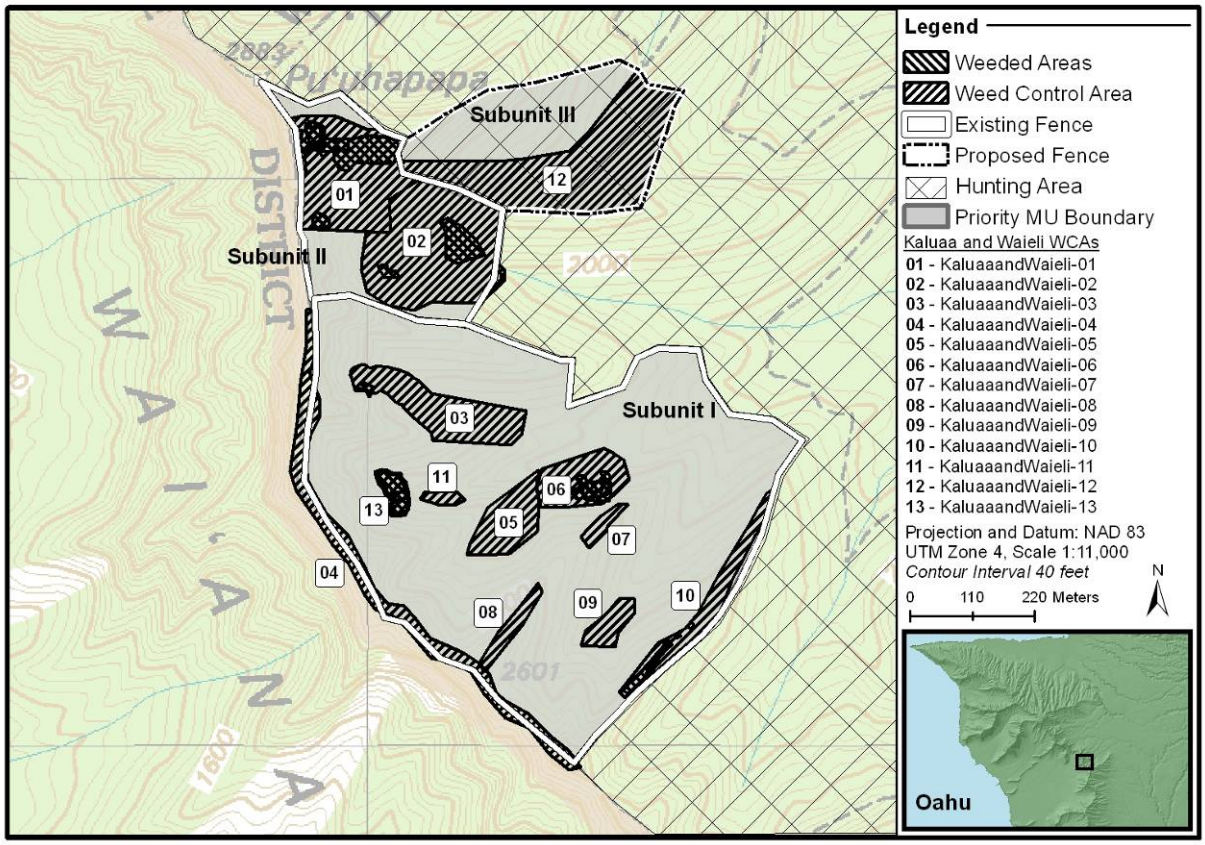


Figure 1.4.25 Ecosystem Management in Kaluaʻā and Waiʻeli MU

<u>Ungulate Control Efforts</u>

Subunit III (107 acre) was completely fenced by TNC in 2001 (Figure 1.4.26). In May 2004, a small PU fence was constructed around a single *Cyanea grimesiana* subsp. *obatae* along the stream bank of South Kaluaʻā gulch. Subunits II A and C were completed in December 2005 as a combined unit and are ungulate-free. Subunit II B is slated for construction for Year 10.

In October 2006, researchers working in the Kaluaʻā Subunit III fence reported seeing piglets running through the area. TNC staff did a fence check of the entire Subunit III fence and did not find any openings where ungulates might enter. As a precaution, snares were set in areas where

pigs frequent, mainly at the back of all the major gulches and along fencelines. NRS and TNC staff spent 80+ hours snaring, deploying 51 snares, and removing 11 ungulates. Fence improvements were also made to reinforce areas where the fence height may have been inadequate. On recent visits to Kalua‘ā Subunit III, no new ungulate sign or activity was observed.

Table 1.4.19 Summary of Kalua‘ā and Wai‘eli Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Kaluaa and Waieli						
KaluaaandWaieli-01	Habitat	6.70	1.73	25.77%	LamSan, MelChr	AchMus, PlaPriPri
KaluaaandWaieli-02	Habitat	4.38	0.41	9.37%	DieFal, UreKaa	AleMacMac, SchKaa
KaluaaandWaieli-03	Habitat	1.83	0.44	24.01%		AleMacMac
KaluaaandWaieli-06	Habitat	1.22	0.23	18.62%	UreKaa	AleMacMac, CyaGriOba, DelSub, PhyMol, SchKaa
KaluaaandWaieli-10	Habitat	1.10	0.13	11.67%		CenAgrAgr, SteKan

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	2.00	MelMin
Ecosystem Weed Control	6	22.00	EriKar, PsiCat, SchTer, TooCil
Totals	7	24.00	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	12.50	BudAsi, CliHir, PasEdu, RubRos, SchTer, TooCil
Totals	2	12.50	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	8	52.00	BudAsi, ChrPar, CliHir, EriKar, HypPec, LanCam, PanMax, PasCon, PasEdu, PasSub, PsiCat, RubRos, SchTer, TooCil, TriSem
Totals	8	52.00	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	16.00	CliHir, PasSub, PsiCat, RubRos, TooCil
Totals	2	16.00	

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	13.00	CliHir, GreRob, LanCam, PasSub, PsiCat
Totals	4	13.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
KaluaaandWaieli-13	Habitat	0.00	0.22			AleMacMac

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	11.00	CliHir, LanCam, PasCon, PasEdu, PsiCat, PsiGua, SchTer, TooCil
Totals	2	11.00	

Total IPMU: Kaluaa and Waieli						
		15.24	3.16	20.72%	25	128.50

WCA Discussion

Kalua‘ā and Wai‘eli-01; Hapapa bench

In the next two years, visit quarterly to:

1) Conduct follow up treatments of canopy weed trees in the 2 acre bench area as needed.
2) Continue weed control in a two meter radius around all NRS reintroductions and assist TNC with maintenance of their reintroductions as time permits.
3) Begin selective control of canopy weed trees upslope toward the crestline (avoiding weed trees populated by tree snails and targeting *S. terebinthifolius* trees that are likely to rip out the cliff side as they become too top heavy).
4) Conduct grass and other understory weed control (especially *B. asiatica*) as light levels increase across 2 acre bench area.
5) Treat all accessible *E. karvinskianus* patches within 50 m of current or planned NRS reintroduction areas. Some patches are on steep, fragile cliffs and control is not feasible without considerable effort and significant damage to cliff sides.

NRS continued large canopy control as well as *E. karvinskianus* and grass control. So far response to large canopy control has been good with no alien weed regeneration. NRS will continue to monitor what appears in the understory of these weeded areas. More *E. karvinskianus* and grass control is needed.

Kalua‘ā and Wai‘eli-02; Kalua´ā North

In the next two years, conduct quarterly visits to:

1) Treat all *T. ciliata* trees greater than 10 cm dbh and all *H. popoyanensis* and *S. campanulata* trees and saplings in the 10 acre area below and above the large cliff in the fenced area.
2) Continue weeding two meters around base of all NRS reintroductions and *A. macrococcus* trees as needed. Assist with maintenance of TNC reintroductions as time permits.

Large canopy control of *T. ciliata* was a priority. Some understory control of *Rubus rosifolia* and *C. hirta* was conducted.

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

In the next two years, conduct quarterly visits to this 8 acre area to:

1) Treat all *T. ciliata* trees greater than 10 cm dbh.
2) Continue weeding two meters around base of all NRS reintroductions and *A. macrococcus* trees as needed.
3) Continue treating large, mature *S. terebinthifolius* in and near native dominated patches.
4) Continue treating aggressive understory weeds as light levels increase primarily within 50 m of reintroduction areas.
5) Continue treating incipient populations of *P. maximum, E. karvinskianus,* and *T. semitriloba* along adjacent ridgelines.
6) Assist with maintenance of TNC reintroductions as time permits.

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. A total of 25 hours of weed control was near the outplantings. NRS has observed native regeneration of ferns *M. strigosa* and canopy *P. albidus* with removal of *S . terebinthifolius.* A total of five hours of weed control was done on the ridge above the outplantings. Grass control was conducted on *P. maximum* and *P. conjugatum.* Herbicide control was conducted on *T. semitriloba and E. karvinskianus.* There still are some *T. semitriloba* populations midslope south of the ridge under *L. camara.* The main goal was to reduce spread of these invasive species from the ridgeline.

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

In the next two years, conduct quarterly visits to this 3 acre area to:

1) Treat all *T. ciliata* trees greater than 10 cm dbh in and adjacent to core 3 acre area.
2) Continue weeding two meters around base of all NRS reintroductions and *A. macrococcus* trees as needed.
3) Continue treating large, mature *P. cattleianum, P. guajava* and *S. terebinthifolius* in and near core area.
4) Continue treating aggressive understory weeds primarily within 50 m of NRS reintroduction areas (especially *C. hirta*).
5) Assist with maintenance of TNC reintroductions as time permits.

The focus in this WCA was on *C. hirta* and *T. ciliata* control. More weed control is needed in this area. NRS should visit this site quarterly next year. The reintroduction site is predominately native except for regenerating *C. hirta*. Common native canopy outplanting may reduce repeated *C. hirta* seedling regeneration. The surrounding area has good native habitat mixed with an abundance of mid-sized *T. ciliata*.

Kalua‘ā and Wai‘eli-10; South Fenceline

In the next two years, conduct annual visits to this 20 m x 250 m area to:

1) Reduce *C. hirta* cover to less than 5% within 10 m of all reintroductions with minimal damage to sprawling canes of *Stenogyne kanehoana.*

2) Continue *P. cattleianum, L. camara,* and *P. suberosa* control across WCA area.
3) Treat 15 x 15 m *C. hirta* patch at old *S. kanehoana* site to release koa saplings from competition.
4) Treat *B. appendiculatum, R. rosifolius,* and *B. asiatica, M. minutiflora* in the 10 x 10 m *Phyllostegia hirsuta* patch.

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. *C. hirta* competes for space and may reduce moisture needs for *S. kanehoana*. Weed control in this area usually happens after monitoring *S. kanehoana*. While clipping *C. hirta* , NRS is careful not to smash any *D. linearis* which seems to shelter and retain moisture for *S. kanehoana*.

Kaluaʻā and Waiʻeli-13; AleMac

A total of 11 hours on 2 trips was used to weed mostly canopy and some understory alien plants around a few *A. macrococcus macrococcus.* This site may also be used as a *P. mollis* outplanting site in the future.

IP MU: ʻĒkahanui

The ʻĒkahanui MU is comprised of two subunits, I & II. There are ten WCAs around wild and reintroduced populations of rare plants throughout both subunits, and one WCA covering the recently cut Subunit II fenceline. Weed control is focused on creating and maintaining reintroduction sites and controlling weed populations near wild rare plants. The area is officially managed by TNCH, but throughout this report year NRS has assumed the majority of the management responsibilities for the MU. The MU consists of small native dominant forest patches between large alien dominant forests. Due to the dry to mesic forest types, stands of dead *Eucalyptus* and *Grevillea* in the makai areas of the MU, and the fallow agricultural fields below, the area is highly threatened by fire. A 170 acre fire occurred in 2005, which fortunately burned only five acres of forest within the TNCHH preserve boundary. In 2004, another large fire in the adjacent Puʻu Maiʻalau Gulch to the south burned to within 300 m of the fence.

Most of the WCA's are protected in the 43 acre subunit I fence. NRS are in the process of constructing the subunit II to greatly increase the area protected from feral ungulates, and to encompass all the presently managed WCA's, their corresponding rare plant and snail populations, as well as to create new reintroduction sites.

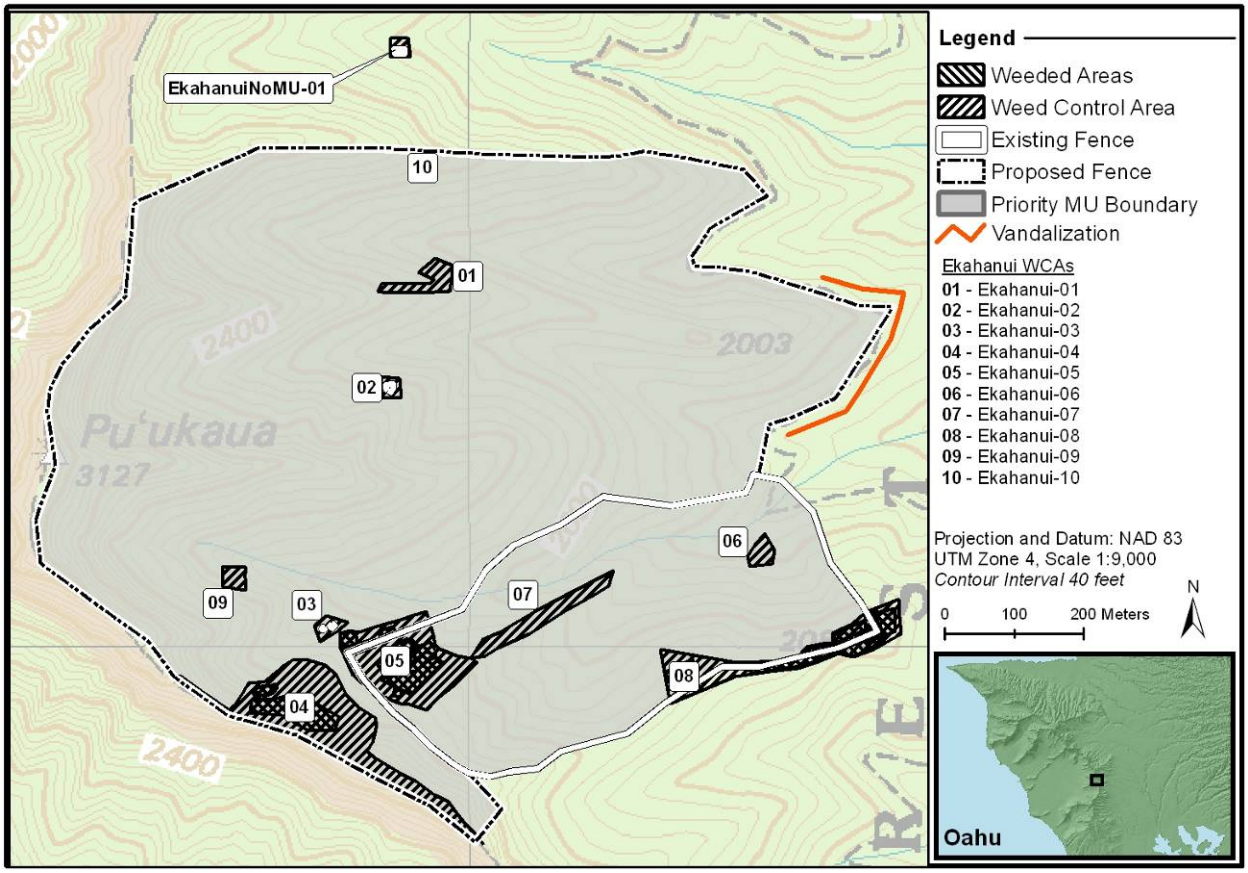


Figure 1.4.26 Ecosystem Management in ‘Ēkahanui

Ungulate Control Effort

TNCH completed the Subunit I fence in 1999. Fence construction has begun on Subunit II, but vandalism has slowed its progress. Construction on the makai line will resume with livestock panels, which are harder to vandalize. This new perimeter fence will encompass about 159 acres (Figure 1.4.27), and is projected to be completed within the coming year. NRS continues to conduct fence maintenance on subunit I. In early July small breaches by immature pigs prompted NRS to conduct hunts with dogs. The piglets were found and chased out of the fence, as they were small enough to travel in and out. Later trips revealed absence of pig sign within the fence. 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 herd is believed to be the last population of feral goats located in the southern Wai‘anae Mountain range. 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.

Table 1.4.20 Summary of ‘Ēkahanui Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Ekahanui						
Ekahanui-04	Habitat	2.17	0.42	16.01%	UreKaa	PlaPriPri, SchKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	2.50	MelMin, PanMax, PasCon
Totals	2	2.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ekahanui-05	Habitat	3.17	1.02	32.23%		AleMacMac, CenAgrAgr, CyaGriOba, DelSub, SchKaa

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	1.00	MelMin, PasCon
Ecosystem Weed Control	4	38.00	CliHir, PasEdu, PasSub, PsiCat, PsiGua, RubArg, RubRos, SchTer
Totals	5	39.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ekahanui-08	Habitat	2.49	1.43	57.55%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	2	4.00	MelMin, PanMax
Ecosystem Weed Control	1	9.00	CasEqu, PsiCat
Totals	3	13.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Ekahanui-10	Fenceline Clearing	1.01	0.52	51.74%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	23.00	CasEqu, CliHir, PsiCat, PsiGua, SchTer
Totals	2	23.00	

Total IPMU: Ekahanui					
	8.84	3.40	38.47%	12	77.50

WCA Discussion

‘Ēkahanui-01; Cenagragr EKA-A

The weed control objective at this WCA is to suppress weeds around the *Cenchrus agrimonioides* var. *agrimonioides* PU. The habitat around the site consists of small areas of native shrubs, underneath an alien dominant canopy, and surrounded by dense stands of *Psidium cattleianum*. No trip was deemed necessary this WCA during this year. Once the fence is completed and this WCA is protected, NRS plan to visit the site one or two times per year to weed around the *C. agrimonioides* var. *agrimonioides* and improve the habitat.

‘Ēkahanui-02; Delsub EKA-B

This WCA exists to keep understory weeds suppressed around a single *Delissea subcordata*. It covers a very small PU fence surrounded by poor quality habitat. 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.

‘Ēkahanui-03; ‘Ēkahanui South Schkaa

No weeding effort was conducted in this WCA for this reporting year. When the entire ‘Ēkahanui MU fence is completed, this largely native site will be used for reintroductions and Weed control efforts will resume.

‘Ēkahanui -04; Upper ‘Ēkahanui

This WCA is comprised of some very steep terrain with three *Plantago princeps* var. *princeps* PUs and *Achatinella mustelina*. The majority of work is focused on grass control, particularly *M. minutiflora* and *P. maximum*. The success of the previous year’s efforts demonstrated that intensive initial investment in weeding can lead to reduced efforts in later years to maintain healthy native habitat. This year only 2.5 person hours of weeding effort were spent controlling the grass here compared to 15.5 hours the previous year. Next year, in addition to monitoring and controlling grasses, NRS plan to survey the WCA for the most intact forest patches and begin weeding selectively within them as time permits.

‘Ēkahanui -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 1.4.27). Initially, a large amount of effort was spent removing *Passiflora suberosa* to establish the site as a reintroduction area. Only minor re-treatment of *Passiflora* has been needed since then. Much improvement has been seen in the reintroduction sites. During the report year, only 39.5 hours were spent weeding in this WCA, compared to 71.5 last year (see Table 1.4.20). NRS noted that most of the weeds seen within the reintroduction areas were seedlings or resprouts. Work efforts in the following year will focus on opening up corridors between reintroduction areas, creating more room for common and rare native plant regeneration as well as opening trails between reintroduction sites.

Only one sweep around the *C. agrimonioides* var. *agrimonioides* outplantings was needed this year. NRS observed increased growth of the *Cenchrus* due to the opening up the canopy through *Psidium* removal during the previous year and fruiting of the *Cenchrus* has been noted as well. Non-native grass control was also done in this area on one trip this year.

‘Ēkahanui -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. TNCH staff conducted limited follow up weeding of understory weeds.

‘Ēkahanui -07; ‘Silky Oak Ridge

This site has been managed by TNCH in years past but has not seen management by NRS. However, the site has great potential for volunteer weeding trips and Koa reintroduction.

‘Ēkahanui -08; ‘Ēkahanui South Fenceline

This WCA was created to help reduce fuel loads close to the exclosure. This is one of the few places where *P. maximum* is found on the fenceline (Figure 1.4.27). With the exception of ‘Elepaio, there are no rare and few common native taxa in this WCA. The WCA was visited twice this year for a total of 13 person hours (Table 1.4.20). This year the grass was relatively under control within minimal resprouting within the sprayed patches. The majority of effort spent this year was towards opening up the camp DZ along the south fenceline and creating a new emergency LZ makai of the camp. Ironically, the LZ is now almost completed engulfed with Koa seedlings that came up after the clearing. NRS will visit this site twice in the coming year to monitor and control *P. maximum*.

‘Ēkahanui -09; AleMac EKA-D site north outside fence

This WCA was created in the previous report year. The area has a native dominant canopy with a few *A. mustelina*, as well as an *Alectryon macrococcus* var. *macrococcus* PU near by. These resources encouraged NRS to weed in the area, taking out small non-native canopy trees and understory weeds. Unfortunately NRS did not return to the WCA this year. However, NRS plan to visit the site next year to monitor and continue to improve the native habitat.

‘Ēkahanui 10; ‘Ēkahanui Fenceline Clearing

This WCA is made up of the fence line cleared in preparation for the construction of the subunit II (Figure 1.4.27). Fence line clearing is now complete after 23 hours of effort (Table 1.4.20). Unfortunately construction of the fence has been delayed by vandalism. NRS will monitor for regrowth of weeds and will assess whether or not additional treatment is necessary.

‘Ēkahanui -NoMU-01; DelSub EKA-A

This WCA exists to keep understory weeds suppressed around a *D. subcordata* population (Figure 1.4.27). It covers a very small PU fence surrounded by poor quality habitat. Although this area was received a fair amount of effort in the past, no weeding was deemed necessary in the past year. However, NRS plan to visit the site next year to monitor and weed if necessary.

IP MU: Puali‘i Portion of Palikea MU

The Puali‘i portion of the Palikea MU is comprised of three WCAs around wild and reintroduced populations of rare plants (see Figure 1.4.28). The area is managed by TNCH but during the coming year NRS will assume management responsibilities for the MU. NRS plans to reintroduce *Phyllostegia mollis x Phyllostegia parviflora* var. *lydgatei* in a site near the original population, which may establish a new WCA at that site (see chapter 2.2.12 for discussion). Weeding efforts will be focused on improving the habitat for this reintroduction. The area is threatened by fire due to large amounts of light and heavy fuel types east of the area and in the fallow agricultural fields below. However, no fires in recent years have threatened the MU. TNCH completed a fence encompassing all the presently managed WCA’s and their corresponding rare plant populations in November 2006.

The WCAs discussed below were created by TNCH staff to create and maintain sites for restoration of rare plants that occur or formerly occurred in the Honouliuli preserve. While several of these reintroductions are either MIP or OIP species, NRS will not be actively managing them. They often are of mixed plantings and not designated as Manage for Stability

(MFS) or Genetic Storage (GS) populations. However they are of interest and value to NRS as examples of areas that may or may not have worked for reintroductions due to site selection, microclimate, etc. For example, at one of the *Delissea subcordata* sites, two seedlings were found within a year of the establishment of the outplanting.

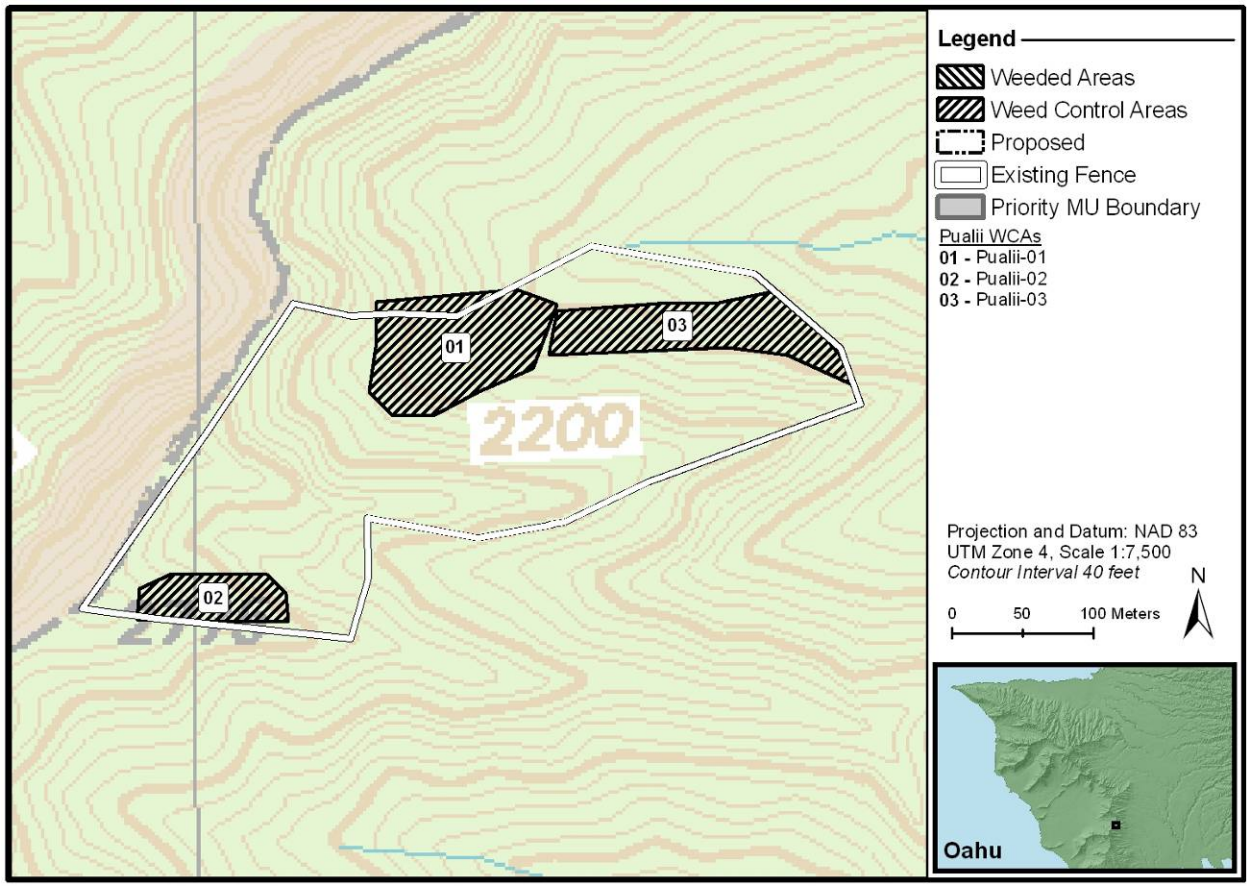


Figure 1.4.27 Ecosystem Management in Puali‘i

Ungulate Control Efforts

Since the completion of the fence by TNCH staff in November 2006, no pig sign has occurred in fenced area. NRS will monitor and maintain the fence as needed in the following year.

WCA Discussion

Puali‘i-01 Central Reintroduction Site

Puali‘i-01 contains a native dominated forest patch consisting of a *Pouteria sandwicensis* stand. This stand is near rare plant populations of *Diellia falcata, Urera kaalae*, and *Sicyos lanceoloidea*. The stand served as a reintroduction site for *Delissea subcordata*, *Urera kaalae,* and *S. lanceoloidea*, which were outplanted by TNCH staff last year. There was no weeding effort in this WCA by the NRS staff for this reporting year. However, TNCH staff weeded the area once this year.

Puali‘i-02 South Reintroduction Site

Puali‘i-02 is a native dominated area consisting of a *Metrosideros polymorpha* canopy. This area also served as a reintroduction site by TNCH for *Delissea subcordata*, *Gardenia brighamii*, and *P. mollis* last year. There was no weeding effort in this WCA by the NRS staff for this reporting year. However, TNCH staff weeded the area once this year.

Puali‘i-03 *Sapindus oahuensis* Reintroduction Site

Puali‘i-03 contains a native dominant forest of *Sapindus oahuensis*. The forest served as a reintroduction site for TNCH staff last year, where *Abutilon sandwicensis* and *Gardenia brighamii* were planted. There was no weeding effort in this WCA by the NRS staff for this reporting year. However, TNCH staff has weeded the area once this year.

IP MU: Palikea

The Palikea MU is on the southern end of the Wai‘anae Mountains (Figure 1.4.29). In the last year, NRS has collaborated with TNCH staff on weed control in this area. The area contains both relatively intact areas and completely alien dominated areas. *Schinus terebinthifolius* is particularly dominant in the areas below the MU. *Ehrharta stipoides* and *Morella faya* are also prevalent on the primary access route to part of this area. As far as NRS knows, this is the only area where these species are widespread on O‘ahu. NRS is careful to clean gear after visiting this MU.

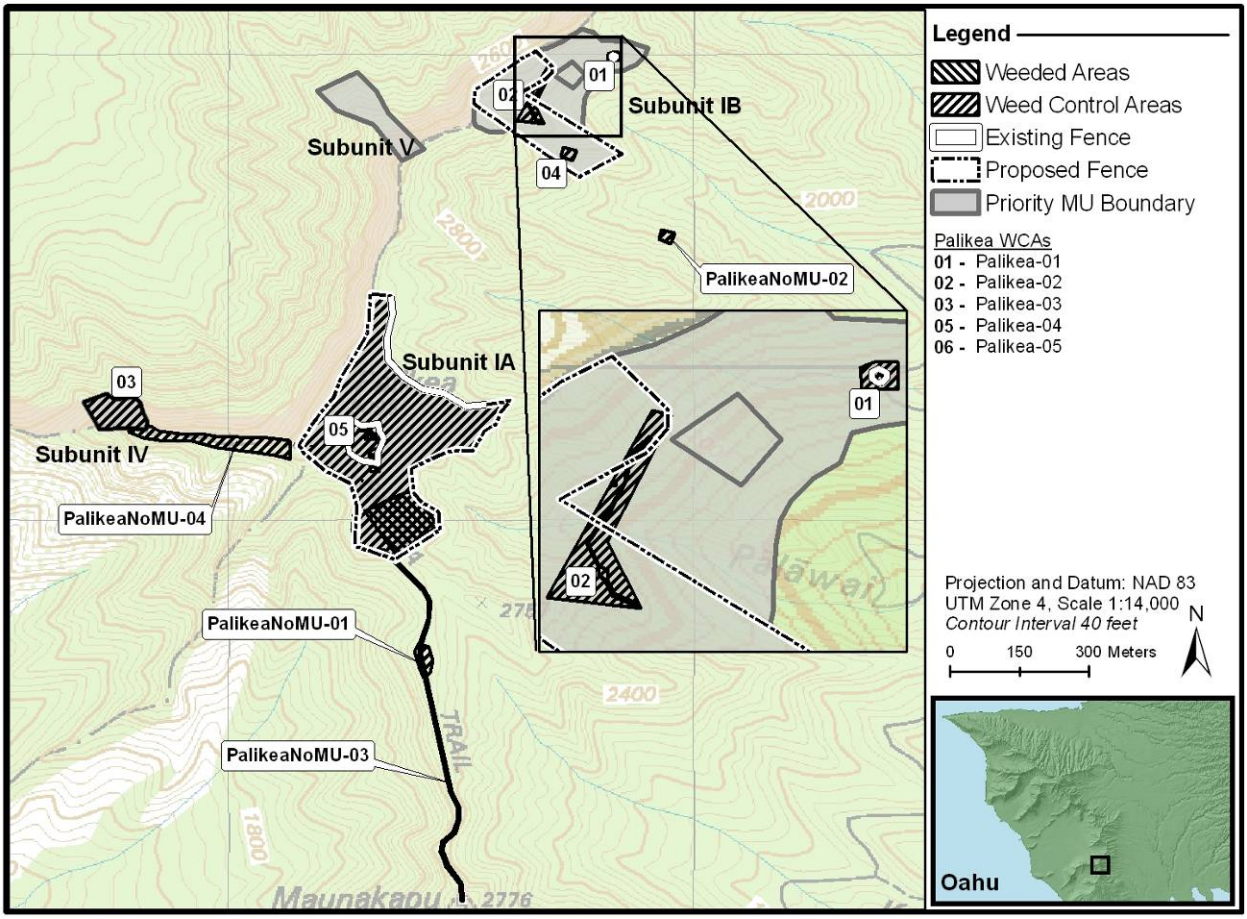


Figure 1.4.28 Weed Control and Ungulate Management Areas in Palikea

A small PU fence has been completed around a population of *Cyanea grimesiana* subsp. *obatae* within Subunit IA. Several PU fences were built in Pālāwai gulch during 2003 and 2004 to protect *Hesperomannia arbuscula* and *D. subcordata*. Subunit IA (21 acres) is almost complete, with about 1200 m left to build; the fence should be completed by November 2007. Once this MU subunit fence is completed, NRS will compose a weed control plan for it. Subunit IB (11 acres) is slated for construction in Year 5 of the MIP. At this time, the EA is completed for the proposed fence but route has yet to be determined (Figure 1.4.29).

Ungulate Control Efforts

No ungulate control efforts were conducted this year other than constructing Subunit IA fence.

Table 1.4.21 Weed Control Effort in Palikea

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Palikea						
Palikea-01	Habitat	0.04	0.01	16.03%		HesArbu

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	1.00	PsiCat, SchTer
Totals	1	1.00	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Palikea-02	Trail	0.56	0.05	8.61%		HesArbu

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	1	2.00	EhrSti, MelMin
Ecosystem Weed Control	2	0.60	MyrFay
Totals	3	2.60	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
Palikea-05	Habitat	9.95	1.30	13.04%		CyaGriOba

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	4	24.50	CasEqu, CliHir, MyrFay, PsiCat, PsiGua, RubRos, SetPal, SphCoo
Totals	4	24.50	

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
PalikeaNoMU-03	Trail	1.17	1.17	100.00%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Grass Control	3	15.50	EhrSti, SetPal
Ecosystem Weed Control	1	0.10	CasEqu
Totals	4	15.60	

Total IPMU: Palikea						
		11.71	2.52	21.51%	12	43.70

WCA Discussion

Palikea-01; Hesarb fence

Palikea-01 is located in the upper reaches of Pālāwai Gulch (Figure 1.4.29). This WCA is centered on a wild population of *H. arbuscula* and is relatively free of alien species from past years of weeding. NRS conducted one weeding trip (one person hour) in the WCA this year. Two staff covered about 16 % of the WCA (Table 1.4.21). Effort was focused in the understory eradicating weed re-sprouts and seedlings. NRS believed that weeding in this WCA would encourage *H. arbuscula* regeneration. So far, this hasn't been the case but there seem to be other factors in play here that NRS does not understand.

Palikea-02; Pālāwai Hesarb unfenced

Palikea-02 is the trail to and the area immediately outside of Palikea-01 (Figure 1.4.29). NRS conducted two weeding trips (2.6 person hours) to the WCA this year. One staff member covered about 9% of WCA spraying *E. stipoides* and M. *minutiflora* along the trail to Palikea-01 (Table 1.4.21). NRS regularly conduct spray operations as an effort to stem the spread of *E. stipoides* to the exclosure and the possible spread to areas outside of Palikea. The sprayed area is a very small percentage of the entire WCA but the point was to focus interest on *E. stipoides*. So far, it appears that the spraying is working and the population has been severely reduced. Staff also spent some time killing a couple of large *M. faya* trees.

Palikea-03; Hedpar Hālona

This WCA surrounds a wild population of *Hedyotis parvula*, located mostly on the State owned cliff face. While there are both native canopy and understory components, much of the area is dominated by *M. faya* and *S. terebinthifolius*. Weeding effort in this area is focused on reducing competition from surrounding understory weeds, *M. minutiflora* in particular. The area is steep and difficult to navigate with a backpack sprayer. NRS plan to return to this site in the coming reporting year to assess the need for further weeding and investigate options for using ropes to access areas. NRS will also investigate clearing a drop zone that could be used to fly in a small power sprayer. This would allow NRS to use the 100 ft hose connected to the sprayer to access treatment areas without having to maneuver with a backpack sprayer while on rappel.

Palikea-05; Palikea CyaGri Fence

Palikea-05 is a small PU fence located with Subunit IA that is constructed around a population of *Cyanea grimesiana* (Figure 1.4.29). Many of the canopy weeds have been removed in this area so that most of the focus now is on understory species. This understory is predominantly native and seems to have responded favorably to all of the weed eradication. NRS conducted four weeding operations (24.5 person hours) in the WCA this year. Thirteen staff covered about 13% of the WCA (Table 1.4.21). Overall this is a small percentage of the WCA but most of the weeding effort was conducted around the population of *C. grimesiana*. Efforts included scoping and hand-pulling *S. cooperi* and ecosystem wide weed control. Once the larger MU fence is constructed, NRS will spend more time in the WCA conducting ecosystem-wide weeding operations and investigating the need to enlarge the WCA boundaries or increasing the amount of WCAs within the MU. To date, NRS has overlapped weeding efforts with the quarterly restocking of rodent baiting grids around *Achatinella mustelina* populations.

Palikea NoMU-01; Palikea Meadow site

Palikea NoMU-01 is located on the ridge trail from Mauna Kapu to Pu‘u Palikea (Figure 1.4.29). It is the location of a NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year but will do so if needed.

Palikea NoMu-02; Pālāwai Delsub Pal-C

Palikea NoMU-02 is located in the mid reaches of Pālāwai Gulch. The MU consists of a small PU fence around *D. subcordata* that is designated as ‘Manage for Genetic Storage’. NRS did not conduct any weeding operations within this WCA during the 2006-2007 reporting year but will do so if needed.

Palikea NoMu-03; Palikea trail Ehrsti

Palikea NoMu-03 consists of the trail from Mauna Kapu to Palikea-05 (Figure 1.4.29). NRS made three weeding trips (15.6 person hours) and one scoping trip to the WCA this year. Four staff covered 100% of the WCA, spraying *E. stipoides* and *Setaria palmifolia* on the trail out to the Palikea MU (Table 1.4.21). NRS initially started spraying *E. stipoides* as a way to stem its spread throughout Palikea and other areas that NRS work. Prior to this, NRS would find seeds clinging to clothing and inside the vehicles after visits. The treatment has been effective so far for *E. stipoides* but there is still some re-growth and seedlings coming in. *Setaria palmifolia* is a newer weed found inside the WCA. NRS will take the same approach with this weed as it appears to be quite widespread in the area as well. With the completion of the new MU fence, NRS will have more of a presence in the WCA and be able to expand the treatment area for both *E. stipoides* and *S. palmifolia*.

PalikeaNoMU-04; Hālona Ridgeline

This ridgeline WCA spans the area from a LZ along the proposed Subunit IA fence to the Palikea-03 WCA (Figure 1.4.29). The area is alien-dominated, therefore ecosystem scale control is not done at this WCA. However, there are a few non-native species in the area that NRS believes would significantly threaten the rare plant populations in the surrounding area if allowed to spread unchecked. These species include *G. robusta, P. cattleianum, M. faya*, *E. karvinskianus*, *M. minutiflora*, *Sphaeropteris cooperi,* and *Melaleuca quinquenervia.* NRS controlled these species in the 2005-2006 and did not work in the WCA this year. NRS will revisit the WCA in the coming year and follow up with the weed control performed two years ago. Visitation of this WCA on a two year cycle should be adequate.

Region: *Kahuku Training Area, KTA*

The Kahuku Training Area (KTA) is owned by the Army and contains six MUs in which the primary focus is six populations of *Eugenia koolauensis* (Figure 1.4.30). The MU fences at Kaunala, ‘Ō‘io, and Pahipahi‘ālua were completed by NRS during the summer of 2006.

Fire is a serious potential threat at most of the MUs in KTA. In 2003, a fire burned down from the ridge above the Pahipahi‘ālua WCA, traveling through duff in the *Casuarina equisetifolia* which dominate the ridge top near the fenceline. In 2004, NRS contracted tree trimmers to remove most of the *C. equisetifolia* in Pahipahi‘ālua and ‘Ō‘io. NRS also removed a large stand of the *C. equisetifolia* in Kaunala. To date, the majority of these ironwoods have been removed.

NRS will continue removing the remainder of these trees and bucking up slash left by the contractors. In the coming year NRS will begin to cut back *C. equisetifolia* from the fencelines, as well as retreat any regrowth of cut *C. equisetifolia* within the fences.

Weed control in KTA has been a constant battle as the area has a host of weed problems. *Eugenia koolauensis* habitat is predominantly *Psidium cattleianum* canopy. Initially, most of the invasive *P. cattleianum* canopy was removed from the *E. koolauensis* habitat in an effort to reduce competition for resources. However, this created light gaps that enabled the increased establishment of aggressive understory weeds that now out compete native seedlings. Weeding efforts are now primarily focused on understory weeds and limited canopy removal around *E. koolauensis*.

In order to assist in mitigating the weed issues in KTA, NRS plan to use common natives to fill in light gaps and act as natural competitors to weed domination. This year, working with PhD candidate Naomi Arcand, NRS transplanted *Cibotium glaucum* into all three fences as an experimental reintroduction. NRS are interested to see if native fern canopy will help to reduce weeding effort needed in this area. Initially the *C. glaucum* flourished, but later were hit hard by drought conditions during the summer of 2007. Future reintroductions may need more frequent site visits, accompanied by hand watering.

NRS made an effort to collect *Acacia koa* seeds this year in Kahuku to outplant during the rainy season but the *A. koa* did not appear to have a substantial seed set. In the coming year, NRS will collect *A. koa* seeds as well as other common natives from the area to outplant in the fenced PUs.

One possibility that may assist in common native plant propagation is the establishment of field nurseries. The benefits of using onsite field nurseries to grow common native species include minimizing risk of non-native pest introduction to wild rare plant populations, eliminating transport issues, and using plants that are already suited to outplanting conditions. Water catchments set up with automated irrigation would be installed so that maintenance of the nursery is minimized. Once the common natives have reached sufficient height they can be outplanted into the nearby areas.

In the past couple of years, *E. koolauensis* has been heavily impacted by the ʻŌhia rust, *Puccinia psidii.* As the driving force for management in these areas is for the *E. koolauensis* stabilization, and the fate of the populations is in question due to the impacts of *P. psidii*, NRS is struggling with what management action should be undertaken in the next year (See the Rare Plant Chapter). Many person hours of weed control could be spent attempting to stabilize the *E. koolauensis*, however if they are ultimately extirpated by *P.psidii* then the effort will be wasted. This decision should be considered carefully because person hours spent in these areas could be time used working in more pristine areas where a little weed control goes a long way. In considering these factors NRS propose the following plan for the KTA MUs over the next year.

1) NRS will strive to increase volunteer involvement in managing these areas. A goal of two trips to each fence per year will be set (with three fence units, a total of six trips). In this way, NRS can maintain management presence with minimal personnel effort. This is also an excellent place for volunteer groups as it has easy access and relatively gentle terrain.

2) NRS will work with volunteers to translocate *A. koa* seedlings into fenced units to continue area rehabilitation.
3) NRS will focus staff efforts on monitoring *E. koolauensis* to determine the impacts of the rust and adapting management appropriately (see Rare Plant section for details).
4) NRS will continue to work with the *C. glaucum* reintroduction project to maintain the translocation and document results that can be applied to future *C. glaucum* projects.

Presently there are no ungulate control actions occurring in this region aside from maintaining the MU fences discussed below.

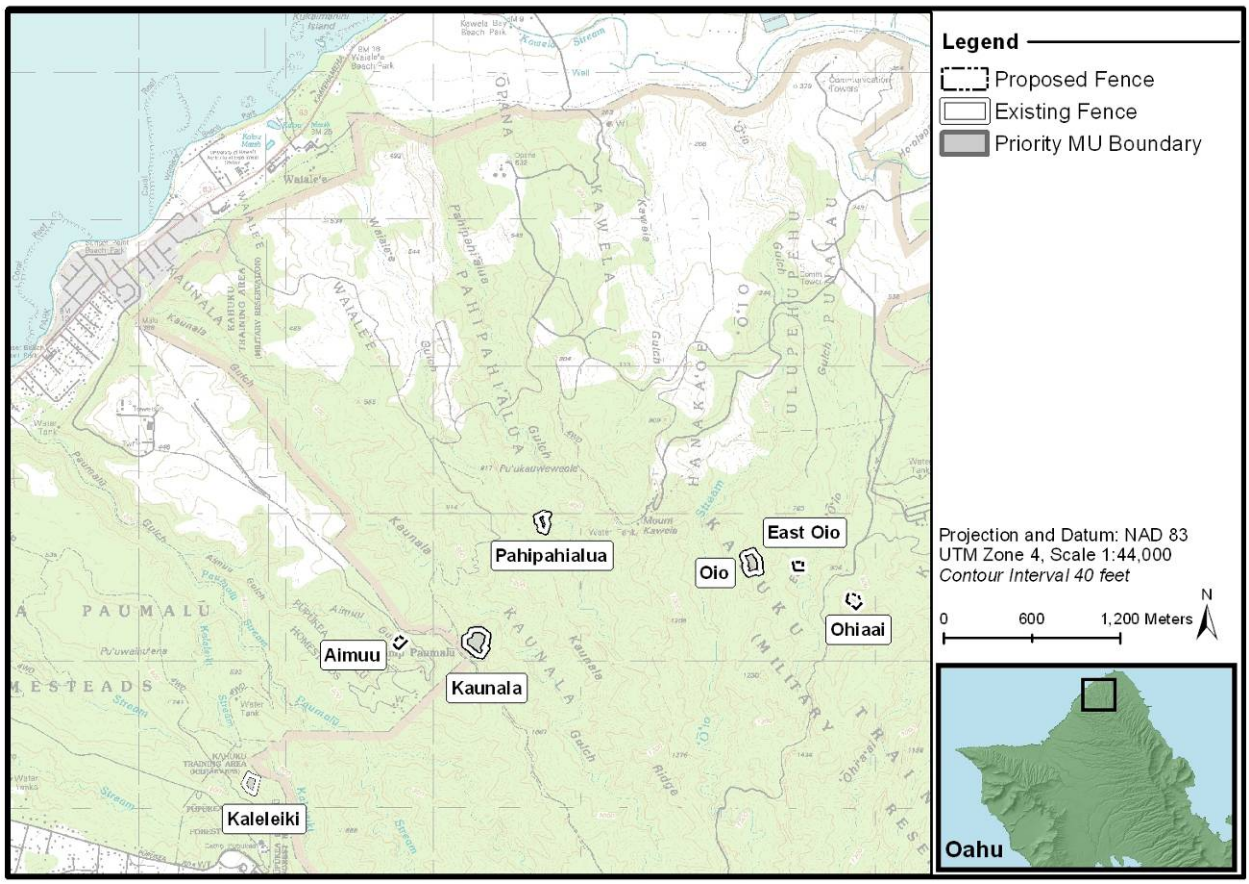


Table 1.4.29 Kahuku Training Area MUs

IP MU: East of ‘Ō‘io

There is one WCA in this MU encompassing a small population of *E. koolauensis* (Figure 1.4.30). Since this population is not designated MFS, weed control efforts here are currently minimal and no ungulate control is conducted.

WCA Discussion

East ‘Ō‘io-01; EugKoo KTA-D East ‘Ō‘io

Due to the dominance of *P. 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 not weeded last year. NRS will follow the plan outlined in the regional discussion. As this WCA is outside of a fenced unit and not MFS, it will be low priority for management.

IP MU: Kaleleiki

This WCA is drawn around a population of *E. koolauensis* found on State Forest Reserve land. NRS conduct management here in collaboration with State personnel. This site is not designated ‘MFS’ for *E. koolauensis*, thus NRS effort here is limited.

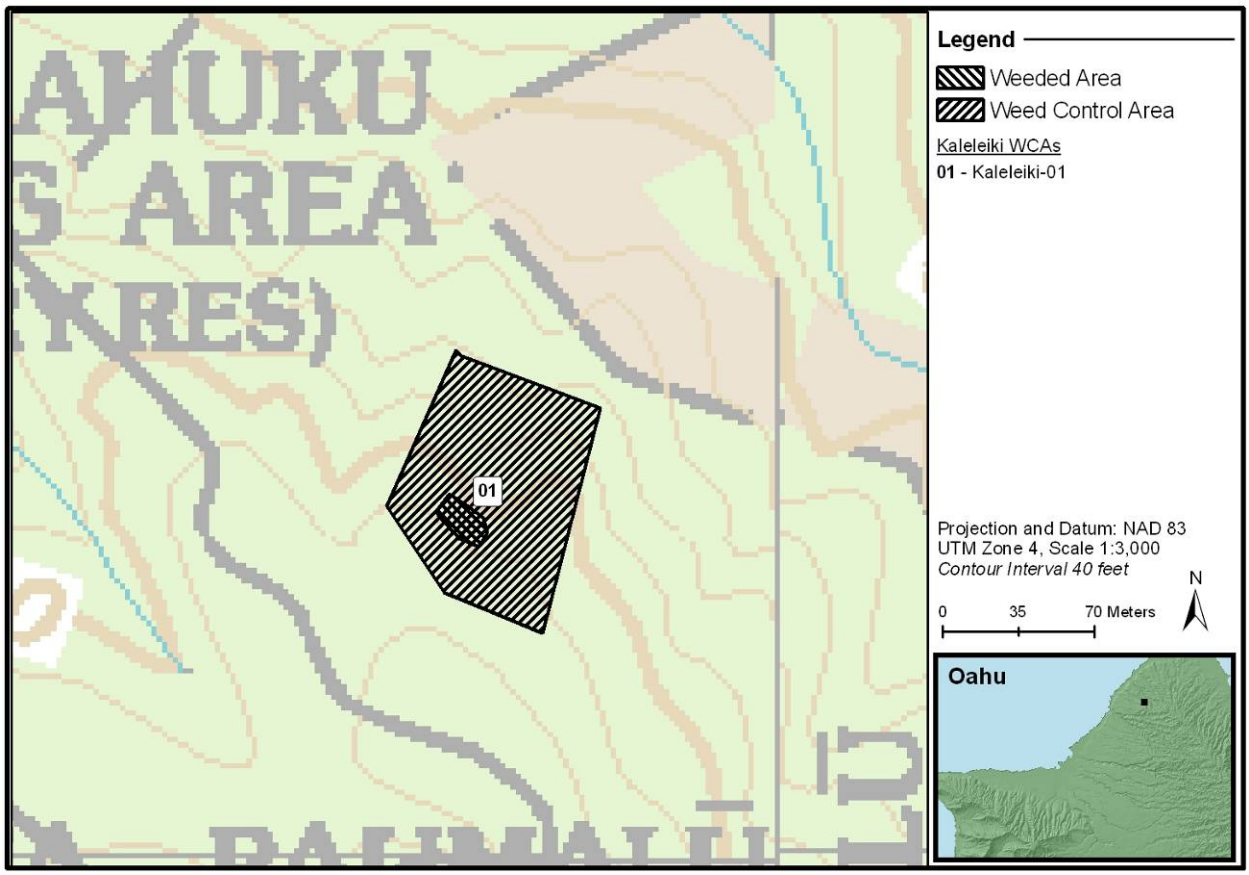


Figure 1.4.30 Ecosystem Management in Kaleleiki, Kahuku Training Area

WCA Discussion

Kaleleiki-01; EugKoo KTA-C Kaleleiki

This WCA is defined by a small ungulate-exclusion fence installed by the State (Figure 1.4.31). NRS targeted understory weeds around the core of the *E. koolauensis* population. Canopy weeding was minimized to prevent drastic alteration of microsite conditions. NRS weeded once

here in 2006-2007 (Table 1.4.22). *Clidemia hirta* was controlled in an area where there were many *E. koolauensis* seedlings. In the future, NRS will follow the plans discussed in the regional discussion above. This is not an MFS population. NRS will work with the state to determine the potential for using volunteers at the site; this could be a viable volunteer work site, once goals are met for MFS PUs in the region.

Table 1.4.22 Summary of Kaleleiki Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Kaleleiki						
Kaleleiki-01	Habitat	0.80	0.03	3.79%		EugKoo
				Treatment Type	**# of Visits**	**Effort (Person Hrs)** / **Species Controlled**
				Ecosystem Weed Control	1	24.00 / CliHir, PasEdu
				Totals	1	24.00
Total IPMU: Kaleleiki						
		0.80	0.03	3.79%	1	24.00

IP MU: Kaunala

One of the largest populations of *E. koolauensis* occurs in this MU, which encompasses two gulches: Kaunala and Aimu‘u. Weed control is concentrated around the greater part of this population in Kaunala Gulch (Figure 1.4.30). 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. Kaunala-01 is defined by a fence, completed in 2006, which protects *E. koolauensis*, while Kaunala-02 is defined around a landing zone and camp site. NRS did not conduct any weed control at either WCA this year due to staffing limitations. Like the other MUs in KTA, this site poses major weed challenges, as it is made up of predominantly weedy species. However, it does include some tiny remnants of one of the most endangered ecotypes in the State: lowland wet-mesic forest. Future management will center on common native reintroduction, and weed control, with an emphasis on using volunteer labor. NRS will strive to visit the site 2-4 times in the next year.

<u>Ungulate Control Efforts</u>
The Kaunala MU fence is the largest of three exclosures protecting *E. koolauensis* in the KTA. The 4.9 acre fence was completed in July 2006 and remains ungulate-free. No other ungulate control efforts were conducted.

IP MU: ‘Ō‘io

This IP MU contains one WCA, is delineated by the ‘Ō‘io fence (Fig. 1.4.32). The fence protects a large population of *E. koolauensis* which is designated MFS. NRS will strive to visit the site two times for weed control with volunteers in the next year.

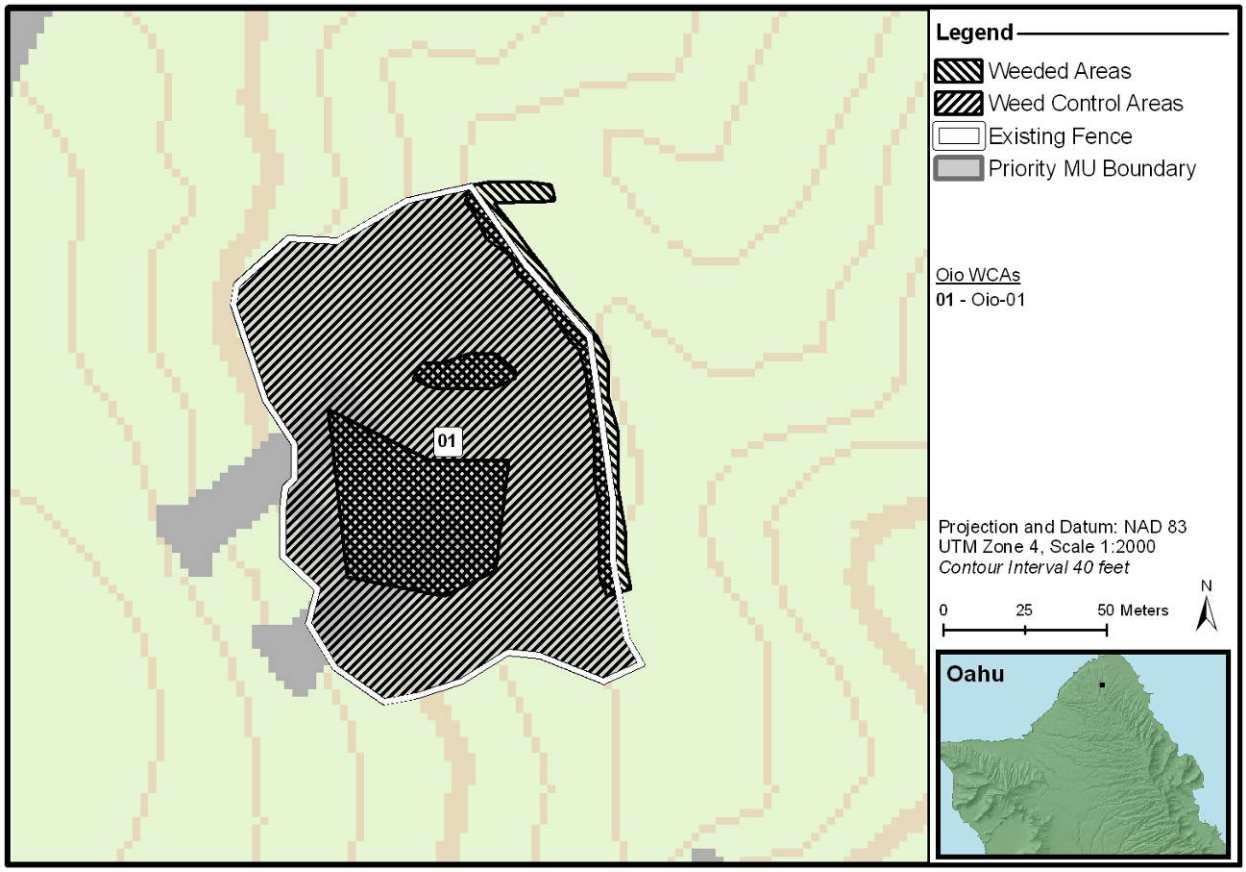


Figure 1.4.31 Ecosystem Management in ‘Ō‘io, Kahuku Training Area

Ungulate Control Efforts

A 3.3-acre ungulate exclosure was completed in July 2006. Built to protect a population of *E. koolauensis,* the fence was routinely checked and found to still be ungulate-free. No other ungulate control efforts were conducted.

Table 1.4.23 Summary of ‘Ō‘io Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Oio						
Oio-01	Habitat	1.33	0.21	15.70%		EugKoo

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	1	21.00	ArdEll, CasEqu, ChrPar, CliHir, OplHir, PimDio, StaDic, TreOri
Totals	1	21.00	

Total IPMU: Oio						
		1.33	0.21	15.70%	1	21.00

WCA Discussion

‘Ō‘io -01; EugKoo KTA-F ‘Ō‘io

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. 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. Control efforts are summarized in Table 1.4.23. The area is so weedy that regular understory weeding will not suffice. Instead, in the coming year NRS hope to transplant naturally-occurring *Raovulfia sandwicensis* and *A. koa* seedlings from nearby areas into the weeded site. It is hoped that planting canopy native species will help restore some level of shade to the site in both the short and long term. Weed control will be conducted directly around plantings. Restoration of this site will be challenging. NRS will strive to visit the site two times for weed control with volunteers in the next year. If more volunteer time is available, this area will be considered a priority.

IP MU: Pahipahi‘ālua

This IP MU contains one WCA, which is delineated by the Pahipahi‘ālua fence (Figure 1.4.30). 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.

Ungulate Control Efforts

A small fence was constructed and finished in July 2006. The 1.5 acre exclosure continues to be pig-free. No other ungulate control efforts were conducted.

WCA Discussion

Pahipahi‘ālua -01; EugKoo KTA-A Pahipahi‘ālua

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, the weeding strategy has focused on controlling canopy and understory weed species directly around the *E. koolauensis* trees, allowing the native canopy trees to begin filling in. NRS have seen noticeable *Carex* and mixed native recruitment in a portion of the WCA. No weed control was conducted this year. NRS will strive to visit the site two times for weed control with volunteers in the next year.

Region: *Northern Ko‘olau Mountains*

This region includes parcels with multiple landowners, namely Kamehameha Schools, the State of Hawai‘i, the US Government and Hawai‘i Reserves Inc. Within this region is Kawailoa Training Area (KLOA), which the Army has a license to use from Kamehameha Schools. NRS work extensively in the summit portion of this region. Presently, there are eleven MUs

designated in this region; NRS are currently working in four. There are three fenced units including two large units, Opaeula and Helemano, where NRS are involved in vegetation management. A fourth large scale fence is being pursued at Koloa, on Hawaii Reserves Inc. land. At Helemano and Opaeula, three WCAs are designated in each fenced area. In these six WCAs, NRS work to remove invasive species from otherwise predominantly native landscapes. There are two WCAs designated outside of fenced areas; they were created to track invasive species management along the summit, to the north and south of the fenced units. NRS is currently involved in ungulate management within all the fenced areas. No ungulate control occurs outside of fenced areas. Access to this area is difficult as it requires helicopter support.

IP MU: Koloa

Work in this MU just began this year. NRS have conducted several surveys and preliminary fence-scoping trips to the region, but no management activities except incipient invasive control have yet been implemented. See the Incipient Weed Report for details concerning *H. coromandelianum* and *L. scoparium* control efforts in this MU.

IP MU: ‘Ōpae‘ula/Helemano

This large MU is divided into two subunits, ‘Ōpae‘ula, and Helemano. Encompassing approximately 100 hectares, this MU protects pristine wet forest at the Ko‘olau summit. A host of IP taxa, including *Achatinella sowerbyana*, *A. lila*, *Cyrtandra viridiflora*, and *Cyanea st. johnii* are found in the MU. The primary threats to this MU are pigs and weeds. In addition, rats are controlled around rare snail sites, as discussed in the Rare Snail Management chapter. All three ‘Ōpae‘ula WCAs are contained within the ‘Ōpae‘ula exclosure (Figure 1.4.34), which was completed in 2001. The 175-acre Helemano fence was completed in May 2007 and encloses the Helemano WCAs (Figure 1.4.34). The primary weed threats to the MU include *P. cattleianum*, *S. palmifolia*, *C. hirta*, and *Pterolepis glomerata*. Of these, *C. hirta* and *P. glomerata* are very widespread and are not controlled. *Setaria palmifolia* has a patchy distribution and is treated in as an incipient in ‘Ōpae‘ula (Incipient Weed Report).

The short term objectives for this MU are:

1) Complete control of all ungulates in Helemano subunit.
2) Continue weed control in ‘Ōpae‘ula subunit.
3) Resume weed control in Helemano subunit.
4) Conduct periodic fence checks to maintain structural integrity of both exclosures.
5) Evaluate the distribution of *S. palmifolia* in Helemano to determine whether control efforts are best tracked via WCA or ICA designation
6) Monitor vegetation plots, including LCTA plots and *P. glomerata* plots on a defined schedule.

Most of the weeding done in the Helemano WCAs was primarily to clear fenceline. Future weeding efforts of the Helemano WCAs will be similar to weeding in the ‘Ōpae‘ula WCAs. This year, the priority in Helemano was to control ungulates inside the fence. In the coming year, NRS will sweep for *P. cattleianum* and control *S. palmifolia* (see Incipient Weed Report)

Weeding within the ‘Ōpae‘ula WCAs consists mainly of large scale sweeps for scattered *Psidium cattleianum,* which is a threat to the integrity of the ecosystem. Occasionally, NRS find other weedy tree species, such as *Schefflera 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 (see Figure). The spotters locate *P. cattleianum* 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 Ko‘olau summit environment is not easily infiltrated by most weeds, including *P. cattleianum,* and with ungulates excluded from ‘Ōpae‘ula, weed dispersal vectors are severely limited. NRS are confident that with regular but infrequent sweeps of the exclosure, *P. cattleianum* will become an almost non-existent component of this summit ecosystem. Control efforts for this year are summarized in Table 1.4.24. In the coming year, NRS will focus on weeding those portions of the ‘Ōpae‘ula fence which have not been weeded in the last five years. These relatively small areas are noted in Figure 1.4.34.

Figure 1.4.32 NRS searching for *Psidium cattleianum* along ridge top in Ko‘olau Mountain Range

The Ko‘olau summit is very wet and is frequently obscured by rain clouds. Since access to the MU is most efficient via helicopter, and since herbicide use must be conducted in dry conditions, NRS are not always able to conduct management operations on a quarterly basis. However, since the MU is fenced, and thus weed spread via ungulates is reduced, NRS are able to have the flexibility to wait for optimal weather conditions.

Ungulate Control Efforts

Ungulate control efforts within the Helemano fence are ongoing and include primarily snaring (Figure 1.4.34). The difficulty of accessing the remote Helemano area has limited NRS to four work trips, resulting in six natural resource staff spending 118 person hours deploying 138 snares in the upper half of the fence. A total of 12 pigs were removed from the area. The last trip in August 2007 resulted in no new fresh sign in the snaring areas as well as other areas surveyed in the lower half of the fence. NRS will continue to monitor pig sign to determine if control strategies need to be adjusted to attain an ungulate-free exclosure.

The ‘Ōpae‘ula fence has been ungulate free since its completion in 2002. In May 2007, breaches by smaller pigs prompted NRS to install eight snares along the fence line. No pigs have been

caught thus far. Further monitoring of the fence line and enclosed area for pig sign will determine future ungulate management actions in this area.

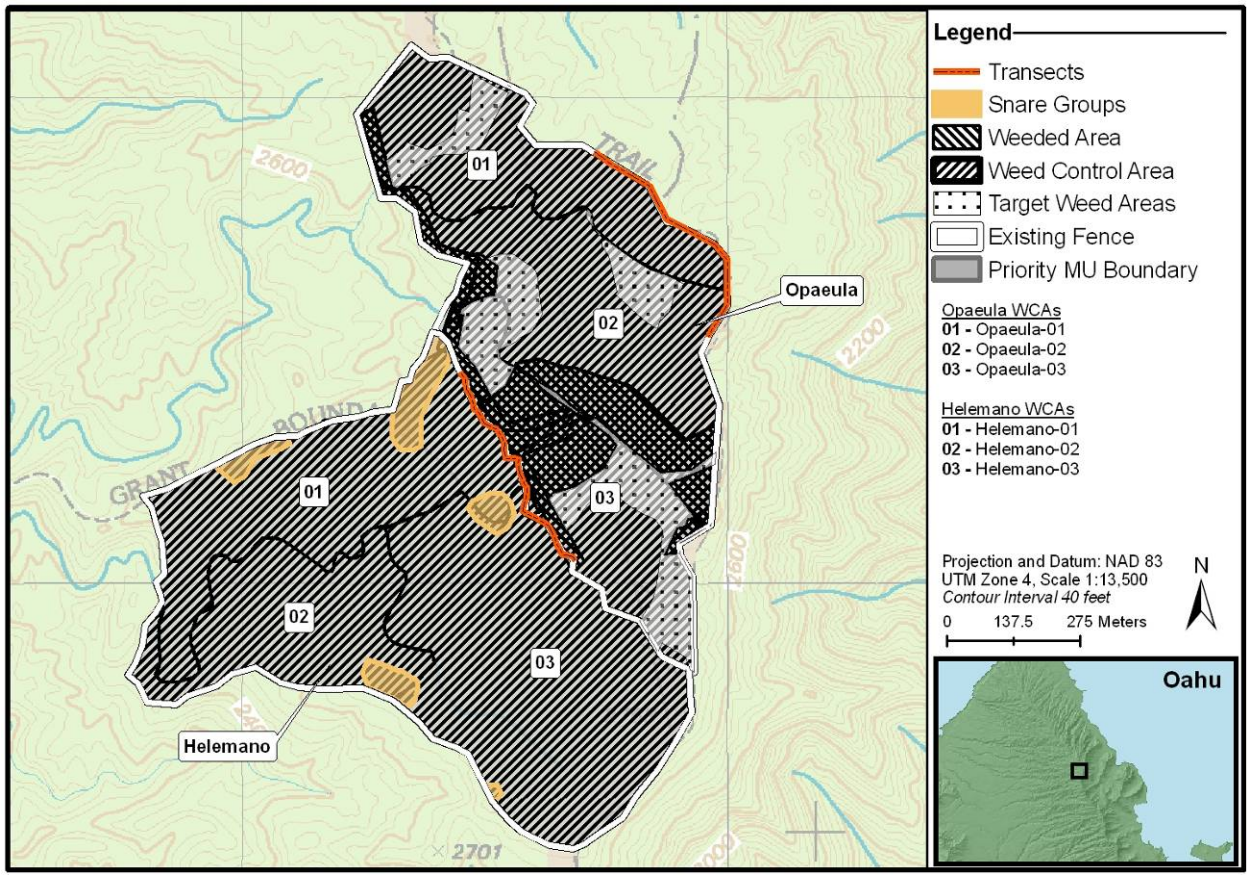


Figure 1.4.33 Ecosystem Management in Helemano & Peahinaīʻa, KLOA

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 1.2, Incipient Weed Report.

WCA Discussion

ʻŌpaeʻula -01; Northern ʻŌpaeʻula

NRS visited this area once this past year to sweep for guava. The weeding efforts took place mainly along the fenceline (Figure 1.4.34). It is important that NRS continue to walk the fenceline and weed for *P. cattleianum* to keep it from penetrating deeper into the WCA. Before the fence was built, *P. cattleianum* was spread through the area by pigs, but now the pigs are eradicated from within the fence. The pigs may still spread *P. cattleianum* along the fenceline so it is important that we contain these *P. cattleianum* outbreaks along the fence. NRS plan to visit this site quarterly next year and will continue with their quest of sweeping this entire WCA.

Table 1.4.24 Summary of ‘Ōpae‘ula/Helemano Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: Opaeula/Helemano						
Opaeula-01	Habitat	14.42	0.43	2.95%	JoiAscAsc, LobGauGau	CyaKoo, CyrVir, MyrJud, VioOah
				Treatment Type	**# of Visits**	**Effort (Person Hrs)** / **Species Controlled**
				Ecosystem Weed Control	1	2.00 / PsiCat
				Totals	1	2.00
Opaeula-02	Habitat	20.29	4.27	21.03%		CyrVir, VioOah
				Treatment Type	**# of Visits**	**Effort (Person Hrs)** / **Species Controlled**
				Ecosystem Weed Control	3	39.00 / PsiCat
				Totals	3	39.00
Opaeula-03	Habitat	14.41	5.94	41.22%	JoiAscAsc	ChaRoc, CyrVir, VioOah
				Treatment Type	**# of Visits**	**Effort (Person Hrs)** / **Species Controlled**
				Ecosystem Weed Control	3	37.00 / PsiCat
				Totals	3	37.00
Total IPMU: Opaeula/Helemano						
		49.12	10.63	21.65%	7	78.00

‘Ōpae‘ula -02; Central ‘Ōpae‘ula /Goosehead Ridge

This year NRS visited this WCA tree times and observed a decline in the *P. cattleianum* population. Sweeps were made throughout this WCA and along the fenceline. NRS plan on revisiting this WCA quarterly over the next year and hope on penetrating deep into the thick native vegetation to finish weeding this entire area.

‘Ōpae‘ula -03; Southern ‘Ōpae‘ula

Three sweeps were made in this WCA over the past year and NRS staff observed low numbers of *P. cattleianum*. A *Cyrtandra viridifolia* was found on one of the sweeps and weeds were removed from its immediate area. NRS plan to revisit this WCA quarterly next year to continue sweeping mainly for guava.

KLOANoMU-01

This WCA covers the summit trail between the ‘Ōpae‘ula fence and the Lehua Makanoe bog fence, including the bog fence. While this site itself is not fenced, there is heavy pig activity along the summit trail, and NRS hope to reduce the spread of *P. cattleianum* along it. Doing so will help to reduce the effects of *P. cattleianum* to other rare taxa in the region, including *Lobelia gaudichaudii*. This WCA was not weeded last year. NRS plan on weeding this WCA two times next year, and will continue to focus efforts on *P. cattleianum*.

IP MU: Poamoho

The Poamoho MU includes a large region around the uppermost portion of the Poamoho Trail, including the summit. Several species of *Achatinella* are found here, as well as numerous rare plant species, including *Sanicula purpurea*. Dominated by native forest, the primary threats to the area include ungulates, *P. cattleianum*, and *L. scoparium*. Management work centers around rodent control and incipient invasive control of *L. scoparium* (see Incipient Weed Report). Only one WCA has been designated, along the Poamoho trail. The MU fence is proposed to be built in Year 3 of the OIP.

Ungulate Control Efforts
No ungulate control efforts were planned for Poamoho this year. However, this area is a well known Public Hunting Area (Hunting Unit C). In the summer of 2007, DOFAW modified Poamoho Road with new gates and access points. Ungulate control efforts in this area will, in a large part, remain a public affair. A fenced management unit is planned for the summit portions of this area. NRS will re-evaluate ungulate control measures prior to construction of this fence.

WCA Discussion

Poamoho-01; Poamoho Trail
Encompassing the uppermost portions of the Poamoho Trail, the primary target of this WCA is *P. cattleianum*. NRS almost exclusively work in this WCA with volunteer groups. It is a good volunteer project, as large numbers of people can be accommodated, weed targets are easy to identify and kill and are located along the trail, and the dense native forest provides many educational opportunities. No control was done this year, but NRS hope to revisit the site in the coming 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. NRS are awaiting a license agreement with Kamehameha Schools to begin work in this MU.

Region: *Schofield Barracks East Range, SBE*

Schofield Barracks East Range (SBE) is owned by the Army. NRS do not work extensively in this region at this time, due to staffing limitations and the prioritization of other projects. There are three MUs designated around rare plant populations. There are no WCAs presently designated for native vegetation management. This reflects NRS decision to focus weed management within fenced MUs and ungulate management areas. There are no fenced areas presently in this region. Weed and pest management is being conducted in the lowest-elevation portion of SBE. Presently, NRS work at one WCA centered on vegetation management to

facilitate coquí frog control (Figure 1.4.35). NRS also participate in control of a coquí frog infestation located near Leilehua Gate. There are many ICAs designated in the lower areas of the region where NRS is working towards eradication of invasive incipients (see Incipient Weed Report for details). As incipient weed control projects progress toward completion and NRS begins to develop plans for possible future fencing, NRS will expand weed management actions in this region.

Ungulate Control Efforts

No ungulate control actions were conducted this year. There are two snare line present at in SBE and NRS plan to monitor them in the coming year.

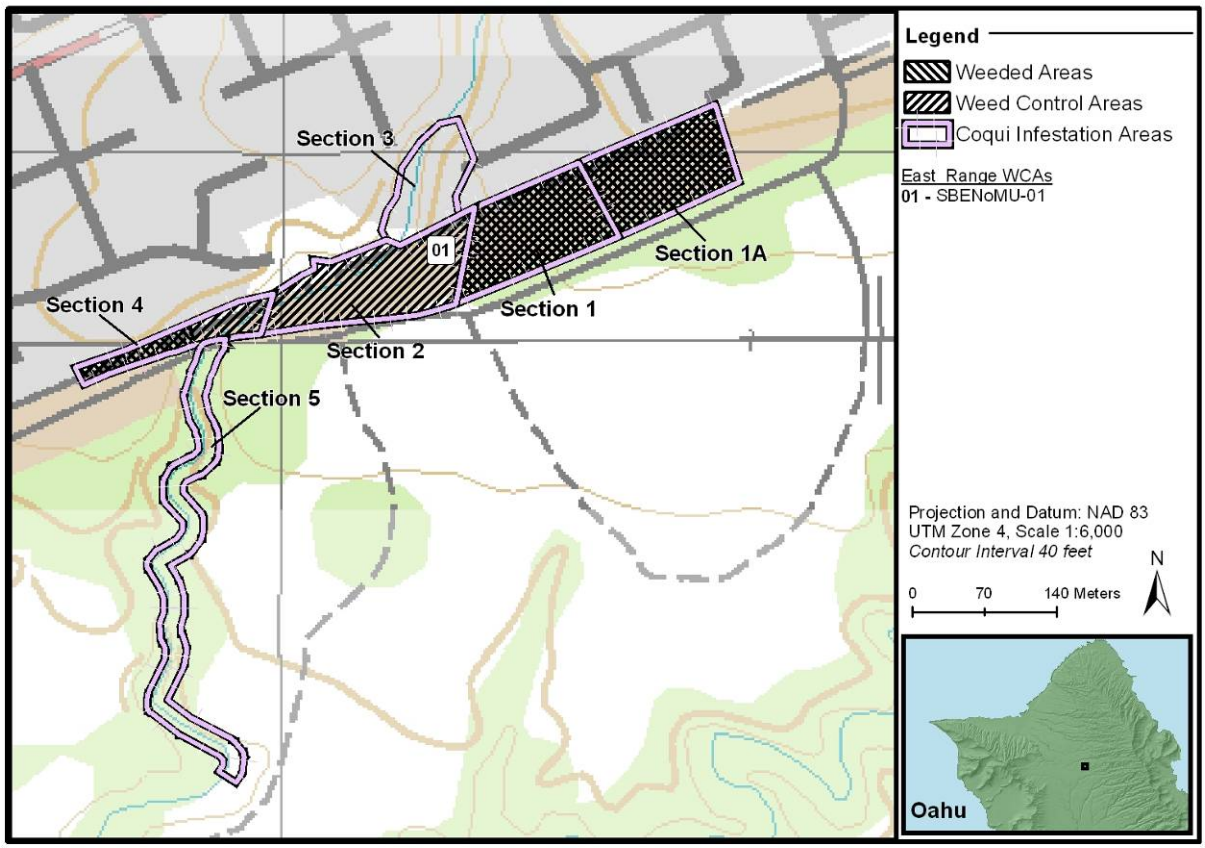


Figure 1.4.34 Ecosystem Management in Schofield Barracks East Range

Coquí Discussion

In 2001, *Eleutherodactylus coqui*, or coquí frogs, were discovered in Wahiawa. Introduced into the area on greenhouse plants at a private residence which runs a plant rental business, the frogs quickly spread into neighboring areas, including SBE. At the time, the infestation was the largest on O‘ahu. A joint task force was created to deal with the infestation. Partners from the Department of Agriculture (DOA), O‘ahu Invasive Species Committee (OISC), US Fish and Wildlife Service (USFWS), and the Conservation Branch of DPW created the Coquí Working Group (CWG). Over the past six years, the CWG directed control efforts in Wahiawa, working with both private residents and the Army to eradicate the infestation. The infestation was

divided into six areas: Sections 1, 1A, 2, 3, 4, and 5; see Figure 1.4.35. Originally, the infestation was limited to Sections 1, 2 and 3. However, despite control efforts, it expanded first to include Section 1A, and later, in 2006, Sections 4 and 5. The basic strategy for treating the Wahiawa infestation has evolved over the years. Currently, both daytime leaf litter drenches and nighttime forest canopy drenches of citric acid are used very effectively. Daytime drenches are used to treat large areas, and nighttime drenches are used to treat small areas known to contain calling frogs. Both citric acid and lime are effective at killing coquí; due to label restrictions, however, the CWG only uses citric acid at Wahiawa. Sprays are conducted by a crew of temporary staff hired by OISC (3 positions) and NRS (1 position). Regular night time monitoring surveys are conducted by various members of the CWG to track frog presence and absence in the various Sections.

In 2005 and 2006, large scale sprays of citric acid were highly effective in reducing frog numbers. In 2006, sprays were conducted between April and September 2006, during the coquí breeding season, when the frogs are easiest to locate. At the end of the 2006 season, the infestation was estimated at 30-40 frogs, down from hundreds of frogs in 2001. Section 3 was deemed clear of frogs, in part because the area had been cleared for construction. However, frogs had spread into Sections 4 and 5. This may have been a result of heavy rains washing frogs downstream.

Nightly monitoring efforts between the end of the 2006 spray season and the beginning of the 2007 spray season in May showed no frogs calling in any of the six sections. In previous years, coquí had always been observed calling by April at the latest. Encouraged by this, the CWG decided to continue to treat the area aggressively, and hopefully prevent any remaining frogs from reaching maturity. NRS assisted with preparing the area for spraying (see SBE-NoMU-01 WCA discussion below). Sprays were conducted between May and September 2007, prioritizing the previous season's hot spots: Sections 4 and 2. High priority areas were drenched twice and low priority areas were monitored for frogs and spot sprayed as needed.

At the conclusion of the 2007 spray season, coquí are yet to be heard in Wahiawa. Figure 1.4.36 shows the number of calls heard at Wahiawa over time. Typically, calls peak during summer calling seasons, but these peaks have been steadily becoming shorter from year to year as control has continued. Note the lack of a peak in 2007. Generally, an area is considered coquí free when no calling has been heard for 9-12 months. Given this guideline, it appears that the Wahiawa population may be extirpated. However, the results of this season's spray will not be obvious until the calling season begins in May 2008. Future management plans for the site will be discussed by the CWG in the coming months. In 2008, it is likely that efforts will focus on night monitoring, including using remote sensing techniques (digital recorders) to thoroughly survey the area. NRS will continue to participate in the CWG until Wahiawa is labeled "coquí free."

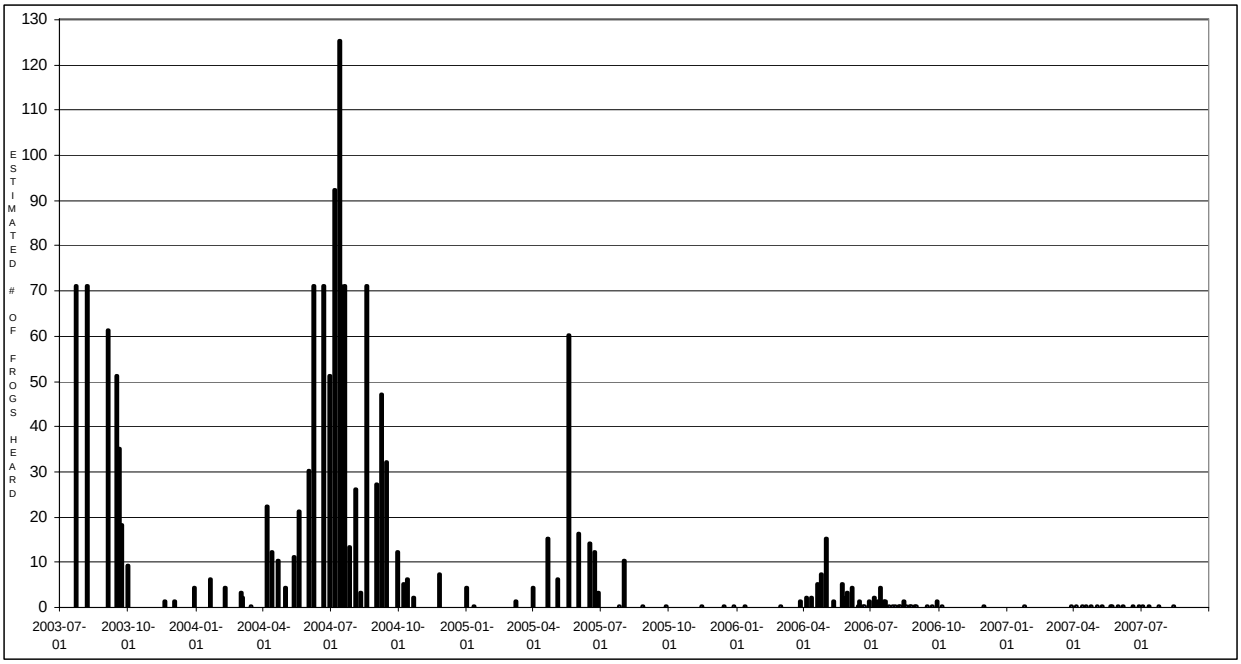


Figure 1.4.35 Number of Coquí Heard Over Time, 2003 to Present

Table 1.4.25 Summary of SBE Weed Control Efforts

WCACode	WCAType	WCA TotalArea (hectare)	Total Area Covered (hectare)	% Area Covered	Rare Taxa Present	Stabilization Taxa Present
IP MU: SBE No MU						
SBENoMU-01	Habitat	3.95	2.40	60.82%		

Treatment Type	# of Visits	Effort (Person Hrs)	Species Controlled
Ecosystem Weed Control	2	61.00	CitCau, CluRos, PanMax, PsiCat, PsiGua, SchTer
Totals	2	61.00	

Total IPMU: SBE No MU						
		3.95	2.40	60.82%	2	61.00

WCA Discussion

SBENoMu-01; Coquí Area

Management at this WCA is geared towards facilitating coquí management. As described above, the coquí infestation site is divided into several areas. This year, NRS assisted in controlling weeds in three areas: Sections 1, 1A, and 4. In Sections 1 and 1A, NRS sprayed 22 access transects with Roundup in order to keep them clear, drivable, and unattractive to coquí. In Section 4, a joint NRS and OISC team cleared vegetation from the area, decreasing its attractiveness to the frogs, as well as improving access for coquí drench treatments. This clearing resulted in a huge pile of debris; perfect habitat for the frogs. Rather than leaving it or moving this potentially coquí contaminated material off-site, NRS contracted Glad's Landscaping and Tree Inc. to chip the material so that it could be left on-site. Unfortunately, due to contract difficulties, this clearing work did not happen in June, as originally planned, but rather in September. Despite this, the temporary spray crew was able to drench the area twice.

Given the current positive prognosis for the coquí's eradication from Wahiawa, it is unclear how much longer NRS will work in this WCA. Once the infestation has been eradicated, NRS will discontinue this WCA. Until then, NRS will continue to maintain access trails and otherwise facilitate coquí drenches.

Chapter 2.1.0: RARE PLANT STABILIZATION PLAN STATUS

General Rare Plant Issues

This section includes a discussion on the taxon status, genetic storage, outplanting and threats for each rare plant taxa covered by the MIP. The requirements for stabilization are to achieve a stable number of mature plants, have a population structure which can maintain that number of mature plants, obtain full genetic storage, and control all observed threats at each MFS PU. This will be done by implementing Population Unit (PU) and Management Unit (MU) management at all of the 'Manage for Stability' PUs. The most current list of the MFS PUs were proposed in the 2006 Status Report. Management designation changes discussed at last years IT meeting have been incorporated in this year report. In addition, NRS have included a Stabilization Plan for *Gouania vitifolia* that was found to require stabilization by the 2007 Mākua Military Reservation Biological Opinion from the USFWS. General rare plant issues are discussed below followed by 27 Species Status Summaries for each of the MIP taxa and the Stabilization Plan from *Gouania vitifolia*.

Propagation infrastructure

NRS has been working with NARS on the construction of an additional shade-house at the Pahole Mid-elevation Nursery. The frame and ground work is largely complete and NRS expect to have the shade cloth attached and benches and irrigation infrastructure complete in the next year. NRS has continued to work with State NARS Horticulturist, Doug Okamoto, on projects at the Pahole Mid-Elevation Nursery and on stock from Pahole NAR. Mr. Okamoto has been extremely valuable in providing assistance in maintaining stock and providing expertise on propagation and outplanting. He has been maintaining critical stock from the Pahole NAR at the Pahole Mid-Elevation Nursery and at Lyon Arboretum. NRS continue to use two plant growth chambers at the Schofield baseyard for germination and early stage propagation.

Research Issues

Research issues related to propagation and threats are discussed in detail in Chapter 5 Research Activities and in the Species Status Summary for each taxon. NRS had identified several propagation research projects in the last year. In particular, methods to produce seed from greenhouse collections of *Dubautia herbstobatae, Viola chamissoniana,* and *Schiedea obovata* were to be studied. These projects were successful in determining pollination techniques and producing viable seeds from hand-pollination and these methods will be utilized for producing propagules for meeting genetic storage goals in the coming years. In addition, research on determining the best collection and storage techniques for *Cyanea superba* subsp. *superba* showed that mature seeds which are collected and dried can be germinated and stored with greater success than previously observed collections.

Living Collections

NRS has identified several MIP taxa that would benefit from having a living collection of plants for genetic storage, propagation, and threat control research. In the last year, NRS began preliminary discussions with Office of Hawaiian Affairs (OHA) about expanding sites at Waimea Botanical Garden. During a site visit, potential planting sites for several taxa were discussed and a proposal will be submitted to OHA in January 2008, once the transfer of management from the Audubon Society is complete. This site can be used to hold stock from

PUs where threat control is not yet in place, produce propagules for genetic storage and conduct propagation research.

Monitoring

NRS was unable to fill the Monitoring Program Manager Position. In the next year, NRS will contract Jim Jacobi (USGS Botanist) to address monitoring issues, develop monitoring protocols, oversee implementation of sampling methods, and begin analysis.

In the absence of a Monitoring Manger NRS was involved in a limited number of projects including the three discussed below. First, intensive monitoring of *Sanicula mariversa* to begin to collect demography data and develop Population Viability Analysis (PVA) models for the species to better guide management (see Chapter 2.1.23). Second, the deployment of weather stations at *Phyllostegia kaalaensis* reintroduction sites to measure micro site variation and begin to collect environmental data that may be important for developing future reintroduction plans (see Chapter 2.1.20). Finally, this year NRS began a trial vegetation mapping project for Mākua Military Reservation with help from the Jim Jacobi and Stephen Ambagas, of USGS. The two objectives of this project are to prepare a detailed vegetation map focused on the northwestern section of the Mākua Action Area and conduct a pilot study using very high resolution multi-spectral imagery to map the distribution and abundance of selected native and alien plant species in Kahanahāiki and ʻŌhikilolo management units. The vegetation mapping will follow methodologies developed by S. Ambagis and J. Jacobi and will utilize the object-based classification software eCognition with IKONOS and QuickBird satellite imagery as well as very high resolution digital image data. This data is collected with a multi-spectral camera mounted on a helicopter to be flown over Mākua Valley.

In March of this year, high resolution (15-20cm) imagery was collected with a multi-spectral camera and other equipment brought here from the mainland. Unfortunately, the weather was not optimal for collecting data and many of the areas covered are not useful because of cloud shadow. To supplement this data lower resolution Quickbird (MS 2.6m) and IKONOS (MS 4m) data will need to be used in more areas than initially planned. The imagery has been processed and S. Ambagis is looking at it along with the Quickbird data. S. Ambagis is working on coming up with spectral signatures for the different plant species that could be identified in the images. NRS is assisting by collecting ground data on areas identified by S. Ambagis. In August 2007 a meeting was held to go over some possible signature areas and to confirm these sites with NRS knowledge of the ground in those areas. NRS and USGS-BRD continue to move forward with this project, and are planning to use it to stratify monitoring plot placement in the near future. NRS are interested in other very high-resolution imaging systems currently being developed that can be deployed in Hawaiʻi such as the project being led by Dr. Greg Asner of the Carnegie Institute (Asner et al. 2007).

Stabilization Strategy

This is the third year that NRS has used the stabilization strategy for designing rare plant management. The new stabilization species *Gouania vitifolia* was analyzed with the strategy described previously (OANRP 2006) and a draft stabilization plan is included here (Chapter 2.1.12).

Example of Species Status Summary

The species status summary outlines all PU work conducted for each of the 28 MIP taxa. Each species summary has the same format. Each section is explained in detail in the example below:

Requirements for Stability: This section defines requirements for reaching stability for each taxon.

- 3 Population Units (PUs) are designated for all species. However, for species meeting the following criteria 4 PUs have been designated:
  - with presence in both Makua Action Area (AA) and Schofield AA (Example: *Plantago princeps*)
  - for species occurring in the high fire threat area of the Makua AA (Example *Chamaesyce celastroides*)
  - for taxa that have no extant wild PUs and therefore rely completely on reintroduction for stability (Example *Cyanea superba*)
- [25-100] reproducing individuals in each PU (justification based on the number of individuals, average life span, life form, and other factors from the final MIP)
- Threats controlled: may include fences, weed control, arthropod and rodent control
- Complete genetic representation of all PUs in storage: may include nursery living collections, seed storage, and tissue culture storage
- Expedited Stabilization: (5 or 10 yrs) Expedited Stabilization is required for 12 species identified in the 2007 Biological Opinion (BO). Expedited stabilization actions will not begin until NRS receive the additional funding needed to accomplish these new goals.

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/4	3/4	1/4	1/4	0/2

This table provides a general overview of progress on the stabilization of the MFS PUs for each species. The second and fifth questions have changed slightly to reflect shorter term assessments of the long term goals outlined in the 20 year MIP plan.

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 in threat levels at the PU that warrant a management change?
- 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?
- Are there significant propagation or genetic storage issues?
- Are there new taxonomy issues?
- General prognosis for the taxon given current threat control trends.

Example 'Taxon Status' Table

Table 2.1.2a Taxon Status Summary

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides TaxonCode: CenAgrAgr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki and Pahole	Manage for stability	81	11	7	227	30	2	311	47	31	**308**	**41**	**9**	Some reintroductions have died in the last year.
	Total for Taxon:	81	11	7	227	30	2	311	47	31	**308**	**41**	**9**	

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides TaxonCode: CenAgrAgr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Ekahanui	Manage for stability	30	3	16	52	1	0	86	3	16	**82**	**4**	**16**	Some reintroductions have died in the last year.
Makaha and Waianae Kai	Manage for stability	12	0	0	0	0	0	14	0	0	**12**	**0**	**0**	This is a real decline due to ungulate impacts.
South Huliwai	Genetic Storage	21	0	0	0	0	0	21	0	0	**21**	**0**	**0**	No monitoring in the last year.
	Total for Taxon:	63	3	16	52	1	0	121	3	16	**115**	**4**	**16**	

This table displays the current status of the wild and outplanted plants in each PU and the 2006 population estimates for comparison. The extant PUs are grouped into those in and out of the AA, and new PUs established via reintroductions.

Mākua Population Unit Name: PUs' names are based on decisions made at the January 2006 MIT meeting. Only PUs designated to be Manage for Stability (MFS) or Genetic Storage (GS) are shown in the table. Other PUs with No Management designations are not monitored or managed and will not be reported. Reintroductions for stability or storage which have not yet begun are shown in the table with zeros for population numbers.

Management Designation: The Management Designation for each PU is based on decisions made at the January 2006 MIT meeting. Naturally occurring PUs are either MFS or GS. In the case where reintroduction is going to be used to reach stability the designation is Manage Reintroduction for Stability. The 'manage as a propagule source' that was used in the 2006 Status update has been eliminated. This designation was used to identify PUs from which stock would be used for reintroduction into other sites. In most cases, PUs that had this designation have been labeled as GS and the intent of the previous designation is preserved. When four MFS PUs are designated the justification is given in the discussion.

Current Mature, Immature, Seedling (Wild): The first three columns reflect the most up to date population estimates of the wild plants in each PU. In most cases these numbers are generated from NRS monitoring data, but data from the O'ahu Plant Extinction Prevention Program (PEP) and State NARS staff are used for some PUs. The current estimates reported may have changed from last year if new monitoring data was taken or if the PUs have been split or merged since the last reporting period. If no additional monitoring was conducted in the last year, the estimate given in the 2006 Status Report is used.

Current Augmented Mature, Immature, Seedling: The second set of three columns display the numbers of individuals NRS and partner agencies have outplanted into each PU. In most cases, the number represents augmentations into the existing PU rather than reintroductions of genetic stock from that PU into other areas. While most augmentations of a PU will be from genetic stock from that PU, there are exceptions discussed in the text.

NRS Mature, Immature and Seedling 2006: NRS reports the ***sum*** *of the number of wild and outplanted* mature, immature plants and seedlings observed, as reported in the *Taxon Status* Table for each PU in the 2006 MIP Status Report. For new populations discovered since the 2006 MIP Status Report, this column is left 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 which are left blank.

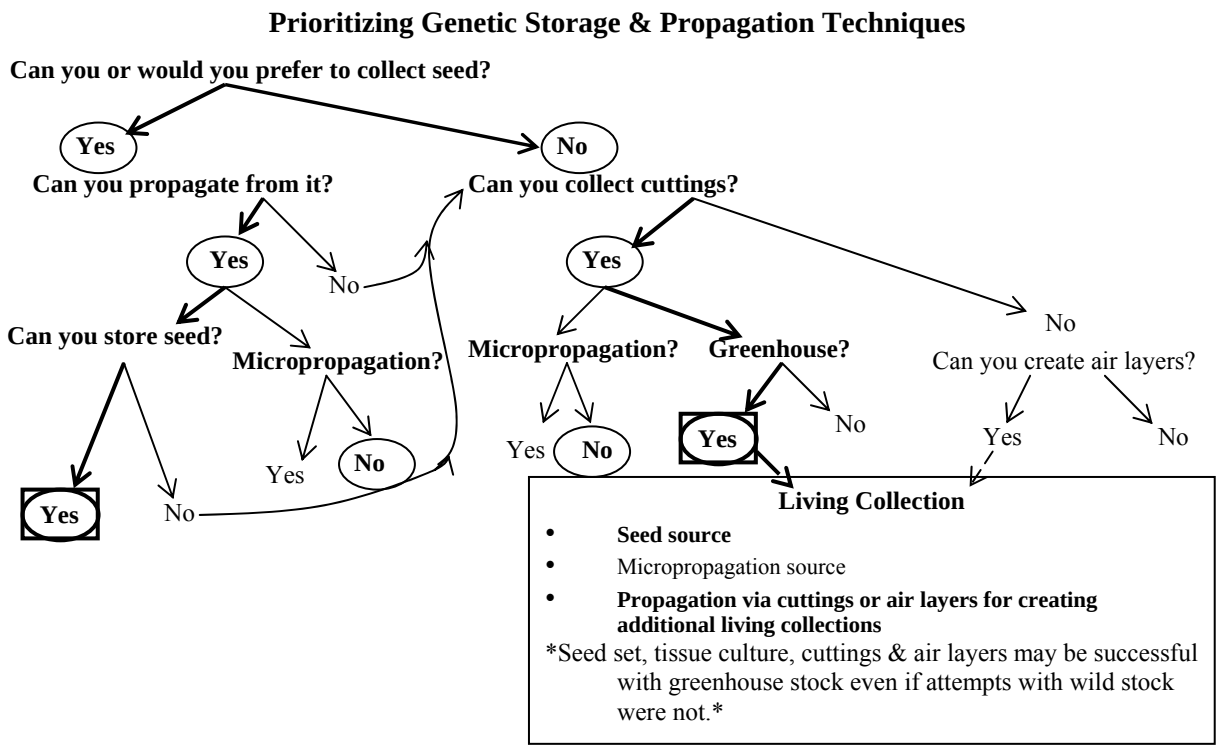
Total Mature, Immature, Seedling: The sum of the current numbers of Wild and Augmented plants in each PU. This number will be used to determine if each PU has reached the goal for the number of mature individuals required for stability. These three columns should be compared with the NRS 2006 estimates to determine the trend for each PU in the last year.

Population Trend Notes: Comments on the general population trend of each 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 2006 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 2006 is used.

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. The maintenance of this storage method is continual, but requires much less resources and personnel than establishing a living collection. 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 least preferred genetic storage option. This is because these plant collections are the least secure and most expensive and time consuming method. The format includes the table and flow chart shown below, followed by brief text discussions of collection, propagation, seed storage research and genetic storage. Extensive information for these fours sections was provided in the 2006 Status Report that summarized propagation and genetic storage progress to date. If there was no new information for this year, the 2006 Status Report has been cited for background information.

1) At this time, what is the preferred propagation technique?	**2) At this time, what is the preferred genetic storage technique?**	**3) Has a successful storage method been determined?**	**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



Ex: *Cenchrus agrimonioides* var. *agrimonioides*

This chart appears in all of the 28 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. All bold arrows indicate the actions NRS are actively pursuing. The question, "Can you store seed?" has been tested

because the "Yes" is circled indicating that it has been determined that seed can be stored. There is also an 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 clonal propagation may be preferred for certain instances and is possible. If the technique has been tried but not answered, 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 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. Ongoing collaborative research with the USDA National Center for Genetic Resources Preservation (NCGRP) focuses on determining seed storage classifications for the Hawaiian flora and creating germination and storage protocols for the taxa studied. This project was initiated following observations by NRS that seeds from many taxa in the Campanulaceae family could not survive -18C storage temperature, but retained good storage longevity at 4C. Research with NCGRP identifies lipid composition as a possible reason for the inability to tolerate -18C storage (Volk *et al.* 2006). If some of the lipids within the seed have a freezing point around -18C, then storage at this temperature may cause cellular damage due to continual phase changes. Lipid analyses of *Delissea subcordata* seed indicate that this taxon may possess some of these lipids. Careful examination of storage trends have revealed that over 40 Hawaiian taxa with substantial storage data (over two years of storage) have shown good storage potential at 24C and 4C but not at -18C. Over half of these are from the Campanulaceae family, and many more species of *Cyanea* have less than two years of storage data, yet some are already showing the same trend). The strategy for all MIP and OIP species is this family is to test both -80C and -150 (lN2 (liquid nitrogen)). Theoretically, if lipid composition is hindering -18C storage, storing seeds below the phase change range will prolong viability longer than at higher temperature above the range (*ie.* 4C). NRS has acquired access to a -80C freezer on the University of Hawai'i at Mānoa campus. Testing has already been initiated on several species within the family Campanulaceae in order to determine if storage viability will be extended further at this temperature than the current 4C. Testing will continue as seed becomes available.

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 may be 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 an appropriate collection frequency greater than five years. Therefore, the recommended frequency remains five years.

Example 'Genetic Storage Summary' Table

	# 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
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), PEP and the State NARS) 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 because the stock is coming from another PU.

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 adequate threat control techniques. For these threats, NRS will support further research into discovering and implementing control methods. For example, NRS is 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. Most discussion of ongoing research is in Chapter 5, Research Activities.

Surveys
A summary of surveys that have targeted each taxon in the last year is given 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
In this section, the threat table is displayed and the status of each of the population units is discussed. This section is split into two parts, with the MFS PUs discussed first then the other PUs.

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 each PU. The 'Population Unit' and 'Management Designation' columns are the same as in the 'Taxon Status' table above. 'Partial' designations are explained within the PU discussions. For 'Manage reintroduction for stability' PUs, threat control conducted before and after planting is reported. This approach demonstrates where effort is being spent and what threats are being controlled. 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 still 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 is included in the text within PU discussions for MFS PUs.

Rats controlled: 'Yes' is entered into this column if a rat bait 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 most 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.

'Manage for Stability' PUs

Each 'manage for stability' PU is discussed and any large changes in population estimates or other management designation from the Makua IP Addendum are explained. Management efforts at the PU are discussed, including any collections, augmentations, fencing, and rat control or weeding in the vicinity of the PU.

Other PUs

In this section, the other PUs with Genetic Storage or Manage Reintroduction for Storage designations are discussed. The Manage Reintroduction for Storage designation does not appear in the Taxon Status Table as this designation is only used to manage stock from PUs already designated as either MFS or GS. Management efforts at the PU are discussed, including any collections, augmentations, fencing, and rat control or weeding in the vicinity of the PU. Extirpated PUs will be discussed for two years and after that will no longer be discussed.

2.1.1 *Alectryon macrococcus* var. *macrococcus*

Requirements for stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial with reproductive problems)
- Stable population structure
- 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 had *in situ* recruitment?	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 been initiated?
2/4	2/4	0/4	1/4	2/4

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 BTB impacts. NRS has collected mature fruit from only eight trees in the last eight years.

Major Highlights/Issues for Year 3

- A large-scale Management Unit fence around the Mākaha PU was completed, protecting the largest population of this taxon.
- NRS revisited every known population within the Central Kaluaʻā to Central Waiʻeli PU and installed air layers on all plants with suitable stock (see Figure 2.1.1.a).
- 17 trees were air layered in the Central Kaluaʻā PU in the last year. 1 successful air layer was collected, and 16 potential air layers still remain developing on the trees.
- Eight mature fruit were collected from the Mākua PU and rat baiting was initiated around the population this year to protect the fruit from rat predation.

Plans for Year 4

- Continue to air layer individuals from MFS PUs.
- NRS plan to have BTB researchers examine individuals that appear unaffected by BTB.
- NRS plan to conduct BTB research using ethanol traps as an alternative to verbanone (see Research Chapter 5).
- NRS will continue to pursue a formal relationship with Botanical Gardens to determine suitable *inter-situ* living collection sites.
- Conduct a trial outplanting in Central Kaluaʻā to Central Waiʻeli PU with air layered

plants in a gulch bottom similar to the successful *Flueggea neowawraea* outplanting in Kahanahāiki.

- Conduct thorough surveys of the Mākaha PU to accurately assess the population numbers.

Figure 2.1.1a *Alectryon macrococcus* air layer in Kalua‘ā wrapped with chicken wire for protection form rat predation

Table 2.1.1a Taxon Status Summary

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus TaxonCode: AleMacMac

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to West Makaleha	Manage for stability	37	4	0	0	4	0	37	8	0	37	8	0	No monitoring in the last year.
Makua	Manage for stability	33	0	0	0	0	0	33	0	0	33	0	0	A thorough census found no change in population numbers in the last year.
South Mohiakea	Genetic Storage	5	0	0	0	0	0	5	0	0	5	0	0	One additional plant died in the last year.
	Total for Taxon:	75	4	0	0	4	0	75	8	0	75	8	0	

Action Area: Out

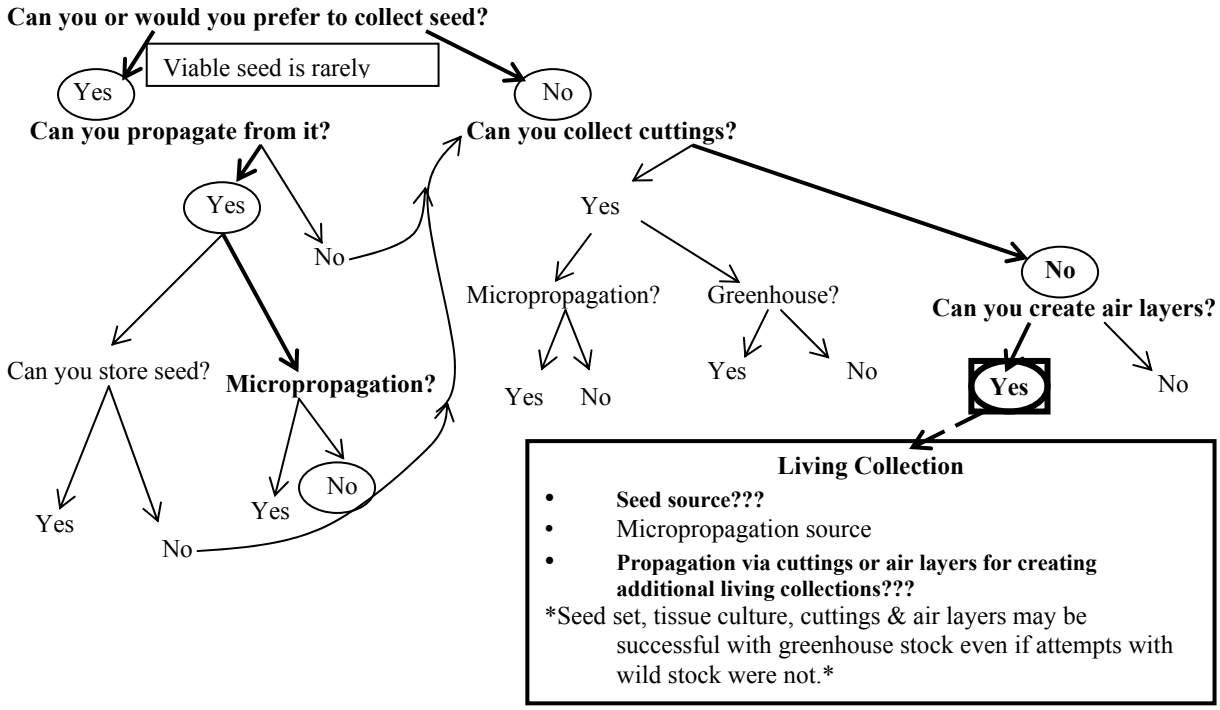
TaxonName: Alectryon macrococcus var. macrococcus TaxonCode: AleMacMac

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa to Central Waieli	Manage for stability	52	1	1	0	8	0	53	9	1	52	9	1	A thorough census showed one less live tree than previously known
Makaha	Manage for stability	63	5	2	0	0	0	63	5	2	63	5	2	Population numbers remained the same
Waianae Kai	Genetic Storage	6	0	0	0	0	0	6	0	0	6	0	0	No monitoring in the last year.
	Total for Taxon:	121	6	3	0	8	0	122	14	3	121	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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed (when available), and air layers	Living Collection	No	Yes; research & living collections?

Prioritizing Genetic Storage & Propagation Techniques



Collection: This year, an additional 20 trees were air layered. A total of seven air layers have been collected, and half survived. Average success rate is 16% for this taxon, but many air layers are still alive in the field (26 installed, seven collected, three died in greenhouse, eight died in field, eight remain alive in field).

Propagation: refer to OANRP 2006

Seed Storage Research: refer to OANRP 2006

Genetic Storage: Air layering for living collection remains the best genetic storage option at this time. An additional founder has been added to the Army Nursery's living collection this year from the Central Kaluaʻā to Central Waiʻeli PU.

Table 2.1.1b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Alectryon macrococcus var. macrococcus							
Central Kaluaa to Central Waieli	52	1	0	0	0	1	0
Kahanahaiki to West Makaleha	37	4	0	0	0	0	0
Makaha	63	5	0	0	0	0	0
Makua	33	0	0	0	1	1	1
South Mohiakea	5	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	2	1

Unique Species Observations

The fruit of *A. macrococcus* from Mākua is remarkably smaller than the fruit from the other PUs **(see Fig 2.1.1.b).** The Mākua population produces small fruit that is comparable to the Kauai *A. macrococcus* var. *macrococcus* (J. Lau pers. comm.). The Mākua trees were observed to be fruiting and flowering in August of 2007, and baiting was reinitiated in an effort to secure fruit collection of this unique population.

Figure 2.1.1b Mākaha *Alectryon macrococcus* with characteristic large fruit and smaller Mākua fruit

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-pace the BTB. NRS installed air layers in South Mohiākea and Honouliuli for future reintroduction in Honouliuli.

Research Issues
Refer to Chapter 5.1 for detailed discussion of BTB research. NRS aim to study which factors are contributing to the high productivity and good health of the fruiting trees in Mākaha and Mākua. Such investigations may include research 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 BTB impacts. NRS Research Specialist will conduct a fertilizing trial to address this issue.

Surveys
NRS focused surveying efforts in the Central Kaluaʻā to Central Waiʻeli PU as this population seems to be severely declining. NRS conducted 14 surveys in which they revisited all of the known plant populations in the PU. This year, surveys and monitoring trips will continue to be emphasized to update numbers of this taxon. NRS will seek to obtain stock for reintroduction within the fenced MU in Kaluaʻā. NRS plans to make collections from outlier plants in all of the MFS pupulations. NRS will discuss priorities for collection with this year's IT.

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 Kaluaʻā (to Central Waiʻeli) MFS populations are considered 'healthy' by NRS. Most often, 'poor' trees have little or no remaining canopy due to BTB damage, but rather consist of few basal suckers that are also continually attacked by BTB. NRS is beginning to attempt to control the BTB on *in situ* trees by using experimental treatments. See Chapter 5 for further discussion.

Additional threats include rats and invertebrates that prey on the seeds of this taxon and reduce seed viability and germination. NRS conducts rat baiting around trees in Mākaha and Central Kaluaʻā in conjunction with 'Elepaio management. NRS also reactivated a bait grid around the small fruited population in Lower Mākua this year. Baiting will likely allow for greater fruit production; more fruit can be collected for seed storage trials as well as left to encourage on-site germination. *A. macrococcus* is also susceptible to ungulate browse, and weeds pose ecosystem-level threats for this species.

Population Unit Level Discussion

Table 2.1.1c 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: No monitoring was conducted in this PU in the past year. 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: This past year NRS visited all of the known populations in this PU and installed 21 air layers on a total of 17 trees. One air layer was successful and was brought back to the nursery and 16 are still developing on the trees. The trees with air layers will be revisited this coming year. 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. A thorough census found many dead trees. This decline isn’t evident in the current number of live trees as shown in the taxon status table, since thorough monitoring in the past year found that previous numbers were under estimated.

There are additional areas in northern Wai‘eli that have not been visited and NRS believe that more individuals will be discovered. Efforts will be made this year to install more air layers in this area in an effort to secure more stock for outplanting within the fenced MU in Kalua‘ā. In order to boost founder numbers for this outplanting, stock from populations from elsewhere in Honoluliuli, such as ‘Ēkahanui, will be reintroduced in this PU. Additionally, stock from air

layered 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. A large-scale MU fence encompassing this PU was completed this year. Preliminary counts suggest that more than half of the known plants in the valley are included within the fence. The status table reflects the number from the most current count, which is not a complete assessment of the PU. 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. NRS will consider rat baiting around known *A. macrococcus* sites if fruit damage is observed.

Mākua: NRS was unsuccessful at obtaining viable air layered stock from this PU over the past year, however eight mature fruit were collected in August 2007. A rat bait grid was reactivated this year to facilitate a more current collection of this small fruited population. Six bait stations and 12 snap traps were set and will be restocked every eight weeks during the fruiting stage. Four mature trees were observed to be reproductive, three with flowers and one with mature fruit.

Other PUs

South Mohiākea: NRS has 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 have air layered five plants in this PU this year. This stock will be outplanted in Kaluaʻā when ready.

Waiʻanae 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 Audubon Center and NRS assists Waimea staff with monitoring and drenching quarterly with the systemic insecticide Merit ®. The trees appear to be healthy. NRS will continue to pursue a formal relationship with OHA to determine suitable *inter-situ* living collection sites at the Waimea Audubon Center.

2.1.2 *Cenchrus agrimonioides* var. *agrimonioides*

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/3	3/3	0/3	1/3	2/3

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 both. Two of the three MFS PUs have stable numbers of mature individuals. Management of the the Mākaha Subunit I fence is complete so NRS can begin reintroducing Wai'anae Kai and Mākaha PU stock. This stock is well represented *ex situ*. 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 example to examine long-term stability trends and seed dispersal limiting factors.

Major Highlights/Issues Year 3

- Obtained permission for additional planting site within Pahole Gulch.
- Clarified outplanting founder targets and founder representation issues within sub-sites in PUs with IT.
- Conducted weed control at Pahole wild site.
- Significant weed contamination of greenhouse plants destined for outplanting resulted in minimal reintroductions of this taxon.
- Began balancing founders at MMR-E according to the Kahanahāiki to Pahole PU planting strategy presented in the 2006 report.
- Completed construction of Makaha Subunit I MU fence.

Plans for Year 4

- Continue implementing Kahanahāiki to Pahole PU planting strategy presented in 2006 report.
- Initiate reintroduction in Mākaha Subunit I.
- Use the Mākaha reintroduction for propagules from the Mākaha to Wai'anae Kai PU.
- Begin collecting data necessary to conduct a population viability analysis for *C. agrimonioides*. Use this data to determine a target population structure for maintaining stable numbers.

Table 2.1.2a Taxon Status Summary

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides TaxonCode: CenAgrAgr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki and Pahole	Manage for stability	81	11	7	227	30	2	311	47	31	**308**	**41**	**9**	Some reintroductions have died in the last year.
	Total for Taxon:	81	11	7	227	30	2	311	47	31	**308**	**41**	**9**	

Action Area: Out

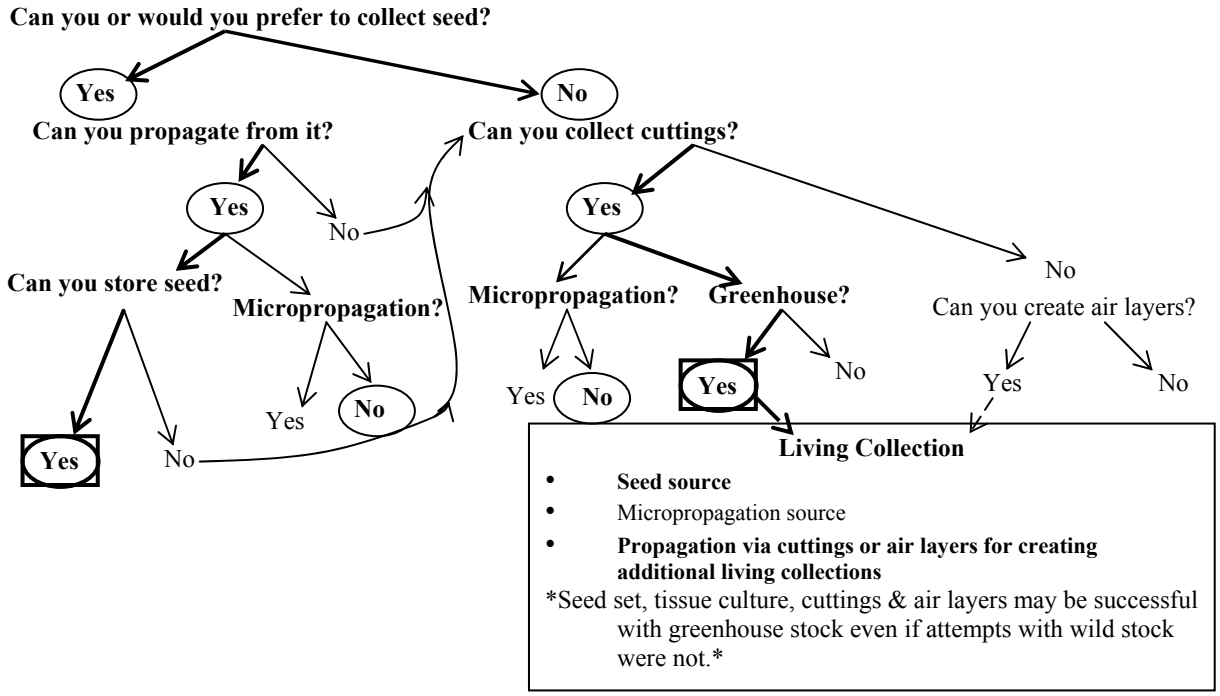
TaxonName: Cenchrus agrimonioides var. agrimonioides TaxonCode: CenAgrAgr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Ekahanui	Manage for stability	30	3	16	52	1	0	86	3	16	**82**	**4**	**16**	Some reintroductions have died in the last year.
Makaha and Waianae Kai	Manage for stability	12	0	0	0	0	0	14	0	0	**12**	**0**	**0**	This is a real decline due to ungulate impacts.
South Huliwai	Genetic Storage	21	0	0	0	0	0	21	0	0	**21**	**0**	**0**	No monitoring in the last year.
	Total for Taxon:	63	3	16	52	1	0	121	3	16	**115**	**4**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings for living collection & reintroductions	Living collection and seed	No, but all necessary tests have been initiated	Collect seed from living collections & reintroductions for genetic storage

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: One small collection stored dry at -18C showed no signs of aging after 4.5 years, though sample size is very low for itse viability tests. Large collections set up for testing will be assayed in 2009 to determine viability after five years of storage in multiple conditions. Observations of germination of stored seeds for propagation have indicated that seeds germinate slowly over time and may be subject to dormancy that would skew storage results if seeds were simply dormant rather than dead. In general, seed collections from any wild stock may have very high variability in terms of viability. Initial viability tests conducted on this taxon should be larger, tested for a longer amount of time, and investigated for dormancy. NRS will continue to study germination and storage for this taxon with collections already at the Army Seed Conservation Lab and from mixed greenhouse stock.

Genetic Storage: NRS plans to collect seed from the living collection once space permits. Adequate separation of population sites is required to ensure no mixing occurs. A recollection time table has yet to be established for this taxon.

Table 2.1.2b 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
Cenchrus agrimonioides var. agrimonioides							
Central Ekahanui	30	3	1	13	0	22	4
Kahanahaiki and Pahole	81	11	23	48	0	23	27
Makaha and Waianae Kai	12	0	1	0	0	11	4
South Huliwai	21	0	1	10	0	12	5
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				71	0	68	40

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.

Outplanting Issues

Most reintroductions last year were halted due to growing media contamination. Many *C. agrimonioides* destined for reintroductions were heavily contaminated with the weed *Oxalis corniculata*. Although this weed already occurs in all of the destination MUs, NRS decided not to conduct the plantings. NRS chose to be conservative in case other weed contaminants not already at the destination site were present. The infestation was so heavy that instead of weeding the pots, NRS took new cuttings and started new plants. The postponed plantings included adding founders to the Kahanahāiki to Pahole and ʻĒkahanui PU reintroductions and establishing a new planting in Mākaha. These plantings will go forward this winter. The only reintroduction of this taxon that occurred in this reporting period was into the Kahanahāiki MMR-E site. A total of eight outplants were added to the site.

Table 2.1.2c 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	115	63
Makaha and Waianae Kai	Manage for stability	13	0
South Huliwai	Genetic Storage	22	15
	Total for Taxon:	**184**	**96**

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 numbers of founders increases each year as this taxon is relatively short-lived and new plants are often discovered when wild sites are monitored.

Last year, the IT had extensive discussions about how best to balance founders for this taxon. The recommendation from the IT was to use between 10-50 founders for reintroductions. Striving for 50 is ideal. The IT also felt that as long as plantings are conducted within 1,000 meters of each other, NRS can assume genetic communication is occurring between them. Therefore, there is no need to represent all 50 founders at each sub-site within a PU unless it is outside the 1,000 meter distance.

Research Issues
Since this taxon is the closest to stability, NRS would like to use it as a case study for conducting population viability modeling. NRS propose collecting the additional monitoring data necessary as input for an appropriate model. NRS will consult experts in this area for assistance.

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. Alien grasses compete with this taxon and serve to increase fuels that may carry fire into native habitats. *C. agrimonioides* responds positively to removal of alien canopy trees such as *Psidium cattleianum*. In the last year, NRS observed mouse predation on inflorescence stems in a Pahole reintroduction. This is the second time rodent predation has been observed on this taxon. Mice were more abundant this year than in years past. Perhaps when population numbers are higher, mice begin using novel food sources.

Population Unit Level Discussion

Table 2.1.2d 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	Partial	No
Makaha and Waianae Kai	Manage for stability	Partial	Partial	No
South Huliwai	Genetic Storage	No	Yes	No

Manage for Stability PUs

Kahanahāiki and Pahole: NRS have a long history of managing this taxon in the Kahanahāiki gulch portion of the PU but have only recently begun working with stock from Pahole gulch and reintroduction sites in Pahole. Ultimately, the goal is to connect sites within these two gulches through strategic reintroductions and threat management.

Kahanahāiki: Figure 2.1.2a illustrates the distribution of wild and outplanted *C. agrimonioides* var. *agrimonioides* across the Maile flats portion of Kahanahāiki gulch. One new wild plant was discovered approximately 100 meters away from the nearest known individual. It is likely that this plant is an F2 plant from the F1 progeny near the C-ridge corner of the SW Quad. These C-ridge plants likely arose from the MMR-E reintroduction. This is the first observation of a possible F2 plant being mature. It also shows how this taxon is slowly spreading out from reintroduction sites across the appropriate habitat in Maile flats and in many cases following human foot trails. Refer to Figure 2.1.2a.

Map removed,
available upon request

Figure 2.1.2a Kahanahāiki reintroduction expansion

Pahole: In the last year, NRS weeded the largest wild site of this taxon. The habitat at this site is very intact and has good restoration potential. There is room for *C. agrimonioides* to expand up and down the ridge. The new reintroduction established with 30 plants in the 2005-2006 planting year is a success. So far, NRS have observed 100% survivorship. NRS will work with NARS to determine planting at a new site between the existing reintroductions along the Pahole Rim. NRS may outplant onto a ridge where there is appropriate habitat between Gulches 4 and 5.

Mākaha and Wai‘anae Kai: This population was heavily impacted by feral pigs in 2006. All of the plants were browsed. Vandalism is a concern for this PU. A population of *Cyanea longiflora* nearby was fenced last year and immediately after, both the fence and plants were vandalized. NRS do not recommend fencing or flagging the wild *C. agrimonioides* in this PUs for fear they will suffer the same fate as the *C. longiflora*. The monitoring conducted by NRS during this reporting period found two fewer plants than had been previously observed. Pig sign is still heavy in the area. All the plants observed were in poor or moderate health.

Currently, this PU is well-represented *ex situ*(11 of 13 founders) 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 greenhouse plants. NRS will make seed

collections from this stock once it is outplanted, and in effect isolated, in the new Mākaha fence this winter.

Central ‘Ēkahanui: All of the wild plants within this PU are in Central ‘Ēkahanui but the reintroductions conducted thus far are in South ‘Ēkahanui. For simplicity sake, NRS will change the name of this PU to ‘Ēkahanui to reduce confustion. NRS outplanted *C. agrimonioides* into the ‘Ēkahanui Subunit I fence but the habitat available within is limited. Thus, NRS have reintroduced just outside and north of the fence. The pig sign in this area is very low. The South ‘Ēkahanui reintroduction was not supplemented this year due to weed contamination in plants. NRS observed 100% survivorship of the *C. agrimonioides* planted in the 2005-2006 season despite the fact that over half of the reintroduced plants are outside the pig fence. Overall, plants reintroduced in ‘Ēkahanui are not as robust as plants in the Kahanahaiki and Pahole PU. This may indicate that planting sites are marginal. Nonetheless, NRS are learning about light and habitat preferences of the ‘Ēkahanui stock.

NRS expected the ‘Ēkahanui Subunit II exclosure to be complete by now. Materials procurement and vandalism challenges have slowed the timeline for completion. Once it is finished, much more habitat will be available for use in reintroducing this taxon. The habitat that this fence will protect overlaps with site characteristics of Kahanahaiki to Pahole PU sites. NRS will apply lessons learned from the Kahanahāiki to Pahole in designing the initial plantings in this PU. The outplanting strategy remains unchanged from what was presented in last year’s report. NRS plan to establish two new nodes of reintroduced plants each with 100 total individual representing two replicates each of 50 founders. NRS may proceed with some reintroductions prior to fence completion if suitable habitat that is not susceptible to pig damage can be located.

Other PUs

South Huliwai: Additional collections were secured from this PU in the last year. This stock will be added to the Central ‘Ēkahanui PU reintroductions. Ungulate activity was not detected at this PU and this PU remains unfenced.

2.1.3 *Chamaesyce celastroides* var. *kaenana*

Requirements for Stability

- 4 Population Units (PU)
- 25 reproducing individuals in each population (long-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
3/4	4/4	0/4	4/4	N/A

Taxon Level Discussion

Due to the high fire threat to this species at Mākua Military Reservation (MMR), four PUs of *Chamaesyce celastroides* var. k*aenana* are designated as Manage for Stability (MFS). These are Puaʻakanoa, Mākua, Kaʻena to Keawaʻula (Kaʻena) and Kaʻena (East of Alau). The first two of these PUs are within the MMR Action Area (AA) and the latter two are outside the AA on lands owned by the State. NRS have observed *in situ* recruitment of seedlings and juvenile plants at all four MFS PUs. There should be no need for reintroduction or augmentation at any of the PUs. Collection of mature seed for genetic storage has begun at all of the MFS PUs and all of the other Genetic Storage (GS) PUs within the MMR AA. Fire is the most challenging threat to this species and plants in the Puaʻakanoa PU were burned in a fire in August 2007 (see Puaʻakanoa Fire Report Appendix I). Another fire in August 2007 at Kaʻena Point came within 45 meters of the East of Alau PU. Weed and fuel control is underway at three of the four MFS PUs.

Major Highlights/Issues for Year 3

- The August 2007 fire on MMR spread into the Puaʻakanoa PU, damaging but not killing two of the 170 known plants.
- The August 2007 fire near Kaʻena Point came within 45 meters of the Kaʻena (East of Alau) PU but did not damage any plants.
- NRS collected seed for genetic storage from over one-hundred plants in six PUs.

Plans for Year 4

- Prioritize genetic storage collections from the MFS PUs and all other PUs within the AA.
- Continue to facilitate research on *Chamaesyce* by the UH Botany Department.
- Develop weed and fuel control plans for the Puaʻakanoa PU and continue control at the other three MFS PUs.
- Focus monitoring efforts on locating and determining survivorship of smaller size classes.

Table 2.1.3a Taxon Status Summary

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana **TaxonCode: ChaCelKae**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluakauila	Genetic Storage	6	4	0	0	0	0	6	4	0	**6**	**4**	**0**	Monitoring showed no change in the last year.
Makua	Manage for stability	89	45	20	0	0	0	89	45	20	**89**	**45**	**20**	Monitoring showed no change in the last year.
North Kahanahaiki	Genetic Storage	177	0	0	0	0	0	177	0	0	**177**	**0**	**0**	No monitoring in the last year.
Puaakanoa	Manage for stability	160	10	0	0	0	0	160	10	0	**160**	**10**	**0**	Monitoring showed no change in the last year.
	Total for Taxon:	432	59	20	0	0	0	432	59	20	**432**	**59**	**20**	

Action Area: Out

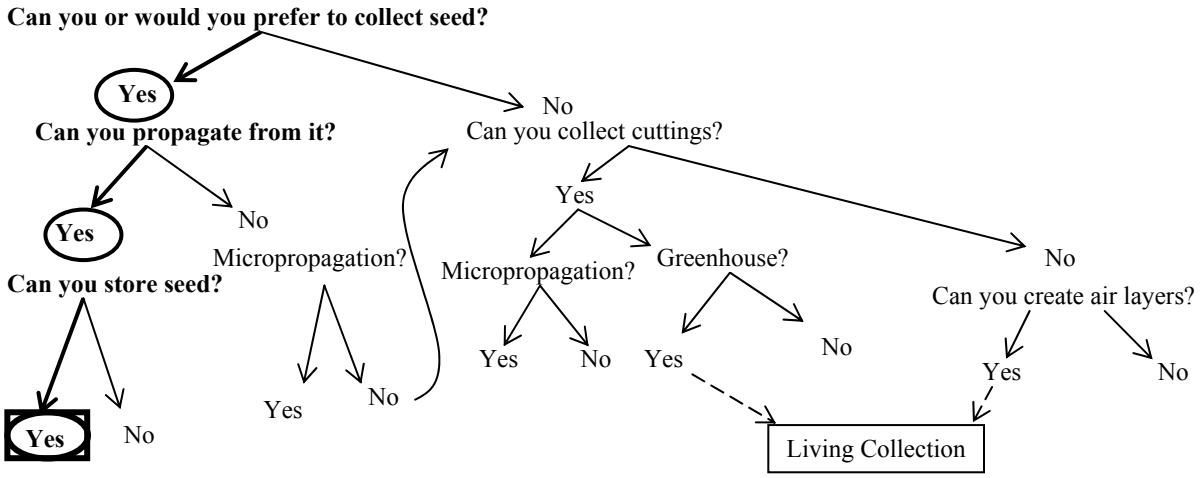
TaxonName: Chamaesyce celastroides var. kaenana **TaxonCode: ChaCelKae**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Kahanahaiki	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	Monitoring showed no change in the last year.
Kaena (East of Alau)	Manage for stability	21	4	20	0	0	0	21	4	20	**21**	**4**	**20**	Monitoring showed no change in the last year.
Kaena and Keawaula (Kaena)	Manage for stability	300	0	0	0	0	0	300	0	0	**300**	**0**	**0**	Monitoring showed no change in the last year.
Kaena and Keawaula (Keawaula)	Genetic Storage	47	1	2	0	0	0	56	2	2	**47**	**1**	**2**	A thorough census of the known sites found less plants in the last year
Waianae Kai	Genetic Storage	33	0	0	0	0	0	33	0	0	**33**	**0**	**0**	No monitoring in the last year.
	Total for Taxon:	403	5	22	0	0	0	412	6	22	**403**	**5**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage: refer to OANRP 2006

Genetic Storage: Seed is currently being collected from Mākua, Ka‘ena and East of Alau PUs. Genetic storage goals should be met for these three PUs by the end of this or next fruiting season.

Figure 2.1.3a Bagging immature fruit for seed collection of *Chamaesyce celastroides*

Table 2.1.3b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Chamaesyce celastroides var. kaenana							
East Kahanahaiki	2	0	0	1	0	0	0
Kaena (East of Alau)	21	4	0	11	0	0	10
Kaena and Keawaula (Kaena)	300	0	0	35	0	0	32
Kaena and Keawaula (Keawaula)	47	1	0	22	0	0	13
Kaluakauila	6	4	0	1	0	0	0
Makua	89	45	4	58	0	1	46
North Kahanahaiki	177	0	1	9	0	0	7
Puaakanoa	160	10	0	7	0	0	2
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**
				144	0	1	110

Unique Species Observations
No new observations have been made.

Outplanting Issues
No outplantings have been conducted with this taxon.

Research Issues
There are no additional research issues to report.

Surveys
There were no additional surveys in the last year.

Taxon Threats
There were no additional threats observed in the last year.

Population Unit Level Discussion

Table 2.1.3c 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	Manage for stability	Yes	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	Yes	No	No
Waianae Kai	Genetic Storage	Partial	No	No

Manage for Stability PUs

Mākua: NRS has conducted census surveys of this PU several times since 2001 and have not observed any change in population estimates in the last year. The number of immature plants has increased since 2001 and NRS continue to tag newly mature plants. This site is easier to survey than other PUs because it is small and not too steep. In addition, the large mature plants are not clustered too closely together and the smaller plants can be counted easier than at other PUs. Seedlings continue to be observed in the wet season and some do survive into the juvenile size class. Although NRS has been effective at removing alien grasses and greatly reducing fuels, the threat of fire remains. NRS has been collecting mature seed for genetic storage from plants in this PU since 2001. There are 46 plants that have over 50 seeds in storage and NRS will likely meet the genetic storage goal of storing 50 seeds from 50 plants in the coming year. Monitoring efforts will focus on locating and determining survivorship of smaller size classes.

Ka‘ena and Keawa‘ula (Ka‘ena): This PU contains a very dense group of an estimated 300 mature plants over about four acres. It is within the Ka‘ena Natural Area Reserve and ungulates are not a threat. There is substantial recruitment of juvenile and seedling plants. However 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 yearly census of this PU as the number is well over the target number

of 25 mature individuals. NRS has stored over 50 seeds from 32 mature plants so far. NRS conducts extensive weed control at this site. Fire is not as large of a threat compared with other PUs due to the lack of sufficient fuels in the wind-swept strand vegetation. In the coming year, NRS will plan to complete genetic storage goals for at least 50 plants and monitoring efforts will focus on locating and determining survivorship of smaller size classes.

Ka‘ena (East of Alau): This PU is located near Ka‘ena Point on State-owned land, but is outside of the Ka‘ena Natural Area Reserve. NRS has been monitoring and conducting weed control at this PU since 2004 and there was no change in population size or distribution observed in the last year. There is no alien grass in the area immediately surrounding the plants and they are not threatened by ungulates. NRS has stored at least 50 seeds collected from ten of the 21 mature plants in this PU and will work on securing the remainder in the coming year. NRS have been conducting weed control at this PU and will continue in the coming year. A fire at the end of Farrington Highway near Ka‘ena Point in August 2007 burned within 45 meters of this PU (Figure 2.1.3b). For more information on this fire and NRS involvement see the Ka‘ena Fire Report attached as Appendix III. In the coming year, monitoring efforts will focus on locating and determining survivorship of smaller size classes and collecting seed to meet the genetic storage goals for all of the known mature plants.

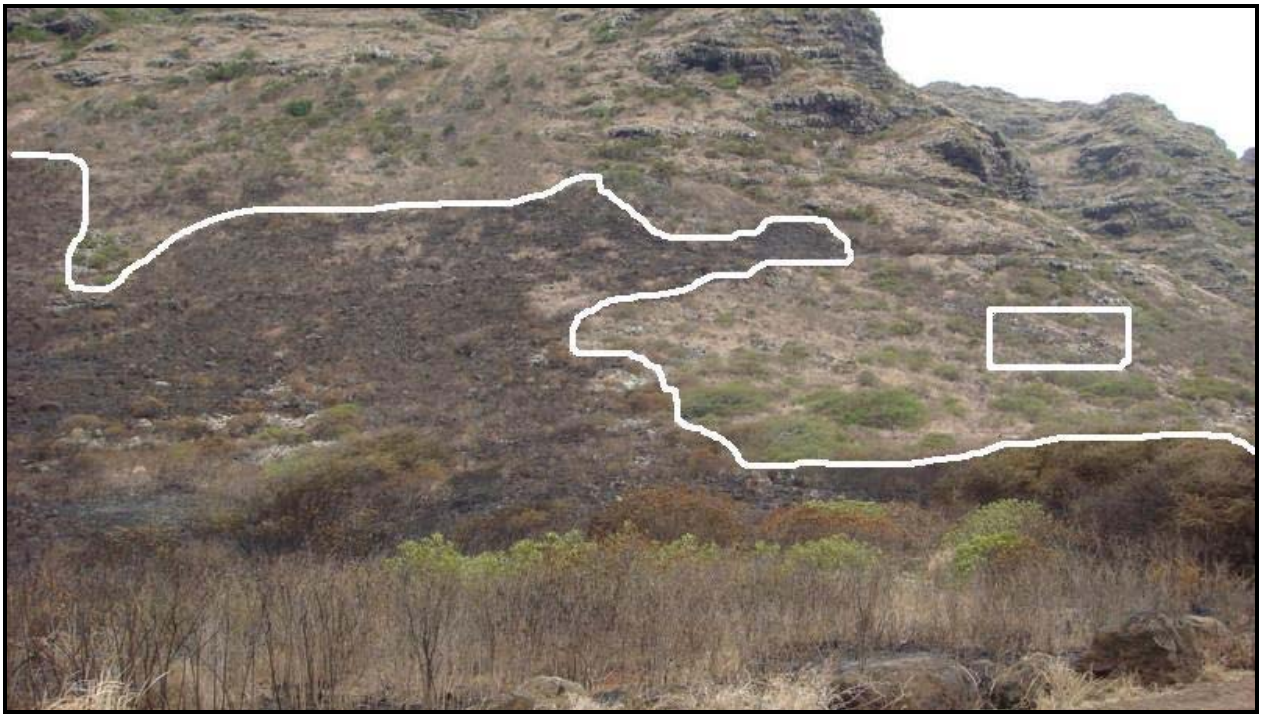


Figure 2.1.3b The western front of the August 2007 fire (outlined above) came within 45 meters of the plants inside the small square (outlined on the right).

Pua‘akanoa: This PU is located on the cliffs above Farrington Highway north of the main valleys of MMR. There are several sites within this PU and NRS has been monitoring the accessible sites, but others are on remote cliffs and may be difficult to reach. NRS has begun collections of mature seed for genetic storage. There are seeds stored from seven plants do far and there are more than 50 seeds stored from two plants. A fire that started along Farrington

Highway burned into this PU on August 10, 2007 (Figure 2.1.3c). For more information on this fire see the Pua'akanoa Fire Report attached as Appendix I. The fire badly damaged one juvenile plant (Figure 2.1.3d) and singed a few branches of another large mature plant. Much of the native habitat surrounding the plants was burned in the nearly 20 acre fire. The juvenile plant that burned will be monitored in the coming year to determine if it died from the fire and the mature plant is expected to recover. In the coming year, NRS will continue to collect mature seed for genetic storage and will focus on locating and determining survivorship of smaller size classes and collecting seed to meet the genetic storage goals for all of the known mature plants. In addition, NRS will begin to develop a plan to control weeds and fuels at this PU in the coming year.

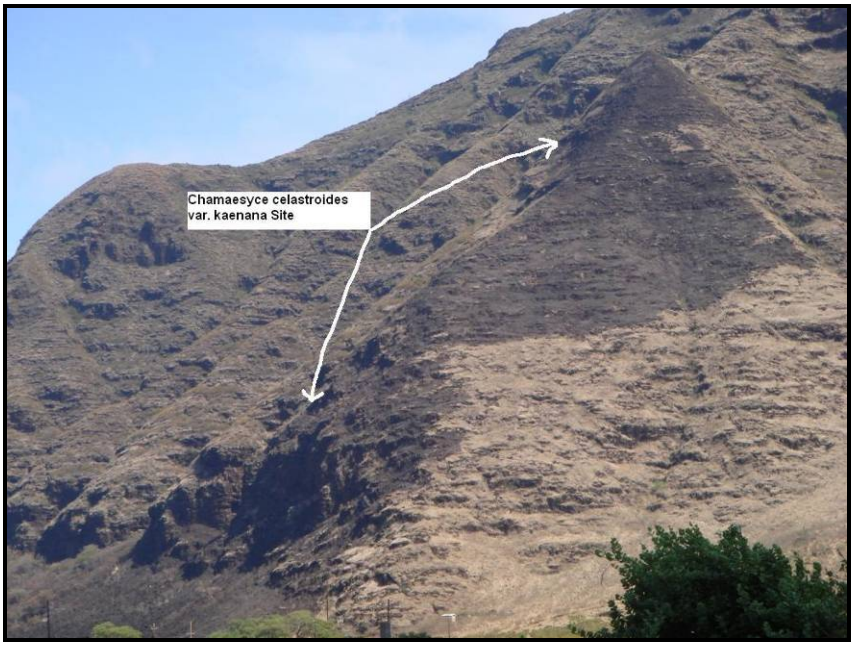


Figure 2.1.3c The August 2007 fire at MMR burned close to sites with plants in the Pua‘akanoa PU.

Figure 2.1.3d Juvenile plant burned by the fire

Other PUs

Kaluakauila: There are two sites in this PU and both are on MMR, north of the main valleys. This PU is highly threatened by fire and plants were damaged by fire in July 2006. The larger of the two sites has five mature and three juvenile plants and was visited several times in the last year to collect seed for genetic storage. Observations of that site showed no change in population structure. The smaller site has one mature and one juvenile plant and both were damaged in the fire of July 2006. Ungulates are not a threat to these plants and weed control is not needed to collect for genetic storage. In the coming year, NRS will continue to collect seed for genetic storage and monitoring efforts will focus on locating and determining survivorship of smaller size classes.

North Kahanahāiki: There have been no NRS actions in the last year. In the coming year, NRS will visit this PU to collect for genetic storage.

East Kahanahāiki: There are two mature plants in this PU and it is in a remote area of MMR. NRS has been monitoring and collecting from these plants since 2000. The site burned in 2003 and both plants were damaged but survived. The plants are not threatened by ungulates and weed control is not needed to collect for genetic storage. NRS has stored seed collected from one of the two plants and will continue to monitor and collect in the coming year.

Ka‘ena and Keawa‘ula (Keawa‘ula): This PU is within the Ka‘ena Point State Park and several separate sites with plants are known. NRS conducted census surveys of these sites in the last year and have revised the population estimates. Collections of seed have been stored from 22 plants so far and at least 50 seeds have been stored from 13 mature plants. The plants are not threatened by ungulates and weed control is not needed to collect for genetic storage. NRS will collect again from this PU in 2008.

Wai‘anae Kai: Plants in this PU are spread across large cliffs in Wai‘anae and population estimates were first made with binocular and helicopter surveys in 2002. Most plants occur in sites where weeds and goats are not a direct threat, but plants have been burned in the past and there is no ungulate management in this area. NRS monitored most of the PU in June 2005 and no change in numbers was observed. In the coming year, NRS will conduct helicopter and ground surveys in order to determine if seed collection for genetic storage can be done and if any other management is needed in order to collect for genetic storage.

2.1.4 *Chamaesyce herbstii*

Requirements for Stability

- 3 Population Units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Expedited Stabilization (10 years)

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have had *insitu* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
1/3	1/1	0/1 (only 1 *in situ* PU)	1/3	0/3

Taxon Level Discussion

The only remaining *in situ* Population Unit (PU), Kapuna to Pahole, falls within the Makua Action Area (AA), and will be Managed for Stability (MFS). Since an initial decline after the MIP was finalized, numbers of plants in this PU have stabilized. Stability goals for numbers of reproducing individuals were met for this PU. Onsite recruitment is observed in this PU, and reintroduction survivorship is high. Ongoing weed control is conducted throughout the PU targeting larger ecosystem altering weeds such as *Schinus terebinthifolius* and *Psidium cattleianum*. Over the next year NRS will continue to assist the State with the completion of the Kapuna subunit II and IV fences which will include all of the plants currently unprotected in the Kapuna to Pahole PU. The other two MFS populations, Makaha and West Makaleha PU, are both outside of the AA. These populations will be established via reintroduction for management for stability. The Mākaha fence was finished this year and NRS began a reintroduction of this taxon there this year. The West Makaleha fence, on state land, is pending a Right of Entry Permit between the Army and the State.

This year, *Chamaesyce herbstii* has been designated by the US Fish and Wildlife Service as an "expedited stabilization species" in which the taxon should be stabilized in ten years. This designation requires that two of the three MFS populations be outside of the AA, as they are currently designated. Weed control, fire management, and monitoring must be ongoing and any cooperative agreements needed to conduct management must be in place. NRS will continue to try to reach stability goals first in the Kapuna to Pahole PU as it is the only *in situ* PU. However, NRS believe that establishing a founder population via reintroduction is possible to do in a short amount of time. There is an observed two to three year turn around of seed collection from wild plants to mature plants in outplantings. This bodes very well for this species as achieving stabilization within ten years.

NRS are also assisting with a UH student researcher, Maggie Sporck, who is looking to study physiology, morphology, anatomy and composition of leaves and stems for each taxon in the Hawaiian *Chamaesyce* radiation. This work will be complemented by Dr. Cliff Morden who will conduct DNA-based phylogeny and population genetics research on *C. herbstii* as well as two other *Chamaesyce* species. M. Sporck is pursuing a permit to access to Pahole NAR to collect leaves and stems from 5-15 *C. herbstii* individuals. NRS support this combined research and suggest that collections be made from reintroduced individuals, however the ultimate decision for collection will be based on whether or not she is given a permit by the State to conduct such research.

Major Highlights/Issues Year 3

- Fence construction is finished in Mākaha and reintroduction has begun.
- Fence construction has begun around the remaining unprotected portions of the Kapuna to Pahole PU.
- High levels of survivorship in Kapuna to Pahole PU reintroductions have been observed.
- The Kapuna to Pahole PU reached goals for numbers of reproducing individuals.
- Collections continued to be made across the Kapuna to Pahole PU in the last year. These have been used to grow plants for outplanting and genetic storage.
- Augmentation continued in the Kapuna to Pahole PU.
- Species designated as Expedited for Stability in 10 years.

Plans for Year 4

- Continue to collect from founders in the Kapuna to Pahole PU for supplementing the augmentation.
- Continue to balance founders in the Pahole augmentation until 50 founders are represented.
- Complete the Kapuna subunit III and IV fences.
- Continue to balance the Mākaha reintroduction until 50 founders are represented.
- Push for expedited processing of the Right of Entry Permit with the State so that West Makaleha fence construction may begin.

Table 2.1.4a Taxon Status Summary

Action Area: In

TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna to Pahole	Manage for stability	49	12	0	18	45	0	51	35	1	**67**	**57**	**0**	37 plants were reintroduced in 2007
	Total for Taxon:	49	12	0	18	45	0	51	35	1	**67**	**57**	**0**	

Action Area: Out

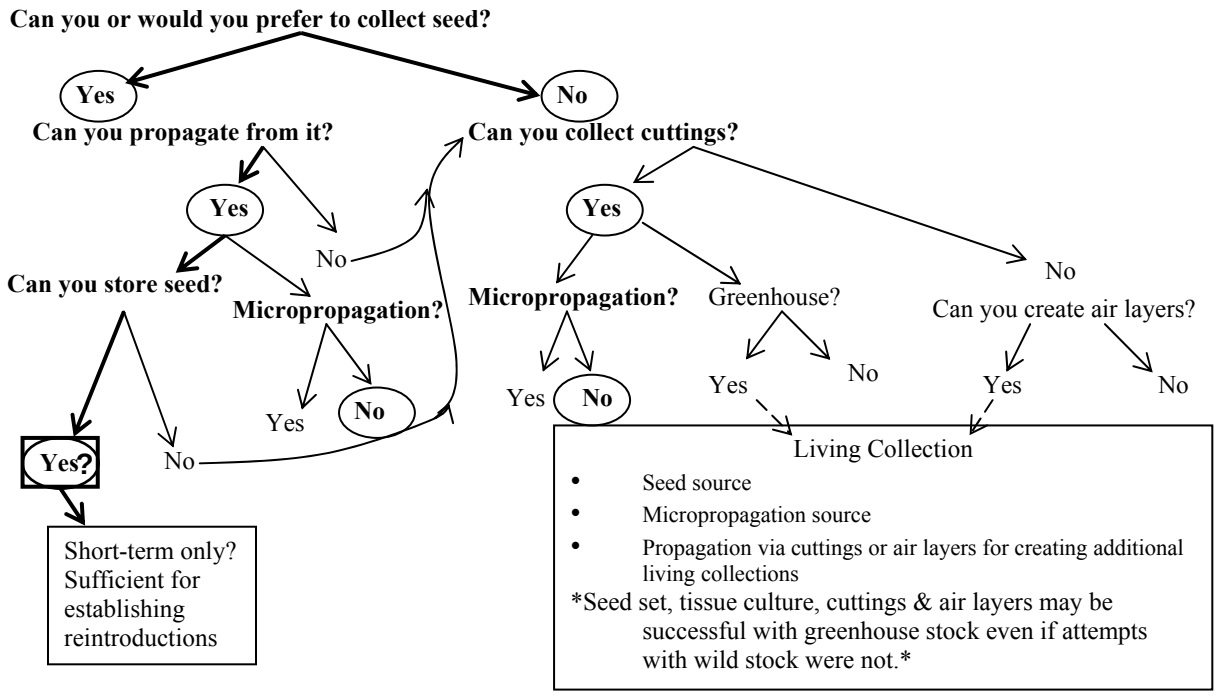
TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	22	0	0	0	0	**0**	**22**	**0**	24 plants were 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	22	0	0	0	0	**0**	**22**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Undetermined (seed for the short-term)	No	Yes – need to collect from reintroductions

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: refer to OANRP 2006. Now that plants in the Pahole reintroduction are mature, seed will be collected from them for storage testing.

Genetic Storage: Seed from four additional founders have been collected. These seeds will be propagated for reintroduction stock. Several other founders were also collected again for the Mākaha reintroduction. NRS will continue to make collections from wild plants until reintroductions are complete.

Table 2.1.4b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Chamaesyce herbstii							
Kapuna to Pahole	49	12	4	19	0	13	8
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				19	0	13	8

Unique Species Observations
There have been no new observations in the last year.

Outplanting Issues
NRS initiated augmentation in the fenced portion of the Pahole PU in February of 2006, and continued to augment this site this year. Following the suggestion of the State, NRS is planting in gaps between existing wild plants. As of the last monitoring this August there is a 97% survivorship and 26% of the 61 plants alive have already reached maturity at the reintroduction. NRS plan to continue to balance this reintroduction as more collections from founders are made. The ultimate goal is to represent 50 founders with two plants each to result in a mostly continuous distribution of plants across the area. This same goal is set for the Mākaha and West Makaleha reintroductions to be managed for stability.

Research Issues
Research on seed storage needs to be conducted.

Surveys
No surveys were conducted specifically for this taxon in the last year. However, NRS continued to find new plants in Pahole at known sites during weed control and regular population monitoring. NRS have also been active in areas with appropriate habitat for this species and always keep an eye out while conducting other tasks, particularly in the Northern Wai‘anae Mountains.

Taxon Threats
No new threats other than pigs in the Pahole exclosure have been identified this year. NRS are working very actively with NARS to remove the pigs from this exclosure.

Population Unit Level Discussion

Table 2.1.4c 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	Yes	Partial	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 the PU during the last few years and discussions with the NARS Specialist, it is clear that this species has declined greatly in numbers in the last five years. However, declines have leveled off, and stable numbers of mature plants exist. Additionally, a few new immatures and a few seedlings have been found over the last few years. NRS worked diligently in the last couple years to collect seed from founders that will be used for outplanting and storage trials. NRS will continue to balance founders at the augmentation established last year. With such high survivorship so far in outplantings, and a wild population with stable numbers of mature individuals, stability for this population will be contingent on recruitment. Collections from all wild plants completely represented in augmentations and reintroductions will not be conducted; wild seed will be left on site to encourage *in situ* germination. However, once the reintroduced plants become mature, they may be used as a source for seeds for genetic storage and testing and to produce plants for Mākaha and West Makaleha PUs. NRS weeded several times throughout the augmentation and wild sites this year and found another five immature plants.

Pigs have been in the Pahole fence for over a year and a half, and while weeding the *C. herbstii* augmentation site, pigs were seen running throughout the area. NRS are actively snaring pigs out of the exclosure.

Mākaha: Kapuna to Pahole founders were used to initiate reintroduction in Mākaha this year. Due to several contracting issues over the last year, the Mākaha fence was not completed when this species was outplanted this year. NRS had planned for an earlier finish date, and therefore had plants ready for outplanting. NRS built a temporary plastic fence around the site, and planted 24 plants. Unfortunately, pigs got in to the temporary fence and dug out plants, and

browsed most others. A total of six deaths resulted from this breech. The Mākaha Subunit I fence is now finished, and NRS will not use plastic fencing in areas of high pig activity again.

West Makaleha: Kapuna to Pahole founders will be used to reintroduce plants to West Makaleha, pending the Right of Entry permit with the State and the completion of the fence. When a clear timeline is established for the fence construction, NRS can begin developing a reintroduction strategy.

2.1.5 *Cyanea grimesiana* subsp. *obatae*

Requirements for Stability

- 4 Population Units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial with large fluctuations in population size and recent history of decline)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4MFS PUs are protected from ungulates?	How many of the MFS PUs that need reintroductions have been initiated?
0/4	2/4	3/4	3/4	3/4

Taxon Level Discussion

While the PUs with single plants have remained stable, a few plants died at the two PUs with multiple plants (see PU discussions). 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 two wild 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, which is discussed in Chapter 5.

Major Highlights/Issues Year 3

- Supplemental plantings were conducted at existing reintroduction sites within three PUs adding a total of 24 new plants.
- Initiated a reintroduction with nine plants from the KAL-A stock (the "type" locale for this taxon) at a new site in North Kaluaʻā.

Plans for Year 4

- Refresh genetic storage collections every four to five years until testing results indicate otherwise.
- Continue to balance founders at reintroduction sites. Try to acquire seed for storage and additional propagation from PAH-A-2 in order to maximize wild 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 Puʻu Palikea MU fence to include more *C. grimesiana* habitat for use in additional augmentations.
- Continue to augment reintroductions at ʻĒkahanui and Kaluaʻā.
- Create a new reintroduction site at Pāhole.

- Continue reintroduction with KAL-A stock from the South Kaluaʻā. "type" locale for this taxon at the new site in North Kaluaʻā.
- NRS will collect another voucher of the soft-bodied scale from affected plants in the Palikea PU for further identification and monitor the damage. Initial identification suggest the scale may be native, but the sample was not in ideal condition. If the scale is an alien then NRS will consider control options.
- Continue slug control research (see chapter 5.2)
- Fence Mākaha PU, continue to collect seed for storage, and began propagation for future reintroductions.

Table 2.1.5a Taxon Status Summary

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Pahole to West Makaleha	Manage for stability	6	0	9	19	8	0	31	3	8	**25**	**8**	**9**	1 mature and 1 immature wild plants died last year. A new seedling was observed at a wild site. Additional plants were added to augment the PU.
	Total for Taxon:	6	0	9	19	8	0	31	3	8	**25**	**8**	**9**	

Action Area: Out

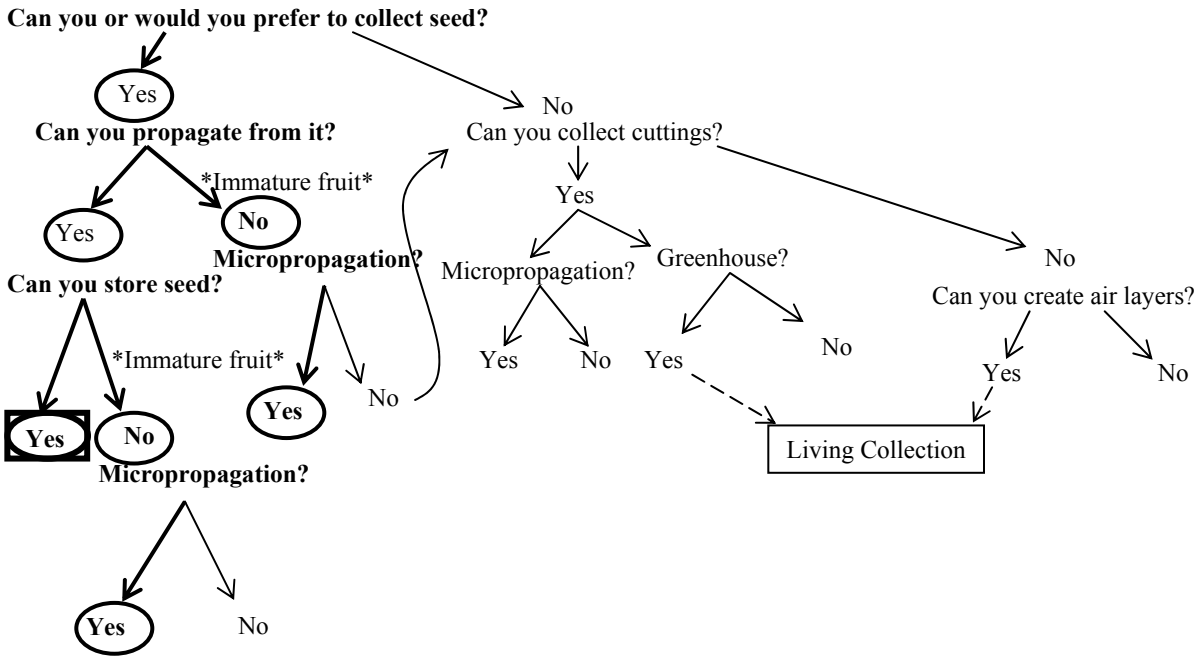
TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa	Manage for stability	1	0	0	18	30	0	23	33	0	**19**	**30**	**0**	The wild plant has been observed in the last year and is healthy. Additional plants were added to the existing reintroduction, and some reintroduced plants died.
Makaha	Manage for stability	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	This plant has been observed in the last year and is healthy
North branch of South Ekahanui	Genetic Storage	0	0	0	23	14	0	21	18	0	**23**	**14**	**0**	The wild plants died in 2000. Decline in TNC reintroduction due to tree fall. One plant added to reintroduction
Palikea (South Palawai)	Manage for stability	7	11	10	64	14	0	54	30	20	**71**	**25**	**10**	Slight decline in wild population, see discussion for seedling count declines
Palikea Gulch	Genetic Storage	0	1	0	0	0	0	0	1	0	**0**	**1**	**0**	This plant has been observed in the last year, new shoot growing from base
South Kaluaa	Genetic Storage	0	0	0	9	8	0	11	7	0	**9**	**8**	**0**	The wild plant died in 2005. An additonal outplanting was created and some reintroduced plants died this year
	Total for Taxon:	9	12	10	114	66	0	110	89	20	**123**	**78**	**10**	

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)** Has a successful storage method been determined?	**4)** Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: Extensive storage testing for many other species of *Cyanea* has indicated that seeds of this genus cannot be stored at -18C. All collections have consequently been stored at 4C, at which no aging has been detected for at least four years. Collaborative research is ongoing with NCGRP to understand why they can not be kept at -18C. The first hypothesis to be tested will be that the transition state for the majority of lipids present in the seed is around -18C. Therefore, storage at this temperature would cause a continual phase change between the defrosting cycles of the freezer. This cyclical freezing and melting of lipids would damage cell walls and cause seed death. Theoretically, temperatures below -18C may age seeds slower than 4C and may possibly be preferred storage temperature. With seeds collected from Pahole and ʻĒkahanui reintroductions this past year, testing was established for -80C. More seed will be collected for -150C (lN2) testing at NCGRP. NRS will continue to store at 4C until a better protocol has been established.

Genetic Storage: As mentioned in the Pahole to West Makaleha PU discussion, there is only one outplanted individual representing one of the dead Pahole founders. This founder is represented in no other way. Once viable seed is collected from this individual, genetic storage goals will have been met for this taxon.

Table 2.1.5b 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 grimesiana subsp. obatae							
Central Kaluaa	1	0	0	1	0	1	1
Makaha	1	0	0	1	0	0	1
North branch of South Ekahanui	0	0	2	1	2	0	2
Pahole to West Makaleha	6	0	3	8	0	8	8
Palikea (South Palawai)	7	11	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**
				24	7	14	25

Unique Species Observations

Refer to OANRP 2006

Outplanting Issues

Reintroduced plants across the Wai‘anae Mountains demonstrate a survivorship rate of 67%, a decline from the previous year’s rate of 75%. Tree fall contributed to one death in ‘Ēkahanui and 12 reintroduced plants died in Central Kalua‘ā. NRS reported a rapid die off of TNCH reintroduced plants in Central Kalua‘ā as well, although the cause is unknown. Supplemental plantings into existing reintroduction sites were conducted within the last year (see the following PU discussions for details). Rat control is conducted to protect reintroductions in sites where rat predation has been observed. Recruitment at reintroductions has not yet been observed. NRS continue to work to develop slug control techniques in order to address seedling predation issues at wild and reintroduced sites (See Chapter 5.2).

Table 2.1.5c 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	Manage for stability	1	0
North branch of South Ekahanui	Genetic Storage	2	1
Pahole to West Makaleha	Manage for stability	9	6
Palikea (South Palawai)	Manage for stability	20	5
Palikea Gulch	Genetic Storage	1	0
South Kaluaa	Genetic Storage	1	1
	Total for Taxon:	35	14

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

Research Issues
Slug research continues to be the highest priority research topic related to *C. grimesiana*. See Chapter 5.2 for a discussion on slug research.

Surveys
No surveys have be conducted for this taxon during this reporting period.

Taxon Threats
The soft bodied scale that was mentioned in last year's report has not been identified. This scale has been observed by TNCH staff since at least 2000. It is negatively impacting outplantings and wild plants at the Palikea PU by feeding on leaf tissue, however the impact seems to be minimal as both the wild and reintroduced plants are healthy. NRS will collect another voucher for identification and continue to monitor for any increase in impact. If the scale is confirmed as an alien then NRS will consider control options.

Population Unit Level Discussion

Manage for Stability PUs

Pahole to West Makaleha: The NARS Specialist monitors the wild populations of this PU within Pahole NAR. The Pahole populations have been fenced since 1997. Breaches in the fence have occurred although no damage has occurred to these populations (see chapter 1.4 for discussion). There is stock representing five founders from Pahole sites (Table 2.15e). Approximately fourteen plants of Pahole stock will be used to supplement the Pahole snail exclosure reintroduction site this winter. Collections were made from the Pahole reintroduction to secure stock from PAH-B-1 in seed storage. The one individual representing PAH-A-2 did not flower last year but did flower this year and immature fruit are currently developing. NRS will continue to secure stock from B1 and A2 and add this lineage to the reintroduction site.

Table 2.1.5d 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	Manage for stability	No	Partial	Partial
North branch of South Ekahanui	Genetic Storage	Yes	Partial	Partial
Palikea (South Palawai)	Manage for stability	Yes	Yes	Yes
Palikea Gulch	Genetic Storage	Yes	No	No
South Kaluaa	Genetic Storage	Yes	Yes	Yes

Table 2.1.5e Propagation Status of Pahole Founders

Stock Source for existing augmentation (PAH-D)	Founder plant #	Comments
Pahole (PAH-A)	2	Founder only represented as one plant in reintroduction. Founder is dead in wild. Collect seed as soon as plant matures to secure stock and balance with rest of founders.
	3	Propagation underway for planting this winter
	4	Propagation underway for planting this winter
Pahole (PAH-B)	1	Founder only represented in reintroduction. Founder is dead in wild. Plants are mature and have been collected from this past October/November to secure stock and to balance founders in reintroduction in future.
	2	Propagation underway for planting this winter

NRS manage, monitor, and conduct rat and weed control within the West Makaleha exclosure of this PU. The population has been fenced since 2001 and is monitored quarterly to ensure that it remains pig-free. Rat control data is shown in Table 2.15f. Bait stations and snap traps are maintained approximately every six weeks. No rat damage has been observed on plants since May 2002.

Table 2.1.5f 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
2006-2007	8	298	209	42%	34	16	5

NRS planned to augment the West Makaleha site this year, but the plants were not ready. NRS have stock from five founders. Only three of these remain in the wild, as two more died within the past year, possibly due to slug damage. Four founders have representation in seed storage and one 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. An experimental fruit smearing effort began in fall 2006 utilizing excess fruit from plants that have met collection goals for seed storage. Fruits are smeared at two sites apart from the wild mature plants and flagged. The sites are then monitored on return visits for germination and survivorship. NRS have observed germination from the smeared fruit.

Palikea (South Pālāwai*):* This site is now managed predominantly by NRS due to changes in TNCH staffing. The population was fenced in 2000 and is ungulate free. Native ferns and shrubs dominate the understory while the canopy is alien dominated (see chapter 9.4). Rat control has been underway since 2002. NRS maintain a rat baiting grid of 18 bait stations and 21 snap traps (table 2.15g). The grid is maintained monthly and also serves to protect native *Achatinella mustelina* populations in the area.

Table 2.1.5g 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
2006 - 2007	20	2122	697	33%	36	26	11

In the previous year, NRS hired a fencing crew to construct planned MIP fences. Expanding the existing fence at Palikea is a top priority. However, construction has been delayed but should be completed by the summer of 2008. TNCH staff and NRS have conducted several augmentations over the past four years. Currently there is limited space in the existing exclosure, but eight plants were added this year to the reintroduction in order to balance founders. More supplemental plantings will occur after the fence expansion is complete. Seed has been germinated in preparation for this planting, and founders will be balanced with the existing augmentation. There was a slight decline in the wild population, and the lower number of seedlings is a result of a shift in monitoring methodology. This year NRS only counted seedlings

that had reached a size where they were more distinguishable from the ferns that also inhabit the small wet cliff where the wild population occurs.

Central & North Kalua‘ā: This PU consists of a single wild founder and one reintroduced population, both located within the Kalua‘ā subunit I fence. The reintroduction was initiated in the winter of 2004-2005, supplemented in the winter of 2005-2006 with six plants, and again this year with seven plants. Some of the previously plantings have died. However, plants from the initial reintroduction have matured and are producing fruit. No recruitment at either the wild or reintroduced sites has been observed, even though the wild plant produces copious amounts of fruit.

Mākaha: The single plant in this PU was discovered in 2005, and is currently unfenced. NRS began rat baiting (table 2.15h) while it fruited and collected two fruit in 2005, however no viable seed was produced. NRS baited again this year and collected six mature fruits. Weeds have been controlled within a two meter radius of the plant. NRS plan to erect a PU fence with the permission of BWS. In the upcoming year an additional fence (subunit II) will begin construction in Mākaha (see chapter 2.1). Within the next two years, or as stock becomes available, two reintroduction sites using stock from this plant will be created. One will use pure stock of this plant while the second will mix Mākaha stock with plants from West Makaleha.

Table 2.1.5h Mākaha *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
2005 - 2006	2	64	17	27%	3	4	2
2006 - 2007	2	98	37	38%	5	4	3

Other PUs

North Branch of South ‘Ēkahanui: This PU lies within the ‘Ēkahanui subunit I fence and is comprised of two reintroductions of EKA-A stock. In prior years NRS collected fruit from the first reintroduction of this stock (EKA-B). This reintroduction was conducted by TNCH using mixed ‘Ēkahanui and Kalua‘ā stock. Collection of pure ‘Ēkahanui seed from this mixed population was done by ensuring that none of the Kalua‘ā plants were in flower at the same time or by removing developing inflorescences. The ‘Ēkahanui stock used in this reintroduction was collected from the last remaining EKA-A individual by TNCH staff in 1999. Stock from a previous collection by John Obata is currently stored at Lyon Arboretum Micropropagation Lab. This collection was described as being from one of eight plants, so the possibility that this stock is from a different plant from the TNCH collection is rather high. This stock almost perished in the lab as the last remaining culture was in poor health and was recalcitrant to sub-culturing. However, a subculture was created and now the stock is abundant in the lab. Pure stock of the EKA-A population 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).

In the winter of 2004-2005, a pure ‘Ēkahanui reintroduction was initiated with 33 outplants from the seed collected from the EKA-B reintroduction. They have matured, produced fruit, and are thriving. This winter only one individual was added to the reintroduction because the rest of the stock was not ready. However, additional plants will be added this winter when they reach the appropriate outplanting size. NRS are waiting for the completion of the subunit II fence (see chapter 9.2) to initiate an additional reintroduction site. This additional reintroduction will consist of a mix of stock from the TNCH EKA-A collection and the stock at Lyon Arboretum Micropropagation Lab. Once enough seed is secured for genetic storage, no further reintroduction effort will be necessary. However, NRS will continue to conduct management in the area as this PU overlaps with other IP taxa.

Palikea Gulch: This PU consists of one immature plant within a small fence. NRS have monitored the plant since February 1999. It is still small and immature, although it has grown an appreciable amount in the past year. A large log lies above the plant, and the plant has begun to grow around the log. The plant also produced a new side shoot, which may be collected in the coming months as it has its own roots. No rat predation has been observed. NRS will continue to monitor this plant for signs of reproduction.

Figure 2.1.5a Palikea gulch plant with new side shoot

South Kalua‘ā: The last remaining South Kalua‘ā PU plant died in the Fall of 2005. However, seed stock and reintroduced plants exist from this PU. This PU is morphologically most like the type specimen of this taxon. TNCH outplanted stock from this KAL-A plant near the KAL-B founder before the KAL-B plant was discovered. Cross pollination between the KAL-A outplanted stock and the wild KAL-B individual may have occurred. However, a geographically separated population, which was recommended by the IT, was established this year within the North Kalua‘ā subunit II fence with nine plants. 13 more plants are being propagated for outplanting in the winter of 2007-2008. However, only one plant is currently large enough for planting. Furthermore, the KAL-A stock that TNCH planted in a mixed reintroduction with EKA-A stock (see North Branch of South ‘Ēkahanui PU discussion) is an additional seed source that can be isolated, collected from, and used in future reintroduction efforts.

2.1.6 *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
- Expedited Stabilization (10 years)

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have had *in situ* recruitment?	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	3/3	0/3	2/3	0/3

Taxon Level Discussion

There are three Manage for Stability (MFS) Population Units (PU) for this taxon. Kapuna to West Makaleha and Pahole PUs are inside the Action Area (AA), and Makaha and Waianae Kai PU is outside the AA. Fenced off from ungulates the longest, the Pahole PU contains the largest number of plants of all size classes. Seedlings have been observed in all PUs. While most plants are found in habitats with high native species composition, *Cyanea longiflora* habitat is threatened by weeds such as *Psidium cattleianum* and *Clidemia hirta*. NRS weeded throughout sections of all PUs this year. The first reintroduction of this taxon was conducted in an exclosure near wild plants in West Makaleha and survivorship there is high. Currently, these reintroduced plants are the only individuals of this taxon that are fenced in the Kapuna to West Makaleha PU. Three *ex situ* plants near the West Makaleha exclosure occur on a steep slope and are topographically protected from ungulates. This year NRS finally secured genetic representation of all three of these plants that are reached on rappel. All other known plants in this PU will benefit from the completion of the Kapuna subunit III and IV fences currently under construction.

All known plants within the Mākaha and Waianae Kai PU are now all fenced. A small fence was completed around the plants prior to the completion of the Mākaha subunit I fence this year. Unfortunately, plants within this smaller fence were subject to vandalism. Plant heads were snapped off two tagged mature plants. See taxon threats for further discussion of this issue. NRS weeded around the population this year and found another seedling. Stock collected from this population will be outplanted into an augmentation site within the new Mākaha MU fence.

This year the Fish and Wildlife Service designated *C. longiflora* as a species "Expedited for Stabilization" in 10 years. This designation requires that in addition to three PUs managed *in situ*, one PU outside the action area must be rushed for stabilization in 10 years. The Mākaha and Wai‘anae Kai PU was selected for this effort. Given the low numbers of wild mature plants currently in the PU, stability goals will be challenging to meet in this timeframe for this PU. The

Makaha subunit II Management Unit fence will encompass appropriate habitat for reintroduction of this taxon. This fence is proposed for construction in year five.

Major Highlights/Issues Year 3

- A small fence was constructed around the Mākaha and Waianae Kai plants encompassing all plants.
- Blatant vandalism occurred in Spring of this year, after the smaller Mākaha fence was built; the stems of two mature tagged plants were deliberately snapped.
- The Mākaha subunit I fence was finished this year (vandalism experienced during construction).
- Collected from third of three founders from West Makaleha.
- West Makaleha reintroduction 83% survivorship since 2005.
- Species Expedited for Stabilization in 10 years.
- Collected from new founders in Keawapilau Gulch in the Kapuna to West Makaleha PU.

Plans for Year 4

- Continue to augment West Makaleha until balance 3 founders, with 10 representatives of each.
- Assist NARS with completion of the Kapuna subunit III and IV fences this year.
- Work with NARS to develop an augmentation strategy for Pāhole.

Table 2.1.6a Taxon Status Summary

Action Area: In

TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna to West Makaleha	Manage for stability	23	16	4	0	19	0	28	28	0	**23**	**35**	**4**	Five mature plants died and four new seedlings were found while monitoring
Pahole	Manage for stability	50	63	22	0	0	0	49	39	13	**50**	**63**	**22**	Additional mature and immature plants were observed in known sites
	Total for Taxon:	73	79	26	0	19	0	77	67	13	**73**	**98**	**26**	

Action Area: Out

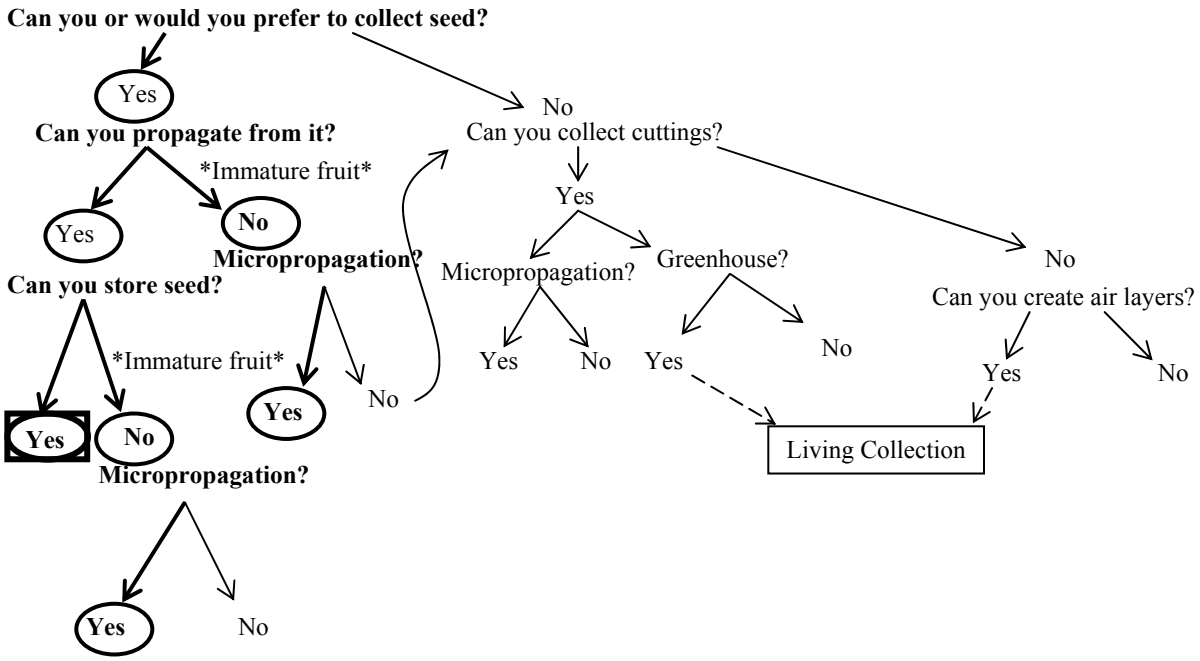
TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha and Waianae Kai	Manage for stability	3	5	2	0	0	0	3	6	4	**3**	**5**	**2**	Mature plants died/were killed; immatures became mature; two seedlings remain
	Total for Taxon:	3	5	2	0	0	0	3	6	4	**3**	**5**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage: Plants flowered in the greenhouse this year. If fruit mature; this seed will be used to test a new storage treatment (dry, -80C) to see if this treatment slows the aging process in seeds more than at 4C (see 2.00 Seed Storage). Until results indicate otherwise, banked seeds are stored refrigerated at 20% relative humidity. No aging has been detected at these conditions after four years.

Genetic Storage: Collections have been made from five new plants in the Kapuna to West Makaleha PU. NRS will continue to store seed to meet genetic storage goals.

Table 2.1.6b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cyanea longiflora							
Kapuna to West Makaleha	23	16	0	14	1	3	14
Makaha and Waianae Kai	3	5	2	3	1	1	2
Pahole	50	63	5	27	1	2	27
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				44	3	6	43

Outplanting Issues

Due to the fact that plants are found on both ends of the range within the Kapuna to West Makaleha PU, there will be two separate reintroductions on either side of this PU. In February 2005, NRS outplanted 23 immature *C. longiflora* in West Makaleha from two of three nearby founders. So far 19 have survived, and most are healthy. The plants initially experienced some slug damage, but none has been since this first observation. NRS will continue to balance stock at this reintroduction until there are ten representatives of each of the three founders. Stock from the Keawapilau Gulch and Kapuna Gulch sites will be used for augmentation in either the Kapuna subunit III or IV fence for the 2008/2009 winter outplanting.

Research Issues

There are no new research issues associated with this taxon this year.

Taxon Threats

Slugs continue to be an observed problem for this taxon, however ongoing slug research has offered a few potential means of controlling this threat in a rare plant population (Chapter 5.2).

Population Unit Level Discussion

Table 2.1.6c 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	Yes	Partial	No

Manage for Stability PUs:

Pāhole: This year NRS monitored and counted all known plants in this PU. Most of these plants occur in a relatively continuous band of steep, ferny, north facing slopes about 30 meters below Pāhole rim. This population appears healthy, with plants of all size classes present. NRS conducted careful weed control throughout this population this year. NRS continued to collect fruit from all unrepresented plants this year, however, very few plants had fruit. This may have been due to the fact that many plants while for the most part were healthy, were water-stressed. Many *C. longiflora* plants were dropping leaves, and associated species such as ferns and mosses throughout the habitat were dried and droopy.

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. NRS are expected to finish the Kapuna fence by the end of this year. This will provide protection for a single individual in Kapuna, as well as future outplanting sites. 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. This species was reintroduced for the first time within a small fenced exclosure near the wild plants in West Makaleha in early 2006. This reintroduction currently represents two of the three founders. The third founder was collected from for the first time this year and stock is being grown out to add to this reintroduction.

Mākaha and Wai‘anae Kai: The smaller Mākaha fence that encompasses the only extant leeward population of *C. longifolia* is very conspicuous as it runs right along the Kumaipo Trail. It has obviously drawn negative attention to the plants. NRS are shocked at this vandalism to the plants and continue to participate in outreach projects that target the community. NRS work with Bruce Koebele of Ka‘ala Farms and Waianae High School Students on natural resource projects

in the fenced exclosure in Mākaha, and are currently working with community hunters to hunt pigs out of the exclosure. These efforts, along with focus on the issue by two new outreach and education focused NRS staff, will hopefully help prevent future problems in this area.

Weed control was conducted this year with care not to radically increase light levels in the understory. All tags and flags were moved off individual plants and placed nearby to avoid a repeat occurrence of vandalism. Augmentation will be pursued in the Makaha subunit II fence proposed for year five.

2.1.7 *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
- Expedited stabilization (five yrs)

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/4	0/4	1/1 (only one *in situ* PU)	3/4	0/4

Taxon Level Discussion

As with other MIP taxa, NRS 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 will increase the odds of success given that all four MFS PUs will be established solely by reintroductions. NRS have the necessary tools to overcome many of the threats that this taxon faces. The major challenge with this taxon is overcoming the lack of recruitment. NRS have never seen recruitment in the wild, either at the wild site or at reintroduction sites. Many of the reintroduction sites have been established for many years and have produced copious amounts of seed without any germination. NRS believe that this is largely due to predation by introduced slugs and feel that development of a management tool for this threat is critical to the stabilization of this species. The 2007 BO requires that three *C. superba* PUs attain numerical stability outside the Action Area (AA). This is a topic that NRS would like to discuss with the IT as there have only been four PUs identified, two of which are in the AA. To meet this requirement an additional PU would have to be identified outside of the AA. This would result in five PUs for *C. superba* as the two in the AA are already established. The establishment of additional off site PUs will also be problematic for this species. While propagation has started for Mākaha, the first offsite PU, no propagation has begun for Makaleha, the second offsite PU, as there is no assurance that fencing will be complete with out an MOU with the state. Until an MOU is in place, a fencing plan can not be developed, until there is a fencing plan plants should not be germinated. In addition to the offsite PUs expedited stabilization requires; weed control, fire management and monitoring must be ongoing at all the MFS PUs within this time frame.

Major Highlights/Issues Year 3

- The fencing in Mākaha is complete and NRS will begin reintroduction in Mākaha this year.

- The last remaining F_1 individual from founder MMR-A-2 was not collected from in the last year as NRS had planned. The infructescence aborted.
- NRS analyzed survivorship data this year to better understand the population dynamics.
- NRS are considering reintroducing staggered age classes by staggering propagation times.
- The 2007 BO was issued by FWS requires five year expedited stabilization

Plans for Year 4

- NRS plan to begin seed plot experiments this spring to investigate impacts of controlling slugs on seedlings recruitment.
- NRS will attempt to collect seed from the last remaining MMR-A-2 founder. Presently, this stock is unrepresented in the seed bank and reintroductions.
- NRS plan to continue collection, propagation, and reintroduction efforts with the eventual goal of establishing balanced populations with the greatest possible genetic diversity.

Figure 2.1.7a Flowering *Cyanea superba* subsp. *superba*

Table 2.1.7a Taxon Status Summary

Action Area: In

TaxonName: Cyanea superba subsp. superba TaxonCode: CyaSupSup

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	0	0	0	19	92	0	17	108	0	19	92	0	Two plants have become mature in the last year and a few more immature plants have died
	Total for Taxon:	0	0	0	19	92	0	17	108	0	19	92	0	

Action Area: Out

TaxonName: Cyanea superba subsp. superba TaxonCode: CyaSupSup

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	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	0	0	0	72	68	0	72	84	0	72	68	0	Many of these plants became mature in the last year
	Total for Taxon:	0	0	0	72	68	0	72	84	0	72	68	0	

Table 2.1.7a Taxon Status Summary

Action Area: In

TaxonName: Cyanea superba subsp. superba TaxonCode: CyaSupSup

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	0	0	0	19	92	0	17	108	0	19	92	0	Two plants have become mature in the last year and a few more immature plants have died
	Total for Taxon:	0	0	0	19	92	0	17	108	0	19	92	0	

Action Area: Out

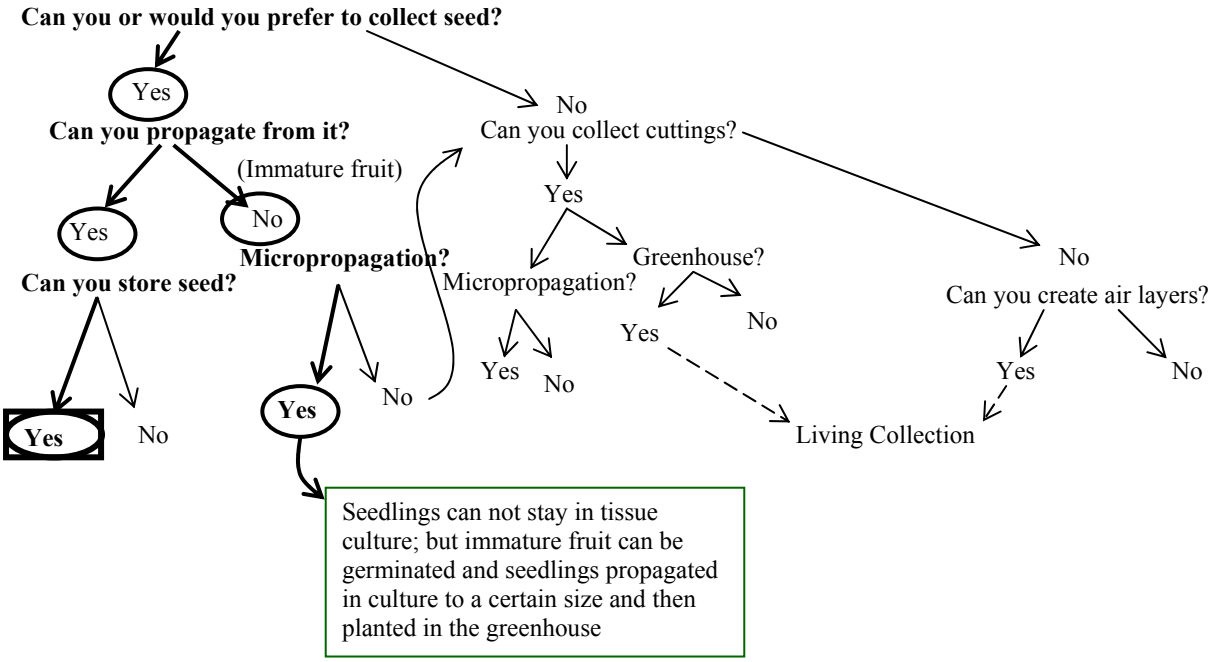
TaxonName: Cyanea superba subsp. superba TaxonCode: CyaSupSup

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	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	0	0	0	72	68	0	72	84	0	72	68	0	Many of these plants became mature in the last year
	Total for Taxon:	0	0	0	72	68	0	72	84	0	72	68	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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Collection methods were fine-tuned this past fruiting season to pinpoint the best collection time and handling protocols to maximize seed quality and storage potential. Prior to this past season, the majority of fruit were collected by suspending weed mats underneath the fruiting plants and allowing the fruit to mature and drop onto the mats. This method reduced the number of immature fruit collected (unless fruit aborted), but time delays between maturation to fruit drop, as well as fruit drop to collection time may have damaged seeds. Average initial germination rates for collections via this method were low and highly variable. Seeds of this species may not tolerate prolonged exposure to ambient temperatures and humidity while still in the fleshy fruit. This year, in response to both highly variable initial and storage viability germination rates, fruit were picked off the plant when fruit began to turn orange, and inside pulp was ripe (red) and seeds appeared mature (seed coats were shiny, seeds at full size) (Fig.2.1.7b). Initial germination rates were high and consistent with this method. One of these picked collections was tested separately and exposed to ambient conditions for three days, then processed and sown. None of these seeds germinated, supporting the hypothesis that seeds lose viability when exposed to ambient conditions while inside the fruit (Table 2.1.7b). Fruit will therefore not be collected in mats and will continue to be picked and handled as they were this year, and processed quickly.

Figure 2.1.7b *Cyanea superba* fruit

Propagation: refer to OANRP 2006

Seed Storage Research: Extensive, high-quality collections were made from reintroductions this past fruiting season. Following testing strategies designed by ongoing collaborative research between NRS and the National Center for Genetic Resources Preservation (NCGRP), seeds entered tailored storage tests at new temperatures in attempt to determine if temperatures below -18C will maintain seed viability longer than 4C (see 2.00 for lipid research details). Seeds can not be stored at -18C, but have good storage longevity at 4C. Theoretically, seeds should age slower at even lower temperatures. Therefore, -80C and -150C (lN2) are being tested for this taxon. Similar to initial germination results, storage tests have been highly variable in the past. NRS hopes that, by reducing collection error in storage viability results, these new storage trials will provide the information necessary to determine the best storage conditions for this taxon.

Genetic Storage: refer to OANRP 2006

Table 2.1.7b Mean germination of *Cyanea superba* by collection & handling method

Collection	Fruit Harvest	Fruit Store Temp (prior to processing)	Mean Germ	P
Dec 2006	**Picked**	**4C**	**0.72**	**0.000**
Dec 2006	**Picked**	**Room temp**	**0.00**	
Prior to 2006	**Fell off plant into net**	**Field temp**	**0.27**	**0.000**

Table 2.1.7c 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	3	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	3	3

Unique Species Observations

No unique observations were made by NRS in the past year.

Outplanting Issues

Reintroductions will 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, no wild collected stock is available from two of the four original founders to balance these sites. For these two founders, F_2 plants will be used so that Kahanahāiki and Pahole to Kapuna PUs will be established with both F_1 and F_2 plants. The other two PUs (Mākaha and Central and East Makaleha) will be established with all F_2 stock grown from the first two reintroductions. These F_2 plants will be grown from as many reintroduced F_1 founders as possible to maximize potential genetic variation. Mākaha reintroduction will begin in the next year, however NRS do not expect habitat scale fencing in Makaleha to begin for several years and will not begin propagation until appropriate.

Table 2.1.7d is an example of how the original founders can be used to select the necessary stock for balancing founders at existing sites and establishing new reintroduction sites at Mākaha and Central and East Makaleha PUs using all four founders.

Table 2.1.7d Propagation Plans for Mākaha and Makaleha Reintroductions

Original Founder	Current representation:	Plan to balance existing sites:	Makaha and Makaleha Reintroduction sites: Goal of 100 plants using 25 individuals from each founder
MMR-A-2	Single F_1 planted in Kahanahāiki in 2005 will likely be collected from 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	Propagate with the goal of having 25 plants from the single F1 founder in Kahanahāiki
MMR-A-3	52 F_1 plants in Pahole and Kahanahaiki	Now germinating seeds from the wild that were stored at Lyon	Propagate with the goal of having 25 plants from 25 different F1 founders 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	Propagate with the goal of having 25 plants from 25 different F1 founders 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	Propagate with the goal of having 25 plants from 25 different F1 founders in Kapuna

Additional outplanting issues are summarized below:

- The maximum number of F_1 founders should be used to provide the seed stock for future F_2 reintroductions, thus maximizing possible genetic variation.
- 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 are two sites in Kapuna that were planted by the State will be utilized in this way.
- The MMR-A-10 site in Kapuna 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.

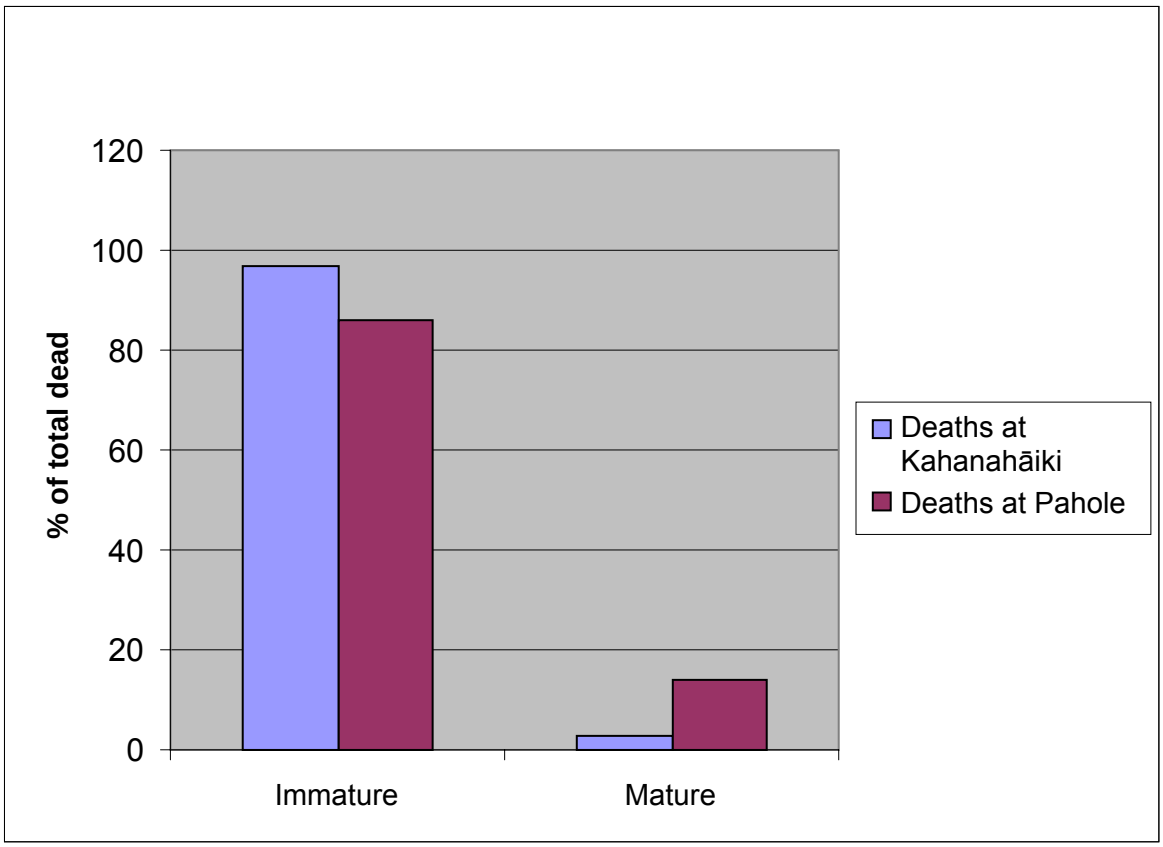


Figure 2.1.7c *Cyanea superba* mortality as a function of age class

In an effort to investigate if *C. superba* is truly a long lived perennial, NRS analyzed reintroduction data that spans a total of eight years. NRS was motivated to do this by inspecting the reintroduction data survivorship trends. Most outplantings that are four or more years old show survivorship rates of about 60%. NRS was interested in investigating where the mortality was occurring. Analysis showed that most of the mortality occurred before the plants became mature. Most plants mature at reintroduction sites in three to four years. Figure 2.1.7c shows that 97% of the mortality at Kahanahāiki and 86% at Pahole are with plants that have not yet reached maturity. (For the purpose of this analysis all plants that died of tree fall where removed). This may be due to a combination of factors such as site selection during planting (inappropriate micro-sites) and stock vigor (greenhouse propagated plants not suited for wild conditions). These results do seem encouraging as they suggest that once plants reach maturity they appear to have

even higher survivorship. NRS will continue to track the fate of the growing number of mature plants and report on the survivorship rates of these plants as the population grows. In the next year, NRS will work to develop queries that will be able to use the number of days to maturity and senescence to further this investigation. In particular, NRS is interested to know if a majority of the plants die soon after planting or if it is the result of a particularly bad year or season.

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 spring of 2008. See discussion in the Research section, Chapter 5.2.

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

Table 2.1.7e 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 storage	Yes	No	No
Pahole to Kapuna	Manage reintroduction for stability	Partial	Partial	No

Manage for Stability PUs

Kahanahāiki: Since 1998, 223 plants grown from Kahanahāiki stock were planted at six sites in Kahanahāiki gulch. Overall, survivorship is at 50% and there are now 111 plants, 19 mature and 92 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 continue this year for storage and propagation. Last year, NRS planned to collect stock from the only remaining progeny of MMR-A-2. Unfortunately, the

peduncle rotted before the fruit matured. NRS will continue to monitor this individual and hope that fruit can be secured this year.

Pahole to Kapuna: Since 2001, 137 plants grown from Kahanahāiki stock have been planted at one site in Pahole gulch. Overall survivorship is 51% and there are now a total of 70 plants remaining; 36 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 continue this year for storage and propagation. This site does present challenges with weed control. NRS has worked successfully to remove habitat modifying weeds from the area to such as *Spathodea campanulata*, *Montanoa hibiscifolia* and *Kalanchoe pinnata*. Unfortunately, the understory is dominated by hard to manage species including; *Christella parasitica* and *Rubus rosifolius*. Presently, NRS do not have the resources to control these species. NRS believes that control of these weeds is not a priority until slugs can be controlled and there is a better chance of seedling survivorship on site. In addition, these understory weeds do not appear to be competing with the *C. superba* that are all much larger than the weedy understory. See the Chapter One for more information. Rats are also impacting fruits produced in this reintroduction site. NRS found significant damage to fruit when collecting this year and will consider baiting in future years.

There are two sites with reintroduced *C. superba* in Kapuna Gulch. There are currently 34 mature and six immature plants in these sites. NARS staff originally outplanted into these sites in 1997 and 1998. The original number of plants are unknown. NRS supplemented one site in 2001 with stock from more recent Kahanahāiki collections. Collections of mature fruit will be made this year for storage and propagation.

Mākaha: The ecosystem fence in this area was completed in August 2007. NRS will begin this reintroduction this winter. A site needs to be chosen and NRS will work with Joel Lau to determine the most appropriate area and begin site preparation. A candidate site has already been weeded of canopy trees.

Central and East Makaleha: No reintroductions will begin until the MU fence is built.

Other PUs

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 when feasible. Stock planted in 2004 are now beginning to mature.

2.1.8 *Cyrtandra dentata*

Requirements for Stability:

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/4	3/4	1/4	1/4	0/2

Taxon Level Discussion

There are four Manage for Stability (MFS) Population Units (PU) for this taxon because two PUs occur within the Makua Action Areas (AA). However, this taxon has stable numbers at both of these PUs. Conducting a general census of plants across these large PUs is quite time consuming, and NRS will monitor these more stable populations less frequently. The other two MFS PUs occur in the Ko‘olaus, outside the AA. Numbers are not stable in any of the PUs outside the AA. This year NRS were able to meet storage goals for the Pāhole to Kapuna to West Makaleha PU and will now focus collection efforts in other PUs. The Kapuna fence construction should be finished by the end of the year and a sizeable population of this taxon within the Pāhole to Kapuna to West Makaleha PU will then be protected from ungulates. The State and NRS and NARS staff are actively working to eradicate pigs within the Pahole MU fence.

Two new plants were found by NRS this year in Central Makaleha. These plants fall outside any current PU designation and extend the range of this taxon further east. NRS plan to collect from these plants when visited again.

NRS are still working on a license agreement with landowner Kamehameha Schools that will allow NRS to build a fence that will encompass all the plants in the ‘Ōpae‘ula PU. NRS will census all known plants before fence construction begins to ensure that all plants in the PU are included in the fence. In the Kawai Iki PU, two NRS spent three days re-monitoring the known sites and surveying new sites of *C. dentata*. They were overwhelmed with morphological variation and associated with this species. The species is difficult to identify if not reproducing, and freely hybridizes with other taxa in the genus.

Major Highlights/Issues Year 3

- NRS met storage goals for the Pāhole to Kapuna to West Makaleha PU.
- Two new individuals were found in Central Makaleha this year extending the range of this species in the Wai‘anae Mountains.
- NRS continue to work on a license agreement with KS for management at the Lower ‘Ōpaeula MU.
- Kapuna subunit III fence construction started.
- Two NRS spent three days surveying for *C. dentata* in the Kawai Iki PU.

Plans for Year 4

- Finish Kapuna subunit III and IV fences.
- Monitor ‘Ōpae‘ula PU before finalizing fence placement.
- Establish collections from the Kawai Iki and ‘Ōpae‘ula PUs.
- Work with Botanist Joel Lau to identify numbers of pure *C. dentata* in Kawai Iki
- Work with the NARS staff to eradicate all pigs from Pahole MU.
- Test seed storage at NCGRP for -150C (1N2) testing.

Table 2.1.8a Status Summary

Action Area: In

TaxonName: Cyrtandra dentata **TaxonCode: CyrDen**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	156	57	27	0	0	0	156	57	27	**156**	**57**	**27**	No monitoring in the last year
Pahole to Kapuna to West Makaleha	Manage for stability	534	520	171	0	0	0	530	517	171	**534**	**520**	**171**	No monitoring in the last year, however no obvious decline in population while collections conducted
	Total for Taxon:	690	577	198	0	0	0	686	574	198	**690**	**577**	**198**	

Action Area: Out

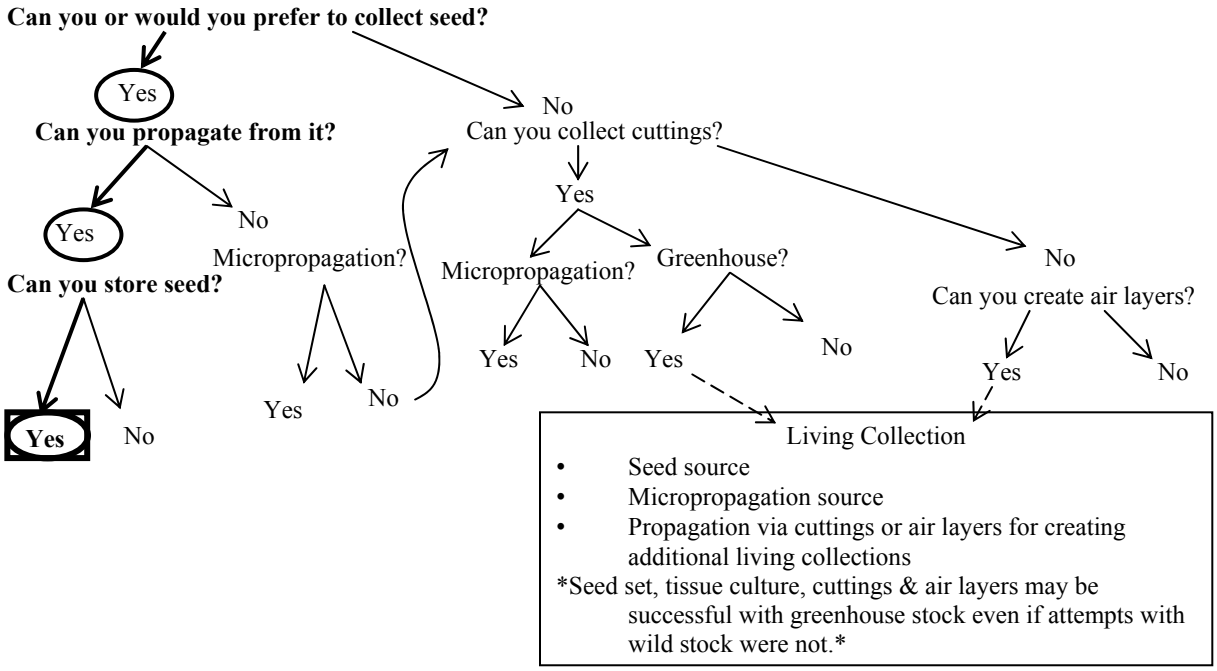
TaxonName: Cyrtandra dentata **TaxonCode: CyrDen**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Makaleha	Genetic Storage	3	0	0	0	0	0	3	0	0	**3**	**0**	**0**	Newly discovered in 2006
Kawaiiki (Koolaus)	Manage for stability	15	31	39	0	0	0	19	35	43	**15**	**31**	**39**	Monitoring highlighted difficulties in taxon identification
Opaeula (Koolaus)	Manage for stability	16	12	0	0	0	0	16	12	0	**16**	**12**	**0**	No monitoring in the last year
	Total for Taxon:	34	43	39	0	0	0	38	47	43	**34**	**43**	**39**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: Viability trends indicate that this taxon may be short-lived in the storage seed bank (Fig.2.1.8a). Seeds stored very dry at -18C have not shown signs of aging after two years. All other temperatures and relative humidity combinations have aged after only two years of storage. Ongoing collaborative research with NCGRP suggests that a particular seed collection lost half of its viability after five years. Continued research should be able to determine exactly how often seed will need to be recollected within the next two years. Seeds of this species will be sent to NCGRP for -150C (lN2) testing.

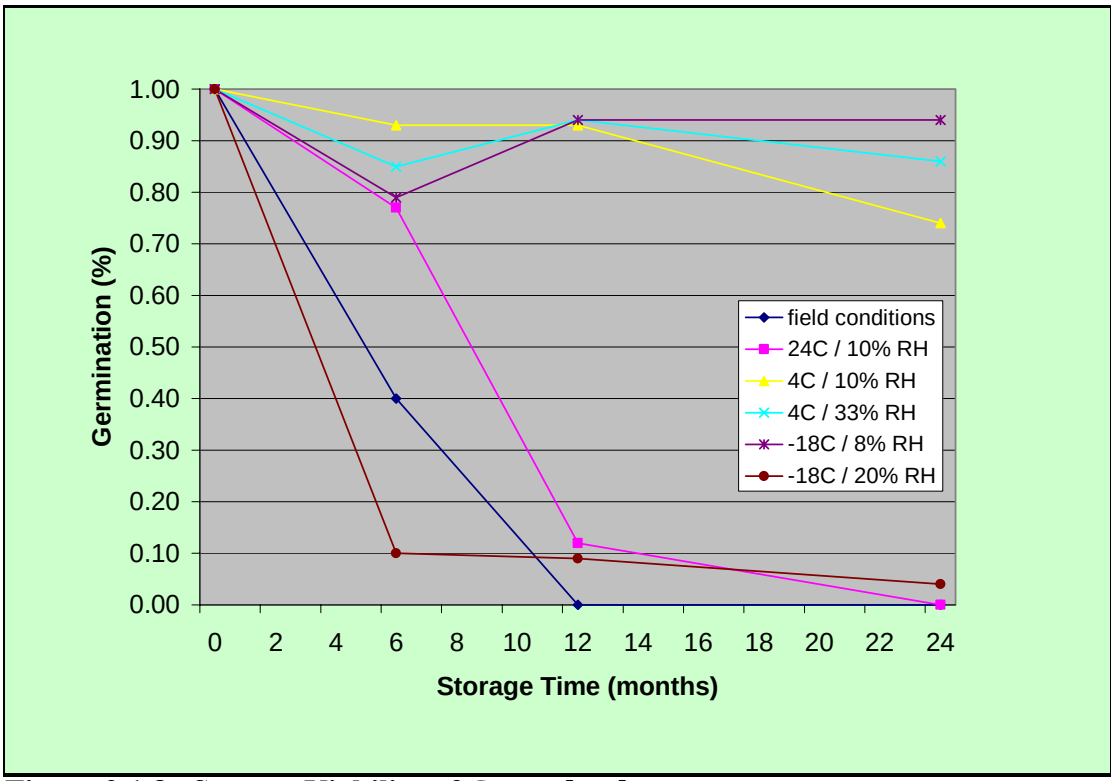


Figure 2.1.8a Storage Viability of *Cyrtandra dentata*

Genetic Storage: More opportunistic collections will be made from new individuals as seen this fruiting season.

Table 2.1.8b 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							
Central Makaleha	3	0	0	0	0	0	0
Kahanahaiki	156	57	0	21	0	0	21
Kawaiiki (Koolaus)	15	31	0	0	0	0	0
Opaeula (Koolaus)	16	12	0	0	0	0	0
Pahole to Kapuna to West Makaleha	534	520	0	49	0	1	50
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				70	0	1	71

Unique Species Observations
There have been no new observations for this taxon in the past year.

Outplanting Issues
This taxon has not been outplanted because wild populations are healthy and have good recruitment.

Research Issues
Research on slug impacts and control is underway (Chapter 5.2).

Surveys
Surveys and genetic storage collections were conducted by NRS in Kahanahāiki, Pahole to Kapuna to West Makaleha, and Kawai Iki PUs.

Taxon Threats
Pigs still remain a large threat to this taxon. Several pigs that are in the Pāhole fence are actively being snared out of the gulch. NRS have seen no direct damage to any individuals in Pāhole due to these pigs.

Population Unit Level Discussion

Table 2.1.8c 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
Central Makaleha	Genetic Storage	No	No	No
Kawaiiki (Koolaus)	Manage for stability	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 collected from 12 more individuals this year for genetic storage and are nearly half way to reaching full genetic storage goals (Table 2.8b). NRS will continue to collect in the coming year.

Pāhole to Kapuna to West Makaleha: The plants in the Pahole gulch fenced portion of this PU continue to thrive and recruit vigorously. It is important to get pigs out of this exclosure as soon as possible. Some weed control conducted for other taxa in the last year also benefited *C. dentata*. Genetic storage collection goals were met, with the bulk of seeds coming from Kapuna and Keawapilau MUs where fences are not yet complete.

‘Ōpae‘ula: There is no new information for this PU.

Other PUs

Kawai Iki: As mentioned above, the presence of hybrids complicate determining pure *C. dentata* numbers. During surveys this year, one gulch had up to five species of *Cyrtandra* (within 100m) and there were many hybrid combinations of these five. Another gulch where plants were earlier confirmed as *C. dentata* by botanist Joel Lau, no longer had mature plants, making the individuals difficult to identify. However, one gulch to the west, *Cyrtandra* were counted as *C. dentata* as there did not seem to be any obvious signs of different looking species nearby. Collections of this species in this PU were held off during these surveys due to these complications. Further visits to these spots with J. Lau will be made to try to identify true forms of this species. This effort may involve tagging individual plants so that plants can be better tracked and pure *C. dentata* ‘zones’ can be more clearly defined within the hybrid swarms. The surveys did however help outline the range of *C. dentata* as every gulch west of the known populations was surveyed. The surveys also gave NRS a better idea about where fencing in this PU might be appropriate.

2.1.9 *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
- Expedited Stabilization (10 years)

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have had *in situ* recruitment?	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	3/4	4/4	3/4	0/4

Taxon Level Discussion

There are four Manage for Stability (MFS) Population Units (PU) for this taxon because there are *Delissea subcordata* within both the Mākua and SBMR Action Areas (AA). Three of the MFS PUs are outside both AAs and one is in the Mākua AA. The Manuwai PU has recently been selected as the fourth MFS PU. All PUs are consistently monitored and some threats are controlled at all sites. Declining, this taxon seems to survive in fairly weedy forest dominated by *Schinus terebinthifolius* and *Psidium cattleianum*. The Huliwai and Ka‘awa PUs have been removed from the genetic storage management designation this year because no collections were historically made, and plants are believed to be extirpated from these PUs. NRS and NARS have been successful in establishing genetic storage collections of seeds from all PUs with *in situ* founders. This taxon does show occasional recruitment at wild and reintroduction sites, and collections will continue to be made as wild plants mature. Three MFS PUs have been augmented and survivorship is high. The largest threats to *D. subcordata* are pigs and goats. Slugs, rats, insects and weeds are also threats to this taxon. The Kapuna subunit III and IV fences currently under construction will include a historic *D. subcordata* site, as well as the remaining *in situ* plants in the Kahanahā‘iki to Keawapilau PU.

This year *D. subcordata* has been designated as a species “Expedited for Stabilization” by the US Fish and Wildlife Service. Conservation management requirements for this status are in alignment with current plans for this species. Four MFS PUs will be stabilized, three of which are to be outside of the AA. The significance of this new designation for this species is the expedited timeline for stability goals. Numerical stability will therefore need to be met in ten years at Kahanahā‘iki to Keawapilau within the AA, and at the following sites all outside of the AA:‘Ēkahanui, Kalua‘ā and Manuwai. This will only be accomplished by augmenting all PUs, as numbers of founders at each site are so low. Plants can mature in one year in the greenhouse, and this bodes well for reaching stability goals in the expedited time frame.

Major Highlights/Issues Year 3

- Fence construction of Kapuna subunit III and IV fences underway, protecting all *in situ* plants in this Kahanahāʻiki to Keawapilau PU.
- Large scale augmentation begun in the Kahanahāʻiki to Keawapilau PU.
- Reintroduction of Keālia stock established in Kaluakauila to be managed for Genetic Storage collection.
- Reintroduction of Palikea Gulch stock established in Kapuna to be managed for Genetic Storage.
- Storage goals met for seven of seven PUs from all mature founders; collected from remaining founders in South Mohiakea and Palikea Gulch.

Plans for Year 4

- Continue to supplement the Kahanahāʻiki to Keawapilau PU augmentation to balance founders from this PU.
- Continue to supplement the ʻĒkahanui PU augmentation to balance founders.
- Begin construction of ʻĒkahanui subunit II fence protecting large habitat around all *in situ* plants.
- Continue to balance founders at the Kaluaʻā reintroduction of South Mohiākea stock.
- Assist NARS to complete Kapuna subunit III and IV fences this year.

Table 2.1.9a Taxon Status Summary

Action Area: In

TaxonName: Delissea subcordata **TaxonCode: DelSub**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Keawapilau	Manage for stability	5	0	0	17	111	0	22	0	0	**22**	**111**	**0**	117 plants reintroduced for augmentation this year
South Mohiakea	Genetic Storage	2	0	0	0	0	0	1	1	0	**2**	**0**	**0**	Reintroduction of stock to be managed in Kaluaa for genetic storage collections
	Total for Taxon:	7	0	0	17	111	0	23	1	0	**24**	**111**	**0**	

Action Area: Out

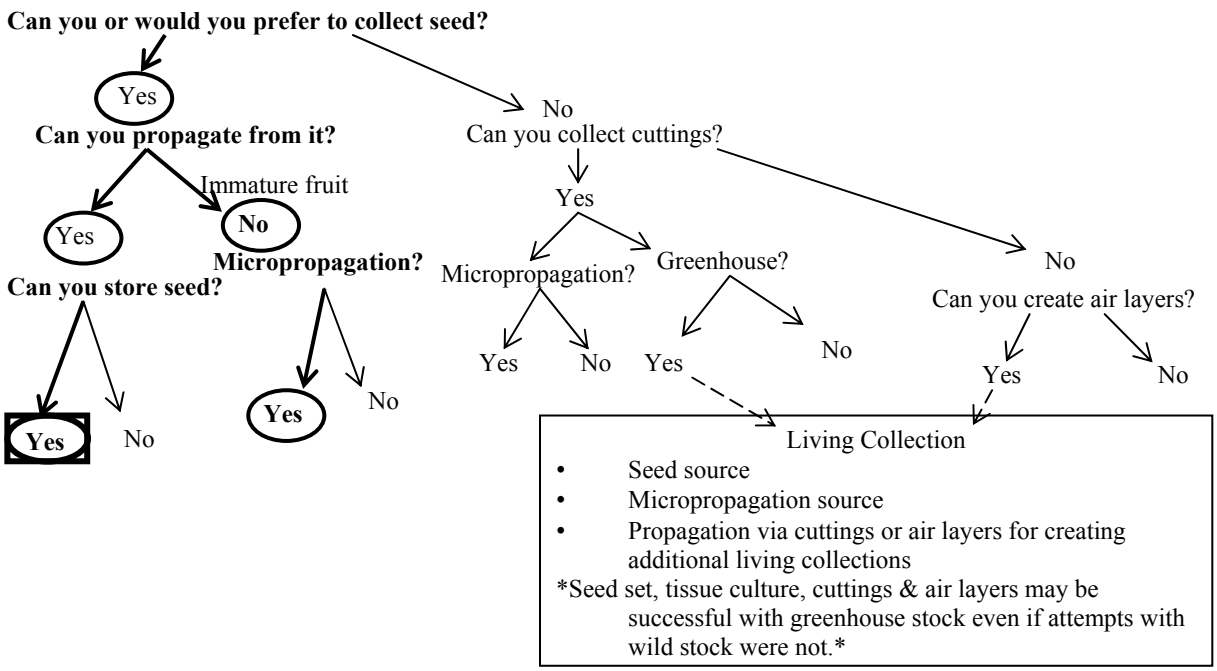
TaxonName: Delissea subcordata **TaxonCode: DelSub**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	4	0	0	109	0	0	113	0	0	**113**	**0**	**0**	An additional 30 new plants were added to the augmentation this year
Kaluaa	Manage for stability	1	5	2	24	1	5	28	0	11	**25**	**6**	**7**	Several reintroduced mature individuals died this year; seedlings found in reintroduction
Kealia	Genetic Storage	2	0	0	5	34	0	2	0	0	**7**	**34**	**0**	NARS observations show no change in the last year
Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	Reintroduction will begin when MU fences are complete
Palawai	Genetic Storage	4	0	1	0	0	0	5	0	0	**4**	**0**	**1**	Seedling found near mature individuals
Palikea Gulch	Genetic Storage	2	0	0	9	37	0	2	0	0	**11**	**37**	**0**	40 plants reintroduced in Kapuna
	Total for Taxon:	13	5	3	147	72	5	150	0	11	**160**	**77**	**8**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage: Research is ongoing to test why this taxa can not be stored at -18C, while it has not shown a decrease in viability at 4C for over five years, and can be stored at -150C and -80C. Preliminary studies on lipid composition suggest that melting points of dominant lipids within the seeds of this taxon may be around -18C, causing continual phase changing at this temperature and consequential cell membrane damage. Until longevity at -80C and -150C is determined, seeds will remain stored at 4C.

Genetic Storage: New seed collections were made from one plant in the Palikea gulch PU and an additional founder in the South Mohiākea PU. NRS has reached genetic storage goals for this taxon.

Unique Species Observations
No new observations have been made in the last year.

Genetic Storage Summary Table 2.1.9b

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	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
Kahanahaiki to Keawapilau	3	1	8	12	1	9	12
Kaluaa	1	5	0	1	0	1	1
Kealia	2	0	0	2	0	2	2
Palawai	4	0	2	6	1	2	6
Palikea Gulch	2	0	5	6	1	6	6
South Mohiakea	2	0	3	4	0	2	4
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				37	3	26	37

Outplanting Issues

This year a new strategy for augmentation was used in the Kahanahāʻiki to Keawapilau PU. A target of 220 plants are to be planted at one site (so far 117 plants went out this year) with hopes that if frugivorous birds have a reliable, prolific food source, they may visit frequently and disperse seeds throughout the PU. This strategy has also been used in ʻĒkahanui by TNC and NRS continue to augment the PU there with this method. Recruitment in reintroductions has so far been seen in Kahanahāʻiki to Keaawapilau and Kaluaʻā.

NRS are also using reintroductions as genetic storage sources for Manage for Genetic Storage (MGS) PUs. As seed stock diminishes in the seed bank from extirpated plants in the MGS PUs, new collections will need to be made. NRS will establish reintroductions balancing all the founders from a PU at appropriate sites where current management is taking place. Seeds collected from these reintroductions can be used to meet genetic storage goals for these PUs, to use for experimental outplanting, and for seed storage testing. Table 2.1.9c illustrates where such PUs will be managed. No reintroduction will be established for Palawai stock given that there are still *in situ* plants, and seed stock is still fresh.

Palikea Gulch stock will be managed for stability in Manuwai Gulch. This stock was chosen to be used in the fourth MFS PU because there are no plans for management in Palikea Gulch. NRS will manage other taxa in the Manuwai MU fence, and it will be an appropriate site for Palikea Gulch stock.

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 Waiʻanae Mountains and surveys at these historic sites will be considered by NRS.

Table 2.1.9c Reintroductions managed for Genetic Storage or Stability

Population Unit Name	Management Designation	Site Selected for Management
South Mohiakea	Genetic Storage	Kaluaa (reintroduction managed for genetic storage)
Kealia	Genetic Storage	Kaluakauila (reintroduction managed for genetic storage)
Palikea Gulch	Manage for Stability	Manuwai (reintroduction managed for stability)

Research Issues
For more discussion on slug impacts see the Research Section Chapter 5.2.

This year NRS are asking Shelly James of Bishop Museum to conduct genetic research on the origin of a single plant that occurs 100 meters from the nearest reintroduced plants in Kahanahā‘iki. It is unclear if this single plant is an F_1 plant from the nearby reintroduction, transported to the site by a bird, or if it is a wild plant from the historic population. NRS will treat this individual plant as unique and significant pending results from genetic analysis.

Taxon Threats
No additional threats have been noted in the last year.

Population Unit Level Discussion

Table 2.1.9d Population Unit Threat Control Summary

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	Partial
Kaluaa	Manage for stability	Yes	Partial	No
Kealia	Genetic Storage	No	No	No
Manuwai	Manage reintroduction for stability	No	No	No
Palawai	Genetic Storage	Yes	Partial	No
Palikea Gulch	Genetic Storage	No	No	No

Manage for Stability PUs

ʻĒkahanui: There are currently four living wild mature plants at two sites. NRS and TNC staff built fences around these sites in 2004. Both sites are highly degraded and only minimal management is done to encourage the plants to mature and produce seed for storage and for reintroduction into higher quality managed habitat. A large augmentation exists in the 40 acre ʻĒkahanui subunit I fence. The source stock for this site comes from six founders in ʻĒkahanui. NRS continued to supplement this augmentation this year. Weed control is ongoing at this site. Seeds have been collected from wild and reintroduced plants in this PUfor storage. NRS will continue to monitor all plants in ʻĒkahanui and continue collections as needed. NRS will emphasize searches for seedlings this year within the reintroduction as plants have been mature there for several years.

Construction of the ʻĒkahanui subunit II fence will begin this year. This large exclosure will include all *insitu* plants, and protect a great deal of habitat for this taxon within the PU. NRS will consider another reintroduction in this exclosure of ʻĒkahanui stock.

Kahanahāʻiki to Keawapilau: There are five *in situ* plants in this PU. All but one of these plants is fenced. The Kapuna subunit IV fence currently under construction will include this plant, as well as historical sites of this taxon in Kapuna Gulch. These five plants as well as three other extirpated plants from Kapuna Gulch serve as founders for the large-scale Pahole Gulch reintroduction. Established in February this year, the reintroduction currently has a 98% survivorship.

NRS will no longer continue to supplement reintroductions established elsewhere in this PU in the past, as they are no longer believed suitable to satisfy the stability requirements set for this taxon. However, remaining plants are still monitored, and a F1 plant reached maturity at this site.

Kaluaʻā: There is currently one mature, five immature plants, and two seedlings at an *in situ* site in this PU. All plants are within the Kaluaʻā fence exclosure. NRS target ecosystem altering weeds such as *Schinus terebinthifolius,* and *Passiflora suberosa* around these plants. NRS are propagating plants from seed of the mature individual to be outplanted nearby this year. As the plants mature, they will be added to the augmentation. TNC has also reintroduced 250 individuals in nearby gulches in the Kaluaʻā area of mixed stock from the Southern Waiʻanae Mountains. The wild Kaluaʻā plants are in a separate gulch from the TNC reintroductions and cross pollination is presumably unlikely.

Manuwai: This year, NRS have decided to manage the Palikea Gulch stock at a reintroduction in Manuwai. In order to satisfy stability goals, NRS chose a fourth MFS PU from a PU designated MGS. Palikea Gulch was chosen as it has the most founders currently represented in storage, and because there were no management plans other than fruit collection within Palikea Gulch itself. This reintroduction will be established when the MU fence is completed.

Other PUs

Pālāwai: Fences are being maintained around all plants at two sites in Pālāwai. Collections were secured from all 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 seed from the wild founder. A seedling was observed within one of the fences near a mature plant this year. Weeds are controlled at one site with native components. The other site is dominated by *S. terebinthifolius* weeds are controlled only two meters around the plants.

South Mohiākea: There are currently two mature plants in this PU. This year, one of these fruited for the first time and NRS were able to collect two fruits. Past collections have been made from this PU and are stored at the Army Seed bank. There are currently five founders for this PU. NRS controlled weeds within the small exclosure around these plants this year. Reintroduction of this stock has already begun in Kaluaʻā, where access is unlimited and active management is currently underway. This reintroduction will also be used to collect for genetic storage for this PU as stock numbers diminish in the seed bank. NRS will consider crossing this stock with the one mature and potentially more Kaluaʻā founders, but will keep sites of pure PU stock for now.

Palikea Gulch: Two mature plants are left in this PU at two separate sites. Neither site is protected by a fence and pigs are a noted threat at both. The fire this summer that burned through Lower Kaʻala NAR burned within 500 meters of this PU. Mature seed has been collected for storage and germination by NARS and NRS from both sites in the past. There are currently 6 founders for this PU, one of which was collected from this year for the first time. Stock from this location is currently represented in a reintroduction in the West Makaleha exclosure, however this site has been deemed too wet, and rats were predating plants. NRS therefore reintroduced plants of this PU stock into Kapuna gulch as a living collection. Forty plants were planted this April, and currently 92% have survived. Seed stock from this reintroduction can be used for propagules for the Manuwai PU reintroduction. NRS may also use the Kapuna reintroduction seed to achieve genetic storage goals until this can be done so from Manuwai. This stock will also be used as a source for the forth MFS PU in Manuwai Gulch once the fence is built there.

Keʻālia: NRS have never visited this site as NARS Biologist is handling all collections from Keʻālia. Plants from two founders were reintroduced in nearby Kaluakauila where management for other taxa is currently underway. This reintroduction will be managed for future genetic storage collections. The *in situ* plants in this PU are currently on land in landholder transition, making management difficult. However, NRS will still pursue a fence around this PU to encourage more onsite recruitment.

2.1.10 *Dubautia herbstobatae*

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *insitu* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/3	2/3	0/3	3/3	0/1

Taxon Level Discussion

The ‘Ōhikilolo Mauka and Makai PU’s both have stable numbers of reproducing individuals, whereas the the Mākaha PU currently has 36 known reproducing individuals. However, with more surveys a stable population number may be reached. However, there are not the large numbers of individuals seen on ‘Ōhikilolo in Mākaha. NRS will assess the threats to this population to see if they can be mitigated to achieve population stability. Augmentation may also be considered pending survey data. The remaining PUs will be managed for genetic storage. The major challenge in working with this species is that all populations require rappelling making it difficult to get frequent and thorough monitoring data and collections. NRS has also struggled to collect viable seed from populations for storage and propagation trials. This year NRS was able to perform successful pollinations with greenhouse stock for the first time, resulting in the production of viable seed. NRS believe that with management at the two ‘Ōhikilolo PUs, stability is attainable. At the Mākaha PU additional survey and perhaps augmentation will be used to achieve stabilization.

Major Highlights/Issues Year 3

- Conducted cross-pollination with greenhouse plants that resulted in the production of viable seed.

Plans for Year 4

- In the coming years, NRS will continue to survey for new plants, particularly in the Mākaha PU, refine counts, determine management needs, including augmentation, and collect cuttings for propagation and seed collection.
- Investigate available habitat in the newly completed Mākaha fence for candidate reintroduction sites.
- NRS will continue to investigate remote sensing technologies and ways these methods could be applied to this taxa to achieve monitoring goals.

- NRS will attempt to use a spotting scope from strategic locations around PUs to search for additional plants and monitor existing sites.
- Continue pollination studies to determine if ambient pollination produces adequate seed for storage goals.

Figure 2.1.10a Flowering *Dubautia herbstobatae*

Figure 2.1.10b Detail of *Dubautia herbsobatae* flower

Figure 2.1.10c Rappel access to *Dubautia herbsobatae* PU

Figure 2.1.10d Detail of *Dubautia herbsobatae* fruit

Table 2.1.10a Taxon Status Summary

Action Area: In

TaxonName: Dubautia herbstobatae **TaxonCode: DubHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Genetic Storage	70	0	0	0	0	0	70	0	0	**70**	**0**	**0**	No monitoring in the last year
Makaha/Ohikilolo	Genetic Storage	350	0	0	0	0	0	350	0	0	**350**	**0**	**0**	No monitoring in the last year
Ohikilolo Makai	Manage for stability	358	0	0	0	0	0	358	0	0	**358**	**0**	**0**	No monitoring in the last year
Ohikilolo Mauka	Manage for stability	382	6	0	0	0	0	382	6	0	**382**	**6**	**0**	No monitoring in the last year
	Total for Taxon:	1160	6	0	0	0	0	1160	6	0	**1160**	**6**	**0**	

Action Area: Out

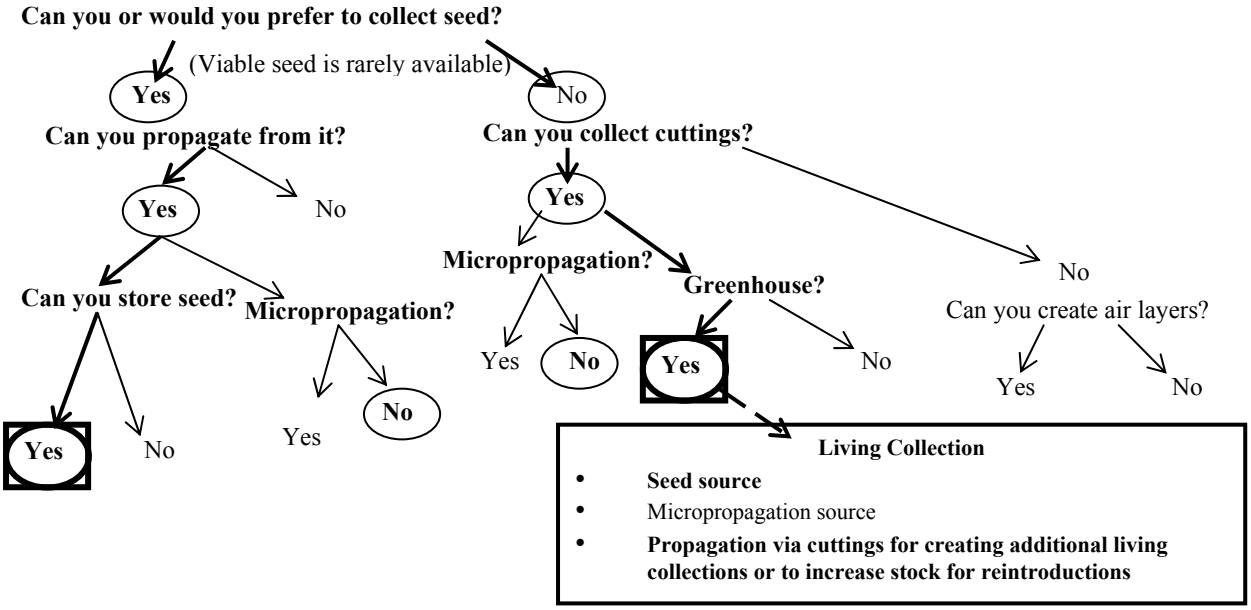
TaxonName: Dubautia herbstobatae **TaxonCode: DubHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	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	0	0	0	36	1	0	**36**	**1**	**0**	No monitoring in the last year
Waianae Kai	Genetic Storage	10	4	0	0	0	0	10	4	0	**10**	**4**	**0**	No monitoring in the last year
	Total for Taxon:	46	5	0	0	0	0	46	5	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?	Has a successful storage method been determined?	Are additional steps required for obtaining enough seed?
Cuttings	Seed & Living Collection	Yes	No, new pollination protocol established

Prioritizing Genetic Storage & Propagation Techniques



Collection: Please refer to OANRP 2006 for current status.

Propagation: Please refer to OANRP 2006 for current status.

Seed Storage Research: Please refer to OANRP 2006 for current status.

Genetic Storage: In response to results from the pollination study (see Research Issues), cuttings from wild plants will be taken one PU at a time, isolated in the greenhouse, and used as seed source via intra-PU cross pollination. This will be the first attempt to collect enough seed from greenhouse stock for genetic storage purposes. The number of flowers produced remains limiting factor in collecting seed. Plants will be transplanted into larger pots and fertilized to promote flowering. Initial viability testing will be conducted to determine if enough viable seed is produced for genetic storage. If viability is low, then the number of seeds that need to be collected will be reciprocally large. Methods may need to be adjusted depending on next year's success.

Table 2.1.10b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	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	1	1	6
Keaau	70	0	0	0	0	0	12
Makaha	36	1	0	12	0	2	1
Makaha/Ohikilolo	350	0	0	1	0	0	2
Ohikilolo Makai	358	0	0	0	0	0	6
Ohikilolo Mauka	382	6	0	1	0	0	6
Waianae Kai	10	4	0	4	0	6	4
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				19	1	9	37

Unique Species Observations
No unique observations by NRS in the past year.

Outplanting Issues
NRS are not proposing to do any reintroductions with this species in the next year. If NRS decide reintroductions are needed in the Mākaha PU, plans will developed in the next year.

Research Issues
Greenhouse Pollination Study**:** It is impractical to collect seed from wild plants as the areas are difficult to access and the plants are not large enough to produce enough fruit at one collection event to acquire enough seeds to meet genetic storage goals. As cuttings are easily established in the greenhouse, NRS planned to use cutting stock as seed source, yet none of the greenhouse plants had produced viable seed as of 2006. Pollination studies from last year clearly showed that no viable seed was produced from controlled selfing (OARNP 2006). To determine if this is due to self-incompatibility, crosses between plants must be conducted and produce viable seed. This summer, enough plants flowered to cross stock from four different founders. Viable seed was consequently produced, yet the number of viable seed per infructescence still remains low (Table 2.1.10c). This suggests that these plants may likely be self-incompatible to some degree. It has yet to be determined if there is any difference in seed set between intra-PU and inter-PU crosses. It has also yet to be determined whether or not plants in the greenhouse will receive enough crossing from ambient pollination or if hand-pollination is necessary to collect enough seed for storage goals within one flowering season. These questions will be addressed for the following flowering season.

Table 2.1.10c Summary of Germination of *Dubautia herbstobatae* in Pollination Study 2007

Female	Male	Cross Type	Percent Viable
MAK-A-1	MAK-A-1	Selfed	0.00
MAK-A-1	MAK-B-2	Inter-PU	4.00
MAK-B-1	MAK-A-1	Inter-PU	0.00
MAK-B-1	MAK-B-2	Intra-PU	2.00
MAK-B-1	WAI-A-3	Inter-PU	12.00
MAK-B-2	MAK-B-1	Intra-PU	0.00
MAK-B-2	MAK-B-2	Selfed	0.00
MAK-B-2	MAK-B-2	Selfed	0.00
WAI-A-3	MAK-B-1	Inter-PU	0.97

Surveys
No surveys were conducted for this taxon this year.

Taxon Threats
No new threats were identified this year.

Population Unit Level Discussion

Table 2.1.10d 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

‘Ōhikilolo Makai and ‘Ōhikilolo Mauka:
NRS do not monitor the majority of these PUs regularly because of their size and the need for rappelling to access populations. Rather, NRS monitor sites within the PUs when monitoring

more critically endangered sites of other taxa (*Hedyotis parvula*, *Sanicula mariversa* and *Viola chamissoniana*). If NRS see new threats or unexpected declines in these sites, then larger monitoring efforts would be initiated. Otherwise, NRS will strive to monitor a sample of sites within the PU every 3-5 years. NRS attempted a remote sensing trial this year within this PU. The goal was to use a high resolution camera mounted on a helicopter to capture images of the remote cliffs that this species inhabits. Unfortunately, due to a combination of factors the trial was unsuccessful. NRS will continue to pursue applying these methods in the next year. (See the Rare Plant Chapter Introduction). In theory, these images could then be geo-referenced. (With this method the picture is fitted to a map such that they mapped with GIS). If the image was of high enough quality individual plants and flowers could be seen on the image. NRS are hopeful that this technique will work as *D. herbstobatae* has a tendency to grow on exposed rock areas with sparse to little vegetation. This PU is fenced, and protected from ungulates. NRS will continue to maintain the fence on ʻŌhikilolo ridge and keep the area goat free.

Mākaha:
NRS planned to access this PU in the last year and were unsuccessful. Access to this PU is challenging. The only way to access the site is via helicopter and the Landing Zone (LZ) is treacherous. Unfortunately, due to the narrow rocky substrate of the ridge crest where the LZ is located there is no way to improve the site. In the last year, NRS did not have a pilot that had adequate experience to attempt a landing at the site. In the next year, NRS will attempt a trip to the area. NRS will also consider alternative access methods to include setting a permanent system that can be accessed from the bottom of the cliff. NRS needs to resurvey and refine counts, determine the feasibility of threat control, consider augmentation possibilities and collect cuttings for nursery stock. This stock will then be used to produce seed for storage and propagation. In addition, NRS will attempt to use a spotting scope to remotely monitor this PU.

Other PUs

Keaʻau:
No action was taken in this PU by NRS in the past year. NRS will seek permission to visit this site in the next year as it has not been monitored since 2005. This PU is also under the greatest threat due to ungulate presence in the area and relative accessibility of plants. Therefore, NRS will collect cuttings to use as greenhouse stock to secure seed collections.

Kamaileʻunu:
No action was taken in this PU by NRS in the past year. NRS needs to re-visit the site to determine if there are individuals present as it has been many years since the area was monitored. This will require a substantial effort as the area is relatively large and remote. NRS will attempt this in the next year.

Waiʻanae Kai:
No action was taken in this PU by NRS in the past year. NRS will collect cuttings from this PU once seed collections are secured from Keaʻau.

2.1.11 *Flueggea neowawraea*

Requirements for Stability

- 4 Population Units (PU)
- 50 reproducing individuals in each PU (long-lived perennial, dioecious, low to no reproduction, all senescent, major pest problems)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/4	0/4	0/4	0/4	1/4

Taxon Level Discussion

There are four Manage for Stability (MFS) PUs for this taxon because it is known from the Action Areas (AA) of both Mākua Military Reservation (MMR) and Schofield Barracks West Range (SBW). The Kahanahāʻiki to Kapuna MFS PU and portions of the Mākaha MFS PU are within the MMR AA. The Central and East Makaleha and Manuwai MFS PUs are outside of both the MMR and SBW AAs. The known trees are all mature and no live juveniles or seedlings have ever been observed by NRS. This taxon is primarily dioecious and trees are usually alone, far from plants of the opposite sex. Only a few trees have been observed to produce viable seeds. Most trees are found in degraded unprotected habitat with high 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*). Stress from BTB damage may limit or prevent flowering by killing vascular tissue. Due to the overwhelming threat posed by the BTB, stabilizing this taxon will be challenging. Research on controlling the threat from the BTB is underway at outplanting sites (see Chapter 5). Currently, NRS is focusing on collecting cuttings and air layers from all the known trees and securing habitat with fences. Outplanting sites in Kahanahāʻiki Gulch, at Leeward Community College (LCC) (Figure 2.1.11a) and Waimea Audubon Center (WAC) have done well and NRS will continue to establish clones of all known trees in botanical gardens and other *inter situ* sites. Some of the *inter situ* and nursery plants have flowered in the last year and NRS has been able to collect and store pollen, hand-pollinate greenhouse plants with the stored pollen and allowed the plants to cross naturally. Viable seed has been produced from these crosses and are being propagated for planting (Figure 2.1.11b). One of the plants in the greenhouse that has previously only been observed to produce male flowers was observed with an immature fruit in the last year. Unfortunately, the branch had already been bored by BTB and died before the fruit could mature. This confirms observations made by others in the past that a plant in cultivation can produce perfect flowers or both male and female flowers at the same time.

Major Highlights/Issues for Year 3

- Collections have been established and are being held in a living collection at the Pahole Mid Elevation Nursery from 21 of the 36 known trees.
- Cuttings taken from four unrepresented trees in the Pahole Natural Area Reserve have been collected and are being propagated by the State Horticulturist.
- Over the last year, pollen was collected from greenhouse plants. Some pollen was immediately applied to available female flowers. The rest was dried to 20% relative humidity and stored frozen. The frozen pollen was later applied to flowering female plants. Pollen has been held frozen for as long as six months and used to produce viable seed.
- Seed storage data shows that fresh mature seed can be stored dried and frozen for five years with no decrease in viability.
- Ethanol traps have been deployed around outplantings in the Kahanahāʻiki to Kapuna PU in an attempt to trap out the BTB in the immediate area (see Chapter 5 for more information).

Plans for Year 4

- Collect from the 11 unrepresented wild individuals. (LEH-A-1, LEH-A-3, LEH-B-1, LEH-D-1, LEH-E-2, LEH-G-1, LEH-I-1, LKN-C-1, LKN-C-3, MAK-A-2, MIK-A-1)
- Hand-pollinate plants in the greenhouse using fresh and frozen pollen. Crosses will be made to maximize founder pairs and utilize the oldest pollen first.
- Plants produced from seed collected from these greenhouse collections will be grown for planting into both the Mākaha and Kahanahāʻiki to Kapuna PUs in Year 5.
- Monitor the outplantings in Kahanahāʻiki to detect a relationship or correlation between the numbers of BTB found in the traps and BTB damage on the plants
- Continue to investigate the potential for using compounds like Verbenone® as repellents for BTB control around outplantings
- In Kahanahāʻiki Gulch, transplant the remaining juvenile plants from the Pteralyxia site to the new augmentation site in the gulch bottom

Figure 2.1.11a *F. neowawraea* at LCC

Figure 2.1.11b Seedlings from greenhouse plants

Table 2.1.11a Taxon Status Summary

Action Area: In

TaxonName: Flueggea neowawraea **TaxonCode: FluNeo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Kapuna	Manage for stability/	7	0	0	0	72	0	8	59	0	7	72	0	One of the mature trees was mistakenly double counted until this year. Outplantings were supplemented.
Ohikilolo	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change in the last year.
West Makaleha	Genetic Storage	6	0	0	0	0	0	6	0	0	6	0	0	Monitoring showed no change in the last year.
	Total for Taxon:	14	0	0	0	72	0	15	59	0	14	72	0	

Action Area: Out

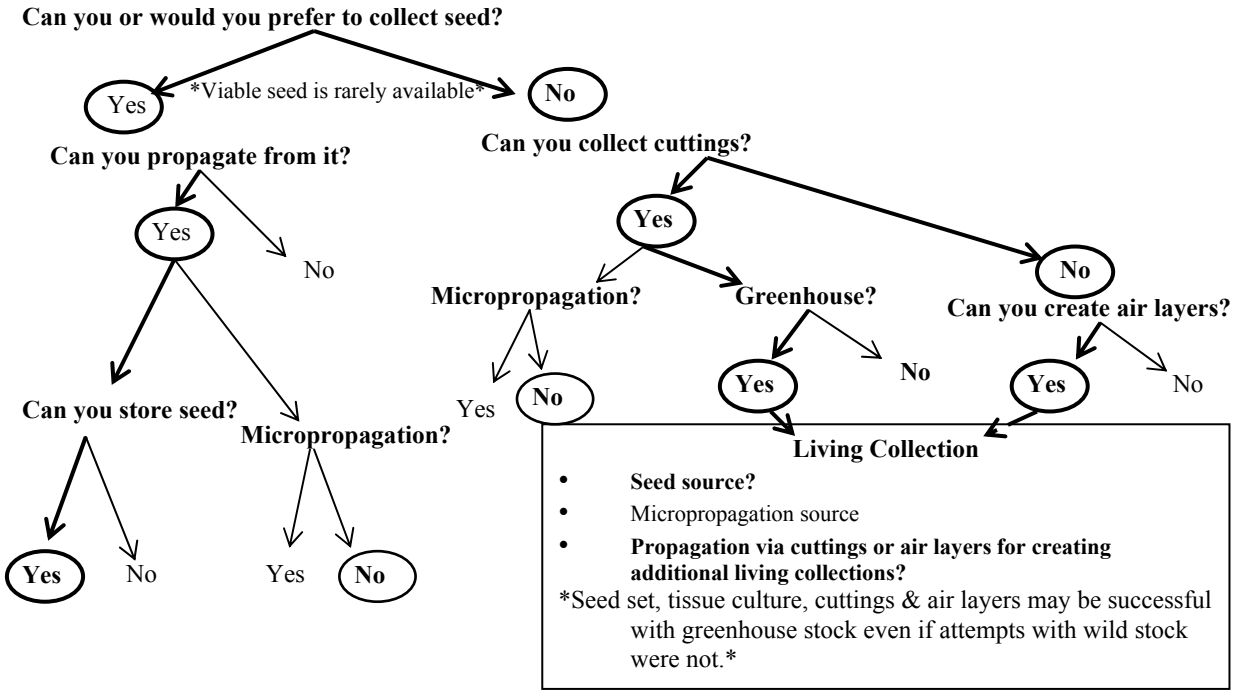
TaxonName: Flueggea neowawraea **TaxonCode: FluNeo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central and East Makaleha	Manage for stability/	5	0	0	0	0	0	6	0	0	5	0	0	One of the known trees was observed to be dead.
Halona	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year.
Kaluaa	No Management	0	0	0	0	0	0	0	0	0	0	0	0	
Kauhiuhi	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change in the last year.
Makaha	Manage for stability/	9	0	0	0	0	0	10	0	0	9	0	0	One mature tree was being double counted last year. Monitoring shows no change.
Manuwai	Manage reintroduction for stability/	0	0	0	0	0	0	0	0	0	0	0	0	Reintroductions will begin once MU fences are complete
Mikilua	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change in the last year.
Mohiakea	No Management	0	0	0	0	0	0	0	0	0	0	0	0	
Mt Kaala NAR	Genetic Storage	3	0	0	0	0	0	4	0	0	3	0	0	One of the known trees was observed to be dead.
Nanakuli, south branch	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year.
Wailanae Kai	No Management	0	0	0	0	0	0	0	0	0	0	0	0	
	Total for Taxon:	22	0	0	0	0	0	25	0	0	22	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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Air layer / Cuttings	Living Collection / Seed	Yes	Yes – living collections

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: NRS continues to collect cutting material and install air layers from wild plants until all individuals are represented in the living collection in the Army Nursery.

Seed Storage: This year, viability assays were conducted on seeds that have been stored for five years. No decline in viability is detected from seeds stored at 20% relative humidity at -18C. Additional seeds for testing may be useful to fine-tune RH protocols and eventually test if -80C better prolongs viability.

Genetic Storage: This year, one additional founder was secured in the living collection via air layering, and cutting collections secured five additional founders. An additional six founders were established in the greenhouse and 11 remain to be collected.

Figure 2.1.11c Fruit of *Flueggea neowawraea* produced from pollinations with stored pollen

Within the last year, greenhouse stock has reached maturity. Plants do not have a set flowering season in the greenhouse, contrary to the typically-observed late fall/early winter flowering season in the field. Plants have been observed to flower in cycles; after they mature, many have been observed to flower approximately once every four to five months. Pollen is collected and stored at 20% relative humidity and -18C until female flowers are available to pollinate. The donor decision is mostly opportunistic, when a female becomes receptive; the choice of donor is prioritized as follows:

1st – donor within the population site
2nd – donor from an old collection (to test storage longevity)
3rd – donor that has yet to be utilized (in storage has yet to produce seed for storage)
4th - donor that is novel for this particular female

There are currently no female-male combinations that NRS will not pursue, as there are only 36 known founders on O'ahu. Also, historically plants were relatively evenly-distributed throughout the Northern Waiʻanae Mountains and long distance pollen and fruit dispersal may have been more likely.

Fruit are collected once the fruit turn a dark purple and the pedicle turns red (Fig.2.1.11c). Empty seeds have been observed, and this may likely be due to low pollen load. Pollen grains are relatively large in comparison to other observed taxa in the MIP/OIP. Also, there is not a lot of pollen produced within each anther. When male flowers are collected, it is optimal to collect an opening flower prior to anther dehiscence. Once anthers dehisce, very little pollen can be collected. These initial crosses were intended to distribute as little pollen as possible to as many flowers as possible in order to estimate a minimum amount required. Since there was not a lot of pollen available, NRS wanted to maximize the amount of seed collected off an individual. It is possible that not enough pollen was placed on each stigma so that all six ovaries could have been fertilized. A minimum pollen load needs to be determined. A standard amount of pollen (slightly higher than the minimum) needs to be applied in order to more accurately track pollen viability through seed set for stored pollen collections. Pollinations will continue to generate seed for storage testing, genetic storage and reintroductions. Pollen is currently being stored or had been stored (and utilized) from eight founders. Pollen stored for six months has been used to produce viable seed. Seed was sown in September 2007 from one cross that utilized pollen that had been stored for one year. Seed has been collected from four founders and have been both propagated and stored. Different combinations of founders have produced seed to test and store (Table 2.1.11b, 2.1.11c.).

Table 2.1.11b Combinations of Founders with Germination Assays

Female	Male	Pollination Type	%Germ	Filled?
LEH-C-0002	x LEH-C-3	Hand	37.50	sink/float
LEH-C-0002	x LEH-C-3	Hand	0.00	float
LEH-C-0002	?	Ambient	100.00	sink/float
LEH-C-0002	x LEH-C-3	Hand	0.00	float
LEH-C-0002	x LEH-C-3	Hand	100.00	sink
LKN-C-0002	x NAN-A-1	Hand	50.00	sink/float
LKN-C-0002	x HAL-B-1	Ambient	54.91	sink/float
LKN-C-0002	x HAL-B-1	Ambient	18.18	sink/float
LKN-C-0002	x HAL-B-1	Ambient	32.35	sink/float
LKN-C-0002	x HAL-B-1	Ambient	100.00	sink/float
MAK-D-0003	x HAL-B-1	Hand	33.33	sink/float
MAK-D-0003	x NAN-A-1	Hand	11.11	sink/float
MMR-A-0001	x HAL-B-1	Ambient	16.67	sink/float
MMR-A-0001	x HAL-B-1	Hand	0.00	sink/float
MMR-A-0001	x MAK-D-1	Ambient	85.71	sink
MMR-A-0001	x MAK-D-1	Ambient	0.00	float

These germination tests were able to establish a quick method to determine seed set. Seeds that float did not germinate and were later opened and found empty. They are not viable. Therefore, only seeds that sink will be germinated and stored. From Table 2.1.11b, is it apparent that sinking seeds are highly viable and have high initial germination. For collections where seeds were not separated by sinker and floaters, “sink/float” appears in ‘Filled?’ Column.

Table 2.1.11c Combinations of Founders with Seeds Stored

Female	Male	Pollination Type	# Seeds Stored
LEH-C-0002	x LEH-C-3	Hand	468
LEH-C-0002	x LEH-C-3	Hand	82
LEH-C-0002	x LEH-C-3	Hand	53
LEH-C-0002	x HAL-B-1	Hand	14
LEH-C-0002	x MAK-D-1	Hand	57
LEH-C-0002	x LEH-C-3	Hand	13
LEH-C-0002	x MAK-D-2	Hand	6
MAK-D-0002	x MAK-D-3	Hand	6
MAK-D-0002	?		8
MMR-A-0001	x MAK-D-1	Ambient	33
MMR-A-0001	x MAK-D-1	Ambient	10
MMR-A-0001	x LEH-A-1	Hand	12

Table 2.1.11d Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Flueggea neowawraea							
Central and East Makaleha	5	0	1	1	0	2	1
Halona	2	0	0	0	0	2	0
Kahanahaiki to Kapuna	7	0	0	1	0	3	0
Kauhiuhi	1	0	0	0	0	1	1
Makaha	9	0	0	1	0	8	1
Mikilua	1	0	0	0	0	0	0
Mt. Kaala NAR	3	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	2	1
				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	21	6

Unique Species Observations

There were no additional observations in the last year. See OANRP 2006 for discussion.

Outplanting Issues

Since there is no natural recruitment in any of the PUs, augmentation will be needed to achieve stability. NRS has begun augmentation in three sites in the Kahanahāʻiki Gulch section of the Kahanahāʻiki to Kapuna PU. Plants grown from seed collected from the West Makaleha PU were planted into the three sites beginning in December 2003. Twenty-six plants were planted at the first site in December 2003 and as of January 2007 only five of these had died. The second augmentation site was established in February 2005 and there are currently 38 juvenile trees there. This site was cleared of canopy weeds and is located in the gulch bottom to maximize water availability. The plants at this second site have grown vigorously and far outperformed plants at the first site. Because most of the plants at the first site had not grown vigorously NRS transplanted seven to a new third site in January 2007. This third site is also in the gulch bottom and is more similar to the second site so NRS expect the transplanted plants to perform well. In addition, 17 plants grown from the same West Makaleha PU were also planted in the third site. The transplanted plants have all survived and will continue to be monitored. In the coming year, NRS will transplant more plants from the first site to the new third site in the gulch bottom. 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 LCC and WAC from plants grown from seed from the West Makaleha PU. These plants have flowered in the last year. Many of the fruit at LCC and at the Pahole Mid Elevation Nursery were taken by birds before they matured.

In the coming year NRS will begin to select and prepare outplanting sites in the Mākaha PU and will work with Natural Area Reserve System staff to develop an outplanting site in the Pahole Natural Area Reserve section of the Kahanahāʻiki to Kapuna PU. Plants grown from greenhouse collections will be ready for outplanting in the winter of 2008-2009.

Research Issues
See Chapter 5.1 for discussion on BTB research.

Surveys
Surveys targeting *F. neowawraea* were conducted in Mākaha in the last year, but no new trees were found. 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. For a full discussion see OANRP 2006.

Population Unit Level Discussion

Table 2.1.11e 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	Partial	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	Partial	Partial	No
Mikilua	Genetic Storage	Yes	No	No
Mt. Kaala NAR	Manage reintroduction for storage	No	No	No
Nanakuli, south branch	Genetic Storage	No	No	No

Manage for Stability PUs

Kahanahāʻiki to Kapuna: This PU has seven *in situ* trees known from Kahanahāʻiki, Pahole and Kapuna Gulches, and three outplanting sites in Kahanahāʻiki Gulch. The three outplantings are discussed in the 'Outplanting Issues' section above. BTB research with these trees is discussed in Chapter 5. The three *in situ* trees in Kahanahāʻiki have had cuttings or air layers established from them and are in a living collection at the Pahole Mid Elevation 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 when it is finished in the coming year. NRS collected cuttings from these four trees with State Horticulturist Doug Okamoto in the last year and material was brought to Lyon Arboretum for propagation. The eight mature trees reported in OANRP 2006 included a tree that was mistakenly counted twice. Data has been revised to show this.

Central and East Makaleha: Two trees are known from Central Makaleha. Cuttings from both trees have been successfully rooted and 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 PU scale fences if necessary. NRS has not monitored these trees in the last year.

In East Makaleha, NRS currently knows of three mature trees. NRS surveyed much of this area in the last year and confirmed a tree that was reported by past surveys to now be dead. One pf the three trees was observed with immature fruit in the last year, but the sex of the other two trees are not yet known. In the coming year, NRS will collect from the three unrepresented trees and will monitor the trees for flowers. Goat control was conducted in this PU, but no other management was conducted for *F. neowawraea* in the last year.

Mākaha: NRS know of nine *F. neowawraea* in Mākaha Valley. This is the largest PU. In the last year, NRS worked with the BWS Watershed Planner to install air layers on the unrepresented trees. Collections have now been secured from eight of the nine trees. In the coming year, NRS will collect from the unrepresented tree. Four of the trees in this PU are within the Mākaha fence that was completed this year and weed control in this area has begun. In the coming year, NRS will select an augmentation site and prepare it for outplanting in the winter of 2008-2009.

Manuwai: The fourth MFS PU will be established in Manuwai using stock grown from seeds produced from greenhouse and *inter situ* sites. Outplanting will begin once the MU fence is complete and reintroduction sites have been developed. There are no live trees known from Manuwai but a few have been reported in the past.

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 collected in December 2001. Plants grown from these collections have been reintroduced and planted, as discussed above in Kahanahāʻiki. This tree may prove to be the most productive wild individual

on O‘ahu and NRS will continue to collect mature fruit. The two trees growing closest to this tree are male. NRS has secured stock from two of the six trees in this PU with cuttings and air layers and will collect from the remaining trees in the coming year. A fence will be built around this PU and weed control and augmentation will begin once this habitat is secured.

‘Ōhikilolo: There is one small fence around the last live tree in this PU. Cuttings have been established from this tree, and are being grown at the Pahole Mid Elevation Nursery. Fruit has also been collected from this tree, however none were viable. NRS has conducted weed control in this area and will continue this in the coming year.

Hālona: NRS worked with the Navy to collect cuttings from the two trees in this PU. Clones from both trees were rooted and are now being grown at the Pahole Mid Elevation Nursery. They will be managed as a living collection and will be cloned. No other management has occurred at this site.

Kauhiuhi: One female tree is known from this site and NRS worked with Navy staff to monitor the site and collect cuttings. The cuttings from this collection have become established and NRS will work to clone them in the coming year.. There is no management at this site. NRS will continue to work with the Navy to monitor this tree.

Mikilua: The single tree at this site is protected by a fence constructed by the Navy in 1998. This tree has been monitored and collected from by NRS in the past but cuttings have not been secured. This tree is in poor condition and NRS will work with the Navy again in the coming year to secure collections.

Mt. Ka‘ala NAR: There are three living trees known in this PU. The trees are in one site that is just outside the Mt. Ka‘ala NAR boundary in the Mokule‘ia Forest Reserve. 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. NRS has collected cuttings from two of the trees and there are now plants from one of them established at the Pahole Mid Elevation Nursery. A single tree at a different site in this PU was observed to be dead in the last year.

Nānākuli: NRS has monitored and collected cuttings from this tree in the past. It is a very healthy tree and cuttings are established at the Pahole Mid Elevation Nursery. No other management has occurred at this site.

2.1.12 Draft Stabilization Plan for *Gouania vitifolia*

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (suspected dioecy)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Expedited Stabilization (ten years)


Figure 2.1.12a *Gouania vitifolia* at Kea‘au: Mature plant at left and flowers at right

Taxon Summary

Gouania vitifolia is a liana in the family Rhamnaceae. The vines have tendrils with which it climbs adjacent vegetation. *G. vitifolia* currently occurs only on Oahu and Hawaii Island but historically was collected on Maui. A photo of *G. vitifolia* is included in Figure 2.1.12a. It has been suggested that this taxon evolved from a separate ancestral colonizer than other Hawaiian *Gouania* species. This taxon has been characterized as being dioecious with a specialized breeding system called andromonoecy (Sakai et al, 1995). In addition, no fruit have been observed during long-term monitoring of the Wai‘anae Kai population. NRS have modified the stabilization goal for this taxon from the standard goal of 25 for long-lived perennials to 50 since this taxon is possibly dioecious. The Implementation Team should discuss this decision.

Table 2.1.12a Taxon Status Summary

Action Area: In

TaxonName: Gouania vitifolia — TaxonCode: GouVit

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Manage for stability	60	0	0	0	0	0	50	0	0	60	0	0	Population estimate reported by PEP
	Total for Taxon:	60	0	0	0	0	0	50	0	0	60	0	0	

Action Area: Out

TaxonName: Gouania vitifolia — TaxonCode: GouVit

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	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	Reintroduction will begin when site is determined
Makaleha or Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0		0	0	0	NRS will revisit historic sites in the next year
Waianae Kai	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	Population estimate reported by PEP
	Total for Taxon:	2	0	0	0	0	0	2	0	0	2	0	0	

Discussion of Management Designation

There are only two extant sites known for *Gouania vitifolia* on Oʻahu at Keaʻau and Waiʻanae Kai. PEP has been monitoring and collecting from both sites. The Keaʻau PU has approximately 50 individuals. In contrast Waiʻanae Kai only has two individuals. Mākaha has been chosen by NRS as a site to manage the Waiʻanae Kai stock because of management challenges in Waiʻanae Kai. The Forest Reserve in this vicinity is in the public hunting area and NRS understands that at the current time there is no support for large scale fencing in the area. The site is close to the trail and therefore prone to vandalism. The habitat in the area is degraded however there are native patches in the vicinity. There is a historic site in Makaleha reported form the early 1800s. NRS will investigate the collections and conduct field surveys to explore management options in Makaleha. NRS will also investigate Manuwai as an additional site that may be appropriate for *G. vitifolia*. Expedited stabilization goals for *G. vitifolia* outlined in the USFWS 2007 Biological Opinion are to have three *in situ* PUs, attain numerical stability at two PUs, and initiate reintroduction at one PUs outside the AA. Weed control, fire management, and monitoring must be ongoing and any cooperative agreements needed to conduct management must be in place.

Threats in the Action Area

At Keaʻau *G. vitifolia* is in the low fire threat area as defined by the Mauka however, plants are surrounded by grass. The area is partially protected from fire by its topographic location on the north facing slope of Keaʻau and its distance from the road. It is more than one km from Farrington Hwy and greater than one and a half kilometers from the road. There are grazed areas to the north at ʻŌhikilolo Ranch. There is also private land between the area and the road that limits private access. The southern ridge of Keaʻau buffers the area to the south. When NRS visited the area with PEP in March 2006 there was no evidence that the area had burned in the past. This is remarkable in this area of the Waiʻanae Mountains. However, it this does not mean that the area might not burn some time in the future. Goats are a threat to this PU, PEP reports that goats are often present. Arthropod and rodent impacts have not been documented. The area is predominantly non-native with invasive species including, *Leucaena leucocephala* and *Panicum maximum* (see Figure 2.1.12c)

Propagation, Seed Storage, and Reintroduction Information

Propagation and Genetic Storage

1) At this time, what is the best preferred propagation technique?	2)At this time, what is the preferred genetic storage technique?	3) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No; but all testing has been initiated	No

Figure 2.1.12b *Gouania vitifolia* at Kea‘au: Mature fruit at left and immature plant at right

Collection/Propagation: Plants are easily propagated from seed or cutting. Some plants in the field are very large and therefore there is adequate vegetative material for obtaining cuttings (Figure 2.12.a). Fruit should be collected after they have dried out and turned a tan color. There are typically three seeds per fruit (Figure 2.1.12b). Techniques to maximize germination time are currently being studied. Initial germination rates are low and slow, but storage tests with higher rates of germination suggest a possible dormancy mechanism for this taxon. Currently, it appears that seeds may have physical dormancy; and the seed coat is impermeable to water and scarification is necessary for germination. Also, seed set is variable, and seeds that float in water have all been observed to be empty.

Seed Storage Research: Forty founders have been collected from Kea‘au through the efforts of PEP. Seeds are being stored for all of them, and the majority of these 40 are also being propagated in Lyon Arboretum’s Micropropagation Laboratory. Storage tests have been established from two separate collections made by the PEP Program; once in 2006 and 2007. One additional storage test has been set up with seed from a cultivated plant in a private collection. Preliminary results indicate higher germination after one year of storage when compared to initial germination. This may be reflective of fine-tuning germination protocols, or this taxon may also be subject to some kind of physiological or morphological dormancy. Preliminary storage protocols will be established in the following year.

Reintroduction. There have been no previous attempts at outplanting this species.

Management Notes

Fire Management :

Kea‘au: NRS has little experience with this PU and has relied on PEP for much of the information presented here. As fire is a threat to the PU, fire management plan need to be developed. Grass cover is prevalent in the PU. Fuels reduction around the PU should be considered, however this would be labor intensive. There is an old road that is used to access the site and this may be improved and perhaps maintained as a fire break. Additional breaks could also be constructed with machinery or hand tools. Finally, grazing occurs on adjacent lands and perhaps NRS could direct grazing in other boundary areas to manage fuels.

Waiʻanae Kai: The Waiʻanae Kai PU is in a more forested location and therefore is much less threatened by fire.
Mākaha: A site needs to be determined for the reintroduction in this PU. A forested site will be chosen that has a low fire threat.
Makaleha: As with Makaha the PU site has not been determined. NRS will consider the threat of fire when determining a site.

Ungulate Management:
Keaʻau: There are currently feral goats in the area. PEP reports that there is consistently goat sign in the vicinity of the plants and browse has been observed. However, goats do not appear to actively target *G. vitifolia* for forage and extensive damage has not been observed. NRS and PEP have only begun to consider options for fencing the area although it does appear to be feasible. In the next year NRS and PEP will develop a plan that can be taken to the state to seek support to construct a fence around the PU.
Waiʻanae Kai: This stock will be managed at Mākaha and ungulate impacts will be addressed at this site. The PU in Waiʻanae Kai is within the Public Hunting Area and close to a trail making a possible fence and perhaps the *G. vitifolia* susceptible to vandalism.
Mākaha: The current proposed site is within a fence and other sites that have been considered will be fenced in the future.
Makaleha: Once a site is determined a plan for fencing will be developed.

Weed control:
Keaʻau: There is currently thick cover of *P. maximum* at the Keaʻau site. This weed cover provides fuel for fire. It also likely interferes with recruitment. Currently there is a single immature *G. vitifolia* known from the area (see Figure 2.1.12b). NRS will begin to develop a weed control strategy for the area that will address both fire concerns as well as trying to improve habitat to encourage on site germination.
Waiʻanae Kai: This stock will be managed at Mākaha and weed impacts will be addressed at this site. The PU in Waiʻanae Kai will be monitored and weed control will be conducted to maintain the site as a Genetic Storage site.
Mākaha: Once a site is determined weed management will begin.
Makaleha: Once a site is determined weed management will begin.

Surveys: The highest priority for survey is in the Makaleha. The proposed Makaleha PU is based on a historical location that needs to be researched at bishop and then surveyed on the ground. The second priority area is Mākaha. In Mākaha an appropriate reintroduction site needs to be identified. The site should either be in the newly completed Subunit I fence or the area that will be enclosed by the Subunit III fence. There is also appropriate habitat in many areas of the Waiʻanae that could be surveyed as resources are available.

Mixing stocks: Keaʻau has a significant number of founders, in contrast Waiʻanae Kai has only two plants. With such low numbers a mixed reintroduction has been suggested. However, the two sites differ in many ways: 1) in elevation (400-800 feet for Keaʻau vs. about 1900 for Waiʻanae Kai); 2) associates (*Diospyros sandwicensis*, *Erythrina sandwichensis*, *L. leucocephala* for Keaʻau vs. *Hibiscus arnottianus*, *Pisonia sandwicensis*, *Aleurites moluccana, Pimenta dioica* for Waiʻanae Kai); 3) forest structure (open at Keaʻau and more forested at Waiʻanae Kai); 4) rainfall amounts

(as predicted by elevation and associates listed above). Because of these differences in sites there many be local adaptations present in the populations that many be disrupted by mixing and result in plants that are not well adapted to either or any site. Therefore, perhaps mixing should be considered with caution. There are a couple of ways NRS would propose to work with this issue. First experimental mixes could be conducted in the greenhouse and the resulting progeny could be evaluated for vigor. The drawback to this is that it will take time to perform these trials. Secondly, NRS could mix in some sites and not others, then evaluate the results and adapt management appropriately. In addition to Mākaha, NRS may be able to reintroduce this stock into small fences planned for Waiʻanae Kai to protect other species.

Prefect or Unisexual flowers: Past monitoring suggests that the Waiʻanae Kai stock may be functionally unisexual (male type) and fruit have never been collected from the plants. In contrast, at Keaʻau , flowers appear to be perfect, although they have not been extensively investigated. NRS will continue to investigate these issues to clarify flower morphology and why Waiʻanae Kai has not produced any fruit. The results of this investigation will be important to determining whether or not to mix Keaʻau and Waiʻanae Kai stock.

Off Island Populations: There are extant populations on the Island of Hawaiʻi. NRS will gather information on these sites. At this time it is unclear if NRS should get involved in management on other islands because of logistical constraints.

Figure 2.1.12c *Gouania vitifolia* habitat at Keaʻau: On the right, *Erythrina sandwicensis* moderate slope habitat. On the left, Mixed invasive gentle slope habitat.

Map removed,
available upon request

Figure 2.1.12d Current distribution of *Gouania vitifolia* in the Wai‘anae Kai Mountains, O‘ahu

Table 2.1.12b Priority Management Actions for *Gouania vitifolia* Army Stabilization PUs

Population Unit	Specific Management Actions	Timeline
Kea‘au	• Work with PEP to survey and monitor PU for additional individuals and potential area to fence. • Develop weed control plan. • Collect propagules for genetic storage.	MIP Year 4
	• Construct MU fence. • Conduct grass control and fuels modification. • Continue collections for genetic storage.	MIP Year 5
Wai‘anae Kai	• Investigate flowers to determine if perfect or unisexual. • Collect propagules for genetic storage. • Consider establishing stock in small fences that will be constructed for *Neraudia angulata.*	MIP Year 4
Mākaha	• Investigate sites for future reintroduction	MIP Year 4
Makaleha or Manuwai	• Investigate historical site and explore sites for possible reintroduction • Examine bishop collections to determine if they are similar to Wai‘anae Kai and Kea‘au	MIP Year 4

2.1.13 *Hedyotis degeneri* var. *degeneri*

Requirements for Stability:

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Threats controlled
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
1/3	3/3	0/3	0/3	0/2

Taxon Level Discussion

Over the past several years, this taxon as a whole has not been given high management priority mainly due to the relatively high numbers of individuals in some of the PUs. However, continued population declines in three out of four PUs merit a greater effort by NRS to stabilize this species. Most of the known plants are found in the least degraded habitat for this species, the Kahanahāiki to Pahole PU. This MFS PU is inside the AA. The two other MFS PUs each contain several small degraded sites, and are outside the AA. Only plants in the Pahole area are protected from ungulates (however pigs are currently in the Pahole fence). None of the other sites are protected by a MU fence and weed control has not begun for most sites. Juvenile and seedling plants have been observed at most sites. Management has focused on seed collections for storage and some ungulate control. Propagation for augmentation of the Central Makaleha and West Branch of East Makaleha PU and the Alaʻiheʻihe, and Manuwai PU will begin once the habitat is secured with MU fences. Over the last year, NRS and NARS staff also controlled goat populations around the PUs in the Mokulēʻia Forest Reserve and Mt. Kaʻala NAR.

Major Highlights/Issues Year 3

- Seed collections for genetic storage and propagation were made from the Central Makaleha and West Branch of East Makaleha.
- Census monitoring of the Manuwai site rediscovered plants thought to be dead last year.
- A large fire in August 2007 burned the lower portions of Manuwai and Alaʻiheʻihe Gulches (see Appendix for fire report).
- A continued decline in the number of plants was observed in Kahanahāiki in the last year.
- The East branch of East Makaleha PU was monitored for the first time since 1999 and no plants were found.
- NRS walked a tentative fence route around the Kahanahāiki Subunit II portion of the Kahanahāiki to Pahole PU.

Plans for Year 4

- NRS will survey for new locations in Central Makaleha Gulch, in the West Branch of East Makaleha area, and in the East branch of East Makaleha Gulch.
- NRS genetic storage collection efforts will continue targeting underrepresented plants from all PUs.
- NRS, DOFAW, and NARS staff will continue hunting in the Mokulēʻia Forest Reserve and Mt. Kaʻala NAR to minimize goat impacts.
- NRS will construct a small subunit fence around the Kahanahāiki site in the next two years. Alternatively, NRS will plan a larger perimeter fence along the last unfenced portion of Mākua Valley pending ungulate movement and density research in Mākua.
- If needed, NRS will weed two meters around each plant upon collection to assist in recruitment and individual plant vigor.

Figure 2.1.13a *Hedyotis degeneri* mature dehisced fruits (top photo) and immature fruits nearing dehiscence (bottom photo)

Table 2.1.13a Taxon Status Summary

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri **TaxonCode: HedDegDeg**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	243	9	8	0	0	0	492	16	16	**243**	**9**	**8**	The numbers reported last year were a mistake. The estimate for this year is the best available, although many more plants are likely in Pahole
	Total for Taxon:	243	9	8	0	0	0	492	16	16	**243**	**9**	**8**	

Action Area: Out

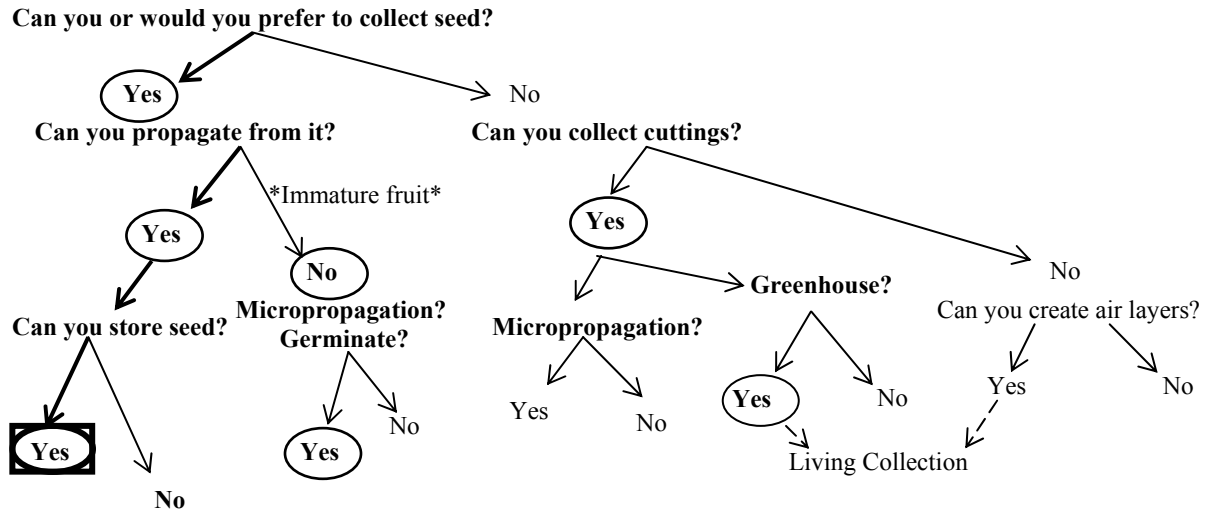
TaxonName: Hedyotis degeneri var. degeneri **TaxonCode: HedDegDeg**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Alaiheihe and Manuwai	Manage for stability	31	6	1	0	0	0	34	0	2	**31**	**6**	**1**	Monitoring in the last year rediscovered plants in part of this PU and another site not monitored since 1999 was found to have no plants
Central Makaleha and West Branch of East Makaleha	Manage for stability	25	10	17	0	0	0	33	3	7	**25**	**10**	**17**	A thorough census discovered less mature but more plants of smaller size classes
East branch of East Makaleha	Genetic Storage	0	0	0	0	0	0	10	0	0	**0**	**0**	**0**	The first monitoring of this site since 1999 found no plants
	Total for Taxon:	56	16	18	0	0	0	77	3	9	**56**	**16**	**18**	

Propagation and Genetic Storage

1) At this time, what is the best preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Has a successful storage method been determined?	Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: refer to OANRP 2006. An additional collection was secured this year to complete all storage testing to determine best RH for storage as well as -80C storage potential.

Genetic Storage: Seeds from three additional founders from Makaleha and 22 founders from Pahole were collected this past year.

Table 2.1.13b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	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	31	6	0	7	0	0	5
Central Makaleha and West Branch of East Makaleha	25	10	16	21	0	0	18
East branch of East Makaleha	0	0	0	0	0	0	0
Kahanahaiki to Pahole	243	9	4	22	0	1	16
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				50	0	1	39

Despite the problem of timing collections for mature, dehiscing fruit, NRS have made good progress at reaching storage goals for some PUs. Collection efforts will need to intensify in the coming year given the lack of a fence around three out of the four PUs and further habitat degradation by pigs in the Ala‘ihe‘ihe and Manuwai PU in particular. Living collections via cuttings may be needed to produce seed for storage in order to avoid losing more unrepresented individuals

Unique Species Observations

There have been no additional observations in the last year.

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. Experimental reintroductions may also be tried in the Kahanahāiki Subunit II fence once constructed. This effort will potentially preserve any local adaptations of this sub-population given its geographic separation from Pahole plants.

Research Issues

A continued decline of this taxon over the last six years is a concern for NRS. Habitat degradation is a likely factor for declines at some of the PUs. More frequent monitoring and detailed observations of microsites would assist NRS staff in documenting habitat changes and other factors contributing to the lack of adequate population replacement. Basic life history information (e.g. lifespan or age at first maturity) of this species is also needed

Surveys

No surveys for new populations were conducted for this species in the last year. Surveys are planned in the coming year.

Taxon Threats
No new threats have been observed to this taxon. Pigs were observed at the Alaʻiheʻihe and Manuwai PU further degrading the area. Fires did burn up to the 1,800 ft. elevation in the Alaʻiheʻihe Gulch in August 2007. While no individuals were directly threatened by fire, large fires irreversibly degrade surrounding habitat and increase the likelihood that future fires will burn even higher in elevation due to the spread of alien grasses. This taxon has been recorded from around 1,800-2,400 ft. in elevation, and known primarily from the windward side of the Waiʻanae Mountains.

Table 2.1.13c 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	No	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: Weeds have not been observed to be a significant threat to the plants in Pahole. Although the Pahole portion is fenced, pigs have been in the fence for a number of months and about a dozen pigs have been removed so far by NRS and NARS staff from this fence unit.

Seed from 22 founders out of over 240 founders were collected from the Pahole portion of this PU in the last year (see also Table 2.1.12b Genetic Storage Summary). In the coming year, NRS will continue collecting for genetic storage. Monitoring efforts will focus on locating younger plants and constructing a better distribution map of the plants in Pahole. The habitat where this taxon lives in the Pahole portion is very intact and more plants are likely to be found.

NRS monitored the Kahanahāiki portion of this PU in June 2007 and found another decline in the numbers of living plants. Although there have been no more than ten plants observed at this site since 2002, this years observation of one mature and one immature plant is the fewest plants ever observed. Although this site is not protected by a fence, ungulates are not thought to have caused this decline as the habitat is still largely intact. NRS will continue to collect for genetic storage and monitor this site closely for further declines. Possible reasons for the decline of this

sub-population include senescence, poor microsites for recruitment, and lack of adequate seed production for recruitment (some flowers of this taxon are only pistillate). Seeds collected from three plants have since died in storage, underscoring the need to maintain living collections to ensure adequate representation before more founders are lost from small sub-populations.

Ungulate control in the area hinges upon NRS decisions to construct the Kahanahāiki Subunit II fence in the next two years or construct a longer fence line along the rim of Mākua Valley. This longer, perimeter fence line would give NRS the opportunity to remove all pigs from Mākua Valley. In the coming year NRS will place GPS collars on pigs caught in Mākua Valley to track their movements hopefully provide better density estimates in order to make a more informed decision on the utility of constructing the last portion of the Mākua Valley rim fence.

Central Makaleha and West Branch of East Makaleha: This PU contains three separate sites. Plants are not protected from ungulates and NRS observed goats in this area again last year. NRS visited two of these sites to collect mature seed for storage and refined old population estimates for these sites in the last year. Fewer mature plants and more immature plants were observed last year than in the previous year (see Table 2.1.13a Taxon Status Summary). The third site was not visited. Seed collections from 21 plants are now storage including ten plants that are now dead (see also Table 2.1.12b Genetic Storage Summary). In the coming year, NRS will collect from the remaining mature plants for genetic storage and work with the DLNR to minimize goat impacts.

Ala‘ihe‘ihe and Manuwai: In the OANRP 2006 report, NRS reported a significant decline in this PU. However, another census of the Manuwai area in the last year rediscovered several plants. A small decline was noted this year, but not as significant as compared to other locations. This site is not protected from ungulates. Goats are known to be in this area, pigs were observed at one site and pig sign was observed throughout the area last year. Competition with weeds may also be a factor in the lack of population growth as *Clidemia hirta* is now a dominant component of the habitat. Seed collection for genetic storage has begun and will continue in the coming year. As mentioned previously, the lower reaches of Manuwai Gulch burned in the August 2007 fire (see Appendix Fire Reports).

There are three sites reported from the Ala‘ihe‘ihe section of this PU. One site that has not been monitored in recent years was searched in the last year and no plants were found. This has significantly reduced the number of known plants from this PU in the last year. NRS will continue to search for new locations in this PU.

Other PUs:

East Branch of East Makaleha: This area was searched last year for the first time since 1999 and no plants were observed. Goats are known to be in this area and a large MU fence is still proposed. NRS will conduct more surveys in this PU in the coming year. If no new plants are found, NRS may reconsider fencing this area for this taxon.

2.1.14 *Hedyotis parvula*

Requirements for Stability:

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/3	2/2 (only 2 *in situ* PUs)	2/2 (only 2 *in situ* PUs)	2/3	0/1

Taxon Level Discussion

There are two MFS PUs with i*n situ* populations and one reintroduction planned for the third MFS PU. The ʻŌhikilolo PU is inside the AA. The Hālona PU and the reintroduction into Makaleha are both outside the AA. The reintroduction planned for the East Makaleha Management Unit fence will begin once construction is complete. Fence completion is tentatively scheduled for early 2009. Plants tend to grow on steep cliffs and feral ungulates are not considered a direct threat at this time. Fire threats have increased over the last several years. Fires in 2005 in Nānākuli and Lualualei came close to the Hālona PU. NRS conducted grass control around the PUs to reduce fire threat in the last year. NRS acquired significant collections of this taxon from the *in situ* populations in the last year and have met the genetic storage goals for this taxon.

Major Highlights/Issues Year 3

- Genetic storage goals have been met for both PUs with *in situ* populations.
- A thorough census of the historic location in East Makaleha found no plants.

Plans for Year 4

- Determine an outplanting location when the proposed East Makaleha fence is complete.
- Expand weed and fuel control at the Hālona PU.
- Focus monitoring on locating and tracking younger plants.
- Determine which stock should be used for the Makaleha outplanting.
- Assist DOFAW and NARS staff with goat control at the Halona and East Makaleha PUs.

Table 2.1.14a Taxon Status Summary

Action Area: In

TaxonName: Hedyotis parvula — TaxonCode: HedPar

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ohikilolo	Manage for stability	120	28	40	0	0	0	120	28	40	**120**	**28**	**40**	Monitoring showed no change
	Total for Taxon:	120	28	40	0	0	0	120	28	40	**120**	**28**	**40**	

Action Area: Out

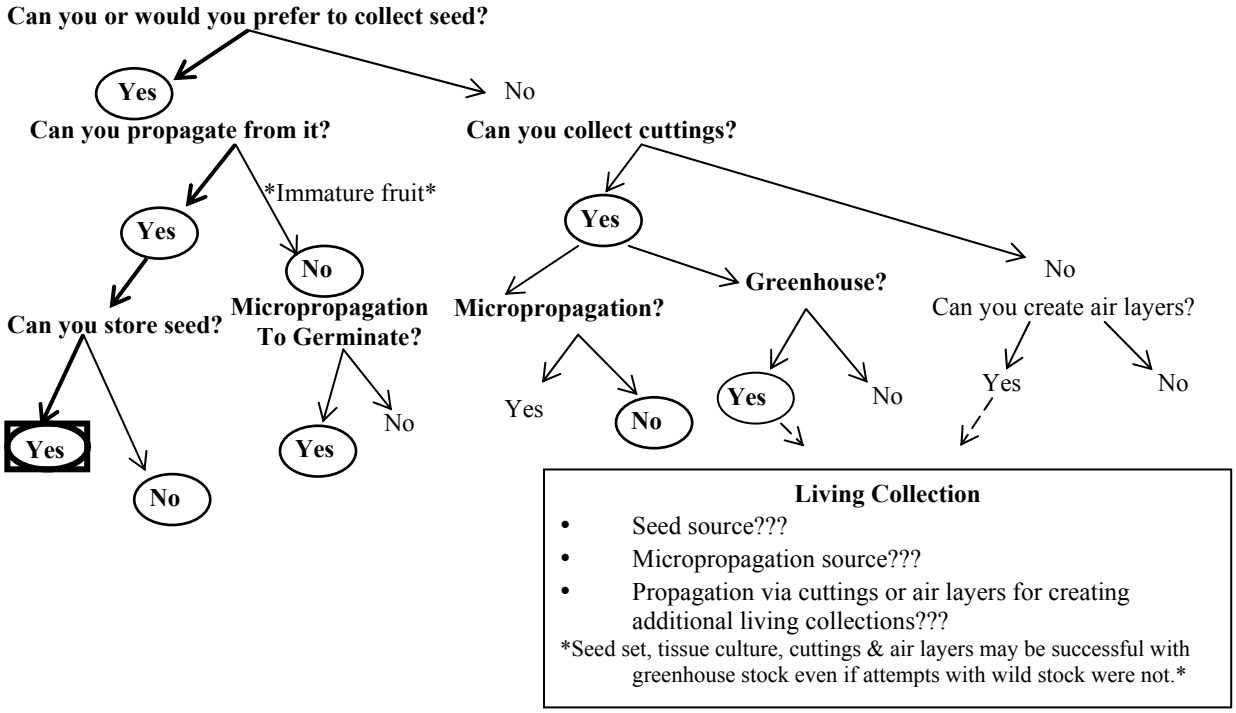
TaxonName: Hedyotis parvula — TaxonCode: HedPar

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Makaleha	Manage reintroduction for storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	A thorough census found no plants
Halona	Manage for stability	97	35	19	0	0	0	87	28	19	**97**	**35**	**19**	A thorough census found more plants in the last year
	Total for Taxon:	97	35	19	0	0	0	87	28	19	**97**	**35**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage: refer to OANRP 2006. NRS was able to make collections for storage testing this year from the Hālona PU.

Genetic Storage: 16 additional founders were collected from the Hālona PU, and 11 from the ʻŌhikilolo PU. Several other plants from the ʻŌhikilolo PU were re-collected to meet storage goals.

Table 2.1.14b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis parvula							
East Makaleha	0	0	0	0	0	0	0
Halona	97	35	0	70	0	2	62
Ohikilolo	120	28	5	108	0	0	102
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				178	0	2	164

Excess seed in storage will be used for propagation of reintroduction stock.

Unique Species Observations
No new observations were made in the last year.

Outplanting Issues
No outplantings of this species have been done although plants of sufficient size for outplanting have been grown at the Army Nursery. Plants grow on very steep cliffs, so outplantings will likely need to take place on rappel. NRS are gaining technical expertise at outplanting on cliffs. For example, *Tetramolopium filiforme* was successfully outplanted on a cliff at Pu‘u Kumakali‘i. NRS will work to determine which stock should be used for outplanting in the coming year. No *Hedyotis degeneri* var. *degneri* are known from the East Makelaha area so possible hybridization with that taxon is not an issue at this time.

Research Issues
There are no research issues for this taxon at this time.

Taxon Threats
Goats can impact this taxon’s cliff habitat. Fortunately, no goat browse has been observed on this taxon. *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 and Hālona PUs. A small herd of goats on State and Navy land in Lualualei threatens the Hālona PU and NRS will work with the landowners in the coming year to plan to eradicate these goats. A large fire, like the Nānākuli fire of 2005, would likely threaten the Hālona PU again. NRS began controlling grass at the Hālona PU in the last year to address the fire threat.

Population Unit Level Discussion

Table 2.1.14c 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 storage	No	No	No
Halona	Manage for stability	Yes	Partial	No

Manage for Stability PUs

‘Ōhikilolo: The ‘Ōhikilolo PU includes three *in situ* sites and has more than the number of mature individuals needed for stability. Goats were removed from ‘Ōhikilolo and pigs do not threaten this PU. NRS monitoring at this PU over a number of years detected significant habitat improvements since goat removals. NRS continues to conduct grass control in the area and more recently began removing non-native trees on the cliff where the population is located. Genetic storage goals were met and exceeded for this PU as over a hundred founders are represented by large collections in the Seed Conservation Lab. Over representation of founders was intentional as excess seeds in storage will be used for propagation purposes. In the coming year, NRS will focus monitoring efforts on locating and tracking the smaller size classes at the two large populations and will search the third and smallest site for any additional plants. NRS will continue to test the seed collections for any decline in viability. Grass control will continue as will removal of alien trees such as *Schinus terebinthifolius* and *Grevillia robusta.*

Hālona: This PU includes two separate sites, one large population at the southern end of Hālona and one smaller population at the northern end of Hālona. Both sites are on State land above Lualualei Naval Magazine. The total population at this PU exceeds stabilization goals. The southern site with more plants will be fully managed with ungulate and weed control; while the northern site will just be monitored and collected from for seed storage. There are no observed ungulate threats directly in this PU. However, NRS will be working with the State and Navy in the coming year to prevent a larger herd from becoming established in the area and moving south to the PU.

The 2005 fire in Nānākuli and Lualualei came close to the southern site. Management of grass at the southern site has begun and NRS will expand this effort in the coming year. NRS will also develop a more comprehensive weed control plan this year as some noteworthy weeds

(*Ageratina riparia, Melinis minutiflora, Sphraeopteris cooperi, Morella faya*) impact the habitat in this PU. Other than landslides, this PU has no other known threats.

Central and East Makaleha: This proposed MU fence is slated for construction in year four of the MIP (2008-2009). State approval for this fence is still pending. In the last year, NRS spent a significant amount of time monitoring the historic site in this PU, and no plants were found. In the coming year, NRS will determine the best outplanting sites in anticipation of the fence completion.

2.1.15 *Hesperomannia arbuscula*

Requirements for Stability:

- 3 Population Units (PUs)
- 75 reproducing individuals in each PU (long-lived perennial but with low seed set, tendency for large declines or fluctuations in population size, and recent severe population declines)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/3	3/3	0/3	3/3	0/3

Taxon-Level Discussion

This year has marked several highlights for *Hesperomannia arbuscula*. With the Army's new Mākua consultation and subsequent change in size and shape of the action area (AA), NRS anticipated that this species would no longer be considered a stabilization species (OANRP 2006). However, in the Mākua 2007 BO the USFWS determined that there would still be a potential fire threat to individuals located in Kapuna gulch of Pahole NAR, although the threat is considered low (USFWS 2007). During the consultation the last remaining individual in the Kapuna gulch population died. The BO however considers data points from the last 20 years. Thus while there are no extant individuals in the AA it is still considered a stabilization species. As mentioned previously (OANRP 2006), NRS worked closely with the Plant Extinction Prevention (PEP) program to ensure that the conservation of this species was continuous and those efforts continued this year. When the BO was finalized the Army Natural Resources and PEP programs determined that NRS would concentrate on the conservation of this species and the PEP would focus on other O‘ahu PEP species.

With the Kapuna PU presumed extirpated with no *ex situ* representation NRS have decided to add Wai‘anae Kai as a Manage for Stability population.

Additionally, this year saw the completion of the Mākaha management unit fence, which means that all three remaining populations of this species are now protected from ungulates (Mākaha, Waiʻanae Kai, and Pālāwai).

This year considerable effort was made to cross pollinate this species both *in* and *ex situ*. Viable seed has been observed in the past, however, with the steep and rapid decline of wild individuals and extremely reduced numbers of flowering individuals within each remaining population there may be only one or two individuals per population that flower each year. Recently, viable seed was collected much less frequently, with no viable seed collected in 2006 and high fruit abortion

observed. Therefore, with the current low numbers of individuals in each population, it appears necessary to cross pollinate these plants by hand.

Major Highlights/Issues Year 3

- This species still within the Mākua AA
- Pollination of wild plants resulted in numerous viable seed
- Mākaha PU is now fenced
- Nineteen propagules in the greenhouse, representing 17 wild individuals and all three of the remaining extant populations
- Wai‘anae Kai PU designated as Manage for Stability
- Kapuna PU presumed extirpated with no *ex situ* representation

Plans for Year 4

- Continue pollination of wild and greenhouse plants
- Continue air layer attempts of greenhouse plants
- Continue surveys for additional populations (SBMR, Wai‘anae Kai, Mākaha, Honouliuli)

Table 2.1.15a Taxon Status Summary

Action Area: In

TaxonName: Hesperomannia arbuscula **TaxonCode: HesArbu**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna	Genetic Storage	0	0	0	0	0	0	1	0	0	**0**	**0**	**0**	This single plant died in the last year
	Total for Taxon:	0	0	0	0	0	0	1	0	0	**0**	**0**	**0**	

Action Area: Out

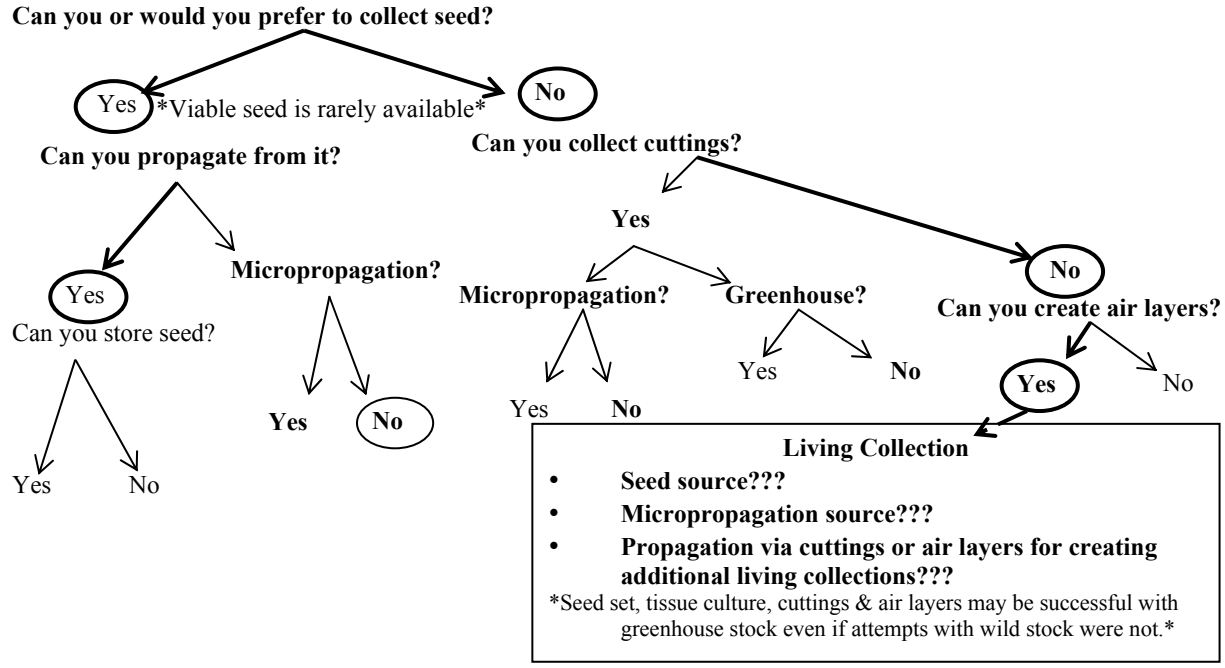
TaxonName: Hesperomannia arbuscula **TaxonCode: HesArbu**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage for stability	4	8	0	0	0	0	5	8	1	**4**	**8**	**0**	One mature plant and one seedling died in the last year
North Palawai	Manage for stability	3	0	0	0	0	0	3	0	1	**3**	**0**	**0**	One seedling died in the last year
Waianae Kai	Manage for stability	2	1	0	0	0	0	2	1	0	**2**	**1**	**0**	No changes in this population since last year
	Total for Taxon:	9	9	0	0	0	0	10	9	2	**9**	**9**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed (if available) & air layers	Living collection	No	Yes; living collection & cross pollination

Prioritizing Genetic Storage & Propagation Techniques



Collection: As mentioned above, there has been a high level of fruit abortion observed in the previous years, and it was proposed that a lack of outcrossing between individuals, due to decreasing number of individuals and potentially the number of receptive flowers at any given time, could be the reason. After observing floral morphology, timing of anther dehiscence and stigma receptivity on greenhouse stock this past February, NRS decided to hand pollinate receptive flowers with pollen from any other available individual (Fig. 2.1.15a). As flowers within a head emerge, anthers dehisce along the elongating style. Two to three days later the stigmas split into two and appear receptive. This is exemplary of a morphology intended to promote outcrossing. Eleven hand pollinations were made as plants were visited 21 times from February through August 2007. NRS and PEP Program staff visited individuals within the Mākaha, Waiʻanae Kai, and Pālāwai PUs for pollen collection, pollinations, and fruit collection (Table 2.1.15b). Pollen was collected for short-term storage for this year's pollinations. Pollen was stored undried at 4C. Pollen age served as an indicator for germination success. Pollen over one month old produced very few achenes that germinated. The last pollen collection was used for long-term viability testing to be used for next year's pollinations. The pollen type in the Asteraceae family is trinucleate, as opposed to binucleate. Trinucleate pollen grains are less likely to withstand desiccation and are typically short-lived (Brewbaker 1967). Pollen may be

difficult to store and proper handling may be important to extend viability throughout the entire flowering season.

Pollinations were documented to record the age of the pollen, pollen source, timing of pollination with respect to stigma receptivity, number of filled achenes within a head, number viable, and seedling mortality. Percent of filled achenes appeared higher when timing was optimal as opposed to pollinations that were conducted as the flower had begun to die. No unfilled achene, whether collected from a hand pollination or ambient pollination, has germinated. Filled achene germination is high and ongoing. Filled seeds will serve as an indicator of embryo presence and unfilled achenes will not be sown.

Figure 2.1.15a *Hesperomannia arbuscula* pollinations
Clockwise from top left: receptive flower; pollinating; tagged immature fruit.

Table 2.1.15b Germination Results from Hand-Pollinations Mar-Jun 2007

Pollination #	Cross (♀ x ♂)	Pollen Age (days)	% Filled	Timing of Pollination	%Germ	# Seedlings
1	PAL-A-2 x MAK-A-16 (GH)	5	0.00%	Optimal	0.00%	0
2	WAI-A-13 x MAK-A-16	28	53.33%	Optimal	75.00%	14
3	WAI-A-13 x PAL-A-2 (or self)	~7	10.34%	Late	100.00%	2
4	WAI-A-13 x MAK-A-16	~90-100	3.03%	?	0.00%	0
5*	PAL-A-2 x WAI-A-13	~30-40	15.38%	Little Late	75.00%	5
6*	PAL-A-2 x WAI-A-13	~30-40	6.12%	Little Late	66.67%	2
7*	PAL-A-2 x MAK-A-16	68	16.33%	Optimal	0.00%	0
8*	PAL-A-2 x PAL-A-9	13	3.77%	Late		0
9	PAL-A-9 x PAL-A-2	13	NA		NA	
10*	PAL-A-9 x PAL-A-2	22	61.67%	Optimal	83.78%	31
11	PAL-A-9 x ?		32.81%	?	100.00%	18
TOTALS	*** assay ongoing**		20.80%		**55.61%**	**72**

Propagation: Filled seeds have a high percent germination and seedlings are easily transferred from germination media to pots of moss/Perlite mix and grown in the controlled-environment chambers. One achene from this year's germination assays produced two separate seedlings (Fig.2.1.15b). Both were slightly smaller than typical seedlings of this taxon, but are thriving. There are currently 72 seedlings growing in the Controlled Environment Chamber (Percival Scientific, Inc.) (Fig.2.1.15.c).

Figure 2.1.15b *Hesperomania arbuscula* twins

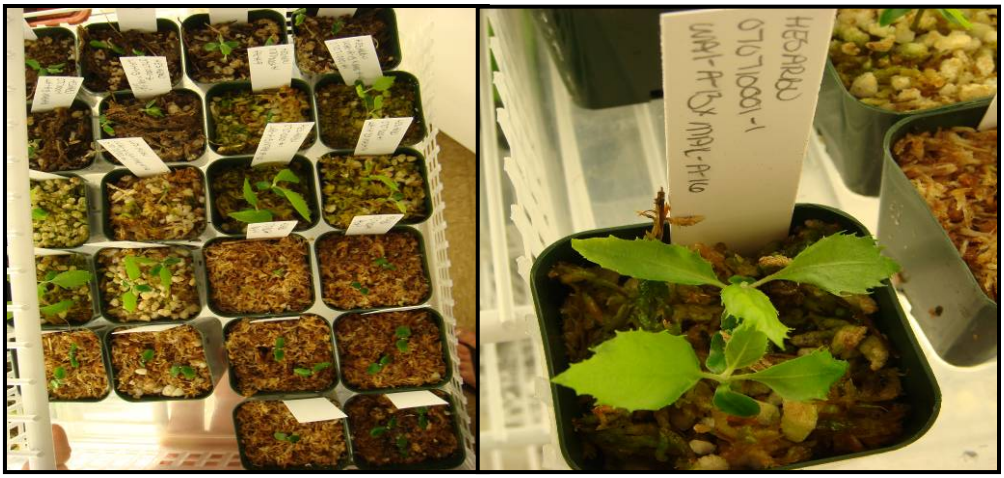


Figure 2.1.15c *Hesperomania arbuscula* seedlings

Seed Storage Research: No seeds are available yet for storage testing.

Genetic Storage: NRS will continue to establish a living collection for genetic storage and hopefully seed and air layer source. This year one air layer was collected off greenhouse stock.

Table 2.1.15c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hesperomannia arbuscula							
Kapuna	0	0	0	0	0	0	0
Makaha	4	8	0	0	0	1	0
North Palawai	3	0	14	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	3	10	4

Unique Species Observations

In previous years NRS reported that flowers of the Waiʻanae Kai population had been picked, presumably by people. This year NRS observed obvious rodent predation on greenhouse and some wild plants. NRS believe some rat predation may be responsible for some flower losses this year and in the past. However, in past years larger woody stems have been cracked when flowers were missing, suggesting that there may have been more than rats targeting the flowers of this species. This year rat traps were placed at the bases of flowering individuals to help protect flowers and developing fruiting heads.

Outplanting Issues

Until NRS are able to propagate a larger number of individuals, no outplanting can be done with this species. When there are sufficient propagules to facilitate an outplanting NRS may choose to do a trial reintroduction at any of the three fenced wild sites or within the Kapuna one-acre fence. The Kapuna 1-acre fence currently contains NARS outplantings of *Cyanea superba* and *Delissea subcordata* and is approximately 500 meters from the wild *H. arbuscula* site within Kapuna gulch. This area appeals to NRS because it could be monitored frequently, watered, and treated for pests more easily than the natural sites. However, the canopy is slightly more open and the understory is more weedy than is found at the remaining natural sites.

Research Issues

As mentioned, this year pollination of wild individuals provided viable seed from Waiʻanae Kai and North Pālāwai PUs. NRS will continue to study the pollination of wild and greenhouse individuals in order to get more viable seed. This species may also benefit from the development of species specific pollen storage protocols as pollen may be the only genetic material we can salvage from some individuals if no viable seed is produced.

It has been suggested that *H. arborescens*, the more common Koʻolau congener, be used as a surrogate for studies and as a base for emergency grafting to save some wild individuals. NRS has grown individuals of this species in the past and will continue to try to establish greenhouse individuals for this purpose.

Surveys
No surveys specific for this taxon in the past year.

Taxon Threats
This species appears to be fragile and trees within fenced areas have died after extensive monitoring and weeding, although, weeds continue to threaten this species in all known PUs. Rat predation of flowering heads and developing fruiting heads is suspected in all PUs. NRS have begun placing rat traps around flowering/fruiting trees during the reproductive season.

Population Unit Level Discussion

Table 2.1.15d Population Unit Threat Control Summary

Action Area: In

TaxonName: Hesperomannia arbuscula

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna	Genetic Storage	No	Yes	No

Action Area: Out

TaxonName: Hesperomannia arbuscula

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage for stability	Yes	No	Partial
North Palawai	Manage for stability	Yes	Partial	Partial
Waianae Kai	Manage for stability	Yes	No	Partial

Manage for Stability PUs

Mākaha: This PU was fenced this year as part of the approximately 100 acre Makaha MU. This is the largest PU with four mature individuals and eight immature individuals. Two individuals flowered this year and cross pollination attempts were made however no mature fruiting heads were collected. The fruiting heads either fell off, did not mature, or disappeared (possibly due to rat predation). Three airlayers were attempted on three individuals in December 2006. Two of the three had good root development and were collected. One of these individuals died in propagation and one remains in the nursery. If this propagule survives it will be the first nursery representative and the only *ex situ* representation of this PU, as all micropropagation representatives from this PU are now gone.

North Pālāwai: Although this PU was fenced in 2003, the number of individuals continued to decline each year. Currently there are two mature individuals within the fence and one mature individual on a steep cliff approximately 20 meters outside the fence. A small immature individual, approximately six inches tall was observed to look water stressed at the end of June 2007. On subsequent visits for pollination/fruit collection NRS monitored and watered this individual. Initial watering and mulching with moss appeared to help, however on following visits the individual looked poor again. NRS discussed rescuing this individual if it looked like it

would not survive in the wild. However, with the rotation of different people visiting the site each week, the decision to remove the plant may have come too late. The plant was taken into propagation several weeks after the initial observation of water stress however, the individual did not survive.

This area contains the most intact habitat for this species with a mostly native canopy and few weeds to control. This PU is also the best represented in *ex situ* propagation; there are nine seedlings from one fruit collection in 2005; five individuals that were rescued seedlings, and two plants represented via collected air layers. The Palikea MU, which is just two major ridges south of Pālāwai and will be fenced in the next year. This MU also contains appropriate intact habitat

NRS have been treating *Ehrharta 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 1 Ecosystem Management for a more detailed discussion.

Wai‘anae Kai: This population continues to have two mature and one immature individuals *in situ*, one wild individual is represented in the nursery and one in the micropropagation lab. The NARS horticulturalist has air layered the nursery individual in an attempt to increase the propagules from this PU, however, this plant is in poor condition and may not survive. NRS assisted the PEP program in the pollination of one individual from this PU this year. This year one of the hand pollinated flowering heads produced 100% viable seeds.

Other PUs

Kapuna: NRS noticed a decline in vigor of this plant in the beginning of 2007 and consulted the NARS Horticulturalist and NARS Specialist as to what actions to take. NRS accompanied the NARS Horticulturalist to administer a liquid fertilizer to the plant. However, the plant died over the following weeks and no material was healthy enough to salvage. This population was never represented *ex situ* as there was only one individual for the last several years and this individual had not flowered for the past four years. NRS will continue to monitor this site periodically for any additional individuals that may come up. This site will be fenced within the proposed Kapuna subunit IV fence and receives weed control.

2.1.16 *Hibiscus brackenridgei* subsp. *mokuleianus*

Requirements for Stability

- 4 Population Units (PU)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Expedited Stabilization (10 yrs)

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/4	3/3 (only 3 *in situ* PUs)	0/3 (only 3 *in situ* PUs)	0/4	1/4

Taxon Level Discussion

Due to the high fire threat posed to *Hibiscus brackenridgei* subsp. *mokuleianus* at MMR, there are four MFS PUs. Three of the four MFS PUs will be established by introducing plants from *in situ* sites to currently unoccupied sites. Two of the four MFS PUs (Mākua and Keaʻau) are within the MMR AA. The Keaʻau population was added as the fourth MFS PU last year and will be established by outplanting stock grown from the Mākua PU once the MU management in that area has begun. The three other MFS PUs were selected to encompass the morphological diversity present in this species and include the Mākua PU on MMR, the Kaimuhole to Palikea Gulch PU on land owned by Dole Foods Co., and the Hāʻili to Kawaiū PU on land owned by the State of Hawaiʻi. Recruitment has been observed in every PU and juvenile plants have been observed surviving into maturity in several PUs.

Most of the *in situ* populations are found scattered across severely degraded habitat and the landowners where the largest PUs are have not yet agreed to *in situ* management such as fencing and outplanting. Because of this, NRS will need to rely on reintroduction of stock into more manageable areas to achieve stability. For the Hāʻili to Kawaiū PU, NRS has begun outplanting at Dillingham Military Reservation (DMR). For managing the Kaimuhole to Palikea Gulch PU, NRS will pursue fencing a site in Kaʻawa Gulch on State land. The Mākua PU will be augmented and the stock will also be used to establish the new Keaʻau PU. Genetic storage collections from all PUs are kept as a living collection of plants at the Army nurseries and in several *inter situ* sites. In addition, collection for seed storage from a reintroduction in the Mākua PU has begun. The threats to this taxon include fire, weeds such as *Panicum maximum* and *Leucaena leucocephala* that both alter habitat and greatly increase fuel loads and ungulates. NRS has worked extensively with weed management and fuels modification in the Mākua PU and is prepared to utilize tools developed there is other PUs.

Expedited Stabilization for this species requires there be four PUs with 50 reproducing individuals in ten years. Three of these PUs must be outside the AA and a reintroduction outside

the AA must be initiated. In addition, weed control and fire management must be ongoing and monitoring plans and cooperative agreements to allow access to all PUs must be in place. The requirements for Expedited Stabilization do not match the management proposed and discussed at the 2006 MIT meeting because only two of the four MFS PUs are outside the AA. This will need to be addressed in the coming year. At this time the landowners where the *in situ* PUs are have not agreed to any management proposed by NRS so it may be difficult to identify another site to conduct management outside of the AA.

The August 2007 Kaukonahua fire burned into the Kaimuhole and Palikea Gulch, Kaumoku nui and Kihakapu PUs. NRS estimate that 97% of the plants known from these three PUs were burned. This is obviously the most significant impact to this species ever witnessed. NRS did their best to support the fire fighting and damage assessment efforts in many ways. These included hiring two helicopters to drop water in known *H. brackenridgei* PUs, providing maps and resource location information to DOFAW and Honolulu Fire Department, communication support and providing resource impact data after aerial and ground surveys of all known rare plant populations. Discussions of impacts to each PU are discussed in the sections below and in the Kaukonahua Fire Report, Appendix II.

Major Highlights/Issues Year 3

- The population estimates for the three PUs affected by the Kaukonahua Fire have been revised to reflect the damage observed during surveys of all the sites after the fire. It is not likely that many of the plants observed to be standing will survive so they have been counted as dead. It is likely that the seeds in or on the ground have survived at these sites and NRS will continue to monitor all locations.
- Although many new seedlings were observed in the Mākua PU, the number of mature plants continues to decline.
- The reintroduction of stock from the Hāʻili to Kawaiū PU was expanded at DMR.
- Expedited Stabilization in ten years

Plans for Year 4

- Augment the Mākua PU with stock grown from cuttings in the winter of 2007-2008
- Pursue an entry permit from Castle and Cooke to monitor sites in the burned PUs for new plants and continue to collect for the living collection
- Continue expansion of the DMR reintroduction of stock from the Hāʻili to Kawaiū PU
- Collect from any new founders at any of the PUs
- Pursue a MU including an exclosure for managing the Kaimuhole and Palikea PU
- Continue expansion of the living collection of the Mākua PU at MMR Range Control
- Scope the Keaʻau MU for suitable planting sites

Table 2.1.16a Taxon Status Summary

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus **TaxonCode: HibBraMok**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Manage reintroduction for storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	Reintroduction will begin once management begins
Makua	Manage for stability	10	4	18	0	0	0	16	4	0	**10**	**4**	**18**	A few more mature plants died and a thorough census found many seedlings at the known site
	Total for Taxon:	10	4	18	0	0	0	16	4	0	**10**	**4**	**18**	

Action Area: Out

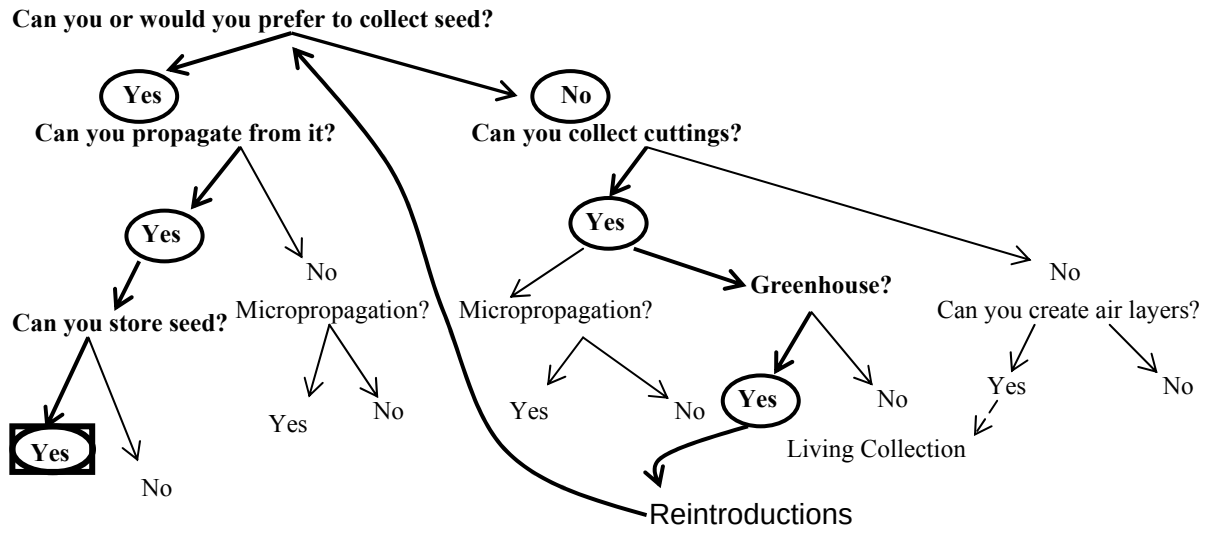
TaxonName: Hibiscus brackenridgei subsp. mokuleianus **TaxonCode: HibBraMok**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haili to Kawaiu	Manage for stability	8	4	9	26	2	0	5	6	0	**34**	**6**	**9**	A thorough census of this PU found more plants at the wild site and more were added to the outplanting
Kaimuhole and Palikea Gulch	Manage for stability	1	8	0	0	0	0	7	230	8	**1**	**8**	**0**	No living plants were found at any known sites, but a new small group of plants was discovered alive
Kaumoku Nui	Genetic Storage	0	0	0	0	0	0	14	0	0	**0**	**0**	**0**	The fire burned all known plants
Kihakapu	Genetic Storage	1	0	0	0	0	0	6	316	57	**1**	**0**	**0**	The fire burned and killed all but one mature plant
	Total for Taxon:	10	12	9	26	2	0	32	552	65	**36**	**14**	**9**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Seed	Yes	Insecticide treatments may help boast viability

Prioritizing Genetic Storage & Propagation Techniques



Collection: Collections made this year from the Mākua Range Control occurred earlier in the year as compared to previous years. Plants were not treated with insecticide, fertilizer, and pruning as they had been the previous year. Collections this year had the highest percentage of viable seed. It is possible that the seed borer might have been at a lower density earlier on in the fruiting season. NRS will not treat plants next year and schedule to collect as early as possible. If seeds are not as viable as this year, then plans for insecticide and fertilizer treatments will be revisited.

Propagation: refer to OANRP 2006

Seed Storage Research: No aging detected after four years of storage.

Genetic Storage: Seeds from ten additional Mākua founders outplanted at Mākua Range Control are now stored in the seed bank.

Table 2.1.16b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hibiscus brackenridgei subsp. mokuleianus							
Haili to Kawaiu	8	4	3	0	0	7	3
Kaimuhole and Palikea Gulch	1	8	0	1	0	11	11
Kaumoku Nui	0	0	7	0	0	0	0
Kihakapu	1	0	0	2	0	10	9
Makua	10	4	15	20	0	17	20
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				23	0	45	43

Unique Species Observations

There is no additional information to report.

Outplanting Issues

There are outplantings planned for all MFS PUs. NRS has planted into *inter situ* sites to hold living collections in accessible areas and plantings have also been done in remote wild sites in order to establish new populations. Both of these types of plantings will be needed to hold and introduce this species into managed areas for stabilization.

Inter situ sites have been used to hold stock from wild sites to provide propagules for production and seed storage. Stock from the Mākua PU is being held at the Ka‘ala Learning Center, Mākua Range Control and Koko Crater Botanical Garden. As discussed in the Genetic Storage section, NRS will continue to balance the Mākua Range Control site to plant clones of those that die and maintain all founders. The other sites will be augmented if stock is available. Stock from the Kaumoku nui PU is being held at Kaiser High School, the NRS baseyard in Wahiawa, Waialua High School and Waimea Audubon Center. These plants were removed from the cattle trails outside of the fence at the *in situ* site in 2002. In the coming year, NRS will consider collecting from the juvenile plants distributed to these sites to increase the number of founders represented in the living collection at the NRS baseyard since PU was burned this year. Stock from the other PUs is being kept as part of the nursery inventory.

Stock from the Mākua PU was planted into remote sites in the Kaluakauila MU in December of 2002. This is the only remote reintroduction location with Mākua stock. NRS first selected a site at the lower end of the MU in good dry forest habitat. This area burned in 2003 and 2006, when all but two of the remaining plants were killed, and the site was abandoned. Previously healthy and robust plants where killed. The plants had been vigorous and flowered even though NRS had not done any management on the site. Since then NRS conducted experimental outplantings in more forested portions of the MU where they are more protected from fire. The fourth MFS

PU in Kea‘au will be established with stock from the *inter situ* collections at Mākua Range Control and NRS will benefit from the lessons learned in these other plantings.

NRS began outplanting at Dillingham Military Reservation in November 2005 in an effort to establish a MFS population with stock from the Hā‘ili to Kaiwaiu PU. Cuttings have been collected as they became available on the wild founders and propagated for planting. There have been 31 juveniles planted at this site and all but three have survived and most have matured this last year. Plantings are being planned for the Kaimuhole to Palikea and Kea‘au PUs and in the next year NRS will begin to explore these areas and determine suitable sites for planting. NRS will continue to monitor past planting efforts to guide these new plantings.

Table 2.1.16c 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	15	9
Kaimuhole and Palikea Gulch	Manage for stability	9	1
Kaumoku Nui	Genetic Storage	7	6
Keaau	Manage reintroduction for storage	0	0
Kihakapu	Genetic Storage	1	0
Makua	Manage for stability	29	22
	Total for Taxon:	**61**	**38**

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

Research Issues
There are no additional research issues to report.

Surveys
There have been no additional surveys in the last year.

Taxon Threats
A previously noted threat was fully realized this year when a fire burned through all of the gulches with *H. brakenridgei* from Schofield to Makaleha. This area has long been noted as having the potential for a large landscape-size fire and NRS will note this in future management strategies for those PUs. There is no change in the general status of threats to the taxa.

Population Unit Level Discussion

Table 2.1.16d 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	No	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	No	Partial	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: This site has been monitored closely since being discovered in November 2000. Initially, not all of the plants that were later found were known. New plants were discovered as management activities increased at the site and NRS became familiar with the distribution. From November 2000 through 2004, it appeared that numbers where steadily rising and that stability may be achieved through germination from the existing seed bank. However, since then the mature plants have been dying and are not being replaced by maturing juvenile plants. The individual counts are down again from last year, however many seedlings were observed this year. In past years NRS decided to not augment this site in order to maximize the diversity of the plants at the site by allowing for recruitment from the wild seed bank. New seedlings in areas not occupied by plants were discovered. The numbers of plants continue to decline and new seedlings are only found under existing plants. NRS will augment this site in the next year with stock grown from cuttings collected from the *inter situ* site. No additional cuttings were collected from additional plants in the *in situ* site this year. The Mākua Range Control *inter situ* collection will continue to be balanced so that there are at least three of each Mākua PU founder represented.

There have been 35 mature and juvenile plants tagged in the Mākua PU since 2001. There are 14 plants alive today and ten are mature. Since tagging started in 2001, 21 plants have died. Of these 21, six died before they were observed as mature and the rest were observed mature at least once before they died. Of the ten mature plants alive today, six were mature when they were discovered. Two were first observed in 2001, six in 2002, one in 2004 and one in 2006. Of the four immature plants alive today, two were first observed in 2002 and one each in 2004 and 2006. The majority of new plants were discovered in 2002 and the number of new mature and immature plants being tagged has declined significantly in the last few years. The 18 seedlings

found in the last year is the largest number of that size class ever observed at this site. They were marked and NRS will continue to monitor and search for these smaller plants to track their survivorship in the coming year. Weed and fuel control by NRS is ongoing and is discussed in the Lower ʻŌhikilolo MU section of Chapter 1.

Table 2.1.16e Mākua PU Population Structure

Monitoring Date	Nov 2000	Mar 2001	Jan 2002	June 2003	March 2004	Aug 2005	July 2006	May 2007
Mature/Juvenile/Seedling	4/2/2	4/2/3	8/5/2	13/6/2	18/8/11	18/8/11	16/4/0	9/5/18

Hāʻili to Kawaiū: There are two *in situ* sites and one outplanting site in this PU and NRS has monitored all three of these sites in the last year. The two *in situ* sites will be used as propagule sources for the DMR outplanting where all the threats will be managed. Both *in situ* sites are not protected from ungulates and are dominated by *Panicum maximum* and *Leucaena leucocephala*. A few more immature plants had matured and nine seedlings were observed during monitoring at one of the *in situ* sites in January 2007. Cuttings were taken from two new founders and will be added to the DMR outplanting. The previous monitoring of this site was conducted in June 2006 when many plants have no leaves and the seedlings may have been there but were missed. Seedlings were also observed at this site in May 2005. The other *in situ* site was also monitored in January 2007 and one of the plants that was immature last year had matured. There are five founders known at this site and all have been collected from. Plants grown from these five founders are represented at the DMR outplanting. NRS will continue to collect from any new founders as they become available. Monitoring will focus on locating and tracking smaller plants.

The DMR outplanting was established in November 2005 with 21 plants and supplemented with an additional ten plants in December 2006. The site was last monitored in July 2007 and three plants had died. Most of the remaining plants were healthy and are growing well at the site. NRS will continue to supplement this site with stock from both *in situ* sites in the next year.

Kaimuhole and Palikea Gulch: This PU contains many sites in two gulches and was burned in the August 2007 Kaukonahua fire. Most of the *H. brakenridgei* in this PU were killed in the fire, but a few plants did survive. For a complete discussion of the fire see the Kaukonahua Fire Report attached as Appendix II. NRS has kept a small living collection of plants grown from cuttings taken from 11 founders from this PU. In OANRP 2006 and at the 2006 MIT meeting, NRS discussed how the landowner, Castle and Cooke had not agreed to any of the management proposed by NRS for the *in situ* sites. While a Management Unit around the *in situ* sites would be preferred, because it was not approved, NRS proposed establishing a MU to manage outplanted stock from this PU in the Mokuleia Forest Reserve in Kaʻawa Gulch. At the 2006 MIT meeting both Kaʻawa and another site in lower Manuwai Gulch also in the Mokuleia Forest Reserve were discussed. The Kaukonahua fire burned into both of these proposed areas and NRS has not visited them since the fire. In the coming year, NRS will survey both Kaʻawa and Manuwai Gulch and develop proposals and plans for managing the outplanted stock. A large fence unit and fuel and weed control projects would have to be in place at either site before stock could be outplanted. Until then, NRS will continue to monitor the *in situ* sites in this PU, collect from any new founders remaining in any of the partially burned sites and maintain the living collection.

Kea‘au: In OANRP 2006 and at the MIT meeting, NRS identified Kea‘au as the fourth MFS PU. There are no *in situ* plants known from this site and the PU will be established by outplanting stock grown from the Mākua PU. Kea‘au is inside the MMR AA and would require a large fence and fuel and weed control before outplanting could begin. Until then, NRS will continue to maintain the living collection of the Mākua stock to be used as the source for this PU. In the coming year, NRS will pursue permission from the landowner and visit the area to develop management proposals.

Other PUs

Kaumoku Nui: This PU is on Castle and Cooke land and was burned in the Kaukonahua fire. When it was monitored in July 2007, eight large mature plants were observed. Many of the plants had mature fruit and no additional threats were observed. A fence was built in this area many years ago, but the only live plants occurred on and above the cliff above and outside the fence. Cattle can walk all around this area but had not been in the area lately and the grass was especially thick. In July 2007, at least three trunks of old dead *H. brakenridgei* trees were observed amongst the living plants. These were some of the older mature plants that were alive as part of the 14 plants observed in 2006. Unfortunately, the Kaukonahua fire burned through this site and all the plants observed in July 2007 were killed. NRS has collected from many founders in this site and will work in the coming year to ensure that none are lost in cultivation. The site will be monitored for any new plants and collections from new founders will be made as they become available. This PU is to be managed for Genetic Storage, and no other *in situ* management is proposed.

Kihakapu: This PU is on Castle and Cooke land and was burned in the Kaukonahua fire. This PU contains ten sites in both Kihakapu and Puulu Gulch. All ten sites in the two gulches were burned but one site in Kihakapu Gulch was not completely burned and one live and two partially alive plants were observed. NRS has kept a living collection of plants grown from cuttings taken from ten founders from this PU. In the coming year, NRS will continue to monitor these sites for new plants and collect from any plants remaining in any of the partially burned sites. This PU is to be managed for Genetic Storage, and no other *in situ* management is proposed.

2.1.17 *Melanthera tenuifolia*

Requirements for Stability

- 3 Population Units (PUs)
- 50 genetically unique individuals in each PU (short-lived perennial with tendency to reproduce vegetatively)*
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
3/3	3/3	0/3	2/3	N/A

Taxon Level Discussion

The three largest populations in the best habitat are designated as Managed for Stability (MFS). 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 ʻŌhikilolo and Mt. Kaʻala NAR PUs and in August 2007 NRS completed a fence in Mākaha that protects a portion of the PU from ungulates. The population estimates for this taxon are being revised and are not yet reliable in determining trends. 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. A challenge in working with this species is that many populations require rappelling to access thus making it difficult to get frequent and accurate monitoring data and collections. NRS has also struggled to collect viable seed from populations for storage and propagation trials. An additional challenge is with monitoring this species. It grows in large sprawling patches with long runners that root when in contact with the ground. Vegetative reproduction is likely an important component of regeneration; however NRS also see seedlings in the field. Estimating the numbers of individuals in these large sprawling patches is difficult. Fortunately, this taxon occurs in many locations and large populations have remained robust over time.

Major Highlights/Issues Year 3

- Completed the fence in Mākaha effectively protecting a portion of the Kamaileʻunu and Waiʻanae Kai PU.
- Isolated potential dormancy-breaking mechanism in seeds

Plans for Year 4

- NRS will investigate need to revisit PUs in high fire threat areas to collect additional material for living collections.

- NRS will continue studies to investigate dormancy-breaking mechanisms in order to determine the storage potential of seeds for genetic storage goals

Figure 2.1.17a Flowering *Melanthera tenuifolia*

Table 2.1.17a Taxon Status Summary

Action Area: In

TaxonName: Melanthera tenuifolia **TaxonCode: MelTen**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	54	23	4	0	0	0	54	23	4	**54**	**23**	**4**	No monitoring in the last year
Kaluakauila	Genetic Storage	64	20	40	0	0	0	64	20	40	**64**	**20**	**40**	No monitoring in the last year
Keawaula	Genetic Storage	45	15	0	0	0	0	45	15	0	**45**	**15**	**0**	NRS did post fire moniotoring and found no change in stautus
Ohikilolo	Manage for stability	1242	1	0	0	0	0	1242	1	0	**1242**	**1**	**0**	No monitoring in the last year
	Total for Taxon:	1405	59	44	0	0	0	1405	59	44	**1405**	**59**	**44**	

Action Area: Out

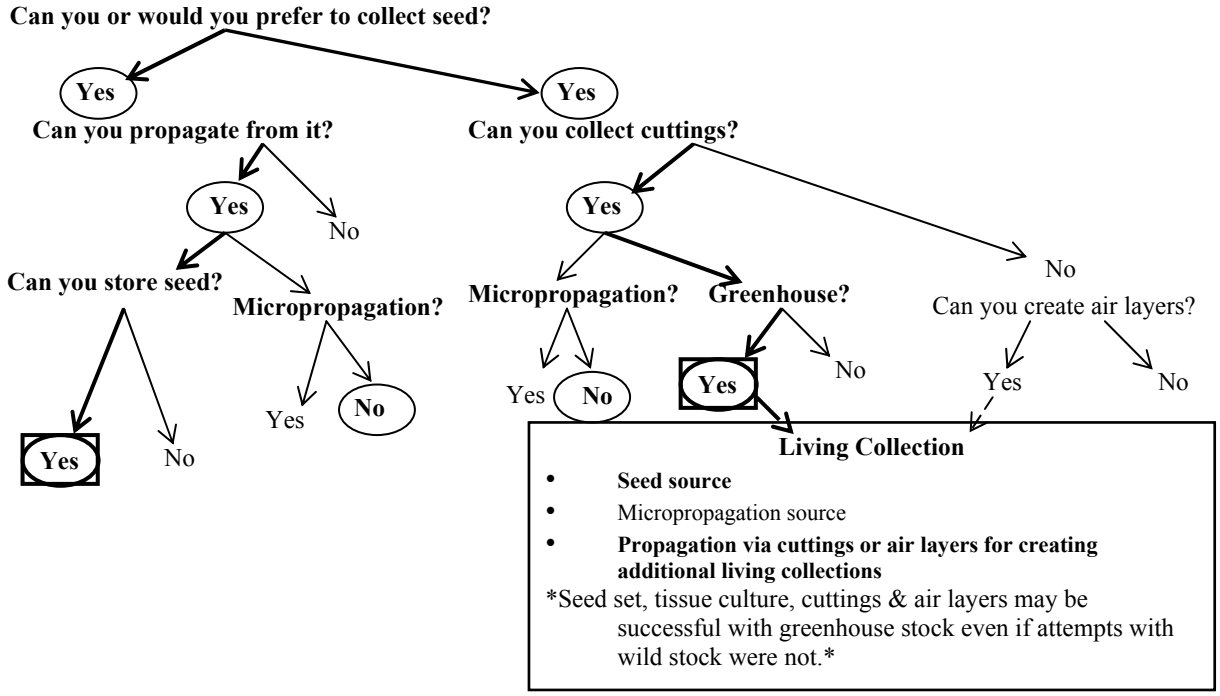
TaxonName: Melanthera tenuifolia **TaxonCode: MelTen**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu and Waianae Kai	Manage for stability	881	269	297	0	0	0	880	269	297	**881**	**269**	**297**	Changes caused by small fluctuations in portions of the PU
Mt. Kaala NAR	Manage for stability	300	0	0	0	0	0	300	0	0	**300**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	1181	269	297	0	0	0	1180	269	297	**1181**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection & Seed	Yes	Yes, living collections

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OARNP 2006

Propagation: refer to OARNP 2006.

Seed Storage: Germination and storage studies are ongoing. Seeds appear to have some type of physiological or morphophysiological dormancy. Seeds may take years to overcome dormancy when stored at conditions used to maximize longevity (cold and dry). Temperature is critical for overcoming dormancy. Freshly-collected seeds sown at average temperatures for their natural environment and then moved to low temperatures after six months germinate more than seeds exposed to any other treatment. These other treatments include low temperature exposure followed by average temperature exposure, high temperature exposure followed by average, and continual exposure to low, average, and high temperatures (Fig. 2.17.b). For every temperature regime, seeds were exposed to an average daily temperature in light and an average nightly temperature in dark. The length of light was determined based on the average natural sunrise and sunset times for each month of the experiment.

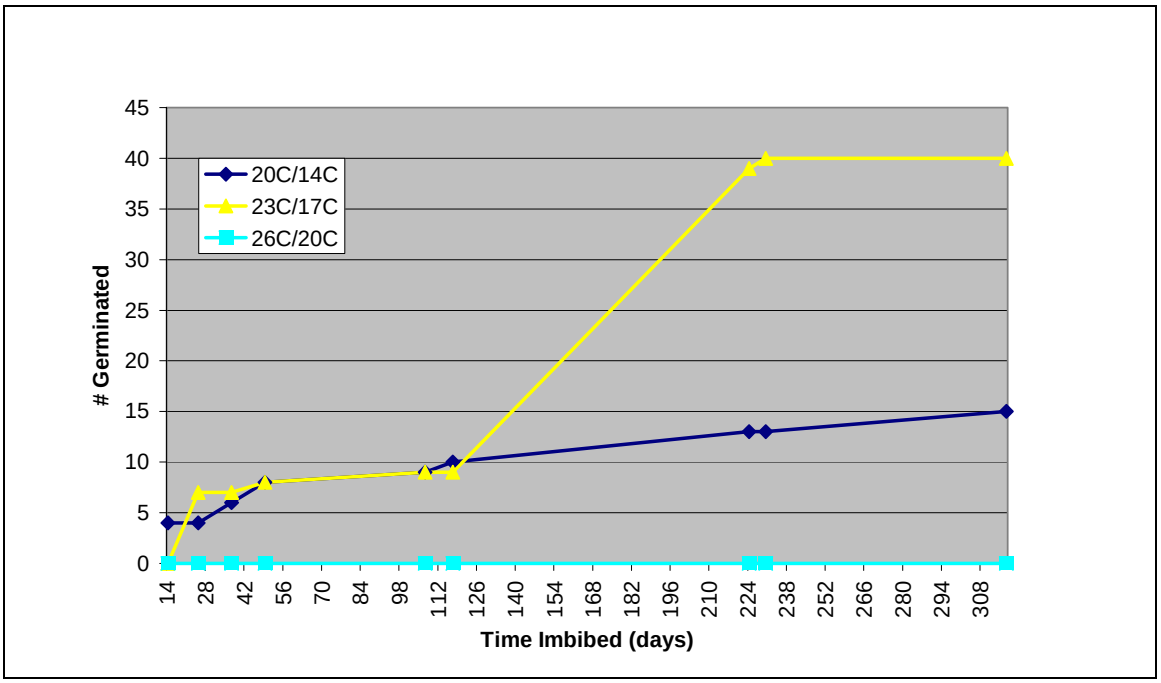


Figure 2.1.17b Germination at various temperature cycles of fresh seed of *Melanthera tenuifolia*

Seeds that have been stored for five years have also been tested this year. For both of the stored collections, fresh germination was low (5% and 12%). After five years, seeds had an average germination of 37.3%. For the one collection, seeds were stored dry at both 24C and -18C. Seeds stored at 24C germinated more than seed stored at -18C (χ^2 = 10.702, P-Value = 0.001). This supports the dormancy hypotheses, as seeds that are aging faster (by remaining at 24C) would be more likely to have come out of dormancy earlier than seeds stored at -18C (Fig. 2.1.17c).

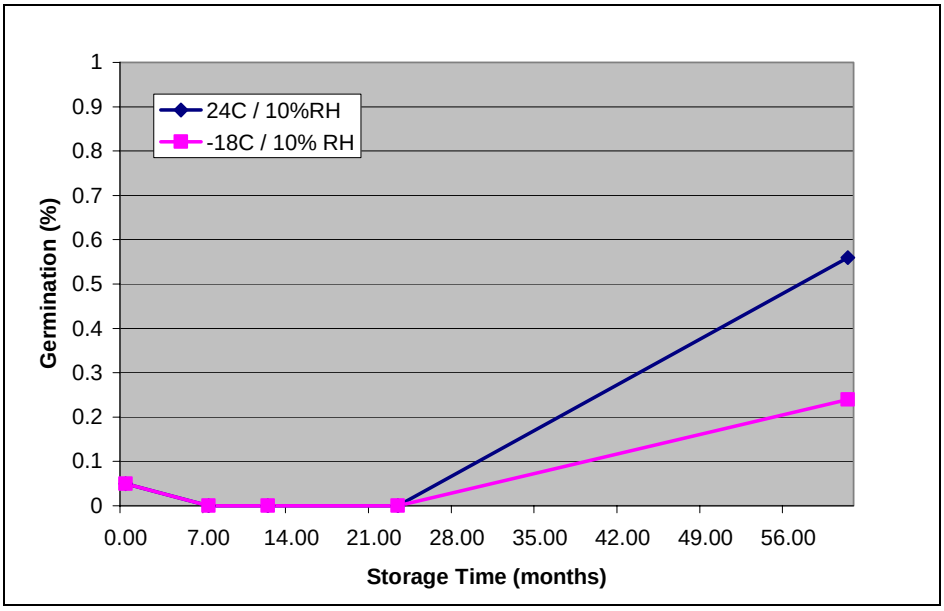


Figure 2.1.17c Percent germination over time stored in *Melanthera tenuifolia*

Genetic Storage: Preliminary results from ongoing germination and storage trials suggest that seeds of this taxon have good storage potential. If this holds true, seed collections from clonal stock in the Army Nursery will be made to meet genetic storage goals. Plants from the most fire-threatened PUs will be collected from first, and plants will be isolated and allowed to self or cross with stock in their PU.

In the next year NRS will revisit high fire threat PUs (Kahanahāiki, Kaluakauila and ʻŌhikilolo Makai portion of the ʻŌhikilolo PU) to collect more cutting for living collections as presently there is not adequate stock from these PUs. NRS will work to secure 35 individuals with two representatives from each plant in living collection.

Table 2.1.17b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Melanthera tenuifolia							
Kahanahaiki	54	23	4	11	0	35	10
Kaluakauila	64	20	0	8	0	10	2
Kamaileunu and Waianae Kai	881	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	18	14
				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	63	26

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

NRS plan to work with a graduate student at the University of Hawaii to continue seed propagation studies designed to determine the best germination method. Once established, the storage potential can be tested.

Taxon Threats

Other than fire, no additional threats have been noted in the last year.

Population Unit Level Discussion

Table 2.1.17c 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	Partial	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

‘Ōhikilolo: NRS do not monitor the majority of this PU regularly because of its size and the need for rappelling to access populations. NRS monitor sites within the PU when monitoring more critically endangered sites of other taxa (*H. parvula*, *S. mariversa* and *V. chamissoniana*). If NRS saw new threats or unexpected declines in these sites then larger monitoring efforts would be initiated. NRS will strive to monitor a sample of sites within the PU every 3-5 years. Although most plants occur along tall cliff faces in the middle of ‘Ōhikilolo Ridge, the ‘Ōhikilolo 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 creating an *ex situ* living collection. In the next year, NRS will revisit the site for monitoring and collect cuttings as needed to establish new founders.

Kamaile‘unu and Wai‘anae Kai: One population site with about 63 individuals was protected from ungulates this year with the completion of fencing in August 2007. In addition, the construction of fencing around a *S. mariversa* in the Pu’u Kawiwi vicinity also protected additional individuals.

Mt. Ka‘ala NAR: The Kaukonahua fire of August 2007 burned extensive areas below this population (Appendix II). This event may have driven ungulates into this PU. NRS will monitor the area in the next year and respond if ungulate control is necessary.

Other PUs

Kahanahāiki: There have been no additional actions in the last year. NRS will visit this PU in the next year monitor and collect to add founders to the living collection.

Kaluakauila: There have been no additional actions in the last year. NRS will visit this PU in the next year monitor and collect to add founders to the living collection.

Keawa‘ula: NRS monitored this PU in September 2004 and estimated that there were more than 45 mature plants. This PU was burned in the July 2006 Keawa‘ula fire (OANRP 2006). In the coming year, NRS will monitor this PU and collect for genetic storage as it is at perhaps the highest risk of extirpation due to fire as compared to other PUs. This PU is now in the AA as it has been redefined due to a re-evaluation of the fuels and fire risk.

2.1.18 *Neraudia angulata*

Requirements for Stability

- 4 Population Units (PUs)
- 100 reproducing individuals in each Manage for Stability PU (short-lived perennial, mostly dioecious, prone to large declines or fluctuations in population size)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Expedited Stabilization (10 years)

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/4	2/4	0/4	2/4	2/3

Taxon Level Discussion

There are four PUs designated 'MFS' 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. 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 the Wai'anae and the Mākua PUs have a relatively large total number of plants (see table below), but also contain many small sites that require genetic storage. Collections have focused on establishing cuttings from the smallest PUs for living collections in the nursery. In the last year, NRS continued collecting from the Kapuna, Wai'anae Kai Mauka, and Mākaha PUs. These collections will produce seed stock for genetic storage as well as storage research. *Neraudia* has been outplanted with initial high survivorship at two sites (Mākua and Kaluakauila) and natural recruitment from reintroductions occurred at Mākua in two instances. Ungulate and weed control is ongoing at some sites. Fire remains a significant threat for both large and small PUs.

This species is slated for Expedited Stabilization (see the Executive Summary for more details. The expedited stabilization goals for *Neraudia* are:

- Manage 4 *in situ* PUs.
- Attain numerical stability at 3 PUs outside the Action Area.
- Initiate reintroduction in one PU outside of the Action Area.

- Fence construction at the Wai‘anae Kai and Manuwai PUs.
- Weed control, additional fire management, and plant monitoring must be ongoing.
- Any cooperative agreements needed to conduct management must be completed.

Major Highlights/Issues Year 3

- Another F_1 mature plant was observed at one augmentation site in the Mākua PU.
- Collections have been established (but not completed) from all PUs in the last year for a living collection in the greenhouse.
- The sole Punapōhaku plant thought to be functionally male produced fruit this past year (hence the plant is polygamodioecious).
- A new reintroduction site at the Lower Kaluakauila patch was established using Manuwai stock.
- One additional wild plant was found at a new location in the Mākaha PU (Kamaili Gulch).
- Seed was produced and germinated from crosses using pollen stored for one year.
- Manuwai Gulch burned in the August 2007 Kaukonohua fire.

Plans for Year 4

- Continue collecting from wild populations in order to meet expedited stabilization goals.
- Continue monitoring wild and outplanted plants to guide reintroduction plans and gather further information about life histories, reproductive strategies, and habitat requirements.
- Continue to supplement the Kaluakauila PU with var. *dentata* stock from Punapōhaku Manuwai, and Kapuna PUs at two separate sites.
- Continue to augment the Mākua PU with stock established from cuttings to help meet stabilization goals.
- Pursue the ungulate control plans proposed to the State for the Wai‘anae Kai Mauka PU.
- Continue pursuing discussions with the State for fencing at the Manuwai MFS PU in order to manage a reintroduction for stability site in Manuwai or decide on another MFS PU elsewhere.
- Re-start fire pre-suppression work at Kaluakauila.

Table 2.1.18a Taxon Status Summary

Action Area: In

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	Monitoring showed no change in the last year.
Makua	Manage for stability	33	5	6	4	0	0	44	6	0	**37**	**5**	**6**	Monitoring showed seedlings replacing dead mature plants.
Punapohaku	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	Monitoring showed no change in the last year.
	Total for Taxon:	36	5	6	4	0	0	47	6	0	**40**	**5**	**6**	

Action Area: Out

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Genetic Storage	30	4	0	0	0	0	30	4	0	**30**	**4**	**0**	No monitoring in the last year (last obs. 2005).
Leeward Puu Kaua	Genetic Storage	9	0	0	0	0	0	4	0	0	**9**	**0**	**0**	No monitoring in the last year (last obs. 2005).
Makaha	Genetic Storage	10	0	0	0	0	0	16	1	0	**10**	**0**	**0**	3 new plants found, 9 matures died, population declined somewhat from 2005, and significantly declined since 1999 when 80 plants observed with numerous seedlings.
Manuwai	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	Monitoring did not detect any new plants.
Waianae Kai Makai	Genetic Storage	46	35	25	0	0	0	46	35	25	**46**	**35**	**25**	Possible decline in matures, non-thorough bino monitoring detected less plants this year.
Waianae Kai Mauka	Manage for stability	57	29	54	0	0	0	57	28	54	**57**	**29**	**54**	Possible decline in matures, more thorough census needed to detect all individuals.
	Total for Taxon:	152	68	79	0	0	0	153	68	79	**152**	**68**	**79**	

Table 2.1.18a Taxon Status Summary

Action Area: Reintro

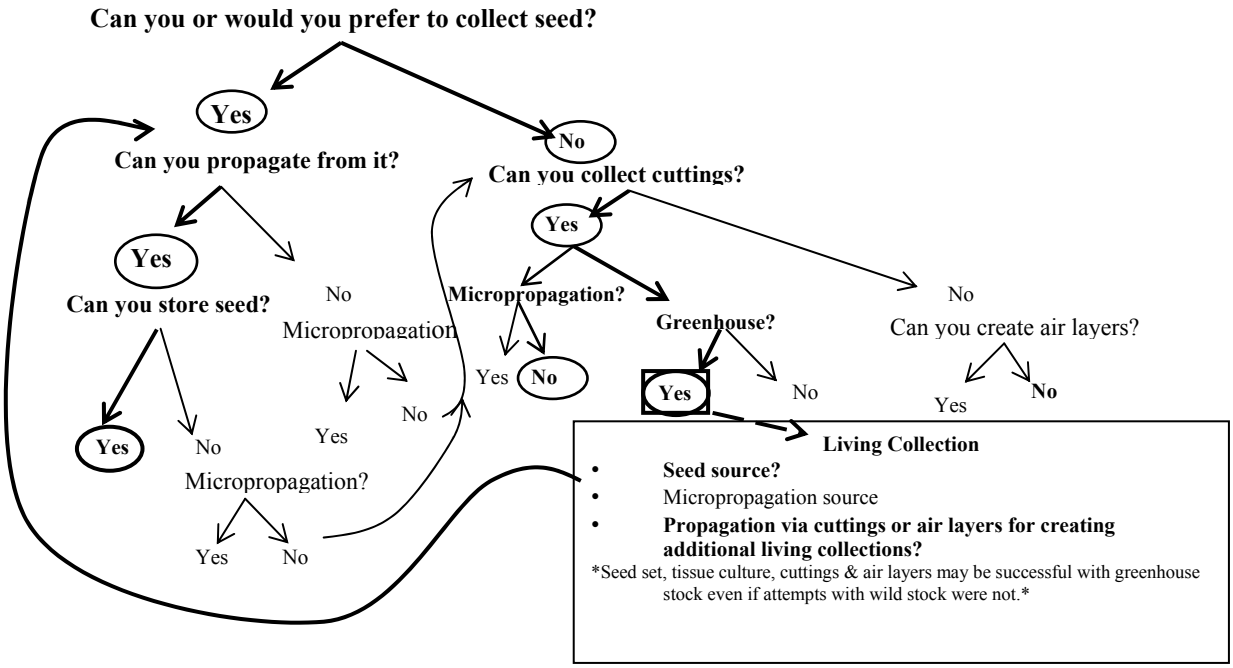
TaxonName: Neraudia angulata TaxonCode: NerAng

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluakauila	Manage reintroduction for stability	0	0	0	44	9	0	27	0	0	**44**	**9**	**0**	Additional plants were reintroduced into the Upper fence and new population reintroduced into Lower Fence.
	Total for Taxon:	0	0	0	44	9	0	27	0	0	**44**	**9**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collections & Seed	Yes	Yes, living collections, possibly including cross pollinations

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006.

Propagation: refer to OANRP 2006.

Seed Storage Research: Recent storage tests support the hypothesis that seeds of this taxon possess a significant physiological or morphophysiological dormancy. Results from viability tests after two years of dry storage at 24C, 4C, and -18C show that seeds have the highest germination at the highest temperature (24C), and the lowest germination at the coldest temperature, -18C. This trend is typically displayed in dormant seeds, as seeds at higher temperature will age faster and come out of dormancy before seeds aging slower at lower temperatures. Future viability tests need to show a slow reversal of this phenomenon to support this hypothesis, where seeds stored at higher temperatures will slowly begin to die and decrease in germination.

Genetic Storage: Based on the above results, NRS will continue to use seed storage as a genetic storage option in addition to living collections. An additional founder was collected from the Kapuna PU and has been established in the living collection in the greenhouse. Stored and fresh pollen from the Punapōhaku male will be used to pollinate this stock to secure seeds in storage as

has already been done for the stock of the other Kapuna female. NRS has continued viability testing of stored pollen this year by hand pollinating Kapuna stock with Punapōhaku pollen that had been stored dry at -18C for one year. Seed set was not high but seeds were produced and are currently being propagated (seeds take at least six months to germinate). The seed that developed last year from Kapuna flowers pollinated by fresh using fresh Punapōhaku pollen has germinated and the plants are growing in the greenhouse. Leaves are dentate (see Figure.2.1.18a). Plants in Kapuna and Punapōhaku remain the only known var. *dentata* individuals.

Left: leaf dentation. Right: Progeny compared to Manuwai stock.
Figure 2.1.18a Progeny of Kapuna x Punapōhaku (Manuwai stock is var. *anulata*)

Table 2.1.18b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Neraudia angulata							
Halona	30	4	0	0	0	12	6
Kapuna	2	0	0	1	0	2	1
Leeward Puu Kaua	9	0	0	0	0	1	0
Makaha	10	0	7	2	0	6	1
Makua	33	5	50	0	0	27	2
Manuwai	0	0	4	0	0	2	1
Punapohaku	1	0	0	0	0	1	0
Waianae Kai Makai	46	35	0	0	0	0	0
Waianae Kai Mauka	57	29	1	0	0	4	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	0	55	14

Unique Species Observations
Based on observations in the field and in the nursery over the past several years, individuals of this species asynchronously produce either male or female flowers throughout their lifespan, but infrequently produce perfect flowers (and be monecious) particularly as the plant ages and is able to produce more flowers over longer intervals. Another endangered Hawaiian Urticacea species, *Urera kaalae* similarly produces only male or female flowers at first maturity, but as it ages, produces both male and female inflorescences but asynchronously.

Both the Kapuna and Punapōhaku plants were observed this past year with immature fruit confirming the potential for an individual plant to have both male and female flowers (and be monecious). This is the first instance of fruiting at the Punapōhaku site since monitoring began in 2005 as all previous observations noted only male flowers. It remains unclear whether this is a common occurrence given the low number of extant plants and the difficulty of regularly monitoring wild populations. Plants at the Army Nursery also produced both male and female flowers in succession. By recording the sex of all monitored plants over time, NRS hopes to clarify this relationship between plant age and degree of dioeciousness.

Outplanting Issues
NRS will continue to monitor all PUs to determine if larger populations are necessary to increase chances of pollination between functionally dioecious plants. Stock may come from seeds to overcome the problem of clones remaining functionally male or female. Reintroduced populations will hopefully have more outcrossing opportunities if more equal ratios of male and female plants are present and plants are planted in close proximity.

Outplantings at Mākua in 2005 were browsed by rats and it appears that this was an isolated incident. More recently, outplantings at the upper Kaluakauila patch were damaged by black twig borer (BTB) beetles. The current drought likely weakened the plants making them more susceptible to predation and disease. Survivorship at Kaluakauila in both the upper and lower patches is still 88% with 77 % plants of moderate to healthy vigor. This is the first instance that BTB damage was observed for this species. However other Hawaiian Urticaceae species (e.g. *Pipturus albidus*) regularly face BTB attacks and so the damage to *Neraudia* is not that surprising. See Chapter 5.1 BTB for an update on NRS research.

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. As mentioned previously, black twig borer control efforts remain at the research stage (see Chapter 5.1 BTB for more details).

Surveys
NRS staff found one additional individual at Mākaha Valley in the course of three surveys in Mākaha this past year. More surveys in the Mākaha and Keawa‘ula areas will be planned in the coming year as time permits. NRS will also continue to survey around known populations for additional plants during regular monitoring.

Table 2.1.18c 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	9	0
Makaha	Genetic Storage	17	0
Makua	Manage for stability	88	3
Manuwai	Manage for stability	4	2
Punapohaku	Genetic Storage	1	0
Waianae Kai Makai	Genetic Storage	81	0
Waianae Kai Mauka	Manage for stability	87	0
	Total for Taxon:	**323**	**6**

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

As mentioned previously, Manuwai and Kapuna stock are represented at the Kaluakauila reintroduction. 45% of the founders from PUs designated as genetic storage will not be represented in outplantings. At the Mākua MFS PU a larger number of founders was previously represented in outplantings. These plants have since senesced given the short life span of this species and only three founders are currently represented. Another larger outplanting at Mākua is planned for the coming year to again represent a much larger percentage of the 88 founders. At the Wai‘anae Kai Mauka MFS PU, *in situ* management as opposed to reintroductions will be the focus once the area is fenced.

Taxon Threats

As mentioned in the outplanting issues section above, black twig borer damage can significantly affect this species, particularly in drought years.

Fire remains a major threat to all of the PUs. The Mākua and Kaluakauila PUs were again threatened by nearby fires this past summer and the Manuwai gulch area burned in the large Kaukonahua fire (see Appendix for fire reports).

Population Unit Level Discussion

Manage for Stability PUs

Mākua: Since March 2005, two strategic fences protected the area with the largest amount of plants from pigs. NRS continues to monitor and collect from the wild sites and inspect the fence.

As mentioned previously, on site recruitment was again observed this year at the augmentation site presumably from an outplanted individual. Given the relatively short lifespan of outplants, establishing larger outplanted populations and multiple plantings will likely be necessary to

obtain recruitment. Additionally, planting younger (but still hardy enough) plants may also be required to ensure the longest reproductive period possible at outplanting sites.

Table 2.1.18d Population Unit Threat Control Summary

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

Kaluakauila: The Kaluakauila MU currently contains two reintroduction sites. The Upper Kaluakauila patch was founded with stock from the Kapuna PU and was supplemented again this past year using Kapuna stock. The goal for this site is 105 plants with equal founder and gender representation. 38 plants are currently at the Upper Kaluakauila patch (see Table 2.1.18e). Stock from the other Kapuna plant as well as the Punapōhaku individual remains to be planted at the upper patch.

Since the first outplantings in 2003, survivorship of outplants has been high at Kaluakauila (88% as of August 2007). 53 mature plants currently remain on site out of a total of 61 individuals planted. 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.

This past year a new reintroduction site was established in the Lower Kaluakauila patch using 17 plants propagated from Manuwai population stock. 14 plants remain from this initial planting effort, of which seven plants are females and five plants are males (two plants could not be sexed as they were not reproductive).This is an important reintroduction as the Manuwai plants have all died in the wild. This reintroduction at the lower patch will eventually 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 separate as it is morphologically distinct.

Table 2.1.18e 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	38,0 0	Cuttings Cuttings
Lower Kaluakauila	Manuwai	4	25	100	14,0,0,0	Cuttings

Wai‘anae Kai Mauka: Collections and monitoring continued at this population this past year. Collections are largely complete. NRS will continue to monitor and collect from unrepresented individuals in the coming year and a more thorough census is needed at this PU. A fence will be built pending approval of a proposal submitted to the State in 2004. Goat control in the area is planned for the coming year.

Manuwai: In just three years the number of plants at this site went from 11 mature individuals and one juvenile to zero because of ungulates. 12 plants were first found in March 2003 during surveys of the Mokulē‘ia Forest Reserve. No plants were found as of August 2007. Fortunately, propagules were collected during a monitoring visit and are being grown at the Army Nursery. These Manuwai plants were cloned and planted into the Lower Kaluakauila site (see Kaluakauila PU discussion above). NRS will continue to monitor for regeneration at the extirpated Manuwai wild site in the coming year.

A portion of Manuwai Gulch burned in the August 2007 Kaukonahua fire (See Appendix for fire reports). Despite the recent fire, proposals for large and small fences are still planned for this area. But 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 continue planting Manuwai stock at Kaluakauila (as well as keep it in living collections). NRS will also 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.

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. 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 Punapōhaku PU (see Kaluakauila PU discussion above).

Mākaha: Plants at the larger population were monitored this past year, but no collections were made. Three surveys were done in the adjacent Kamaili Gulch and one individual was found and collected from. Unfortunately the collection did not survive in the greenhouse and the wild plant has since died. Additional surveys done in the course of other work may locate other individuals.

Leeward Pu‘u Kaua: NRS did not visit this PU in the past year. The only population of feral goats in the southern leeward Wai‘anae Mountains occurs threatens these plants 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, monitor the second remaining historical site in the PU, and hopefully complete collections from this site to meet genetic storage goals. Unfortunately, the plants at this site are very difficult to reach and complete collection may not be possible.

Hālona: NRS did not visit this PU in the past year. NRS hope to visit the three sites in Halona area in the coming year in order to make progress on meeting genetic storage goals.

Wai‘anae Kai Makai: This PU was monitored this past year and no major changes in population size or distribution was noted. Fencing plans to exclude pigs and goats were submitted to the DLNR and NRS is awaiting approval. A few large *Casuarina glauca* and *Grevillea robusta* trees were removed from this area two years ago. 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. Accessibility is difficult at this PU as nearly all the plants are on a nearly vertical cliff. This population is largely secure from ungulates with a relatively intact cliff habitat. It provides an important reference site when planning reintroductions outside of the Action Area. This large, population is not designated MFS because the same area is already a MFS designated PU for *Nototrichium humile.*

2.1.19 *Nototrichium humile*

Requirements for Stability

- 4 Population Units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	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 been initiated?
4/4	1/4	0/4	1/4	N/A

Taxon Level Discussion

There are a total of 13 *Nototrichium humile* PUs known. 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 remain a threat in three of the four PUs. 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. NRS will continue to pursue a relationship with OHA to determine suitable *inter-situ* sites at the Waimea Audubon Center.

Major Highlights/Issues Year 3

- Conducted a post-fire assessment of the Keawa'ula PU. The July, 2006 fire came within 20 meters of the population but the plants were not impacted.
- A large fire burned a portion of the Kaimuhole and Palikea Gulch PU in August 2007. After an initial survey it appears that the fire burned a small patch of *N. humile* in the lower portion of Palikea, but did not affect the plants in the other areas.
- Collections were made from the Kahanahā'iki PU.

Plans for Year 4

- 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 WBG and other similar sites. These will be used to observe flowering and fruit production in order to guide future collection and storage plans.
- Resubmit the ungulate control plans 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.

Table 2.1.19a Taxon Status Summary

Action Area: In

TaxonName: Nototrichium humile — TaxonCode: NotHum

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	67	10	0	0	0	0	70	4	0	**67**	**10**	**0**	A thorough census found a change in population structure with more immat and less mat
Kaluakauila	Manage for stability	198	35	0	0	0	0	198	35	0	**198**	**35**	**0**	No monitoring in the last year.
Keaau	Genetic Storage	21	31	0	0	0	0	21	31	0	**21**	**31**	**0**	No monitoring in the last year.
Keawaula	Genetic Storage	138	5	0	0	0	0	138	5	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	1	0	16	0	0	72	1	0	**72**	**1**	**0**	Monotoring shows no change in the last year
Punapohaku	Genetic Storage	302	14	7	0	0	0	302	14	7	**302**	**14**	**7**	No monitoring in the last year.
	Total for Taxon:	782	96	7	16	0	0	801	90	7	**798**	**96**	**7**	

Action Area: Out

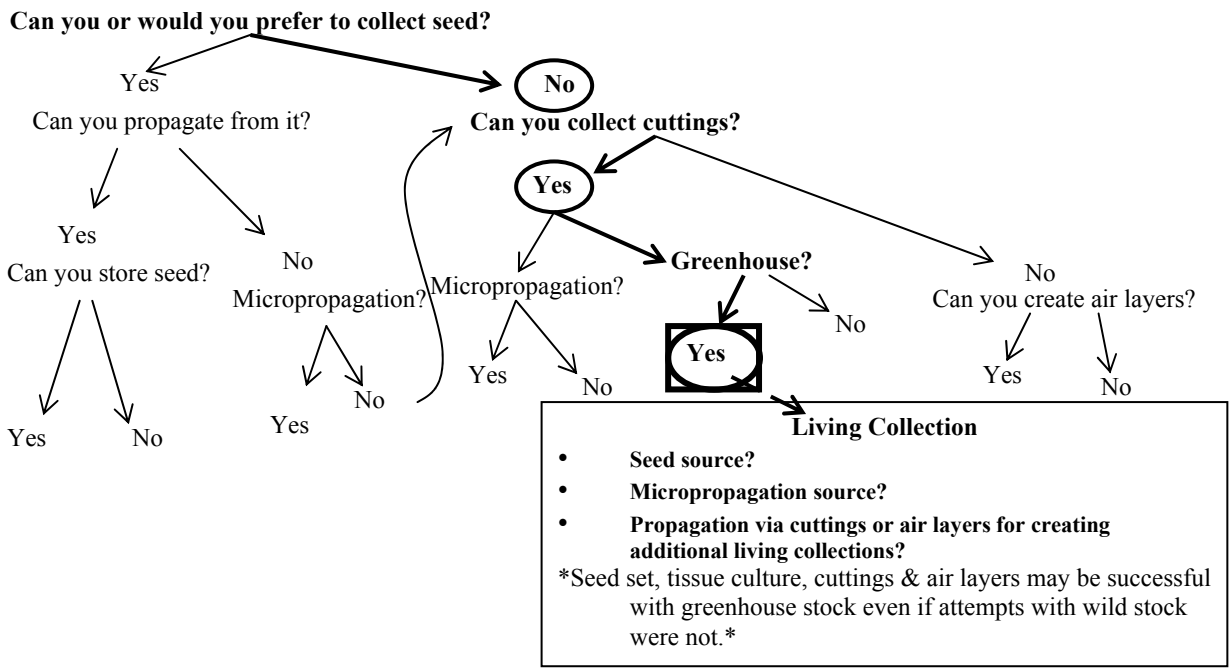
TaxonName: Nototrichium humile — TaxonCode: NotHum

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaimuhole and Palikea Gulch (Kihakapu)	Manage for stability	51	4	0	0	0	0	58	7	0	**51**	**4**	**0**	Monitoring showed one site impacted by August 2007 fire
Keawapilau	Genetic Storage	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	No monitoring in the last year.
Kolekole (east side)	Genetic Storage	12	0	0	0	0	0	12	0	0	**12**	**0**	**0**	No monitoring in the last year.
Makaha	Genetic Storage	15	3	0	0	0	0	16	3	0	**15**	**3**	**0**	No monitoring in the last year.
Nanakuli	Genetic Storage	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	No monitoring in the last year.
Puu Kaua (Leeward side)	Genetic Storage	2	0	0	0	0	0	12	0	0	**2**	**0**	**0**	A thourough census showed a decline in numbers plants
Waianae Kai	Manage for stability	224	5	0	0	0	0	224	5	0	**224**	**5**	**0**	No monitoring in the last year.
	Total for Taxon:	314	12	0	0	0	0	332	15	0	**314**	**12**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection	No	Yes, further pollination studies needed

Prioritizing Genetic Storage & Propagation Techniques



Collection: 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: A collection in Pahole was made by the NAR Specialist in 2002 and stored refrigerated (4C, 15-35% RH) for five years until sown this year by NAR Horticulturist. Germination was high (20:25 seeds). This observation supports the hypothesis that seeds of this taxon will likely have good storage potential. The main obstacle faced by NRS is determining whether or not infructescences contain seed.

Genetic Storage: More cuttings were made from the fire threatened "C-Ridge" in the Kahanahā'iki PU to increase living collection representation. The living collection for this stock is in the Army Nursery and Waimea Audubon Center. Stock in the nursery from all represented founders in this PU is currently being prepared for breeding system studies. All founders will be represented by at least two plants, one of which will be transplanted into large three to five

gallon pots and brought to the baseyard. The study is scheduled to begin within the next six months.

Table 2.1.19b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Nototrichium humile							
Kahanahaiki	67	10	1	5	0	13	5
Kaimuhole and Palikea Gulch (Kihakapu)	51	4	0	0	0	13	12
Kaluakauila	198	35	0	5	0	0	4
Keaau	21	31	0	0	0	0	0
Keawapilau	5	0	0	0	0	5	4
Keawaula	138	5	0	0	0	9	0
Kolekole (east side)	12	0	0	0	0	9	0
Makaha	15	3	0	0	0	0	0
Makua (East rim)	0	0	0	0	0	0	0
Makua (south side)	56	1	0	0	0	0	0
Nanakuli	5	0	0	0	0	0	0
Punapohaku	302	14	1	0	0	11	1
Puu Kaua (Leeward side)	2	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	65	30

Unique Species Observations

There have been no new observations made in the last year.

Outplanting Issues

There have been no new outplanting issues in the last year. NRS has only conducted two outplanting with this species, one in Lower Mākua, and another at the Waimea Audubon Center. NRS visited the Mākua site last 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 the breeding system of this taxon in order to determine more effective seed collection methods. The lack of on site recruitment in protected PUs remains problematic. More study is needed on pollination limitations, seed fate and seed viability. NRS hopes to have significant replacement levels of mature plants in the near future.

Surveys
There were no surveys conducted for this taxon in the last year.

Taxon Threats
Drought this year continues to stress smaller plants.

Population Unit Level Discussion

Table 2.1.19c 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: A fire in August, 2007 threatened this PU. After an initial survey it appears that the fire did not burn the Kaimuhole population, but did burn a small patch of ten plants in the lower portion of Palikea Gulch. Fortunately, it did not reach the large core population in the upper section of Palikea Gulch.

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 with the exception of fire are currently controlled in this PU.

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, 16 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 in 2005. 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 first 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 observe any further reduction in habitat for this taxon (Figure 2.1.19.a) 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. NRS plans to visit this PU in the coming year and make collections.

Kahanahā‘iki: NRS currently have 28 representatives from the unmanaged portion of this PU planted at Waimea Audubon Center. This year, NRS collected from an additional ten unrepresented plants from this 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.

Figure 2.1.19a Keawaula PU after July 2006 burn showing the core area of *Nototrichium humile* in the middle of the patch surrounded by the black line and the area that burned surrounding the patch in white.

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): No additional actions have been taken for this PU in the last year. NRS has collected cuttings from plants found within a small fenced portion of the PU.

Mākaha: No significant monitoring of this PU was done in the last year. A strategic fencing project is currently being planned to protect a site for other taxa. NRS is still trying to assess the most effective method of capturing the core area of this site.

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): NRS surveyed this PU in the past year and found a decline in population numbers from 12 plants to two.

2.1.20 *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)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Expedited stabilization (10 years).

How many of the 4 MFS PUs have stable numbers of mature individuals?	How many of the 4 MFS PUs have had *insitu* recruitment?	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 been initiated?
0/4	0/4	0/4	1/4	3/4

Taxon Level Discussion

There are currently no known wild populations of this species. NRS and the Lyon Micropropagation Lab are maintaining the remaining stock from Palikea Gulch, Wai‘anae Kai, Keawapilau and 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 Kapuna PU, the first of which was not successful. The second is a new reintro site in the Kapuna Gulch. Further reintroductions occurred within the Pahole Gulch. Powdery mildew and predation by mice impacted the outplantings in both Kapuna and Pahole. A new reintroduction site in the Mākaha PU was initiated this year. Unfortunately the plants did not thrive in the new site and most if not all have now declined. NRS are looking into possible microsite differences and greenhouse stock age to explain the low success rate of the reintroductions.

This year the USFWS designated *Phyllostegia kaalaensis* as an “expedited stabilization species” (Introduction for further details) in which the species should be stabilized in ten years. These goals require that NRS manage three stable PUs with 50 genetically unique reproducing individuals. Two of the PUs are required to be out of the action area. NRS aim to achieve this goal with stable numbers in the Manuwai and Mākaha PUs. The goal of expedited stabilization in 10 years may be challenging given the low success rate of reintroducing this taxon. NRS hopes that by examining microsite differences and by getting a better idea of the size class needed for reintroduction survival, expedited stabilization can be attained.

Major Highlights/Issues Year 3

- A new reintroduction was made into the Mākaha PU.
- A new reintroduction was made into the Keawapilau to Kapuna PU.
- The Pahole reintroduction site was augmented with 56 more plants.

- A HOBO ® station was deployed at the Pahole reintroduction site.
- This taxon is expedited for stabilization in 10 years.

Plans for Year 4

- 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 will study microsite differences by deploying weather stations with data loggers in order to improve the outplanting success rate for this species.
- NRS will conduct more reintroductions in both the Mākaha, Keawapilau to Kapuna and Pahole PUs.

Figure 2.1.20a Outplanted *Phyllostegia kaalaensis* in Kapuna Gulch. Note the powdery mildew, insect damage, and browsed canes.

Table 2.1.20a Taxon Status Summary

Action Area: In

TaxonName: Phyllostegia kaalaensis **TaxonCode: PhyKaa**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keawapilau	Manage for stability	0	0	0	17	0	0	0	0	0	**17**	**0**	**0**	17 of the 25 plants reintroduced this year remain at this site
Pahole	Manage for stability	0	0	0	0	30	0	0	2	0	**0**	**30**	**0**	56 new plants outplanted at this site with some 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	0	0	17	30	0	0	2	0	**17**	**30**	**0**	

Action Area: Out

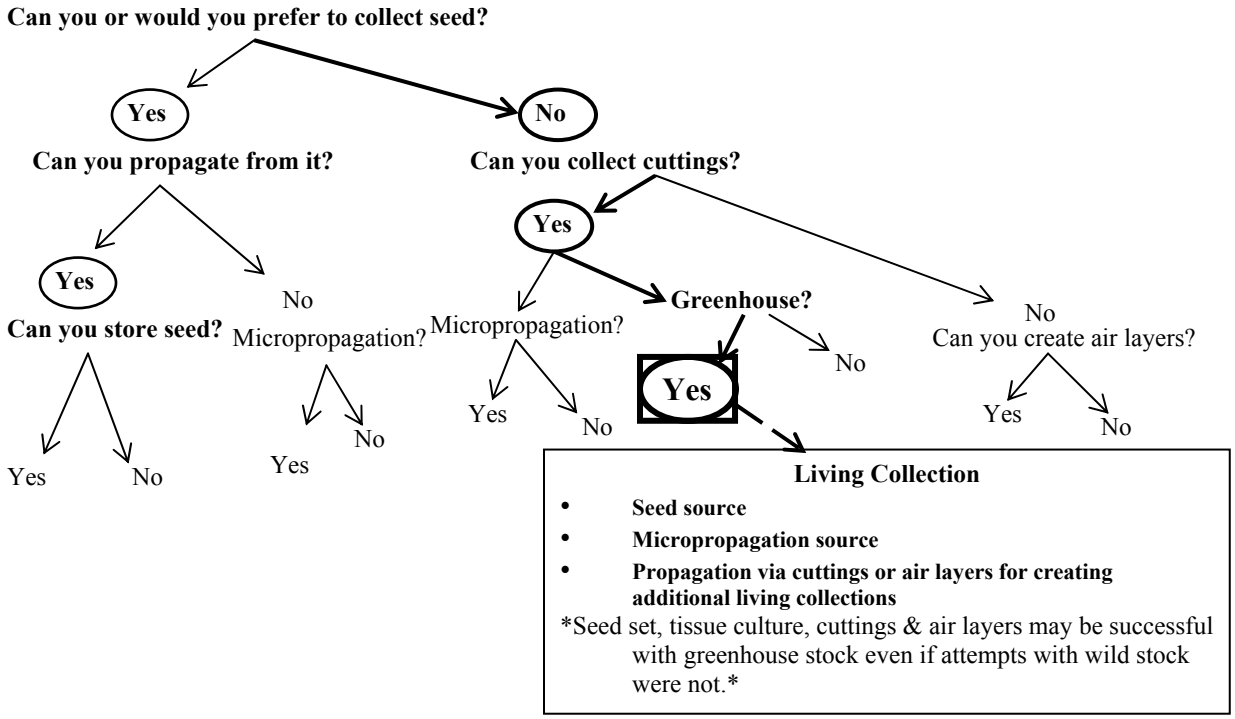
TaxonName: Phyllostegia kaalaensis **TaxonCode: PhyKaa**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	4	20	0	0	0	0	**4**	**20**	**0**	83 plants introduced this year with significant decline
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	4	20	0	0	0	0	**4**	**20**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection	No	Yes, further pollination studies needed

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage: Low seed set remains the major issue for this taxon. A low number of seeds have been available for collection, and of the seeds that are collected many are empty (no embryo). NRS will continue to work with the NARS Horticulturist next year to obtain a larger collection for more tests.

Genetic Storage: All founders are represented in tissue culture. NRS will maintain living and tissue culture collections. Fruit from nursery stock will continue to be collected for viability testing.

Table 2.1.20b Status of Genetic Storage

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Phyllostegia kaalaensis							
Keawapilau	0	0	1	1	1	1	1
Pahole	0	0	4	0	2	2	2
Palikea Gulch	0	0	5	0	2	3	2
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	7

Unique Species Observations
There have been no new observations in the last year.

Outplanting Issues
Four plantings of this taxon have been conducted in the last four years. They have had the lowest survivorship for any taxa planted by NRS. Two sites are located in the Keawapilau to Kapuna PU and one in the Pahole PU. The fourth site is in the Mākaha PU. 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. This year NRS got better idea of the size class needed for reintroduction. It seems that when the plants send out long canes there is a lot of active growth, which is better for outplanting. In the coming year, depending on the availability of healthy stock, NRS will reintroduce plants that are young, growing vigorously, and kept in shallower pots to prevent root rot (Doug Okamoto, NARS Horticulturist, pers. comm.). More intensive monitoring of these sites will also be done to refine site selection criteria and outplanting strategies.

Reintroductions will occur once again in the coming year in Mākaha, Keawapilau to Kapuna, and Pahole PUs. Stock for these reintroductions will come only from their respective PUs with the exception of the Mākaha reintroduction, in which stock will come from the Wai‘anae Kai. In the future, a Kapuna reintroduction will include a mix of stock from various PUs.

Currently, only three 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. NRS is considering Manuwai for the fourth MFS PU with reintroduced Palikea Gulch stock.

Research Issues
Outplanting techniques, as stated above, require further research. When stock is available, research is also needed for seed storage techniques. Slug research continues and is described in detail in Chapter 5.2.

Surveys
No additional surveys were conducted this year.

Taxon Threats
In addition to threats mentioned in previous reports (see OANRP 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. Two of the reintroduction sites in the Pahole to Keawapilau PU were impacted by mice this year. NRS noticed significant browse by mice on the actively growing canes of the *P. kaalaensis.* Bait stations and snap traps were deployed in Pahole Gulch in an effort to curtail mouse impacts on the *P. kaalaensis.*

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.

Table 2.1.20c 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. In November of 2006, there were only two plants left of the original 47 planted. In January of 2007, 56 additional plants were outplanted at this site. The outplantings experimented with different microsites. This year a HOBO weather station was installed in the Pahole Gulch. This device will allow NRS to determine if there are any measurable microsite differences. NRS will continue to examine microsites in an effort to determine optimal growing conditions for *P. kaalaensis.* The reintros were impacted by a host of threats including: mice, slugs and powdery mildew. Bait stations and snaps were deployed this year to lessen the impact by mice. Currently 30 plants remain at this site.

Two adult *Veronicella cubensis* (the Cuban slug) were found at the Pahole Gulch 4 reintroduction site. NRS believe that they may have been introduced during this years outplanting however without a thorough survey, it is not yet known if they are found in Pahole Gulch or the surrounding areas. NRS will continue to visit the site once a month for the next four months to ensure the area remains clean. If the slugs are encountered again measures must be taken to remove them from the area.

Keawapilau and Kapuna: In the past year NRS worked with the NARS Specialist to determine an appropriate outplanting site. A site where the wild plant recently occurred was chosen and stock from the Pahole site was mixed with the Keawapilau stock to establish an outplanting in the Kapuna Gulch. A temporary plastic fence was constructed around the outplanting area to exclude ungulates until the larger Kapuna fence is completed. The fence material is easily breached and NRS questions its effectiveness for future ungulate exclusion. This year in February, 25 plants were outplanted, and currently 17 remain at this site. The plants were impacted by powdery mildew and browsing by mice (see Fig. 2.1.20a). Weed control is conducted there regularly for other taxa.

Other PUs

Mākaha: Wai‘anae Kai stock was used to establish this introduction. Eighty three plants were outplanted into the Makai Gulch in Mākaha . The 100-acre exclosure was not completed at the time of the outplanting. NRS had planned for an earlier finish date, and therefore had plants ready for outplanting. NRS constructed a small temporary plastic fence to serve as a barrier in an effort to exclude ungulates from the outplanting site. NRS frequented the site and on multiple visits observed pig sign within the temporary exclosure. The site is located near a gulch bottom on a talus slope. Breaches in the fence were most often caused by falling rocks that blew through the weak plastic material. Fortunately no significant damage was caused by the ungulate infiltration.

The *P. kaalaensis* outplanting did poorly after initial signs of success. A number of plants flowered and possibly seeded and were growing at moderate levels. In a period of three months all plants quickly declined. Water stress was not the predominant factor as soil moisture

appeared adequate. Plants died gradually, losing their largest leaves first and finally leaves at the meristems. Possible causes of death include slug predation, powdery mildew, insect predation, and transplant shock as nutrients in potting soil was depleted. During the most recent formal observation in July, 24 plants remained and most were poor in health. The large scale Mākaha MU fence was completed in September 2007. This opens up many possible outplanting sites within this MU. NRS will select and prepare another site for outplanting and the Wai‘anae Kai stock will be maintained in the Greenhouse and Micropropagation Lab.

Manuwai Reintroduction: Palikea Gulch stock will be used to establish this reintroduction when the 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 ‘Ēkahanui reintroduction.

‘Ēkahanui: 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 ‘Ēkahanui.

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.

Wai‘anae Kai: There is stock from this PU at the Lyon Micropropagation Lab and the Army Nursery. It will be used in the coming year as a reintroduction in Mākaha.

2.1.21 *Plantago princeps* var. *princeps*

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/4	4/4	0/4	2/4	0/4

Taxon Level Discussion

This year NRS worked closely with PhD candidate Stephanie Dunbar of the University of Hawai‘i Botany Department to collect genetic samples from all presumed *Plantago princeps* var. *princeps* populations on O‘ahu, in both the Ko‘olau and Wai‘anae Mountains. Her analyses, utilizing both nuclear and chloroplast DNA sequences, showed that the Wai‘anae range populations are genetically distinct from the Ko‘olau populations (S. Dunbar pers. comm. 2007). In response to this new genetic information and the fact that the potential threat from military training to this taxon is in the Wai‘anae range, NRS decided to focus management on the Wai‘anae populations. Since this taxon is found in the AAs for both Mākua (MMR) and Schofield Barracks West Range (SBWR), four PUs were chosen as ‘Manage for Stability’: ‘Ōhikilolo (within the Mākua AA), Kalena (within the SBMR AA), ‘Ēkahanui (within TNCH’s Hono‘uli‘uli Preserve), and Hālona (on State land in Nānākuli). Two populations will be managed for “Genetic Storage Collections”: Pālāwai (within Hono‘uli‘uli Preserve) and Pahole (within Pahole NAR).

Another major highlight of this year was the first outplanting of this taxon. The outplanting was conducted within the Kalua‘ā-Wai‘eli management unit (MU) in TNCH’s Hono‘uli‘uli Preserve. This site was chosen after NRS determined that augmentations should not be done with plants infected with the downy mildew reported previously (OANRP 2006). Over the coming year NRS plan to conduct a second reintroduction of this taxon within the ‘Ēkahanui MU. The outplanting site will be sufficiently far from wild plants to avoid possible transfer of mildew spores.

Major Highlights/Issues Year 3

- NRS worked with researcher Stephanie Dunbar to collect and genetically analyze material from all presumed *Plantago princeps* var. *princeps* populations on O‘ahu.

- Genetic research indicates that *P. princeps* var. *princeps* is restricted to the Waiʻanae Mountain Range and that the Koʻolau populations represent a form more closely related to *P. laxiflora* on Maui.
- NRS conducted the first outplanting of this species in Waiʻeli within TNCH's Honouliuli Preserve.
- The South Branch of North Pālāwai site was rediscovered
- NRS observed downy mildew on wild individuals in Pahole

Plans for Year 4

- NRS will continue to refine propagation techniques and try to prevent and treat infestations of downy mildew in greenhouse plants
- NRS plans to propagate this year for a second reintroduction of this taxa near Puʻu Kaua within the ʻĒkahanui MU
- NRS plans to continue efforts to secure genetic storage collections from all populations of this taxon
- NRS will determine if fencing is necessary at the recently rediscovered south branch of north Pālāwai population

Figure 2.1.21a A healthy outplanted individual from the Waiʻeli reintroduction

Table 2.1.21a Taxon Status Summary

Action Area: In

TaxonName: Plantago princeps var. princeps TaxonCode: PlaPriPri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
North Mohiakea	Manage for stability	10	16	2	0	0	0	10	2	11	**10**	**16**	**2**	More immature individuals observed in the last year
Ohikilolo	Manage for stability	12	14	0	0	0	0	12	14	0	**12**	**14**	**0**	No changes observed this year
Pahole	Genetic Storage	2	6	6	0	0	0	2	10	4	**2**	**6**	**6**	Small changes were observed in the last year
	Total for Taxon:	24	36	8	0	0	0	24	26	15	**24**	**36**	**8**	

Action Area: Out

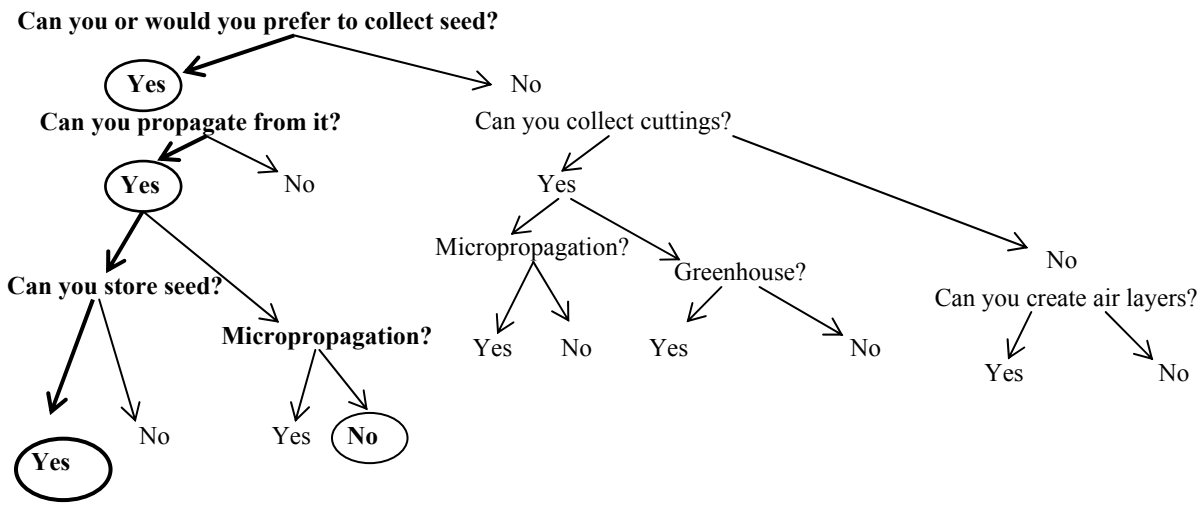
TaxonName: Plantago princeps var. princeps TaxonCode: PlaPriPri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	29	39	7	0	0	0	34	50	36	**29**	**39**	**7**	Population decline observed over this past year
Halona	Manage for stability	10	17	11	0	0	0	10	17	1	**10**	**17**	**11**	Additional seedlings observed this year, not all sites visited
North Palawai	Genetic Storage	2	5	0	0	0	0	1	0	1	**2**	**5**	**0**	Second population rediscovered this year
Waieli	Manage reintroduction for storage	0	0	0	9	7	0	0	0	0	**9**	**7**	**0**	New reintroduction conducted this year
	Total for Taxon:	41	61	18	9	7	0	45	67	38	**50**	**68**	**18**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	No	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage: Seeds germinated for reintroductions after 15 months of storage show no decrease in viability.

Genetic Storage: NRS has continued and will continue to make collections from all the PUs to meet goals. Fifteen new founders were collected from this past year.

Figure 2.1.21b Mature fruit of *Plantago princeps* var. *princeps*

Table 2.1.21b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Plantago princeps var. princeps							
Ekahanui	29	39	12	41	0	5	37
Halona	10	17	0	4	0	0	4
North Mohiakea	10	16	11	13	0	3	12
North Palawai	2	5	0	0	0	0	0
Ohikilolo	12	14	12	14	0	0	9
Pahole	2	6	0	1	1	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**
				73	1	8	63

Unique Species Observations

The downy mildew that was reported by NRS last year on greenhouse plants (NRS 2006) was observed on wild individuals in Pahole. Some individuals appeared severely infected while others showed no signs of infection.

Outplanting Issues

The first reintroduction of this taxon, conducted this year at Waiʻeli MU, has been moderately successful. A total of thirty individuals, representing genetic stock from ʻĒkahanui and North Mohiākea, were outplanted in March 2007. Currently, 1/3 of the plants are healthy, 1/3 are moderately healthy, and 1/3 have died.

NRS anticipate the need for reintroductions at each of the four Manage for Stability PUs in order to reach stability goals. NRS will continue to monitor the trial Waiʻeli reintroduction and will conduct another trial outplanting at ʻĒkahanui PU in the coming year. The ʻĒkahanui outplanting will be a chance for NRS to test different microsites. Following the ʻĒkahanui trial outplanting and progress made on the greenhouse infestations of downy mildew NRS plan to augment the ʻŌhikilolo and Hālona PUs.

Research Issues

As mentioned, genetic analyses by PhD Candidate Stephanie Dunbar (U.H. Botany Department) provided valuable insight on the evolution of this genus in Hawaiʻi over the last year. In addition to showing that *P. princeps* var. *princeps* is restricted to the Waiʻanae Mountains, chloroplast sequences (trnL and ndhF) show that generally the Waiʻanae populations are indistinguishable from each other. However, two separate subgroups were discernible from the other populations with this sequence. The first group was the two sites in North Pālāwai and the second group was ʻŌhikilolo and Hālona PUs (Stephanie Dunbar pers. comm. 2007). It is interesting that the

‘Ōhikilolo and Hālona PUs grouped together when they are closer geographically to the Pahole and North Pālāwai PUs respectively than to each other.

Surveys
No additional surveys were conducted in the last year for this taxon. NRS previously reported that surveys might be needed for a plant observed in Nāpepeiao‘ōlelo Gulch in Honouliuli Preserve. However, TNC and NRS believe that Pālāwai Gulch may have been mistakenly called Nāpepeiao‘ōlelo. NRS will discuss with Botanist, Joel Lau and may survey in this area.

Taxon Threats
No additional threats were noted in the last year however, rats, weeds, fire, pigs, fungal pathogens, landslides, and slugs threaten *P. princeps* var. *princeps*.

Population Unit Level Discussion

Table 2.1.21c Population Unit Threat Control Summary

Action Area: In

TaxonName: Plantago princeps var. princeps

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
North Mohiakea	Manage for stability	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	Manage for stability	Partial	No	No
North Palawai	Genetic Storage	No	No	No
Waieli	Manage reintroduction for storage	Yes	Yes	Yes

Manage for Stability PUs

‘Ōhikilolo: No significant change was observed at this population over the last year. NRS have genetic storage collections representing 14 individuals, nine of which have more than 50 seeds in storage (Table 2.1.21b). NRS have been controlling ungulate threats to this population for the last 12 years. Rats are not being controlled at this site as no threat from rats have been observed at this site. Once propagation and reintroduction techniques are refined this PU will be augmented. NRS will continue to monitor and collect for genetic storage from this PU in the coming year.

ʻĒkahanui: This PU is comprised of three smaller subpopulations along a 150 meter cliff in South ʻĒkahanui Gulch. Currently, almost all individuals in the three groups of plants are protected from ungulates by fencing, cliffs, and steep terrain. All the plants will be protected once the l70 acre ʻĒkahanui subunit II fence is completed in the next year. Rat damage has been observed in this PU and rat control is ongoing at these sites, although, no predation has been documented since May 2004. NRS have observed a decline in the numbers of individuals for this PU over the last year. However, new individuals were observed along the cliff face in some spots. NRS have met genetic storage collection goals for 37 individuals from this population (Table 2.1.21b).

Rat control efforts at this site benefit *Achatinella mustelina,* and other rare species in addition to *P. princeps* (for rat control data in ʻĒkahanui see Chapter 3.1). This year NRS conducted grass control in the southern most population. Grass control remains the priority along with reducing the alien canopy of *S. terebinthifolious* on the cliff.

North Mohiākea: NRS monitored this PU in the last year and made additional genetic storage collections. NRS now have storage collections representing 12 wild individuals. The North Mohiākea PU is located within Schofield Barracks West Range and was designated a MFS PU because it is within the SBMR 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*. Access to this population requires a helicopter and access is limited because of its proximity to the live fire range. In the coming year, NRS will continue to monitor the site and will collect mature seeds from unrepresented plants. There is unsurveyed habitat for this species in this area. NRS will conduct surveys before augmentations are planned for this site.

Hālona: The plants at this site occur along a vertical cliff face in the back of Lualualei Valley on State Land. This area has not been completely surveyed and more plants may be found with additional surveys on adjacent cliffs. This year NRS re-visited a portion of this site, however a complete observation of this population was not made. 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 do not currently pose a threat to the plants. NRS have met with the Navy and DOFAW to discuss goat control in the area.

NRS have only surveyed portions of the available habitat for this species at this site. More surveys are needed before making plans to augment in the area. NRS currently have four individuals represented in genetic storage (Table 2.1.21b).

Other PUs

Pahole: NRS monitored this PU over the last year and observed a few new seedlings and some mortality of immature individuals. This site is within the Mākua AA. The plants occur along a steep cliff face that is dominated by native vegetation. The vegetation band where these plants occur is narrow, however there are adjacent areas that have not been surveyed. NRS will collect from all wild individuals to meet genetic storage goals.

North Pālāwai and South Branch of North Pālāwai: Last year NRS reported that the South Branch of North Pālāwai population was extirpated due to predation by rats. This year NRS revisited this site and found five individuals. This site is threatened by pigs, dominated by weedy species, and is not within any proposed management unit fences. NRS will likely need to fence these plants in order to secure genetic storage collections. NRS collected from one mature plant in the last year. However, the fruit appeared to be aborted. NRS will try to collect mature seed from all mature plants in the coming year.

Wai‘eli reintroduction: This PU will be managed for genetic storage collections and as a trial reintroduction site. NRS will make genetic storage collections from these plants if unable to collect from the wild sites these founders represent.

***Plantago* sp. Ko‘olau Taxon:**
NRS were able to visit two of these sites in the last year in order to help with the genetic identification of this taxon. Although NRS will no longer be working with these populations, we report on them here for the benefit of those interested. They will not be discussed in future reports.

Table 2.1.21d Ko‘olau *Plantago sp.* Status

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling
Konahuanui	No Management	100	10	0	0	0	0	40	5	0	100	10	0
Nuuanu	No Management	4	8	0	0	0	0	1	0	0	4	8	0
Waiawa (Koolaus)	No Management	16	17	50	0	0	0	16	17	50	16	17	50

Nu‘uanu: NRS were able to visit this site this year and observed 12 individuals. This site is on State Forest Reserve land below the Pau‘oa flats trail and above the Nu‘uanu reservoir. The site is somewhat steep and is threatened by weeds such as *E. karvinskianus.* There are several gulches in the area that appear to have similar vegetation and topography. Surveys of these gulches will likely result in new populations being discovered. However, with the Army’s focus shifting to the Wai‘anae populations, surveys for this taxon will not be a priority for NRS.

Kōnāhuanui: NRS visited this site this year with, Botanist Joel Lau, and counted over 100 individuals. There is also habitat on adjacent slopes may contain more individuals. These plants occur on steep, exposed, and erosion-prone rocky substrate.

Waiawa: NRS did not visit this PU in the past year. These individuals will be protected within the Army’s proposed Wai‘awa MU.

2.1.22 *Pritchardia kaalae*

Requirements for Stability

- 3 Population Units (PU)
- 25 reproducing individuals in each PU (long-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
2/3	1/2 (only two *in situ* PUs)	0/2 (only 2 *in situ* PUs)	1/3	2/3

Taxon Level Discussion

There are three Manage for Stability (MFS) PUs for *Pritchardia kaalae.* They are located across the historic *Pritchardia kaalae* habitat belt stretching from ʻŌhikilolo ridge on Mākua Military Reservation (MMR) to the Kalena to Kaʻala ridge between Schofield Barracks West Range (SBW) and Waiʻanae Kai. The ʻŌhikilolo and Makaleha to Manuwai PUs have *in situ* populations with more than 25 mature plants, however very few juveniles or seedlings have been observed in any sites that have not had consistent rat control. The East ʻŌhikilolo and West Makaleha PU lies in between the two *in situ* PUs and has no known trees. This area has appropriate habitat and the PU will be established by outplanting stock collected from both *in situ* PUs. Most trees in all PUs produce flowers but rats are thought to consume most or all of the fruit before it can germinate and goats and pigs are known to browse the seedlings. *Pritchardia kaalae* is easy to grow from seed and outplantings have been successful. Management of all three MFS PUs will require large scale ungulate fences, weed control 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. A fence protects the ʻŌhikilolo PU and a portion of the East ʻŌhikilolo and West Makaleha PU. Fences are planned for West Makaleha, East Makaleha and Manuwai and and this will stabilize the habitat needed for these PUs. Genetic storage collections have not yet begun because research on the optimal storage techniques is ongoing. Preliminary results from research by the National Center for Genetic Resources Preservation (NCGRP) have identified an optimum storage protocol and collections for genetic storage will begin in the next year.

Major Highlights/Issues Year 3

- Rat control continues to be successful in allowing the development of mature fruit and the establishment of seedlings within the ʻŌhikilolo and Makaleha to Manuwai PUs.

- The outplantings that augment the ʻŌhikilolo PU were supplemented with new plants and a new census of the small plants at the *in situ* sites with rat control found 640 immature plants.
- After three years of rat control, NRS began collection and propagation of mature seeds from seven founders from the Makaleha to Manuwai PU.

Plans for Year 4

- Continue to collect from unrepresented founders from the ʻŌhikilolo and Makaleha to Manuwai PUs for propagation and genetic storage.
- Continue to outplant into the ʻŌhikilolo and East ʻŌhikilolo to West Makaleha PUs.
- Consider constructing small fences around *in situ* sites with seedlings in East Makaleha.
- Survey the Makaleha to Manuwai PU.
- Monitor the Waiʻanae Kai PU and assess the need for rat control in order to collect for genetic storage.

Table 2.1.22a Taxon Status Summary

Action Area: In

TaxonName: Pritchardia kaalae **TaxonCode: PriKaa**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ohikilolo	Manage for stability	75	685	19	0	321	0	75	287	407	**75**	**1006**	**19**	Almost 700 plants counted as seedlings last year have been included as immature plants and additional plants were added to the existing reintroductions
Ohikilolo East and West Makaleha	Manage reintroduction for stability	0	0	0	0	75	0	0	72	0	**0**	**75**	**0**	Additonal plants were added to the existing reintroduction
	Total for Taxon:	75	685	19	0	396	0	75	359	407	**75**	**1081**	**19**	

Action Area: Out

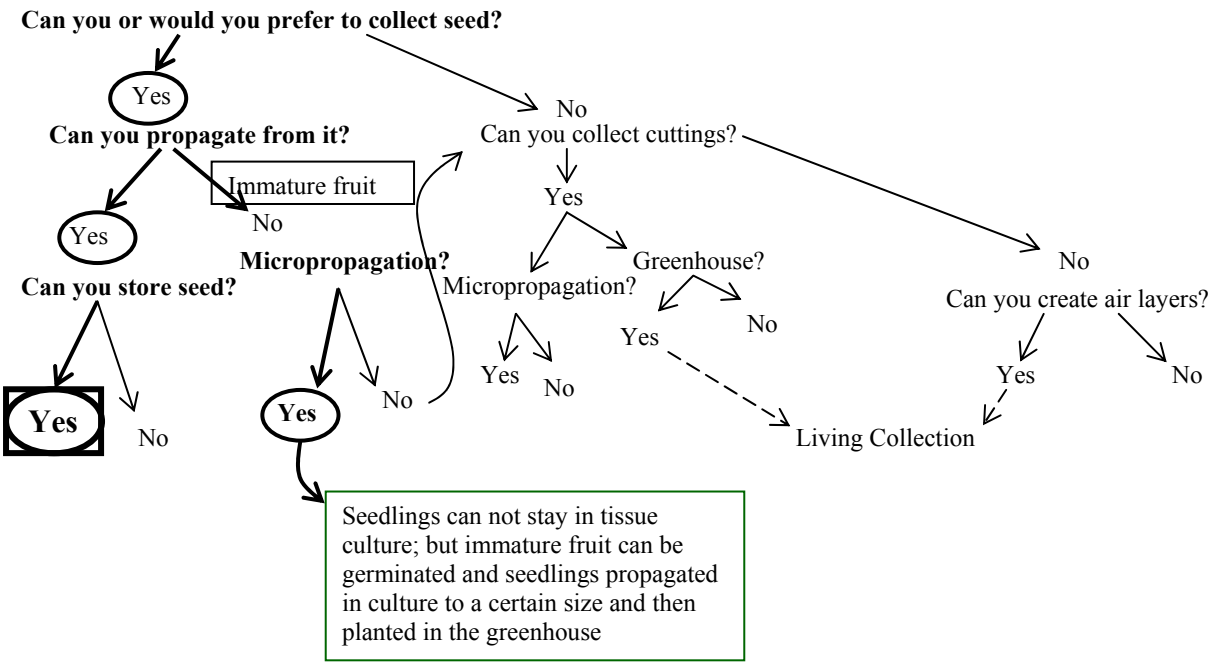
TaxonName: Pritchardia kaalae **TaxonCode: PriKaa**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Genetic Storage	4	0	0	0	0	0	4	0	0	**4**	**0**	**0**	No monitoring in the last year
Makaleha to Manuwai	Manage for stability	68	3	0	0	0	0	54	3	0	**68**	**3**	**0**	A more thorough census found more trees in the last year
Waianae Kai	Genetic Storage	4	5	0	0	0	0	4	5	0	**4**	**5**	**0**	No monitoring in the last year
	Total for Taxon:	76	8	0	0	0	0	62	8	0	**76**	**8**	**0**	

Propagation and Genetic Storage

1) At this time, what is the best preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OARNP 2006

Propagation: refer to OANRP 2006

Seed Storage: The NCGRP continues to conduct extensive seed storage research on the genus, *Pritchardia*. Researchers have determined that perceived dessication-sensitivity and potentially recalcitrant or intermediate storage behavior is not supported. Because seeds are so large and dense (in comparison to other MIP and OIP species), seeds need an exceptionally long time to dry. Standard drying procedures are for one month. Standards for *P. kaalae* are for at least three months, with continued monitoring of RH from month two through four. Seeds store well dry, but may contain certain lipids that would inhibit survival at -18C (see 2.00 Seed Storage). No aging has been detected at 4C, and NCGRP is currently conducting longevity trials at -80C. If -80C storage extends longevity more than 4C storage, NRS will store collections at this temperature.

Genetic Storage: NRS will follow NCGRP recommendations for seed storage protocols for this taxon and start to collect seeds for genetic storage. NRS is initiating a formal agreement with NCGRP for them to store these collections at -80C until NRS acquires their own facility.

NRS will also continue to collect from individuals that need to be represented at the reintroductions.

Table 2.1.22b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Pritchardia kaalae							
Makaha	4	0	0	0	0	0	0
Makaleha to Manuwai	68	3	0	0	1	3	2
Ohikilolo	75	685	0	4	16	28	28
Waianae Kai	4	5	0	0	3	0	2
				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	31	32

Outplanting Issues

NRS has been growing and outplanting *Pritchardia kaalae* onto ‘Ōhikilolo Ridge at MMR since 1999. Overall, outplanted individuals have high survivorship (347/403); however, they are not expected to mature for many years. *Pritchardia kaalae* seeds collected by National Tropical Botanical Garden Botanist Steve Perlman from ‘Ōhikilolo in the early 1990s were grown and planted into an irrigated section of the Hawai‘ian collection at the Waimea Audubon Center (WAC). NRS and David Orr from WAC estimate the mature trees in this collection took at least seven years after planting to become mature.

The ‘Ōhikilolo PU will be augmented with stock collected from the *in situ* sites on ‘Ōhikilolo. The ‘Ōhikilolo East and West Makaleha PU has no *in situ* sites and will be established by outplanting a mix of stock collected from both the ‘Ōhikilolo and Makaleha to Manuwai PUs. The Makaleha to Manuwai PU will be augmented with stock collected from the *in situ* once the MU fences in East Makaleha and Manuwai are built and ungulates removed.

Taxon Threats

This taxon is threatened 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 additional 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

Table 2.1.22c 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	Yes	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: There is one main cluster of 60 mature trees and 15 other outlying patches and solitary mature trees on ‘Ōhikilolo Ridge. There are also three medium sized immature plants near these mature trees. Several hundred immature plants between one and seven years old are now also growing under the main cluster of mature trees where rat control has been ongoing for ten years. In addition to these *in situ* sites, there are three large outplanting sites in this PU. 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 became established within the patch. NRS revised the population estimates in the last year to show that many of the plants that have been included as seedlings in past years are now several years old and have been moved into the juvenile size class. The number of smaller plants observed increased from 400 to 685. In addition, there are still seedlings in the PU that are estimated to be less than a year old. Until monitoring protocols are established to follow a subset of each size class, it may be difficult to determine the dynamics of the population structure in this extremely demographically fractured PU. All the sites in this PU are protected from goats by the ‘Ōhikilolo ridge crest fence, constructed in 1998. Pigs have not been observed as a threat. NRS has conducted weed control in the habitat around the managed *P. kaalae* sites. Stock from 44 of the 75 mature *in situ* founders has been outplanted and collections from the unrepresented trees will continue. NRS administers rat bait and deploys snap traps around three *in situ* sites. Baiting in the largest grid began in 1997 at the Prikaa-A patch (Table 2.1.22d). NRS re-stock 44 snap traps and 15 bait stations quarterly. This year the amount of bait taken increased compared to the last year, but not compared to the last five years.

Table 2.1.22d Prikaa-A Patch Baiting Data from 1997-2007

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Snapped	# of Snap Traps	# of Site Visits
1997	7	141	134	95%	2		1
1997-1998	7	200	125	63%	0		3
1998-1999	7	224	166	74%	3		4
1999-2000	7	252	249	99%	0		4
2000-2001	7	280	280	100%	2		3
2001-2002	7	672	577	86%	5	12	5
2002-2003	15	960	591	62%	9	12	4
2003-2004	15	960	874	91%	9	12	4
2004-2005	15	720	661	92%	7	12	3
2005-2006	15	1136	677	60%	11	18	4
2006-2007	15	672	550	82%	12	18	3

Makaleha to Manuwai: NRS has been monitoring more regions of this PU in the last year and has revised the population estimates. NRS expect numbers may continue to increase as new areas are monitored. The original counts were based on Joel Lau's estimates of trees observed, many from afar, between 1991 and 2001. NRS has been able to visit many of the locations and revise the data. There are still substantial numbers of inaccessible plants on the cliffs of Kaumoku Nui and Kaumoku Iki, which have not been included in this total. NRS plans to manage all of the threats in the portion of this PU that is within the East Branch of East Makaleha. Weed control will begin once the fence is built. NRS has been controlling rats around at least 40-50 trees in order to collect mature fruit. NRS administers rat bait twice a quarter to protect the fruit of *P. kaalae* at these sites. Eighteen bait stations and 27 snap traps are currently deployed in three grids around three groups of accessible trees (Table 2.1.22e). 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 conduct goat control until the fences are complete. Collections of mature seed have begun and they will be used for propagation for the East 'Ōhikilolo and West Makaleha PU reintroductions. In the coming year, NRS will continue to bait for rats, collect for propagation and survey to revise population estimates.

Table 2.1.22e Rat data for Makaleha *Pritchardia kaalae*

Upper Patch	#of bait stations	Amount of Bait Available	Amount of Bait Taken	% of Bait 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
2006-2007	6	560	421	75%	3	11	5
Lower Patch	**#of bait stations**	**Amount of Bait Available**	**Amount of Bait Taken**	**% of Bait 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
2006-2007	8	384	328	85%	8	8	3
TT Patch	**#of bait stations**	**Amount of Bait Available**	**Amount of Bait Taken**	**% of Bait 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
2006-2007	4	278	244	88%	2	8	4

‘Ōhikilolo East to West Makaleha: This PU has no known *in situ* sites and is located in between the known *in situ* sites to the north and south. Stock collected from trees in the *in situ* PUs will be used to establish reintroductions in this PU. Outplanting into the first site which is in West Makaleha in the Mokuleia Forest Reserve began in 2002. This site has high survivorship (41/46) and there is ongoing management of weeds and rats for this and other taxa. The second reintroduction site was established along the eastern portion of ‘Ōhikilolo ridge in 2002. The site is within the ‘Ōhikilolo ridge fence, and is protected from goats. 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 some were later decimated by pigs. A fence was constructed around this site and it has been supplemented with additional plantings in February 2006 and January 2007. The primary weed threats are *Schinus terebinthifolius* and *Melinus minutiflora* and control is ongoing.

Other PUs:

Mākaha: Four mature plants are known from very remote inaccessible sites in Mākaha and NRS will further scope the area to determine if plants can be reached in the coming year. They are tall and spindly and surrounded by weeds. Goats are known from the area, and NRS assumes that rats are present as well. Collections made from this PU would be incorporated into reintroductions and living collections.

Wai‘anae Kai: A small patch of trees are known from just outside the Action Area for Schofield Barracks West Range on the Wai‘anae side of the dividing ridge. NRS has not monitored this site in the last year but will assess the need to restart rat control in order to collect mature fruit for genetic storage and to establish a living collection of all available founders at Leeward Community College.

2.1.23 *Sanicula mariversa*

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial with infrequent, inconsistent flowering)
- Stable population structure
- Threats controlled
- Complete genetic representation in storage of all PUs
- Expedited Stabilization (10 yrs)

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/3	3/3	0/3	2/3	0/3

Taxon Level Discussion

In the most recent Biological Opinion (BO) the USFWS determined that this species should be considered for expedited stabilization prior to the use of some additional weaponry at Mākua Military Reservation (MMR). The requirements for expedited stabilization are that each of the three manage for stability (MFS) populations be at numerical stability within the next 10 years and that one of those three be outside the new AA (see Executive Summary). The current MFS populations are: ʻŌhikilolo (inside the MMR AA), Keaʻau (inside the MMR AA), and Kamaileʻunu (outside the AA); Puʻu Kawiwi (outside the AA) will be managed for genetic storage collection.

This year NRS attempted to conduct a thorough monitoring of all individuals at each of the four known populations. Additional highlights from this year include the fencing of the Puʻu Kawiwi PU in Makaha and the observation of mature individuals at this site. This year NRS revisited this site and observed more individuals than in previous years and were able to represent this population in seed storage.

In the coming year NRS plan to continue long-term monitoring of individuals begun this year and will initiate greenhouse or *in situ* monitoring of laboratory-germinated seed in order to further understand the growth dynamics of this species. NRS also plan to construct the Kamaileʻunu and Keaʻau fences to protect these populations from goats.

Major Highlights/Issues for Year 3

- NRS conducted thorough monitoring of all individuals at each population
- NRS observed mature individuals at Puʻu Kawiwi
- The Puʻu Kawiwi population was fenced this year.
- FWS determined that this species requires expedited stabilization within 10 years (USFWS 2007)

- Installed data loggers to measure temperature at both ‘Ōhikilolo, Kea‘au, and Kamaile‘unu PUs.

Plans for Year 4

- NRS will fence the Kamaile‘unu site in the coming year
- Deploy data loggers at the Pu‘u Kawiwi
- Collect seed for dormancy and germination studies
- Conduct buried seed studies *in situ* to determine soil seed bank potential
- NRS will conduct greenhouse or *in situ* studies to provide more information on the growth rate, seasonality, and development of individuals when seedlings become available.
- Continue long-term monitoring of individuals in each PU

Figure 2.1.23a Recently monitored *Sanicula mariversa* in Kea‘au

Table 2.1.23a Taxon Status Summary

Action Area: In

TaxonName: Sanicula mariversa **TaxonCode: SanMar**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Manage for stability	11	359	5	0	0	0	14	114	0	**11**	**359**	**5**	Due to thorough monitoring more individuals were observed this year
Ohikilolo	Manage for stability	3	112	0	0	0	0	0	52	0	**3**	**112**	**0**	Due to thorough monitoring more individuals were observed this year
	Total for Taxon:	14	471	5	0	0	0	14	166	0	**14**	**471**	**5**	

Action Area: Out

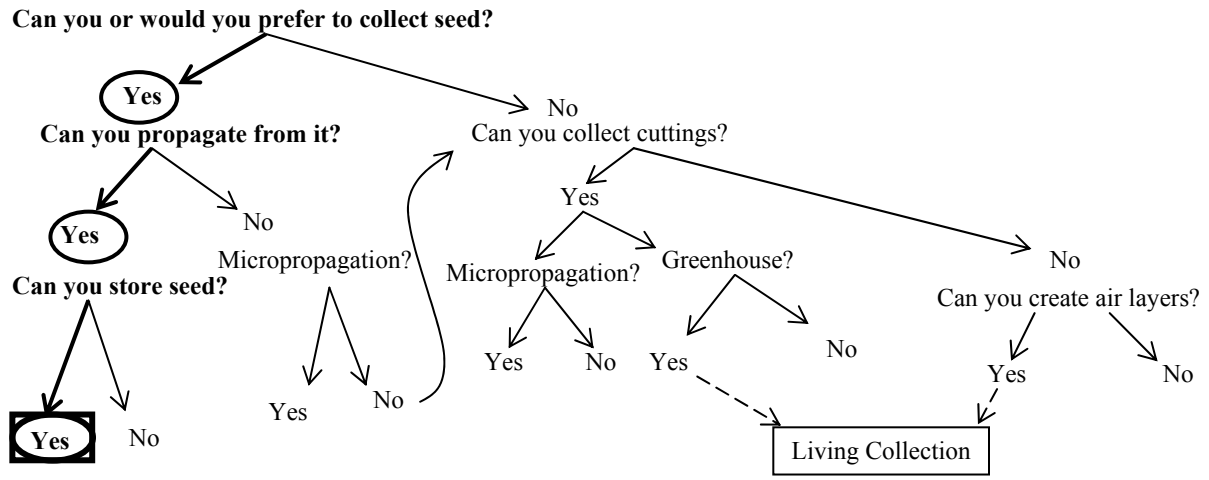
TaxonName: Sanicula mariversa **TaxonCode: SanMar**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu	Manage for stability	5	188	13	0	0	0	4	36	0	**5**	**188**	**13**	Due to thorough monitoring more individuals were observed this year
Puu Kawiwi	Genetic Storage	1	21	1	0	0	0	0	4	0	**1**	**21**	**1**	Due to thorough monitoring more individuals were observed this year
	Total for Taxon:	6	209	14	0	0	0	4	40	0	**6**	**209**	**14**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006.

Propagation: Higher fresh germination was observed from collections made from Kea‘au this year than was expected based on average fresh germination from previous years. Seeds started to germinate eight months after sowing and finished germinating ten months after sowing.

In conjunction with ongoing population viability assessment research (see Research Issues), NRS will propagate all seedlings produced from initial viability assays. These assays will be initiated next year following collection. Plants will be grown out to maturity and growth rate will be measured. This data will be applied to the *in situ* growth measurements to aid in the determination of size classes and to determine what, if any, growth variables could serve as indicators of when a plant will likely reach maturity.

Seed Storage Research: Both fresh and stored seeds exhibit high variability in germination. Sources for variability may be in seed viability (filled vs. unfilled), germination requirements, and laboratory methods. If seeds actually have highly variable seed set, germination tests may be reflective of this, regardless of germination or storage treatment. If there are specific germination requirements or ranges of temperatures that seeds must be exposed to in order to stimulate germination, assays up to now may have been only accounting for random germination throughout collections. In addition, germination substrates and temperatures have been highly irregular and inconsistent. Eliminating these laboratory variables will better address other sources of variation. Based on delayed fresh germination (sometimes up to eight months), the fact that germination of stored seed has been the highest after five years of storage, and that dormancy has been established in other species of *Sanicula*, dormancy is a reasonable

explanation for low germination. NRS will continue to study dormancy in the laboratory, collect temperature data *in situ*, and conduct buried seed trials *in situ* to determine how long seeds last in the soil.

Genetic Storage: NRS continued to make collections from the Puʻu Kawiwi, ʻŌhikilolo, and Keaʻau PUs.

Table 2.1.23b 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	5	188	41	46	0	0	39
Keaau	11	359	29	53	0	0	40
Ohikilolo	3	112	73	48	0	0	15
Puu Kawiwi	1	21	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
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 ʻŌhikilolo. 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 four growing seasons. A seed sowing trial was conducted in 1999 but only one plant was observed the next year. This year seeds were germinated and NRS will study the growth rate of these individuals either in the greenhouse or *in situ*.

Research and Monitoring Issues
As mentioned in previous reports (OANRP 2005b, 2006), this species has been challenging to monitor over time. The deciduous growth cycle of this species and dynamic fluctuations from year to year in the number of 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. Additionally, not all immature individuals emerge each year. It is assumed that seedlings take several years to reach maturity.

This year NRS marked every individual in each population in order to monitor them over time to collect demographic data that will lead to development of a minimum viable population size. Every individual observed was tagged, mapped, and measurements of the number of leaves

(and/or number of cotyledons), height of longest petiole, and radius of largest leaf were taken. Additionally, every reproductive individual was measured for height of inflorescence and number of fruit. This will help in projecting needs for reintroductions, genetic storage collections, and more accurately determine stability goals. It will be several years before NRS are able to determine what measurements are relevant to being able to determine when an individual is likely to mature or what the survivorship is as these individuals move through stage classes. However, as early as next monitoring NRS will be able to determine if the current method for marking individual plants is effective. Phenology data was collected to determine the number of immature fruit each individual produced this year (avg. 211.4 fruit, n=10).

Figure 2.1.23b is a box plot of the length of the longest leaf by population. While Figure 2.1.23c is a box plot of the number of leaves and the radius of the largest leaf by population. Figures 2.1.23d-f also show the three main data sets by population. All of these graphs show that each of the data sets are pretty similar across each population. The line graphs are first look at how well the data may fit a normal distribution and in subsequent years NRS will be able to track a subset of the individuals in each size class. At this time it is difficult to know where to divide the large immature size class into sub-classes of small, medium, and large or which data set is most informative. Although, this years data show that the length of the longest petiole for each individual is not a normal distribution and may be dependant on abiotic microsite differences such as light levels.

Figures 2.1.23d-f are regression plots to show how well each of the three main data points are able to predict any of the other values. Where: S is measured in the units of the response variable and represents the standard distance data values fall from the regression line. (For a given study, the better the equation predicts the response, the lower S is); R^2 (R-Sq) describes the amount of variation in the observed response values that is explained by the predictor(s). R^2 always increases with additional predictors; and Adjusted R^2 is a modified R^2 that has been adjusted for the number of terms in the model. If you include unnecessary terms, R^2 can be artificially high. Unlike R^2, adjusted R^2 may get smaller when you add terms to the model. Use adjusted R^2 to compare models with different numbers of predictors (Minitab 2007). If a regression model shows that any two data sets are highly correlated (perhaps >85%) then NRS may not need to collect both sets of data in the field, as one measurement may accurately predict the other.

Figure 2.1.23b Length of longest petiole by population

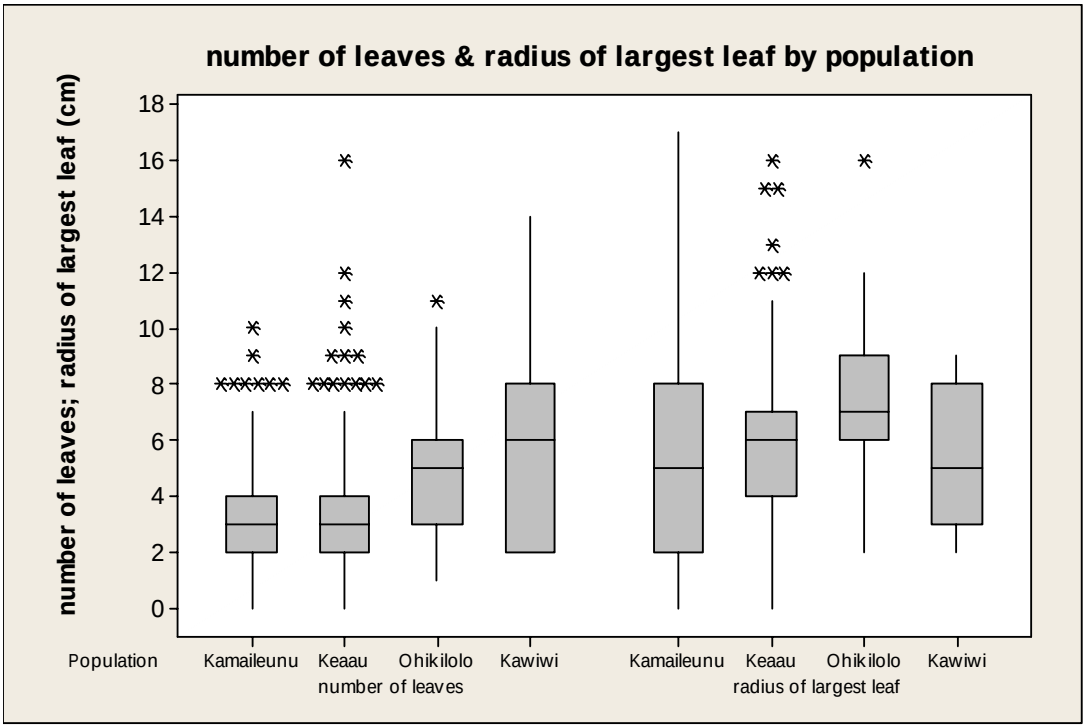


Figure 2.1.23c Number of leaves & radius of largest leaf by population

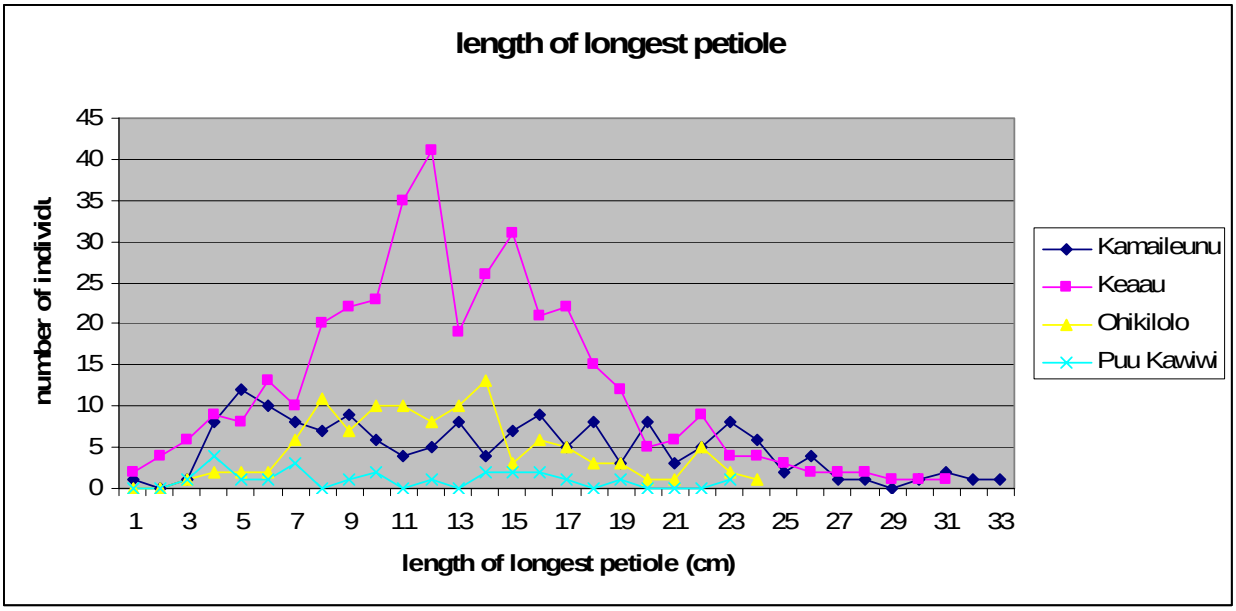


Figure 2.1.23d Counts of the length of longest petiole for each individual by population

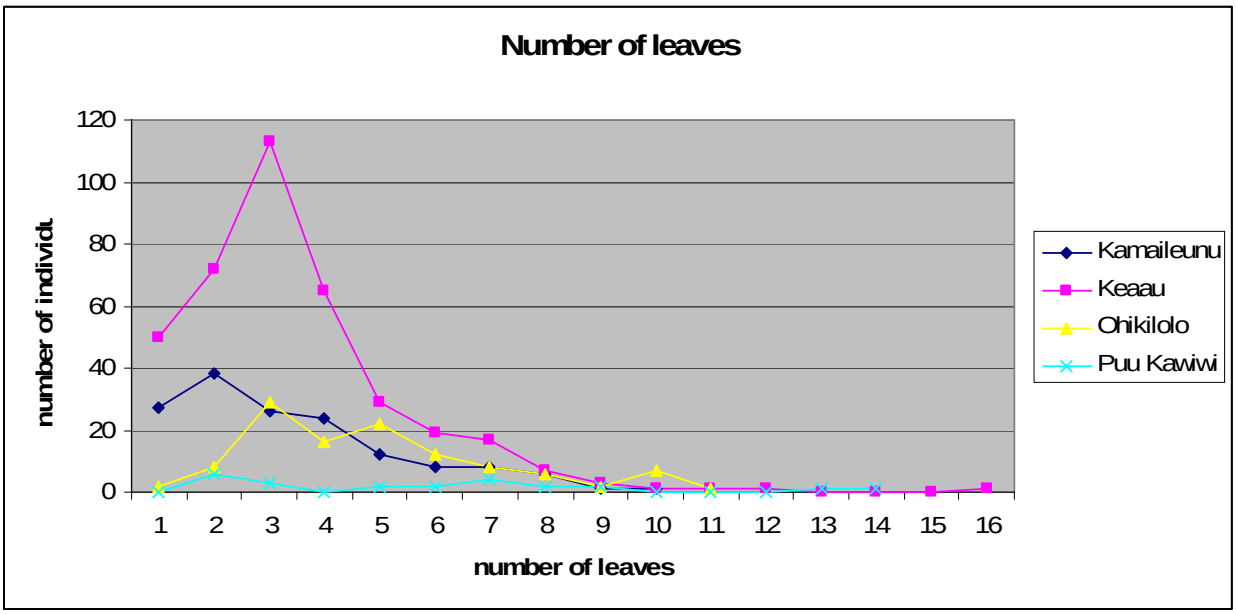


Figure 2.1.23e Counts of number of leaves for each individual by population

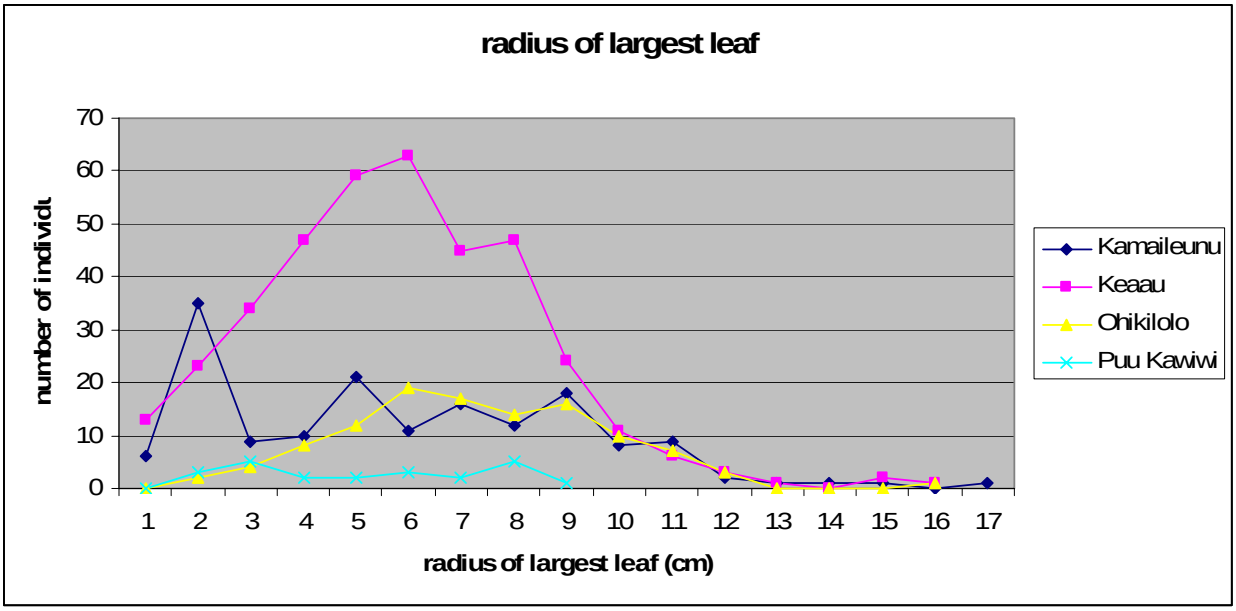


Figure 2.1.23f Counts of radius of largest leaf for each individual by population

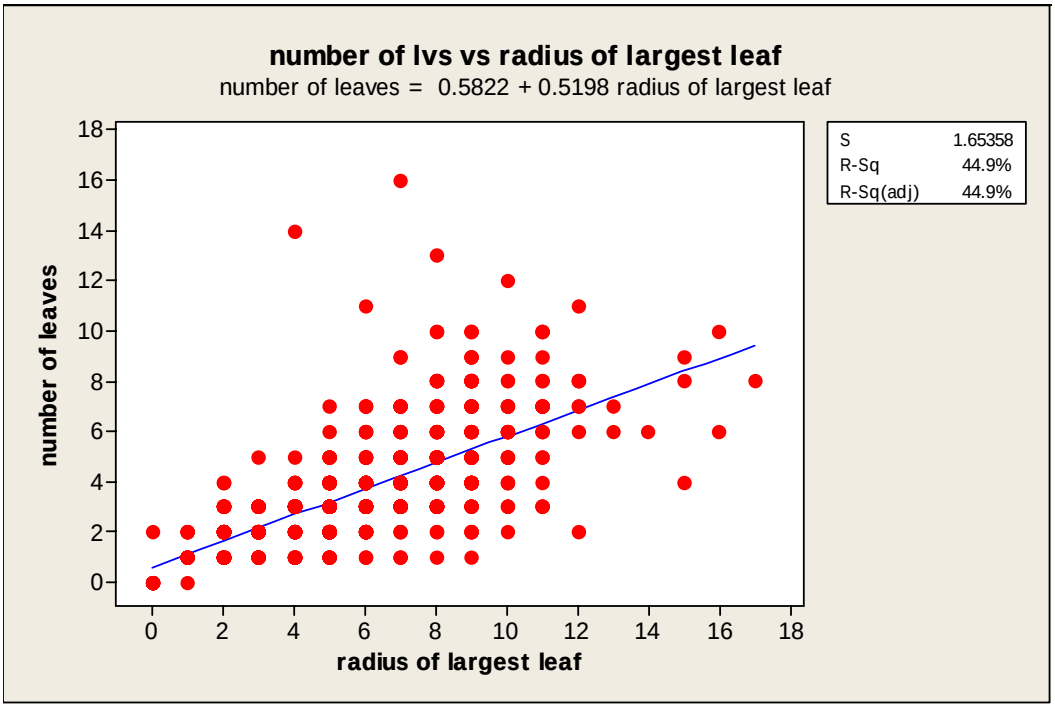


Figure 2.1.23g Regression analysis of number of leaves versus the radius of the largest leaf

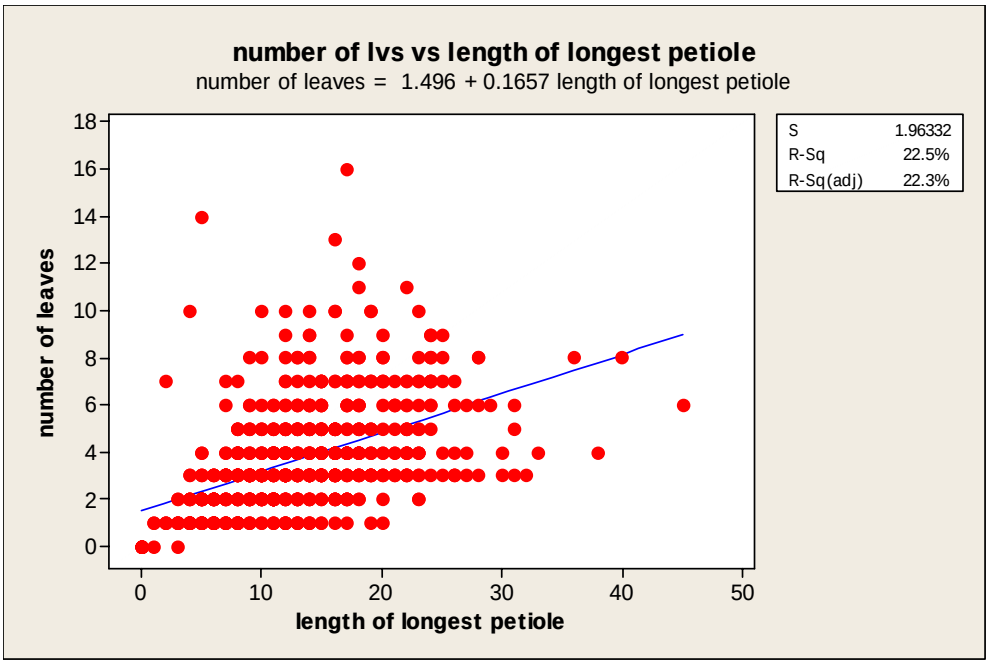


Figure 2.1.23h Regression analysis of the number of leaves versus the length of the longest petiole

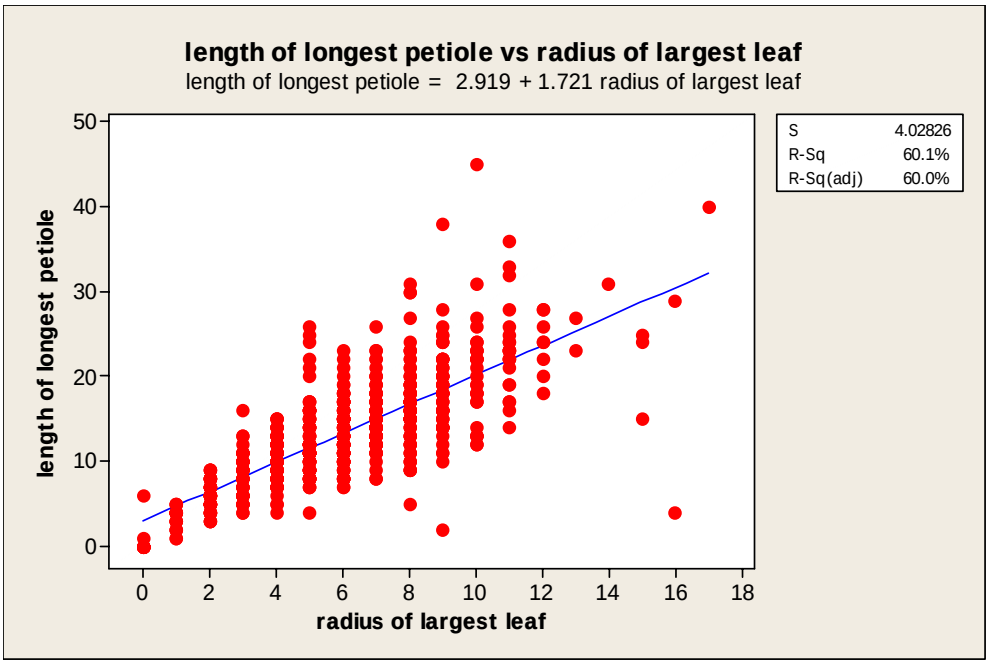


Figure 2.1.23i Regression analysis of length of longest petiole versus radius of largest leaf

The regression analysis depicted in figure 2.1.23d shows the number of leaves and the radius of the largest leaf are 44.9% correlated (R^2=44.9, P=<0.05). Figure 2.1.23e shows the number of leaves and the length of the longest petiole are only 22.5% correlated (R^2=22.5, P=<0.05). The final regression analysis (Figure 2.1.23f) shows the length of the longest petiole and the radius of the largest leaf are 60.1% correlated (R^2= 60.1, P=<0.05). This was the highest level of

correlation among the three data sets. However, the R^2 value indicates one measurement will only predict the other with 60.1% accuracy. Next year NRS will continue to take these three measurements and re-evaluate when more data is available. Eventually, NRS would like to use this information to reassess stability targets for this species as the stability goal of 100 mature individuals may be unrealistic for this monocarpic species.

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. It does not appear that goats are consuming this species but they can cause significant habitat degradation. Currently, two of the four PUs are protected from goats. NRS plan to have all four existing PUs fenced within the coming year.

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 Threat Control Summary

Table 2.1.23c Population Unit Level Discussion (*rats have not been observed to be a threat to this species)

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	Yes	No	No

Manage for Stability PUs

‘Ōhikilolo*:* There are two sites on ‘Ōhikilolo where *S. mariversa* has been observed. The mauka site was first monitored in 2001 when 12 individuals were observed. No individuals were seen in 2005 and the site was not monitored this past year. The makai site has been monitored regularly since the inception of the Army program in 1995. NRS conducted a seed sowing experiment in 1999 and trial outplanting of this species away from the wild plants in 2001. Plants from the

outplanting emerged for two consecutive years however no plants have been observed at this site since 2003. None of the outplanted individuals reached maturity.

As mentioned, NRS conducted a thorough monitoring of the main makai population this year. More individuals were observed this year than any year previous. However, NRS do not believe the population had a sudden increase in numbers. Rather, thorough monitoring resulted in more individuals being observed.

Kea‘au: Significant seed collections have been made from this PU. This PU is also severely impacted by goats and erosion caused by goat populations. Even though goats appear to walk across the lower portion of this PU, NRS observed this population to be the largest of the known locations with 375 individuals. NRS plan to fence this population in the coming year. This site is largely covered in non-native grass habitat restoration with common native grass and shrub species will be considered.

Kamaile‘unu: NRS observed a total of 206 individuals at this PU this year. More individuals were observed due to a thorough monitoring. This area is severely impacted by goats. 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. NRS plan to construct this fence over the coming year. Once the ungulate fence is constructed, NRS will need to conduct weed control in this area.

Other PUs

Pu‘u Kawiwi: This is the smallest known population and is designated to be managed for genetic storage. This PU requires a helicopter to access. Even though it is steep, goats are a threat to the area. NRS were able to fence this population in the last year. This year NRS observed a total of 23 individuals, the largest number recorded for this site over the last five years. This was also the first year NRS observed a flowering individual at this population. Fruit from this individual was collected and is being stored in the Army Seed Conservation Lab.

2.1.24 *Schiedea kaalae*

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
0/4	2/4	0/4	4/4	3/4

Taxon Level Discussion

There are many small PUs of this taxon across Oʻahu. NRS designated four MFS PUs because this taxon is in the Action Area (AA) for both the MMR and SBW training areas. 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 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. NRS periodically monitors this PU with the Oʻahu PEP program.

NRS observed recruitment and vegetative reproduction in both the Waiʻanae and Koʻolau Mountain Ranges amongst wild and reintroduced populations. Numerous seedlings were observed around several TNC outplantings in the Central and North Kaluaʻā area over the last few years (Figure 2.1.25a). NRS staff also observed that reintroduced plants in good microsites (e.g. Puʻu Hāpapa) are growing more vigorously than in areas that are seasonally water limited. Based on observations at Maʻakua Gulch, vegetative reproduction is more likely to occur in vigorously growing individuals.

Currently, NRS efforts are focused on establishing large reintroductions in the Waiʻanae PUs and researching slug control techniques (Chapter 5.2 Slugs). Until a slug control technique is developed, large reintroductions will hopefully overcome slug predation by producing a large seedbank.

The smaller non-MFS PUs will be managed for genetic storage.

Major Highlights/Issues for Year 3

- The first phase of slug control research was completed (Chapter 5.2 Slugs),
- Vegetative reproduction and seedlings continue to be observed at some TNC reintroduction sites in Kaluaʻa (Figure 2.1.25a), but most Waiʻanae PUs do not show any recruitment.
- Smaller, non-MFS PUs continue to decline in numbers (e.g. both the Mohiākea and Kaipapaʻu wild individuals were lost due to rockfall).
- A ten acre pig exclosure was completed in Makaua Gulch in the Koʻolau Mountains protecting *S. kaalae* habitat for that PU.

Plans for Year 4

- Continue balancing founders at reintroduction and/or augmentation sites.
- Continue slug control research (see Chapter 5.2). A label change is being pursued to use Sluggo® in the field and more research is needed to determine application rates and intervals in order to increase seedling survivorship.
- Continue genetic storage collections.
- Complete the larger ʻĒkahanui fence for more outplanting sites.
- Continue monitoring reintroduction sites and plant performances at different microsites.

Figure 2.1.24a Seedlings at North Kaluaʻa on left and vegetative reproduction at Puʻu Hāpapa on right

Table 2.1.24a Taxon Status Summary

Action Area: In

TaxonName: Schiedea kaalae — TaxonCode: SchKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Mohiakea	Genetic Storage	0	0	0	0	0	0	1	0	0	0	0	0	Plant died in the last year.
Pahole	Manage for stability	2	0	0	39	9	0	19	3	0	41	9	0	NARS reports no change to the wild site other than augmentation by NRS.
	Total for Taxon:	2	0	0	39	9	0	20	3	0	41	9	0	

Action Area: Out

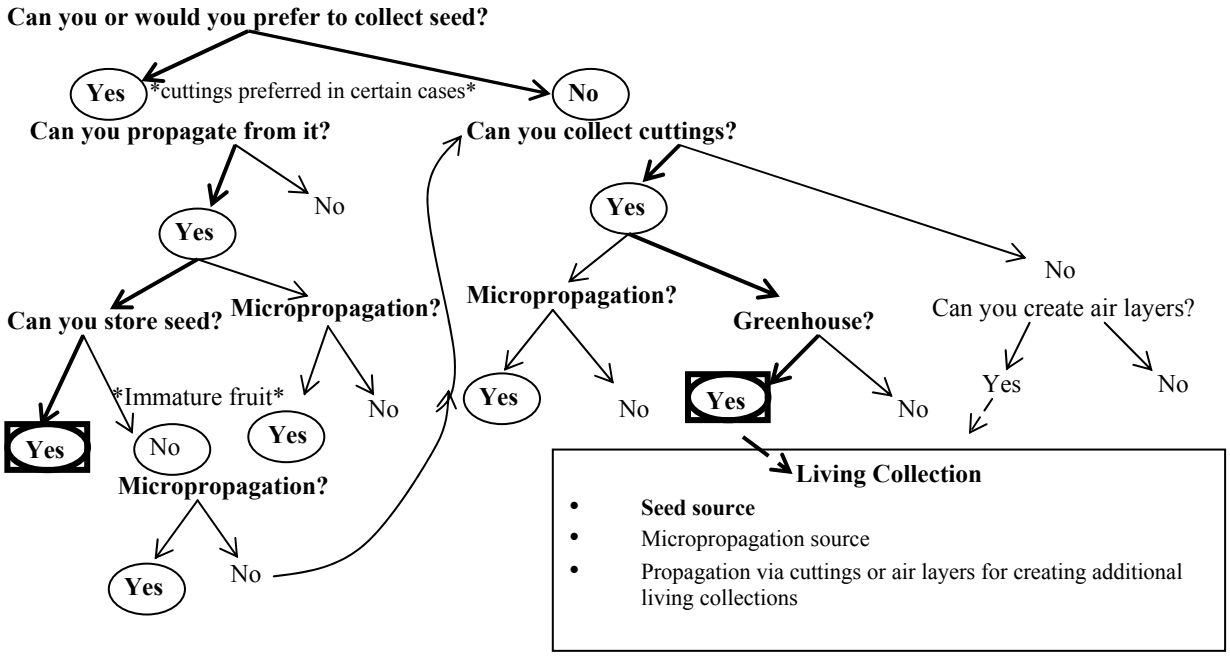
TaxonName: Schiedea kaalae — TaxonCode: SchKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	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	7	0	0	3	0	0	5	2	0	10	0	0	PEP reports no change, more plants are likely exant in area.
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	0	0	0	16	0	0	16	0	0	No monitoring the last year.
Makaua (Koolaus)	Genetic Storage	1	0	0	8	0	0	1	1	0	9	0	0	PEP reported no change at the wild site, 7 individuals outplanted at the new fence area upgulch.
North Palawai	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring found no change.
South Ekahanui	Manage for stability	13	0	0	56	0	0	70	0	0	69	0	0	No change to the wild plants and more plants augmented to the larger fenced area.
	Total for Taxon:	38	0	0	67	0	0	93	3	0	105	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)** Has a successful storage method been determined?	**4)** Are additional steps required for obtaining enough seed?
Cuttings for maintaining wild clones; *in situ* and reintro-produced seed for outplanting.	Seed storage and living collections to produce seed.	Yes	Yes, it is more practical to keep the Koʻolau PUs as living collections in the greenhouse given the remote locations of some of the Koʻolau PUs

Prioritizing Genetic Storage & Propagation Techniques



Collection: Seeds may be able to germinate in the mature capsules if they are moist. For example, they may retain moisture from dew or rain. When collections contain some seeds with radicles already emerging, germination is likely underway for many of the seeds from that collection. Seeds that have already started the germination process, even prior to radicle emergence, have lost the ability to withstand desiccation. These seeds, therefore, can not be stored. NRS will maintain viability testing and continually look for germinating seeds in a collection to secure desiccation-tolerant seeds for genetic storage.

Propagation: refer to OANRP 2006.

Seed Storage Research: No aging has been detected for dry storage at 4C or -18C after five years.

Genetic Storage: Seed collections continue for plants in more easily accessible PUs. Clonal stock is being secured in the greenhouse for eventual seed collection. Seeds from living collections will be used for storage testing, outplanting, and genetic storage.

Table 2.1.24b 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	7	0	0	0	5	0	4
Kaipapau	0	0	2	0	2	0	1
Kaluaa and Waieli	0	0	1	1	1	1	1
Maakua (Koolaus)	16	0	0	0	4	0	3
Makaua (Koolaus)	1	0	0	0	2	0	0
Mohiakea	0	0	1	0	0	1	0
North Palawai	1	0	0	1	0	1	1
Pahole	2	0	0	2	1	2	2
South Ekahanui	13	0	3	12	3	12	13
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				17	18	18	26

Outplanting Issues

In addition to ungulate fencing and ecosystem scale weed control, outplanting has been the primary focus of field work with this species. Plants are easily grown to outplanting size in about a year from seeds or cuttings. Currently, five reintroduction/augmentation sites are monitored and maintained by NRS in three MUs. The goal is to maximize the amount of genetic exchange between all the remaining founders by planting an equal number of plants from each founder.

At, one experimental reintroduction site at Pahole (PAH-E) begun in 2006 only eight plants out of 29 plants planted have survived (28% survivorship). This compares with roughly a 60% survival rate over a two year period for NRS outplanting sites in ʻĒkahanui and Kaluaʻa. NRS assisted NARS staff in planting into a rock wall with netting along the stream bottom and at other sites in the ground. Water stress over the past year likely contributed to the steep decline in survivorship compared to other reintroductions in the Pahole NAR. The newest reintroductions in the Pahole NAR have survivorship rates above 90% (planted in the ground). The rock wall reintroduction effort highlights the value of experimenting with different microsites to determine the requirements for survival and recruitment overtime. Wild *S. kaalae* have been observed growing out of rock walls and waterfalls in the both the Waiʻanae and Koʻolau Mountain Ranges. These types of experimental outplantings are particularly informative for species such as *S. kaalae* that have only a few remaining relict populations and whose precise habitat requirements are unclear.

In 2006 TNC established three additional reintroduction sites in North Pualii, North Kaluaʻā and Puʻu Hāpapa. These other TNC sites will be monitored by NRS staff in conjunction with other management work to learn about plant performance and recruitment rates at these different microsites.

Table 2.1.24c 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	1	1
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	19
	Total for Taxon:	**48**	**25**

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

As the above table highlights, a little more than half of the founders are already represented in outplantings. Twenty-three founders not represented in outplantings are from the Koʻolau Mountains in the Kahana and Maʻakua PUs. The recently completed ten acre Makaua fence will serve as an outplanting site for the Kahana and Makaua PUs.

Research Issues
Slugs pose the most significant threat to this species in fenced areas. The NRS Research Specialist is researching control techniques (Chapter 5.2 Slugs).

Surveys
NRS will continue to encourage and assist PEP staff with more surveys in the Koʻolau PUs to locate additional plants, particularly in the Kahana PU.

Taxon Threats
As mentioned previously, slugs are the primary threat to this fleshy leaved, basal rosette species. Pigs are also considered a significant threat as this plant species prefers gulch bottom and lower slope habitats which are frequently disturbed by pigs. Most PUs are however, protected by fences. Rat damage was observed on individuals in the Pahole reintroduction in 2005. This seems to have been a one time event and has not been observed since. Rockfall also continues to threaten individual plants as this species prefers talus slopes along gulch bottom areas. Prolonged drought also threatens this species given its relatively high transpiration rates from large, wide leaves.

Population Unit Level Discussion

Table 2.1.24d 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	Partial	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	Partial	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	No	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	Partial	Yes	Yes

Manage for Stability PUs

Pahole: The NARS Specialist and NRS continue to monitor the two remaining wild plants. Propagule collection and nursery cultivation of clones (via cuttings) are ongoing. An augmentation was first established by NARS in Pahole Gulch in 2005. Two new reintroductions were planted by NRS in the current reporting period at Kapuna Gulch and Pahole Gulch. A total of three reintroduction sites now exist and all three sites are considered to be augmentations given their relative proximity to the remaining wild plants.

South ‘Ēkahanui: There are still 13 mature wild plants in ‘Ēkahanui however no juveniles or seedlings have survived at these sites. A few of the wild plants continue to reproduce vegetatively. All plants are within ungulate fences and NRS and TNC have been monitoring, collecting seeds and controlling weeds around these plants for many years. The augmentations in this site have been established using stock from many different founders. A 150 acre fence

will be completed in ʻĒkahanui by Spring 2008 and will provide more outplanting sites in the coming year.

Central Kaluaʻā: There are no longer any wild plants in this PU. This PU currently consists of three TNC outplanting sites located in the Central Kaluaʻā fence and one NRS reintroduction site. TNC maintains three 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. NRS also plan to continue supplementing the site with more plants to balance the founders and replace any losses.

Maʻakua: NRS did not visit this site last year and will work with PEP in the coming year to ensure that collections are established as a living collection. Waterfalls protect this PU from ungulates.

Other PUs

Huliwai: There are no wild plants left in this PU. NRS will continue to hold this stock as a living collection and collect seeds for use in reintroduction and storage.

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. Both plants are represented at Lyon and will serve as a living collection in the nursery and a propagule source. Much of the upper reach of this stream has not been surveyed due to inaccessibility and additional plants are likely to be found along those upper reaches.

Makaʻua: PEP has been monitoring this PU over the last year. One mature and one immature plant were observed here in the past. The immature plant died in the last year. Cuttings have been collected from both plants and are growing successfully at Lyon Arboretum. They will serve as a living collection.

Mohiākea: The only known wild plant from this PU recently died due to rockfall. Seeds were collected and individuals grown from these collections were outplanted in Kaluaʻā. NRS will collect mature seed for storage and supplement the existing site in Kaluaʻā utilizing seeds or cuttings from the Mohiākea stock outplanted in Kaluaʻā.

North Pālāwai: There is one mature plant in Pālāwai; it continues to seed prolifically as in past years. This plant is at least ten years old. A PU fence protects it from ungulates and small scale weeding is occasionally conducted. NRS will continue to work with TNC to monitor this site and collect mature seed for storage and propagation for outplanting as needed.

North Kalua‘ā: This population has not been observed since 2000, when a single mature plant was observed and collected. This stock is both in genetic storage and being grown for reintroduction into the Central Kalua‘ā outplanting site. NRS occasionally monitors the known historic locations for this PU in the course of other management work.

Figure 2.1.24b Healthy outplants at Pu‘u Hāpapa

2.1.25 *Schiedea nuttallii*

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Expedited Stabilization (5 years)

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
1/3	2/3	0/2 (only 2 *in situ* PUs)	2/3	0/3

Taxon Level Discussion

Schiedea nuttallii is extremely rare and appears to be in severe decline. There are three *insitu* population sites known, all of which fall in the Kahanahāʻiki to Pahole PU. One of these sites consists of a single plant. The Kahanahāʻiki to Pahole PU has reached the goal set for number of reproducing individuals. The goal has been reached mostly due to reintroduction. Forty-two of the 61 mature plants in the PU are reintroduced plants. This year there was a significant decline in the wild population in Kahanahāʻiki. This site formerly had the most onsite recruitment. Drought is believed to be a significant cause of this abrupt decline. NRS have however been collecting clones and seed from this population since 1996 and therefore not all founder stock is lost. Numbers of plants in the two *in situ* sites in Pahole remain relatively constant, and two new individuals were found this year.

The last known plant at the Kapuna-Keawapilau Ridge PU died this year. NRS had representation from three of the four known plants from this site, however, two of these wild stock were lost in the greenhouse.

This year *Schiedea nuttallii* has been designated by the Fish and Wildlife service as a species "Expedited for Stabilization." Conservation measures required for this status include 3 MFS PUs, and that numerical stabilization be reached at one of the MFS PUs *outside* the Makua Action Area within five years. There are currently only two extant PUs and the Mākaha PU will be the third MFS PU. NRS will plan to reach the goal of 50 mature plants in the Mākaha PU in five years to satisfy this requirement. Considerable propagation and reintroduction efforts will have to take place in the next few years to establish such a population. While NRS feel it is important to get Kahanahāʻiki stock established in Mākaha as another MFS site, efforts to boost numbers at the extant populations are believed to be of greater overall significance to this species as a whole.

Major Highlights/Issues Year 3

- Kapuna fence construction has begun.
- Species identified as expedited for stabilization in five years by USFWS in the 2007 MMR Biological Opinion.
- The Mākaha fence is finished and a small number of plants were reintroduced this year.
- The only extant plant in the Kapuna to Keawapilau PU died this year.
- Two founders from the Kapuna to Keawapilau PU died in the greenhouse this year; stock from only one founder now exists.
- NRS continued to get genetic representation from wild plants in Kahanahāʻiki and Pahole (with the help from NARS staff).
- There was a significant decline in wild plants found in Kahanahāʻiki this year.
- A new reintroduction site was established in Pahole this year for Pahole stock.

Plans for Year 4

- Continue to reintroduce Kahanahāʻiki stock into Mākaha.
- Spend time looking for recruitment at wild and reintroduced sites.
- Assist NARS with Kapuna subunit IV fence construction.
- Reassess reintroduction/augmentation plans for the Kapuna to Keawapilau PU.

Figure 2.1.25a *Schiedea nuttalii* individual *in situ.*

Table 2.1.25a Taxon Status Summary

Action Area: In

TaxonName: Schiedea nuttallii TaxonCode: SchNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	19	3	4	42	4	0	80	8	3	**61**	**7**	**4**	Monitoring showed significant decline in wild population in Kahanahaiki
Kapuna-Keawapilau Ridge	Manage for stability	0	0	0	0	0	0	3	0	0	**0**	**0**	**0**	All of the known plants have died in the last year
	Total for Taxon:	19	3	4	42	4	0	83	8	3	**61**	**7**	**4**	

Action Area: Out

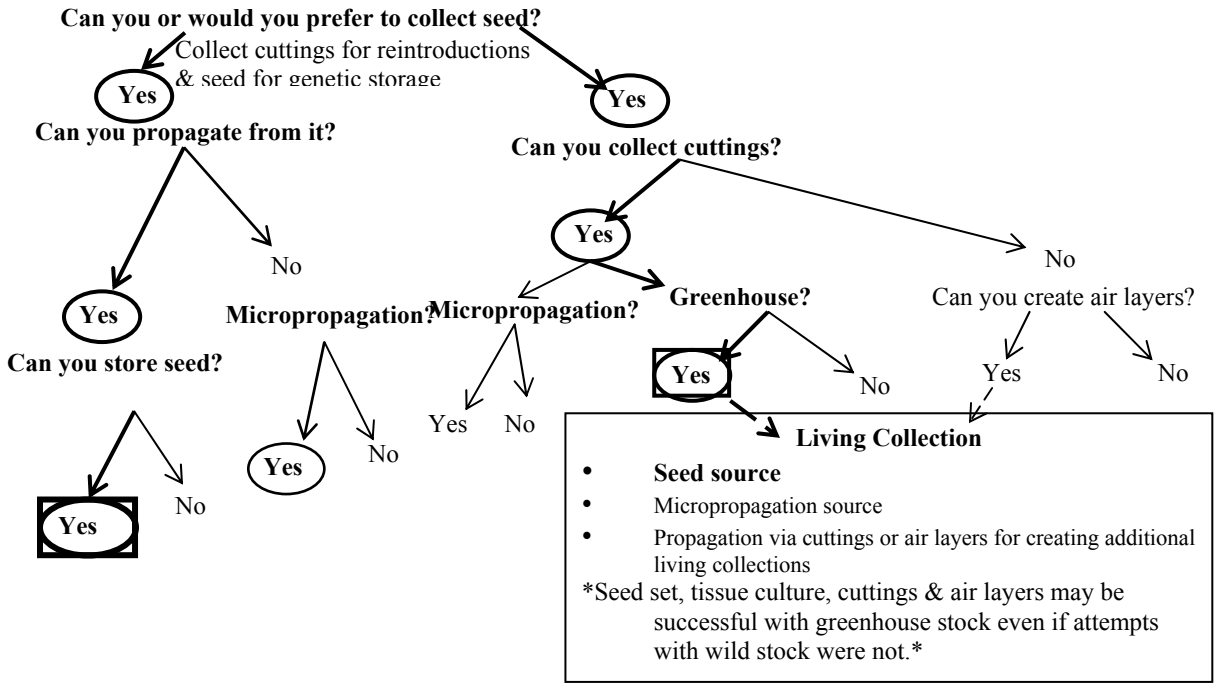
TaxonName: Schiedea nuttallii TaxonCode: SchNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	7	0	0	0	0	0	**7**	**0**	**0**	7 plants outplanted into Makaha this year
	Total for Taxon:	0	0	0	7	0	0	0	0	0	**7**	**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) Has a successful storage method been determined?	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	Yes, collect from living collections

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: refer to OANRP 2006

Genetic Storage: NRS will continue to increase the living collection for this taxon for seed collection as well as propagate for reintroductions. Additional founders from Pahole were collected and propagated at Pahole Mid-elevation Nursery. Wild plants that had died and had been reintroduced were collected from to secure in the greenhouse for propagation stock and eventually to be used as a seed source. Aging has yet to be detected in stored seeds for four years at 4C and -18C at the Army Seed Conservation Lab. Therefore, NRS will not re-collect more often than every four years until storage data indicates otherwise.

Table 2.1.25b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Schiedea nuttallii							
Kahanahaiki to Pahole	19	3	41	16	1	26	21
Kapuna-Keawapilau Ridge	0	0	4	0	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**
				16	1	27	21

Unique Species Observations

No new observations were made during this reporting period.

Outplanting Issues

Reintroductions have been established at four sites in the Kahanahāʻiki to Pahole MU; two in Kahanahāʻiki and two in Pāhole. While NRS still monitor the remaining plants in the Kahanahāʻiki sites, reintroduction will no longer continue at these sites, as more appropriate site, historically known with *S. nuttallii* has been chosen instead. This site occurs on the Pahole side of the Pahole/Kahanahāʻiki fenceline and NRS have been balancing founders here for three years. NRS aim to have at least two representatives from each founder in this reintroduction of Kahanahāʻiki stock. Kahanahāʻiki stock will also be represented in the Mākaha reintroduction that began this year with 7 plants. This year, NRS established a site in Pahole of all Pahole stock, of which there are currently 15 founders. NRS still have not observed any recruitment on site at any reintroduction. However, NRS will make a concerted effort this winter to look for seedlings at all sites where mature individuals have contributed to the seedbank.

NRS had originally hoped to augment the Kapuna-Keawapilau Ridge PU using stock from the four known *insitu* founders in this PU. However, now that there is only stock from one of these founders, NRS need to reassess the reintroduction plan for this PU. NRS do not want to start a reintroduction with only one founder, therefore mixing with the next closest population, Pahole, seems appropriate. When the Kapuna subunit III and IV fences are finished, NRS will consider where to establish a reintroduction for this stock.

Schiedea nuttallii is a particularly fragile plant that is sometimes damaged during transport to outplanting sites. Plants have many opportunities to be broken as they are hand loaded into a transport device, flown by helicopter, landed on often times uneven ground, hand unloaded, and carried to individual planting sites. This year NRS will experiment to better stabilize these plants throughout this transition from nursery to reintroduction site by doing a more intensive packing of each plant individually.

Research Issues
No research was conducted this year on this taxon specifically. Ongoing research by NRS Research Specialist investigating slug control will benefit this species (Chapter 5.2).

Surveys
No surveys were conducted over the last year for this taxon.

Taxon Threats
A new observed threat to this and several other taxa this summer is mice (*Mus musculus*). Mice chewed off all the leaves of several plants at one of the Pahole reintroduction sites this year. NRS are investigating new types of specific mice controls as it is difficult to measure success of reducing the population with the current rat baiting grids and snap traps. If found effective, these types of tools, or the standard rat baiting grid and snap traps will be used at this site. This impact appears very seasonal with focused damage in the summer. Seasonal control will be investigated.

A small number of pigs are currently being snared out of Pāhole exclosure. No pig damage has been observed around any *S. nuttallii* populations. Other threats to this taxon remain the same (OANRP). NRS are researching possible control methods for slugs (Chapter 5.2).

Population Unit Level Discussion

Table 2.1.25c 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	Partial	No
Kapuna-Keawapilau Ridge	Manage for stability	No	Partial	No

Action Area: Out

TaxonName: Schiedea nuttallii

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	Yes	Partial	No

Manage for Stability PUs

Kahanāhaiki to Pāhole: As mentioned above, numbers of wild plants dropped significantly in this PU at what was once the largest wild population site in Kahanahā‘iki. NRS observed significant water stress in the seven remaining mature plants, and managed to take cuttings from these before they died. NRS are hopeful that seeds in the seed bank will germinate with appropriate conditions, and the population may recover. Stock from founders of this population will be continually propagated until safe numbers of individuals exist either in the greenhouse or

in reintroductions. All plants in this PU are within a fenced exclosure and habitat quality at most sites is good. Because most sites are on fragile steep areas, weed control around sites is conducted as needed, and not regularly scheduled. It will be beneficial to try new reintroduction sites in the future, in order to find a site where threats are reduced and ultimately where this taxon will successfully regenerate. NRS will also continue to balance stock at current sites with the hopes of building up a seed bank large enough to overcome threats. This year NRS established a new reintroduction site in Pahole for Pahole stock. NRS continued to work this year with NARS staff to collect and store stock from Pahole founders. NRS also weeded around the larger wild Pahole population while monitoring and collecting from the population, and found one new mature and one immature plant while doing so.

It is essential that pigs are completely removed from the Pāhole fence. No plants have been threatened by the pigs currently in the fence, but there is a potential devastating threat, mostly to the reintroductions.

Kapuna-Keawapilau Ridge: Finishing the Kapuna subunit III and IV fences, will be important in facilitating appropriate habitat for future reintroduction sites for this population. See outplanting issues for more discussion about this PU.

Mākaha Reintroduction: An ecosystem-sized fence in Mākaha was completed this year. The exclosure contains appropriate *S. nuttallii* habitat for reintroductions, and NRS began the reintroduction there with seven mature plants. These plants were planted into a small temporary fence before the Mākaha subunit I fence was completed. Pigs dug up habitat outside this fence where more plants were slated for reintroduction. No plants inside the temporary fence were harmed. NRS will consider whether or not expanding the site into the pigged area is appropriate, or to choose a new site. All pigs should be removed from the Mākaha subunit I fence by the end of this year. NRS will continue to balance founders in the Māhaka reintroduction with Kahanahā‘iki stock this year.

2.1.26 *Schiedea obovata*

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial which is prone to large fluctuations)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage
- Expedited Stabilization (10 years)

How many of the 3 MFS PUs have stable numbers of mature individuals?	How many of the 3 MFS PUs have had *in situ* recruitment?	How many of the 3 MFS PUs have full genetic storage?	How many of the 3 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
1/3	2/2 (only 2 *in situ* PUs)	2/2 (only 2 *in situ* PUs)	2/3	0/3

Taxon Level Discussion

There are currently three *in situ Schiedea obovata* populations, all in the Keawapilau to West Makaleha Population Unit (PU). Prior to the disappearance of *S. obovata* from other known sites, seeds were collected and are being used to augment the Kahanahāʻiki to Pahole, and Keawapilau to West Makaleha PUs. Both of these PUs are to be Managed for Stability, (MFS) and are inside the Mākua Action Area (AA). The Mākaha PU is outside of the AA. A reintroduction established here will serve as the third MFS population. Genetic storage collection goals have been met for this species. NRS will continue to monitor and collect from new plants as they mature. No significant changes occurred within the wild populations this year. This year, NRS continued to balance founders at three reintroduction sites in the Kahanahāʻiki to Pahole PU, and at one site in the Keawapilau to West Makaleha PU. A new augmentation site was established in the Keawapilau to West Makaleha PU with 50 plants this year. The Mākaha subunit I fence is finished and a reintroduction will be established. Rats have still been an observed threat to this species. At one particular reintroduction site where continual rat damage has been observed, NRS plan to install bait stations and snaps prior to new outplantings, for as long as is felt necessary.

NRS have determined this year that plants can be cross pollinated in the nursery. Seed from these crosses were collected, and will be grown to outplant into the Mākaha PU in year 5. NRS are looking to see the differences in survivorship of progeny of these crosses to determine whether or not outbreeding depression will occur. See Research Issues below for more details on these pollination studies.

This year the US Fish and Wildlife service designated this taxon as a species to be "Expedited for Stabilization" in the 2007 Biological Opinion. This requires stabilization for *S. obovata* in one PU outside the action area within five years. NRS are also to initiate a reintroduction outside

of the Mākua Action Area (AA). Therefore the Mākaha PU would serve as both a PU managed for stability and the reintroduction initiated for stability outside of the AA. As with some other species that fall under this designation, the only *in situ* PUs of *S. obovata* are within the AA, and NRS feel these PUs are higher priority populations for stability. However, seed source is readily available, and it is feasible that 100 plants can be propagated and outplanted in Mākaha. Although, in order for this PU to achieve a stable population structure, it will have to overcome threats and recruitment difficulties observed in other PUs.

Major Highlights/Issues Year 3

- Plants from different populations were successfully cross pollinated in the greenhouse.
- Mākaha fence construction is finished.
- Species Expedited for Stabilization in five years.
- A new augmentation site was established in Keawapilau with Keawapilau stock (from Dr. Steven Weller who has seed from the extirpated site)
- Kapuna subunit III and IV fence construction has begun.

Plans for Year 4

- Continue to balance founders at all reintroduction sites.
- Continue growing wild stock in the greenhouse to cross pollinate.
- Grow out progeny from cross pollinated plants to determine signs of outbreeding depression.
- Determine stock to be used in Mākaha

Table 2.1.26a Taxon Status Summary

Action Area: In

TaxonName: Schiedea obovata — TaxonCode: SchObo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augrrented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	0	0	0	177	119	7	103	134	56	**177**	**119**	**7**	
Keawapilau to West Makaleha	Manage for stability	43	16	11	20	48	0	55	30	11	**63**	**64**	**11**	
	Total for Taxon:	43	16	11	197	167	7	158	164	67	**240**	**183**	**18**	

Action Area: Out

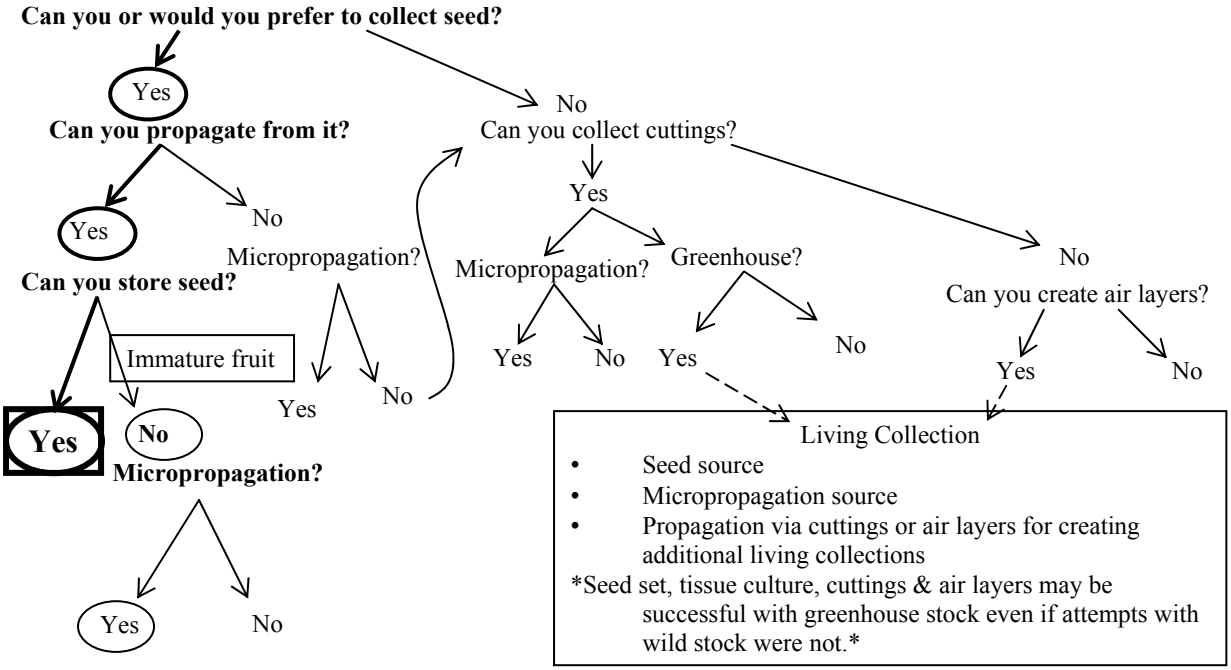
TaxonName: Schiedea obovata — TaxonCode: SchObo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augrrented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	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**	
	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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: refer to OANRP 2006. No aging has been detected in seeds stored dry at -18C or -150C (lN2). Seeds have been tested for over ten years at -150C.

Genetic Storage: refer to OANRP 2006. Genetic storage goals have been met for this taxon. Once backup storage collections are established for this taxon at NCGRP, NRS will most frequently re-collect once every ten years.

Unique Species Observations
Within and among 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 will hopefully be able to tell if leaf variation is environmental or genetic now that cross pollination can occur.

Table 2.1.26b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	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	43	16	9	60	1	12	60
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				65	2	17	65

Outplanting Issues

Using seed collected by NRS and NARS from four wild sites: Kahanahāʻiki, Pahole (2 sites), and West Makaleha, NRS have been propagating and outplanting *S. obovata* to augment those PUs. Stock has only been mixed in the Kahanahāʻiki PU where plants from a site in West Makaleha were outplanted by a U.H. graduate student for a research project. Seedling recruitment has been observed at a few sites, but is significant at only one of the Pahole sites. Whether the absence of slugs or some other factor is responsible for the observed recruitment is still unknown. There were two outplanting events at this Pahole site, the first with 50 plants, and the second with nearly 70. It is also possible that planting lots of plants at a time is helpful in establishing a large seedbank. In order to try many sites for reintroduction, another Pahole reintroduction is spread out across the Kahanahāʻiki/Pahole boundary across 4 sites further north than the other. No seedlings have been seen at any of these sites. However, no more than 30 plants were planted at any of these sites. If NRS do not have enough plants to drastically increase numbers at each site, it may be worth it to reintroduce in to only a couple of the sites to bulk up numbers there. In Kahanahāʻiki, a new outplanting was established last year close to a reintroduction site where recruitment was observed. This site is also near the historical wild Kahanahāʻiki plant. So far there is no recruitment at this reintroduction, and survivorship levels are at 50%. This is likely due to rat damage that was observed within the first two months of the first set of plants being planted.

This year an augmentation was established near the Keawapilau plants found last year, using stock from seed Dr. Weller had from an extirpated Keawapilau individual. NRS were able to collect seed from the wild population found last year, and plants from this seed will be included in this augmentation next year. Dr. Weller has also supplied NRS with stock from extirpated sites in Pahole. NRS are grateful for the relationship with Dr. Weller and will keep up-to-date on his seed stock levels to make sure there is enough seed available to reach stability goals. If not, NRS will utilize greenhouse plants to collect more seed.

Research Issues

Mixed-stock Outplanting Update:

NRS would like to determine what founders should be represented together in a reintroduction in Mākaha. Though not yet formally concluded, *S. obovata* is at least a facultative selfer, and probably has a very high selfing rate in the wild. With typically selfing species, outbreeding

depression becomes a concern for mixed progeny may not be as fit as either parent for the habitat of the reintroduction. NRS decided to cross all available greenhouse stock. NRS attempted crossing plants in the greenhouse during the summer of 2006 with no success. Pollination methods were refined and plants were crossed in the greenhouse this past summer. Flowers were emasculated prior to anther dehiscence, pollinated with fresh pollen, and monitored. Fruit abortion, collection, and number of seeds per fruit were recorded. There were no significant differences between the fruit set or seed set between population site for maternal plants, pollen sources, or any combination. There is a slight trend indicating higher fruit set from plants when the pollen source is Population Reference Site LEH-B (NW corner West Makaleha), though this is not significant nor supported in seed set. Additional crosses from founders that were not yet crossed may be conducted next year. Germination has not yet begun. NRS proposes to start viability assays to measure offspring fitness from these collections.

Surveys
No new surveys were conducted for *S. obovata* this past year.

Taxon Threats
Ungulates, weeds, slugs, and possible rats all threaten the survival of *S. obovata*. There are fences completely protecting plants in two PUs. The completion of the Kapuna subunit III fence will protect the third. Weed control is conducted at all extant populations. Slug research is still underway, and rat control may be necessary at the Kahanahāʻiki reintroduction site.

Population Unit Level Discussion

Table 2.1.26c 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	Partial	No
Keawapilau to West Makaleha	Manage for stability	Partial	Partial	Partial

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

Kahanahāʻiki to Pahole: This PU encompasses three former *in situ* sites of *S. obovata*; two in Pahole and one in Kahanahāʻiki. The wild populations in Kahanahāʻiki and Pahole were gone from the wild by 2001. Historic sites are checked for new seedlings, but none have been found. Reintroduced *S. obovata* in Kahanahāʻiki have performed poorly compared to those reintroduced

to Pahole (see Outplanting Issues). Onsite germination has been seen at two reintroduction sites in Kahanahāʻiki, but numbers were very low. NRS continued outplanting near a reintroduction where germination was observed. This outplanting occurs across a larger area that is actively being restored with common outplantings and frequent weed control.

The most productive reintroduction site in Pahole is over 4 years old and is very successful. There are currently 98 mature individuals, 17 immatures, and 68 seedlings. Twenty-seven % of these mature individuals are F1 generation. Figure 2.1.26d shows F1 plants of all size classes between reintroduced individuals. NRS will continue to balance founders at this site this year, and as long as founders remain balanced, will let the population respond on its own. This population serves as a great opportunity to observe population dynamics for this taxon. Photo below shows a group of more than 30 F1 individuals of all age classes.

Figure 2.1.26a *Schiedea obovata* Pahole outplanting

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 at one site in West Makaleha are numerous. No monitoring was done this year at this population, but will be done next year. NRS conduct weed control around all plants throughout this PU. This year, NRS continued to augment the smaller West Makaleha population in the Three Points fence nearby. This population has 68% survivorship.

Mākaha: Construction of the Mākaha Subunit I was completed this year and NRS will work with the IT to determine the best stock for this PU.

2.1.27 *Tetramolopium filiforme*

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
1/4	1/4	0/4	3/4	1/3

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. 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 increased management of additional habitat, stability is attainable.

Major Highlights/Issues Year 3

- Cuttings from all plants in the Kalena PU are established in the nursery. Kalena PU stock is being duplicated in the greenhouse so the goal of >3 plants per founder can be attained.
- The Pūhāwai outplanting was augmented with three additional plants this year.

Plans for Year 4

- Keep Kalena PU stock separate from other *T. filiforme* stocks at Pahole Nursery in order to secure seed for storage. Continue to subculture greenhouse plants in order to maintain plant vigor and genetic representation.
- Collect cuttings from Wai‘anae Kai PU stock to establish in the nursery as a seed source.
- Show Botanist, Joel Lau the nursery stock from the Kalena PU and the Pūhāwai PU to determine if there are any characteristics unique to one or the other.

Table 2.1.27a Taxon Status Summary

Action Area: In

TaxonName: Tetramolopium filiforme **TaxonCode: TetFil**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	45	0	0	0	0	0	45	0	0	**45**	**0**	**0**	Monitoring showed no change in the last year.
Kalena	Manage for stability	9	0	6	0	0	0	9	0	0	**9**	**0**	**6**	Monitoring showed no change in the last year.
Keaau	Genetic Storage	30	41	17	0	0	0	30	41	17	**30**	**41**	**17**	No monitoring in the last year
Makaha/Ohikilolo Ridge	Genetic Storage	300	0	0	0	0	0	300	0	0	**300**	**0**	**0**	No monitoring in the last year
Ohikilolo	Manage for stability	2442	552	1	0	0	0	2442	552	1	**2442**	**552**	**1**	Monitoring found no change in the last year
	Total for Taxon:	2826	593	24	0	0	0	2826	593	18	**2826**	**593**	**24**	

Action Area: Out

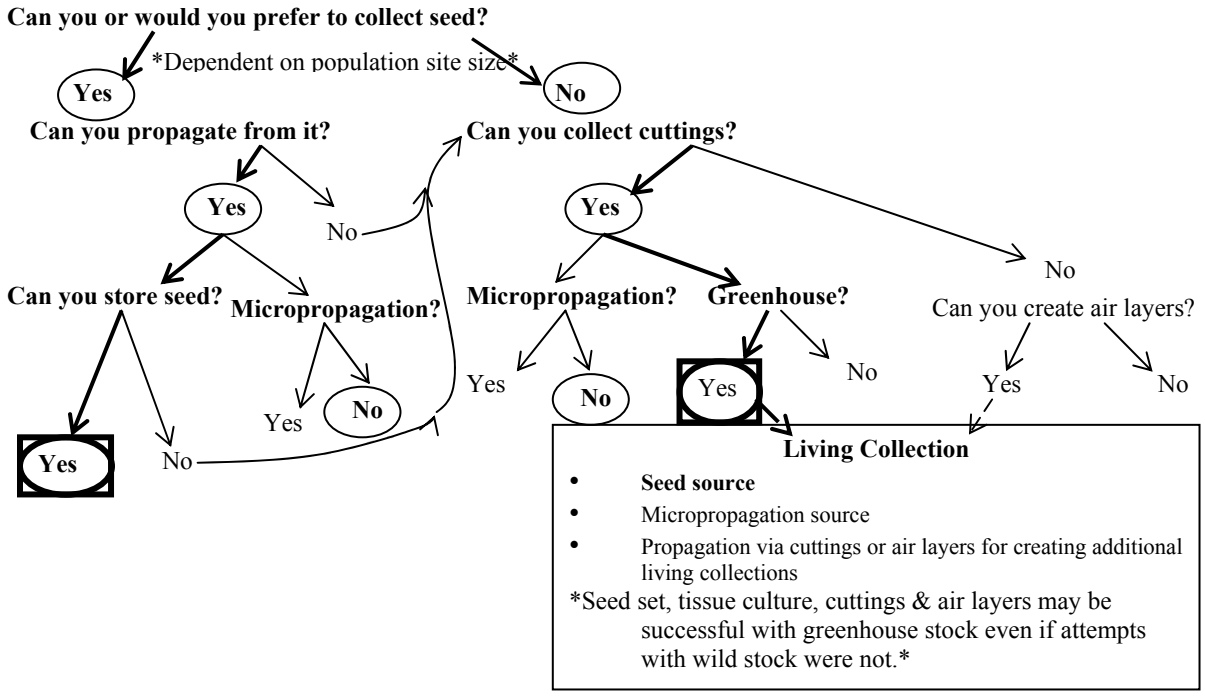
TaxonName: Tetramolopium filiforme **TaxonCode: TetFil**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Puhawai	Manage for stability	1	2	3	6	0	0	19	2	3	**7**	**2**	**3**	High mortality in reintroduced plants since last year. Three new outplants put out this winter. Wild population not monitored thoroughly this year.
Waianae Kai	Manage for stability	30	8	1	0	0	0	30	8	1	**30**	**8**	**1**	No monitoring in the last year
	Total for Taxon:	31	10	4	6	0	0	49	10	4	**37**	**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) Has a successful storage method been determined**?	**4)** Are additional steps required for obtaining enough seed?
Cuttings and seed	Seed	Yes	Yes; living collections as seed source for smaller population sites

Prioritizing Genetic Storage & Propagation Techniques



Collection: refer to OANRP 2006

Propagation: refer to OANRP 2006

Seed Storage Research: Preliminary results from collaborative research with NCGRP has indicated that aging has been detected for this taxon at various temperatures. Collections may become half as viable as they were initially within a decade after collection (rough estimate). This would be the time to re-collect. Seeds may also be stored at lower temperatures and this might extend their longevity.

Genetic Storage: Seed collections from isolated cutting stock in the Army Nursery from the Kalena PU were attempted this year. The plants did flower but viable seed was not produced. Plants were consequently moved to Pahole Mid-elevation Nursery. Though this taxon has produced viable seed at the Army Nursery before, this summer may have been too hot or plants from this PU may have different environmental requirements for seed set. Since the Pahole Nursery is closer in elevation than the Army Nursery, NRS hopes this move may yield viable

seed and plans to continue monitoring plants until genetic storage goals are met in the storage seedbank. Until so, this stock will remain in the nursery as a living collection.

Table 2.1.27b 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	37	99	0	0	60
Kalena	9	0	0	7	0	9	7
Keaau	30	41	0	17	0	0	2
Makaha/Ohikilolo Ridge	300	0	0	0	0	0	0
Ohikilolo	2442	552	1	111	0	0	42
Puhawai	1	2	9	4	0	3	4
Waianae Kai	30	8	0	1	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**
				239	0	12	115

Unique Species Observations

There have been no new unique species observations in this reporting period.

Outplanting Issues

In the last year, NRS supplemented the Pūhāwai augmentation with three additional plants. These plants were added in order to balance founders based on initial survivorship recorded after last year's planting. Of the 28 plants outplanted in the 2005-2006 planting season, only three plants remain. This reintroduction represents the first attempt by NRS to plant onto a cliff. Planting spots with soils deep enough for digging a hole are very limited at the reintroduction site chosen near Pu‘u Kūmakali‘i. NRS will continue to reintroduce at this site but will choose planting locations similar to those where plants have performed the best. NRS expected that the initial attempts at reintroducing this taxon would be somewhat experimental in nature. The last few years have also been extremely dry perhaps further confounding the success of outplantings.

Figure 2.1.27a *Tetramolopium filiforme* from 4”pot and packaged for transport

Table 2.1.27c Founders Represented in Outplantings

TaxonName: Tetramolopium filiforme **TaxonCode: TetFil**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kahanahaiki	Genetic Storage	82	0
Kalena	Manage for stability	9	0
Keaau	Genetic Storage	71	0
Makaha/Ohikilolo Ridge	Genetic Storage	300	0
Ohikilolo	Manage for stability	2995	0
Puhawai	Manage for stability	12	3
Waianae Kai	Manage for stability	38	0
	Total for Taxon:	**3507**	**3**

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

Research Issues

There are no new research issues related to this taxon.

Surveys

NRS conducted surveys near the Kalena PU in adjacent habitat. NRS will continue to investigate undersurveyed habitat near small PUs for more individuals of this taxon.

Taxon Threats

Major threats to this taxon include feral goats and fire. No new threats were documented during this reporting period.

Population Unit Level Discussion

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 ‘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. At this time, weeds are not considered a significant threat and ungulates no longer impact plants in this PU. Fire is only a high threat to the plants found in the lowest elevation 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. In the last year the “*Tetramolopium* peak” site within this PU was visited and a few additional collections were secured.

Table 2.1.27d 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	No	No	No

Pūhāwai: At the wild site within this PU, the number of plants in all age classes has decreased over the last five years. In the last year, NRS did not complete a thorough monitoring on rappel, instead NRS only made observations using binoculars. NRS have observed the Pūhāwai site to be a much drier habitat than ‘Ōhikilolo 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. The amount of appropriate habitat present at Pūhāwai is a key limiting factor to the continued existence of this population. Genetic storage collections from nursery stock of this PU have been very successful and will continue as necessary. NRS augmented this PU in 2006 and again this past year.

Wai‘anae Kai: *Tetramolopium filiforme* at this PU are located on cliffs that are very difficult to access. Because of their inaccessible nature, this area is not well surveyed. In the next year, NRS will attempt to collect from accessible plants and will survey new cliffs in the vicinity. Cuttings obtained will be maintained as clones in the nursery for *ex situ* storage and as seed stock plants.

Kalena: In the last year, NRS secured cuttings from all nine founder plants at this PU. The highest priority action for this PU is to address goat ingress from Wai‘anae Valley. NRS plan to work with the DOFAW in the next year to address the overwhelming goat population in the Wai‘anae Protected Watershed. In addition, NRS will collect seed from nursery clones for storage. The IT last year recommended that Joel Lau look at plants from the Kalena and Pūhāwai sites before any decisions were made about whether to mix the Kalena PU with the Pūhāwai PU. Some IT members supported mixing to avoid inbreeding depression and other IT members felt stock should be kept separate. NRS have not yet observed any traits unique to

either site based on nursery observations. NRS do not plan to augment this PU until a decision is made about mixing populations.

Other PUs

Kahanahā ʻiki*:* 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. Fire is the most significant threat to this site. NRS has seen the forest patch around this PU shrink after each fire burns the forest edge. Ungulate impacts are not an issue as all plants are located on a vertical cliff. This cliff is very sparsely vegetated, therefore the direct impacts of weeds on *T. filiforme* is minimal. *Panicum maximum* invasion, as it is linked to fire, is the most significant weed issue affecting the forest around this PU. NRS have conducted some control in years past. Genetic storage goals have been met for this PU.

Keaʻau: The first estimates for this site were based on the HBMP Botanist's observation from the ridge crest in 2002. In 2006, NRS monitored this site on rappel and collected seeds from 20 mature plants for genetic storage. NRS did not revisit the Keaʻau PU in the last year. This PU is within the Keaʻau Public Hunting Area and is not proposed to be fenced. Goats browse the habitat around the *T. filiforme* cliff region of Keaʻau but as of 2006 were not able to reach any *T. filiforme*. 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 ʻŌhikilolo PU due to the close proximity of the sites, but was later treated separately because of its location outside of the ʻŌhikilolo ridge fenceline. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the ʻŌhikilolo stock. No significant weed threats have been observed.

2.1.28 *Viola chamissoniana* subsp. *chamissoniana*

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- 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 had *in situ* recruitment?	How many of the 4 MFS PUs have full genetic storage?	How many of the 4 MFS PUs are protected from ungulates?	How many MFS PUs that need reintroductions have been initiated?
1/4	0/4	0/4	3/4	0/2

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. A major challenge with this PU has been to collect seeds for storage and propagation. Most sites are accessed only by rope and the plants do not hold onto mature seed for long, instead seed is dehisced soon after maturity. To overcome this difficulty, NRS collected cuttings from wild plants and established a living collection in the nursery. This collection has been used to develop propagation, pollination and seed collection techniques. In the last year, NRS has made significant gains on this project and plan to begin large scale stock management for seed production in the next year. NRS will begin with stocks that have the lowest numbers of founders remaining as a priority.

Major Highlights/Issues Year 3

- NRS collaborated with researchers from the University of Hawaii and Ohio University to investigate physiology and phylogeny of Hawaiian violets.
- NRS completed the Mākaha Subunit I fence protecting the Mākaha PU
- NRS refined management and pollination of greenhouse stock and successfully collected seeds.
- Joel Lau discovered a new population in Central Makaleha

Plans for Year 4

- NRS plans to collect cuttings from PUs with low population numbers to be propagated for seed production.
- Search historical sites within Kamaileunu PU.
- Investigate areas in the Mākaha Subunit I for augmentation.
- Continue to investigate remote sensing options for developing monitoring techniques.
- NRS will search cliff areas around J. Lau's new site in Makaleha and collection if numbers are low.
- Investigate the relationship between the two subspecies of plants found at the Hālona PU.

Table 2.1.28a Taxon Status Summary

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana TaxonCode: VioChaCha

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Genetic Storage	40	10	0	0	0	0	40	10	0	40	10	0	No monitoring in the last year
Makaha/Ohikilolo Ridge	Genetic Storage	7	0	0	0	0	0	7	0	0	7	0	0	No monitoring in the last year
Ohikilolo	Manage for stability	433	10	0	0	0	0	433	10	0	433	10	0	Some portions of MU monitored, no change
Puu Kumakalii	Manage for stability	44	0	0	0	0	0	44	0	0	44	0	0	Monitoring in the last year found no change
	Total for Taxon:	524	20	0	0	0	0	524	20	0	524	20	0	

Action Area: Out

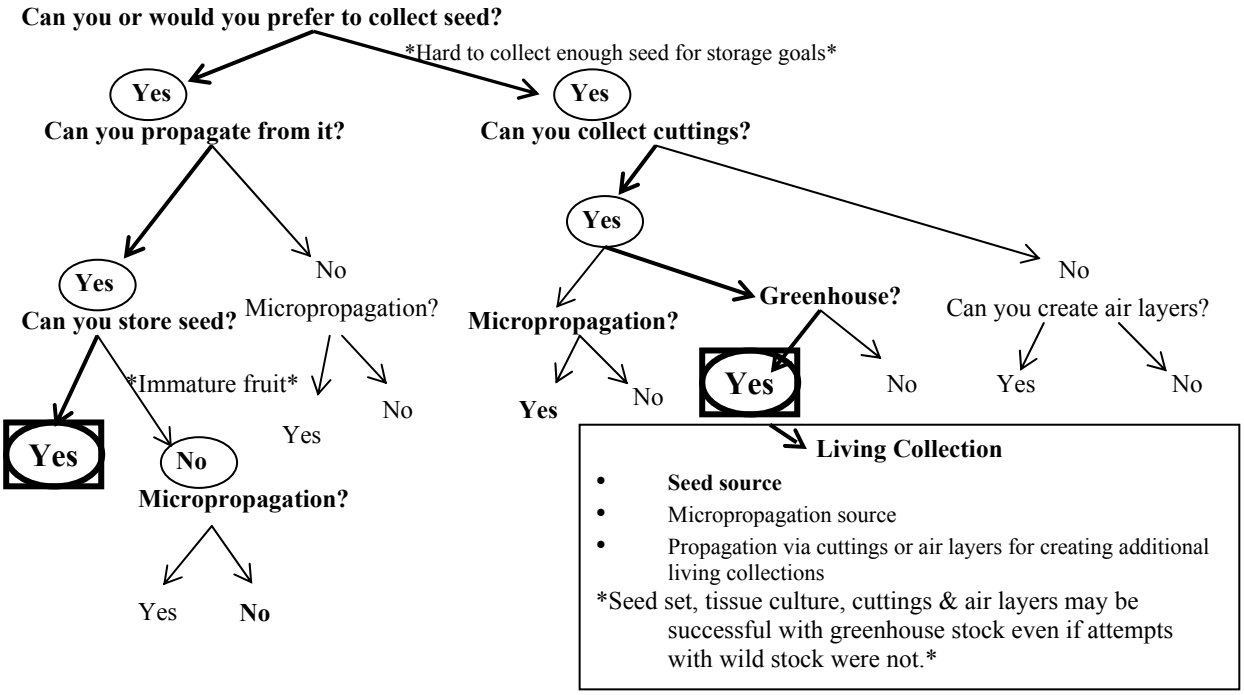
TaxonName: Viola chamissoniana subsp. chamissoniana TaxonCode: VioChaCha

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Manage for stability	41	3	0	0	0	0	41	3	0	41	3	0	No monitoring in the last year
Kamaileunu	Genetic Storage	35	0	0	0	0	0	35	0	0	35	0	0	No monitoring in the last year
Makaha	Manage for stability	17	2	0	0	0	0	24	0	2	17	2	0	Monitoring showed a decline in the last year
Makaleha	Genetic Storage	1	0	0	0	0	0	0	0	0	1	0	0	One new plant was discovered in the last year
Puu Hapapa	Genetic Storage	13	0	0	0	0	0	13	0	0	13	0	0	No monitoring in the last year
	Total for Taxon:	107	5	0	0	0	0	113	3	2	107	5	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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living collection for seed	Yes	Yes; living collection

Prioritizing Genetic Storage & Propagation Techniques



Collection: Viable seed is difficult to obtain from the wild plants. A high rate of fruit abortion has been observed for both wild and greenhouse plants. Also, fruit dehisce violently, dispersing many seeds immediately (Fig.2.1.28a). NRS conducted a pollination study in the greenhouse this year and determined that enough seed could be collected from plants for genetic storage goals. NRS will therefore place light-weight, breathable organza bags over immature fruit in the living collection as the primary method of seed collection.

Propagation: refer to OARNP 2006

Seed Storage: No aging has been detected in seeds stored at -18C and 20% RH. Results are for seeds that have been tested five years after storage.

Genetic Storage: Goals should be met for many of the founders represented in the greenhouse from Puʻu Kūmakaliʻi and Puʻu Hāpapa PUs this year or next year from the pollination study. Additional cuttings will be collected from individuals in the smallest PUs first to add to the living collection to serve as a seed source.

Figure 2.1.28a Dehisced fruit with seeds (left). Flower of *Viola chamissoniana subsp. chamissoniana* (right).

Table 2.1.28b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Viola chamissoniana subsp. chamissoniana							
Halona	41	3	0	3	0	2	1
Kamaileunu	35	0	0	0	0	0	0
Keaau	40	10	0	0	0	0	0
Makaha	17	2	0	0	0	0	0
Makaha/Ohikilolo Ridge	7	0	0	0	0	0	0
Ohikilolo	433	10	0	1	0	4	2
Puu Hapapa	13	0	0	4	0	9	5
Puu Kumakalii	44	0	0	10	0	19	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	0	34	19

Unique Species Observations

No new observations have been made during this reporting period.

Outplanting Issues

NRS have yet to conduct an outplanting with this taxon. In the next year, NRS will begin to look at the Mākaha PU and determine if there is a suitable site.

Research Issues

Phylogeny Study: NRS accompanied researchers from the U.H. (Professor, Dr. Lawren Sack) and O.U. (Chris Havran, PhD candidate) to *Viola* sites this year. In this study researchers are investigating physiology and phylogeny of Hawaiian violets through the groups adaptive radiation in similar micro sites across their range in Hawaii. NRS will keep in contact with these researchers and report on their research results in next year's report.

Pollination Study: This year plants flowered abundantly and continuously from May through September 2007. Plants had been moved from the mist house at Pahole Mid-Elevation Nursery into a more open shade house at the beginning of the year. This may have stimulated flowering. Four treatments were applied: 1) Bagged flower buds for selfed flowers (pollinator-exclusion); 2) Bagged immature fruit for ambient pollination; 3) Pollen added to open flowers from opportunistic donors (including self); 4) Pollen added to emasculated flowers from opportunistic donors (including self). Fruit collection is still ongoing and formal conclusions will be available for 2008. However, ample seed was collected from the fruit in the study. Additional fruit were produced but not bagged for collection. If all fruit produced on the plants were bagged for collection to retrieve all seeds within the fruit, storage goals could be met within one greenhouse flowering season.

Surveys
No surveys specifically targeting this taxon were performed in the last year. NRS plan to survey sites from Ken Wood in 1999 and 2000 in the Kamaileunu PU. J. Lau discovered a new location for this taxom in East Makaleha. A single plant was seen by J. Lau. NRS will return to the area in the next year to search surrounding cliffs and potential habitat.

Taxon Threats
No new threats have been determined for this species.

Population Unit Level Discussion

Manage for Stability PUs

'Ōhikilolo: This large PU has well over the number of plants required for stability. NRS will attempt to determine the population structure in the coming year. As the PU is so large, NRS only monitors a portion of the PU each year. In the next year NRS plan to begin to develop a sampling strategy with Jim Jacobi (USGS Botanist) to better track population trends. A perimeter goat fence along 'Ōhikilolo ridge protects this PU from goats. Last year, NRS reported that goat sign was found near this MU. Fortunately, NRS was able to repair the fence and remove the goats that had gotten through the fence before any damage was observed. Weeds that threaten the *V. chamissoniana* PU include *Erigeron karvinskianus* and *Melinus minutiflora*. Most observations of this taxon are done with binoculars so 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. NRS conducted a remote sensing trial this year at Ōhikilolo in hopes that the flowers of *V. chamissoniana* could be detectable. Unfortunately, the trial was not conducted along dry cliffs for a combination of reasons (see the Rare Plant Chapter Introduction).

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. Two years ago, goats were observed in SBW. NRS have established snares in the area to control the goats and two individuals were removed. Since that time, NRS has not observed any sign of goats. *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 nursery to serve as a source for genetic storage trials as discussed above. NRS took C. Havran from the University of Ohio to this PU this year to collect leaves and make measurements. Currently he is analyzing his data and NRS hopes to receive results within the year.

Table 2.1.28c 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

Mākaha: NRS completed the Mākaha Subunit I fence in September 2007. This effectively protects the majority of the plants from ungulates. Now that the fence is complete, NRS will begin to scope out weed control projects in the area. NRS will also look for potential augmentation sites within MU. NRS will also investigate other sites in the PU that were reported by Ken Wood in 1999. NRS will collect across the PU to establish a living collection that can be used to product seed and cuttings for storage and augmentation.

Hālona: NRS did not monitor the PU this year, but believe with additional surveys more *V. chamissoniana* may be found. Goats have been observed recently in North Hālona. Currently there are no goat populations at the site, but the habitat is vulnerable to impacts. The same set of weeds which are present at other PUs are present at Hālona. However, these weeds are not abundant. NRS consider this site to have a low weed threat. 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/ʻŌhikilolo Ridge: This PU was created by subdividing the ʻŌhikilolo PU with the fence that runs along ʻŌhikilolo 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 ʻŌhikilolo PU. NRS do not plan to control goats or conduct weed control in this area.

Kamaileʻunu: 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 Puʻu Kawīwī. The second site has not been visited by NRS since 1999. These areas will be a priority for monitoring in the next year. Depending on the number of plants found when NRS monitor the PU, the urgency of collection will be determined. If only a few plants are found the site will be high priority for collection to establish an *ex situ* collection. NRS will also consider using this stack to augment the Makaha PU.

Puʻu Hāpapa: NRS has not monitored this population in the last year. Cuttings were taken in 2005 from plants and are being used in a living collection at the nursery to produce seed for research and storage. NRS will revisit this site in the next year and collect more cuttings if necessary for the nursery living collection. NRS will collect seed from this stock as a priority in the next year due to low population numbers.

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

East Makaleha: J. Lau discovered a single plant while working with NRS crews in East Makaleha. It is high priority to for NRS to visit the area with rappelling gear and explore cliff habitat to deter determine the number of individuals.

Chapter 2.1.0: RARE PLANT STABILIZATION PLAN STATUS

General Rare Plant Issues

This section outlines the status update sections prepared for OIP species. In general most of the information regarding the overarching plant management infrastructure, research, monitoring and strategies, is covered in the MIP Rare Plant Introduction. This section will cover any areas that are unique to OIP species.

Stabilization Strategy
This is the third year that NRS has used the stabilization strategy for designing rare plant management for these species. For details on this strategy please see OANRP 2006.

Example of Species Status Summary

The species status summary outlines PU work conducted for some of the 23 OIP plant taxa. NRS reported on 18 of these taxa for which there is significant information to report and management actions need to be evaluated. The six species that are not reported on are species that NRS has not yet begun to work extensively with and therefore do not have significant information to report. The format varies slightly for each taxon. Format follows the MIP, however only sections that have pertinent information are reported on. Deviations from the MIP format for these sections are discussed below.

Requirements for Stability: This section defines requirements for reaching stability for each taxon.

- 3 Population Units (PUs) are designated for all species. However, for species meeting the following criteria 4 PUs have been designated:
    - with presence in both Makua Action Area (AA) and Schofield AA (Example: *Plantago princeps*)
- Tier 1-3 is indicated (see OIP for reference, OANRP 2005a)

Taxon-Level Discussion: This section follows the format of MIP taxa, however there is one difference. The plan years are different in the bulleted lists. This year was “Urgent Action” year for OIP species and next year will be “Year 1” of the OIP

Propagation and Genetic Storage: In most cases this section has been condensed for the OIP species covered in comparison to MIP species. For most OIP taxa there is no follow chart or table in this section. As more information is collected in year one this section will expand.

2.2.1 *Abutilon sandwicense*

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Tier 1 stabilization priority

Taxon Level Discussion

There are several hundred plants known from ten PUs across the Wai‘anae Mountains. Four Manage for Stability (MFS) PUs were selected because it occurs in both the Mākua Military Reservation (MMR) and Schofield Barracks West Range (SBW) Action Areas (AA). There are *in situ* plants known in three of the four MFS PUs and the Kaluakauila PU will be established by outplanting stock grown from the Kahanahā‘iki PU. The major threats to *Abutilon sandwicense* are goats, pigs, fire and weeds. The Kaluakauila PU is protected by a fence and other large fences are planned for Manuwai, Mākaha Mauka and Ekahanui. These fences will secure enough habitat for augmentations which may be needed in all PUs to meet stability goals. Collections of seed have been stored from the ‘Ēkahanui and Huliwai PU and clones from the Kahanahā‘iki plant are maintained as a living collection. NRS will begin a more extensive collection effort in the coming year.

Major Highlights/Issues in Urgent Actions

- The August 2007 Kaukonahua fire killed plants in the Alaiheihe to Puulu PU.
- Additional plants were added to the Kaluakauila PU reintroduction.

Plans for OIP Year 1

- Complete the Ekahanui MU fence
- Begin collections from small PUs with major threats inside the AAs.
- Begin augmentation of the ‘Ēkahanui and Huliwai PU.

Table 2.2.1a Taxon Status Summary

Action Area: In

TaxonName: Abutilon sandwicense **TaxonCode: AbuSan**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Alaiheihe to Puulu	Genetic Storage	14	5	1	0	0	0	22	10	0	14	5	1	Portions of this PU was burned in the Kaukonahua fire killing at least 12 plants
	Total for Taxon:	14	5	1	0	0	0	22	10	0	14	5	1	

Action Area: Out

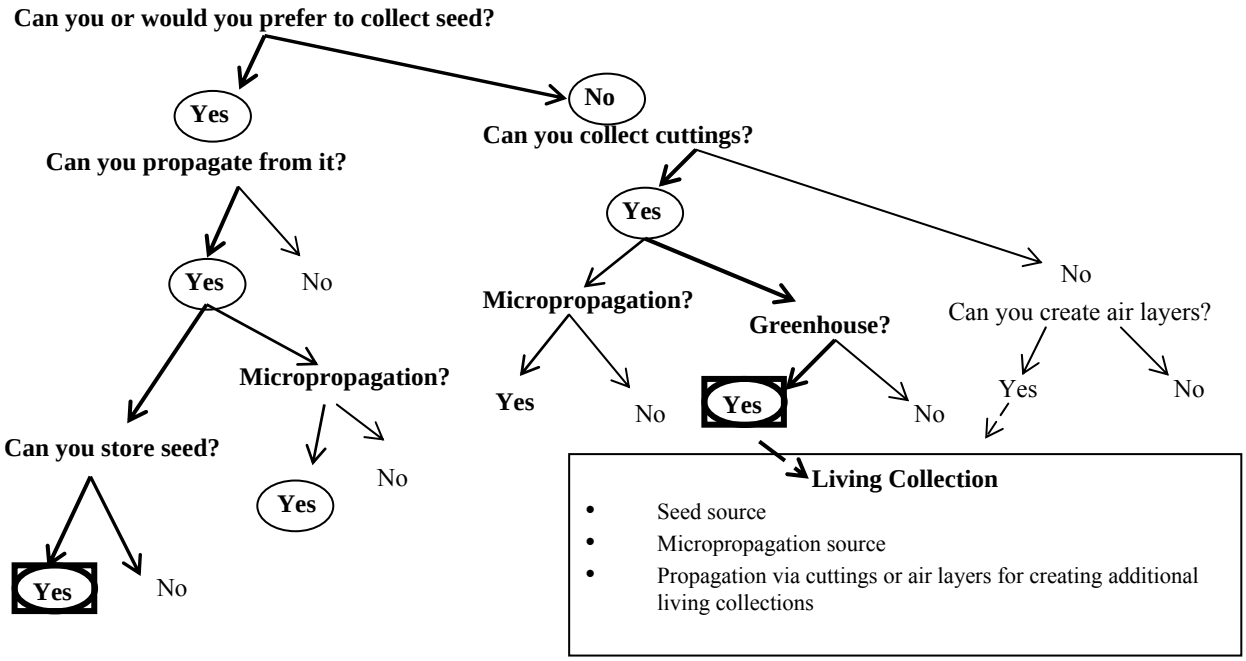
TaxonName: Abutilon sandwicense **TaxonCode: AbuSan**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Makaleha	Genetic Storage	2	2	40	0	0	0	2	2	0	2	2	40	This PU has not been monitored since 1998 so no changes are known
Ekahanui and Huliwai	Manage for stability	18	38	0	0	0	0	16	31	0	18	38	0	More individuals found in known sites in Huliwai this year
Kaawa to Kaomokuiki	Genetic Storage	1	18	1	0	0	0	1	18	1	1	18	1	This PU has not been monitored since 2003 so no changes are known
Kahanahaiki	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	The only known plant has been dead since 2003
Kaluakauila	Manage reintroduction for stability	0	0	0	0	23	0	0	22	0	0	23	0	Three reintroduced plants died and four new plants were added in the last year.
Keaau	Genetic Storage	1	0	10	0	0	0	1	0	0	1	0	10	Population not monitored since 2002 so no changes are known
Makaha Mauka	Manage for stability	5	58	4	0	0	0	40	100	0	5	58	4	A thorough census found a decline since the 2006 estimates
Manuwai	Manage for stability	6	59	1	0	0	0	7	59	0	6	59	1	Monitoring showed a small change in the last year
West Makaleha	Genetic Storage	0	2	0	0	0	0	0	2	0	0	2	0	No monitoring done in the last year
	Total for Taxon:	33	177	56	0	23	0	67	234	1	33	200	56	

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)** Has a successful storage method been determined?	**4)** Are additional steps required for obtaining enough seed?
Cuttings & Seed	Seed	Yes	No

Prioritizing Genetic Storage & Propagation Techniques



Collection: Fruit has been collected and cuttings have been taken. Fruit should be collected when capsules have turned tan and are no longer green.

Propagation: Cuttings have varied success; some collections root easily while others have been difficult to establish. Plants are easily propagated from seed. Seeds of this taxon have physical dormancy and need to be scarified to stimulate germination. Seed viability is variable. Seeds that float in water are typically empty and therefore discarded. This is necessary to get an accurate count of filled seeds that could potentially germinate.

Seed Storage Research: Seeds stored dry at -18C have shown no signs of aging after four years. Actually, seeds have higher germination after one, two, and four years of storage than freshly-germinated seeds. Seeds, therefore, may have some level of physiological or morphophysiological dormancy in addition to the physical dormancy. This phenomenon will continue to be studied. If germination continues to be higher after one year of storage, NRS will try to organize collection and reintroduction plans in order to allow seeds time in storage to maximize the number of seeds germinated and plants produced for reintroduction.

Genetic Storage: Seeds will be collected for genetic storage for plants in PUs where a high number of individuals are present. For plants in PUs with a low number of individuals, cuttings will be taken and clonal representation established in the nursery.

Outplanting Issues
NRS have been outplanting stock grown from the Kahanahā‘iki plant into two sites in Kaluakauila since 2005. Survivorship has been high (23/26) but the plants have not been observed flowering.

Surveys
NRS conducted surveys of the Alaiheihe to Puulu and Manuwai PU that were burned in the August 2007 Kaukonahua fire (see Kaukonahua Fire Report Appendix I). NRS will continue to monitor the burned areas that were known to have plants. In addition NRS will conduct surveys in PUs with low numbers of plants and major threats.

Threats
All known PUs are threatened by goats and pigs except Kaluakauila which is fenced. Fire is a threat to most PUs and the Kaukonahua fire burned into Alaiheihe to Puulu and Manuwai. Weeds threaten most PUs and control will begin once MU fences are complete.

Table 2.2.1b Threat Control Summary

Action Area: In

TaxonName: Abutilon sandwicense

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Alaiheihe to Puulu	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Abutilon sandwicense

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
East Makaleha	Genetic Storage	No	No	No
Ekahanui and Huliwai	Manage for stability	No	No	No
Kaawa to Kaomoku Iki	Genetic Storage	No	No	No
Kahanahaiki	Genetic Storage	No	No	No
Kaluakauila	Manage reintroduction for stability	Yes	Partial	Yes
Keaau	Genetic Storage	No	No	No
Makaha Mauka	Manage for stability	No	Partial	No
Manuwai	Manage for stability	No	No	No
West Makaleha	Genetic Storage	No	No	No

2.2.2 *Cyanea crispa*

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Tier 2 stabilization priority

Major Highlights/Issues in Urgent Actions

- An outplanting within the newly constructed Helemano fence was established using stock from the Kawai Iki PU.
- Stock from NRS collections from the Makaua PU in1997 were transplanted from tissue culture at the Lyon Arboretum to the Pahole Mid-elevation Facility.
- Plant Extenction Prevention (PEP) constructed a small scale fence protecting *Cyanea crispa* habitat was constructed in Makaua.

Plans for OIP Year 1

- Surveys for new plants in the three MFS PUs will be conducted by NRS.
- Continue to monitor and collect from additional founders in the Kawai Iki PU
- Monitor the outplanting in Helemano
- Work with PEP to begin collection of mature seed from the Kahana PU and augmenting the Kahana PU with stock from the nearby Makaua PU

Figure 2.2.2a Healthy wild *Cyanea crispa* in Kahana and reintroduced Helemano *Cyanea crispa* with possible slug predation

Table 2.2.2a Taxon Status Summary

Action Area: In

TaxonName: Cyanea crispa — TaxonCode: CyaCri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kawaiiki	Manage for stability	2	8	0	0	0	0	8	0	0	2	8	0	A thorough cencus showed a change in the population #s
	Total for Taxon:	2	8	0	0	0	0	8	0	0	2	8	0	

Action Area: Out

TaxonName: Cyanea crispa — TaxonCode: CyaCri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Aihualama	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Kahana and Makaua (Makaua portion)	N/A	0	0	0	0	0	0	25	0	0	0	0	0	No monitoring in the last year
Kahana portion of Kahana and Makaua	Manage for stability	6	0	0	0	0	0	30	0	0	6	0	0	No monitoring in the last year
Kaipapau	N/A	0	0	0	0	0	0	3	0	0	0	0	0	No monitoring in the last year
Kapakahi	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Kawaipapa	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Maakua	N/A	0	0	0	0	0	0	2	0	0	0	0	0	No monitoring in the last year
Maunawili	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Pia	N/A	0	0	0	0	0	0	20	0	0	0	0	0	No monitoring in the last year
Pukele	N/A	0	0	0	0	0	0	6	0	0	0	0	0	No monitoring in the last year
Wailupe	Manage for stability	0	0	0	0	0	0	15	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	6	0	0	0	0	0	105	0	0	6	0	0	

Taxon Level Discussion

Cyanea crispa is known from 12 separate small PUs in mesic to wet habitat in both leeward and windward valleys in the Koʻolau Mountains. There are estimated to be 110 mature plants throughout its geographical range and the three MFS PUs were chosen to cover this entire range. NRS have not monitored many of the offsite PU for this species and therefore, the numbers in the table are compiled from a combination of NRS, HBMP and Oahu PEP data. The Kawai Iki PU occurs within the KLOA AA but all other PUs are offsite and out of the AA. There are approximately eight individuals in the Kawai Iki PU, 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 will manage the Kawai Iki, Kahana, and Wailupe PUs for stability. The remaining PUs contains one or a few individuals and the Army has determined that genetic storage collections are not a priority from the other PUs for this taxon.

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings (suckers) & Seed	Living Collection & Seed	Yes	Yes, collect from ex situ stock

Collection: For individuals that are not reproductive, suckers will be collected and propagated *ex situ* to serve as seed source, then outplanting stock. For reproductive individuals, fruit will be collected.

Propagation: Plants are easily propagated from suckers and seeds. Plants propagated via tissue culture have been observed to have altered morphologies when removed from test tubes and grown in the greenhouse. NRS will grow out more plants to see if this was a rare or typical occurrence for this taxon, as it has not been observed before and may be isolated to that particular collection.

Seed Storage Research: As with other species of *Cyanea*, this taxon can not be stored at -18C. Once more seed becomes available, -80C and/or -150C trials will commence. Seeds do, however, have good storage potential, as seeds have been stored dry at 4C for five years with no decrease in viability.

Genetic Storage: No fruit has been observed since March 1998 from the PU. In order to meet storage goals for individuals in this PU, plants will be propagated *ex situ* via suckers to serve as seed source, or seed will be collected from plants at the Helemano reintroduction. Seeds will be collected *in situ* from all other reproductive individuals.

Outplanting Issues

In order to meet the genetic storage goals for the Kawai Iki PU, NRS will need to outplant. Five plants grown from the Kawai Iki PU were grown and outplanted within the newly constructed

Helemano fence in February, 2007. Three plants remained at the site when they were monitored in August 2007. The two plants that died were out in the open, whereas the ones surviving were under mixed ‘ōhi‘a canopy. NRS planted them this way to see what conditions the plants were better suited for. Predation was also observed on the plants, due to slugs (See Fig. 2.2.1a). NRS plan to monitor this introduction in order to collect seeds for storage and eventual augmentation within the Kawai Iki MU. In the coming year, NRS will work with PEP to reintroduce a few plants grown from the Makaua PU into the small fence in either Kahana or Makaua.

All MFS PUs may eventually need augmentation because of the low numbers of individuals. Surveys should be done in nearby habitat both inside and outside the AA to find source material for augmentation. In the event that no new plants are discovered in the Kawai Iki PU, augmentation with stock from Kaipapaʻu or Maʻakua drainages on the windward side of the summit has been discussed. NRS will confer with the IT on this issue. NRS plan to construct the Kawai Iki MU fence in the next five years. Stock for augmenting the other MFS PUs will be determined once surveys are complete.

2.2.3 *Cyanea st.-johnii*

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections for all occurrences
- Tier 3 stabilization priority

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 focusing management on the Helemano PU which is inside the AA. This PU was recently fenced and NRS successfully bagged and collected seed last year. These collections will be used for genetic storage and propagation for future augmentations. In addition, in the last year the O‘ahu PEP program has been monitoring and collecting mature seed from the other PUs. The population estimates displayed for these other PUs are based on monitoring reported in the August 2007 Oahu PEP report. In the next year, NRS will work to support PEP actions for these PUs by assisting in monitoring and collection. PEP identified a relatively large number of seedlings this year in the field at both the Waimano and Ahuimanu-Halawa Summit Ridge PUs. This is encouraging as it shows that despite the impacts of slugs and rats there is germination. Although fencing these PUs outside the AA has been identified as a low priority for the Army, NRS will work with PEP to fence one of the PUs in the next year.

Major Highlights/Issues in Urgent Actions

- O‘ahu PEP secured collections from individuals in PUs and revised population estimates
- NRS completed the Helemano fence
- NRS collected seed from the Helemano PU

Plans for OIP Year 1

- Work with PEP to secure landowner permission to fence the Waimano and Ahuimanu-Halawa Summit Ridge PUs
- Survey the Waihe‘e-Waimalu summit ridge PU for more plants and threats
- Continue to collect mature seed from the Helemano PU for storage
- Support PEP so that all PUs are monitored and collect mature seed

Table 2.2.3a Taxon Status Summary

Action Area: In

TaxonName: Cyanea st.-johnii **TaxonCode: CyaStj**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano	Manage for stability	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	Monitoring found no change
	Total for Taxon:	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	

Action Area: Out

TaxonName: Cyanea st.-johnii **TaxonCode: CyaStj**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ahuimanu-Halawa Summit Ridge	Manage for stability	14	0	20	0	0	0	12	0	0	**14**	**0**	**20**	Population estimates reported by PEP
Waiahole-Waiawa Summit Ridge	Manage for stability	6	0	1	0	0	0	9	1	0	**6**	**0**	**1**	Population estimates reported by PEP
Waihee-Waimalu summit ridge	Genetic Storage	10	0	0	0	0	0	10	0	0	**10**	**0**	**0**	Population estimates reported by PEP
Waimanalo-Wailupe Summit Ridge	Genetic Storage	11	0	0	0	0	0	12	1	0	**11**	**0**	**0**	Population estimates reported by PEP
Waimano	Genetic Storage	8	0	20	0	0	0	12	0	0	**8**	**0**	**20**	Population estimates reported by PEP
	Total for Taxon:	49	0	41	0	0	0	55	2	0	**49**	**0**	**41**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed & Tissue Culture	Yes for genus, but not specific to species	No?

Collection: Mature fruit for this taxon has been difficult to collect. Immature seeds found in aborted fruit typically have lower germination than mature seeds and do not store well.
Fruit appears to abort prior to maturation on many of the individuals. At this time, it is unclear as to why this phenomenon occurs.

Propagation: For fruit collected with immature seeds, tissue culture has been a necessary technique, yet this species remains one of the hardest species of *Cyanea* to propagate for the Harold L. Lyon Arboretum Micropropagation Lab. Seedlings grow very slowly and the controlled environment has been essential for their survival. Seeds germinated in Petri dishes then potted and kept in the controlled-environment chambers have had high mortality and displayed a lack of growth. Seedlings have yet to be removed from test tubes and propagated in the greenhouse.

Seed Storage Research: Not enough mature seed has been collected to use for testing.

Genetic Storage: PEP has made many collections from plants in Halawa, Waiawa, Hawaii Loa Ridge, and Waimano. Individuals are represented mostly in tissue culture and some in seed storage. Mature seed will continue to be stored, while immature seed will be propagated via tissue culture.

Outplanting Issues
Outplanting may be necessary at all of the MFS PUs once they are fenced. No outplanting of this species has been attempted to date. NRS will attempt to augment these species into the Helemano MU once enough propagules are available.

Population Unit Level Discussion
Plans for management of each PU are outlined below.

Manage for Stability PUs

Helemano
There is currently one site with five mature plants in the Helemano PU. This PU is the northernmost location in the Ko`olau Mountains and one of a few known from habitat other than the wind-sweep ridge crest. It is in a very intact native area and in order to limit 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 none have rooted. Viable seed was successfully collected in November 2006 after fruits were bagged. Seeds from this collection are currently being propagated at the Lyon Arboretum Micropropagation Lab. This stock is being cultured at the Lyon Arboretum Micropropagation Lab until there is adequate stock to allow for

material to be moved to the nursery while keeping the remaining in the lab for storage. It will likely take a year or more before there are plants in the greenhouse. As this approaches, NRS will develop reintroduction plans. The upper Helemano drainage fence was finished during the summer of 2007. This fence excludes ungulates from the fragile area around the *C. st.-johnii*, protects numerous other endangered plant species, and secures additional habitat that may be used for reintroduction.

Ahuimanu-Halawa Summit Ridge
NRS will work with PEP to continue collections from this PU. This area is a high priority for fencing as there is often ungulate sign in the area around the plants and the terrain is such that fencing would be relatively easy. Because this PU is on Kamehameha Schools' (KS) property, it may be advantageous for PEP to pursue a fencing plan as they are a non-federal agency. NRS can provide technical assistance, labor and materials. NRS will work to develop plans with PEP over the next year.

Waiahole-Waiawa Summit Ridge
NRS will work with PEP to continue collections from this PU. It is designated as MFS and as with the Ahuimanu-Halawa Summit Ridge PU, NRS will work with PEP to develop a fence plan that PEP can be taken to KS. The fencing of this PU will be second priority to Ahuimanu-Halawa Summit Ridge PU.

Other PUs

Waimanalo-Wailupe Summit Ridge
NRS will work with PEP to continue collections from this PU. Steep terrain in the vicinity of the plants appears to protect the area from ungulates; therefore this population is not a high priority for fencing. This PU occurs on State land.

Waiheʻe-Waimalu Summit Ridge
NRS visited this site with Joel Lau in 2003, but it has not been monitored since. In the next year, NRS will work with PEP to seek permission from KS to do another survey of the area and develop management plans.

Waimano
This PU has the second highest number of seedlings as reported by PEP. It also overlaps with *Lobelia gaudichaudii* subsp. *koolauensis* PU and occurs on state land. Because of these factors, it is the highest priority area to fence and NRS will work to pursue a fence around the PU. NRS will work with PEP to scope the project and approach the DLNR with a proposal in the next year.

2.2.4 *Cyrtandra subumbellata*

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from accessible portions of PUs managed for stability
- Tier 3 stabilization priority

Taxon Level Discussion

NRS observed a new PU of this species in Uwao Valley on the windward side of the Koʻolau Mountains. Just two individuals were observed which may have been hybrid with sympatric species in the area. This PU is designated at 'Manage for genetic storage'. Therefore there are now four known PUs, three of which are designated as 'Manage for stability': Kaukonahua, Kahana, and Punaluʻu.

This species is not well known and the habitat that this species seems to preferentially occupy, along the wet steep slopes of the windward side of the Koʻolau Mountains, is relatively under surveyed. Therefore, NRS believe there may be many more individuals than are currently known. The only leeward population for the species is in South Kaukonahua Gulch in SBE. A total of about 212 plants are known from the four PUs. The South Kaukonahua PU, which is the only one in the AA, contains two mature and one immature plants.

Three of the four currently known PUs were found since 2000. The South Kaukonahua Gulch PU was found in 1994 on a biological survey of SBE. The Punaluʻu plants were discovered 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.

Major Highlights/Issues in Urgent Actions

- No monitoring of known populations in the last year
- One new PU found
- Observation of flower and fruit production in Army Nursery of seedling stock (Figure 2.2.4a)

Plans for OIP Year 1

- Monitor the South Kaukonahua and Punaluʻu PUs
- Survey areas in the windward Koʻolau Mountains
- Collect propagules for storage testing if observed

Table 2.2.4a Taxon status summary

Action Area: In

TaxonName: Cyrtandra subumbellata **TaxonCode: CyrSub**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaukonahua	Manage for stability	2	0	1	0	0	0	3	2	0	**2**	**0**	**1**	This PU was not visited in the last year
	Total for Taxon:	2	0	1	0	0	0	3	2	0	**2**	**0**	**1**	

Action Area: Out

TaxonName: Cyrtandra subumbellata **TaxonCode: CyrSub**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahana	Genetic Storage	8	7	0	0	0	0	8	7	0	**8**	**7**	**0**	This PU was not visited in the last year
Punaluu	Manage for stability	200	0	0	0	0	0	100	0	0	**200**	**0**	**0**	Clarification of data resulted in higher numbers; This PU was not visited in the last year
Uwao	Genetic Storage	2	0	0	0	0	0	2		0	**2**	**0**	**0**	new PU discovered this year
	Total for Taxon:	210	7	0	0	0	0	110	7	0	**210**	**7**	**0**	

Figure 2.2.4a Flowering *Cyrtandra subumbellata* in Greenhouse

Propagation and Genetic Storage
Plants can be propagated from seed. Seedling stock has flowered one year after being sown. Seeds from a 2006 collection were placed in one -18C storage treatment and will be first tested in 2008. Based on recent studies that indicate several species of *Cyrtandra* may age rather quickly in storage, this collection will be closely monitored to try and detect when seeds first start to age in storage. Future collections will be used for additional storage tests.

Unique Species Observations
Hybridization appears to easily occur between this species and other native members of this genus.

Outplanting Issues
It will be important to utilize what is considered pure stock when outplanting this species. Collections for genetic storage and/or future outplantings should be made from pure stock.

Research Issues
Seed storage potential specific for this species needs to be tested.

Surveys
More surveys need to be conducted in the future to determine the extent of the known PUs. Additionally, surveys in potential habitat may reveal more individuals. Priority habitat to be surveyed is the area around the Kaukonahua PU which currently has only three individuals (Figure 2.2.4b).

Map removed,
available upon request

Figure 2.2.4b Priority potential survey habitat for *Cyrtandra subumbellata*

2.2.5 *Eugenia koolauensis*

Requirements for Stability

- 3 population units (PUs)
- 25 reproducing individuals (long-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from all MFS PUs
- Tier 1 stabilization priority

Major Highlights/Issues in Urgent Actions

- All MFS populations have sharply declined in health and number of individuals.
- Air layer collections, fruit collections, cuttings, and seedling removals, were made at all three MFS populations in an attempt to secure genetic representation in the nursery. Air layers and cuttings have been largely unsuccessful so far, but most seedlings rescued from the sites have survived.
- A complete census was done for all individuals in the fence areas (including marking all seedlings).
- An experimental outplanting of tree ferns was done at all three fenced areas to help restore the understory to a more native composition and reduce weed density.

Plans for OIP Year 1

- Continue census of MFS PUs (including surrounding areas just outside the fences).
- Continue propagation research to determine best means of securing genetic representation.
- Collect genetic representation from other PUs in addition to further collections from MFS PU populations.
- Continue air layering mature trees.
- Selective weed control to prevent seedlings from being smothered by weeds.
- Possibly conduct fungicidal control on relatively healthy mature trees during their reproductive period to obtain seeds for propagation.
- Fund *Puccinia* rust research to determine best management practices for control work.

Table 2.2.5a Taxon Status Summary

Action Area: In

TaxonName: Eugenia koolauensis TaxonCode: EugKoo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Aimuu	Genetic Storage	5	3	6	0	0	0	5	3	0	5	3	6	
Kaunala	Manage for stability	36	45	89	0	0	0	36	43	89	36	45	89	
Pahipahialua	Manage for stability	37	42	171	0	0	0	37	42	171	37	42	171	
Western portion of Ohiaai and Oio	Manage for stability	17	14	40	0	0	0	17	14	40	17	14	40	
	Total for Taxon:	95	104	306	0	0	0	95	102	300	95	104	306	

Action Area: Out

TaxonName: Eugenia koolauensis TaxonCode: EugKoo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Hanaimoa	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	
Kaiwikoele and Kamananui	Genetic Storage	16	16	15	0	0	0	16	16	0	16	16	15	NRS did not visit in the last year
Kaleleiki	Genetic Storage	25	30	250	0	0	0	25	30	0	25	30	250	NRS did not visit in the last year
Palikea Gulch	Genetic Storage	0	0	0	0	0	0	3	0	2	0	0	0	may have burned
Papali	Genetic Storage	0	0	0	0	0	0	1	0	0	0	0	0	
	Total for Taxon:	42	46	265	0	0	0	46	46	2	42	46	265	

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 began at the three largest populations of this taxon two years ago: Pahipahi‘ālua, Kaunala and West ‘Ō‘io. These sites were chosen for their size, accessibility, and quality of surrounding habitat. They were fenced two years ago protecting them from pigs and trampling. These three sites continue to show the deadly impacts from the ‘ōhi‘a rust, first detected in 2006. Figure 2.2.5a displays the population estimates from monitoring pre-rust (NRS 2006 numbers). The 2006 numbers come from population estimates conducted mainly in the 2005 reporting year before the rust was detected. Therefore, the numbers show the full impact of the decline due to the rust. Of the remaining populations, most were not monitored in the past year, and ‘ōhi‘a rust impact is unknown. No weed control occurred at any of the populations largely because of concerns of further drying out the seedling microsites in a drought year. The steep decline of these populations as shown in the graphs below paints a bleak picture for this species. NRS staff fear that this species may go extinct in the wild within the next five years because of the rust. NRS will be funding research to determine the efficacy of fungicides on this rust species in the coming year. The rust acutely affects new growth including young leaves, flowers and fruits (Figure 2.2.5a). Thus, plants are unable to survive (much less reproduce) on just their older leaves and eventually senesce.

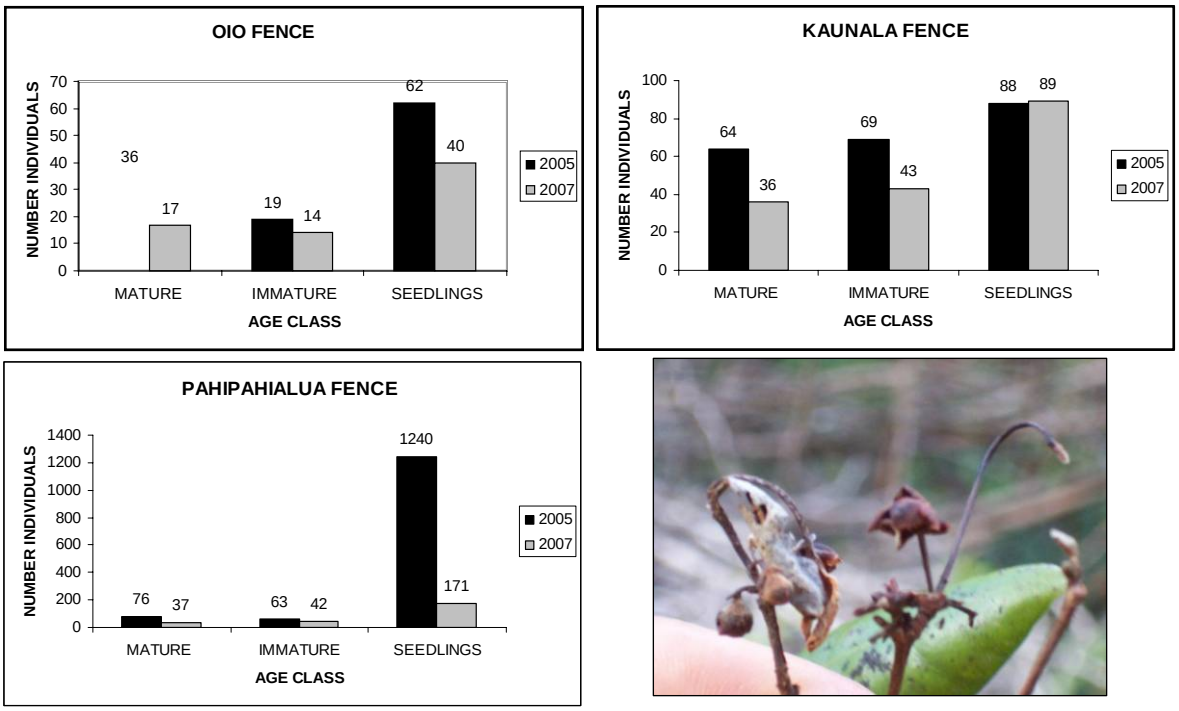


Figure 2.2.5a Graphs of population decline and photo of diseased reproductive growth

Most worrisome is the loss of roughly half of the mature trees at each MFS site given that the largest mature trees contributed the most seeds for population replacement. The high number of seedlings remaining after two years (with the notable exception of the Pahipahi‘ālua area) appears promising. However, after a review of our database it was likely that not all seedlings were counted in 2005.

In the course of building fences around the Kaunala and Pahipahi‘ālua 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.

Fire remains a significant threat to this species, particularly in this period of drought.

Propagation and Genetic Storage

Collection and Propagation: Cuttings have not been successful so far, and one air layer did produce roots but soon died in the greenhouse. Seedlings that have been removed from the field are growing in the Army Nursery where they can be more carefully monitored, maintained, and treated with fungicide. Seeds from eight individuals have been collected and sown this year. Germination is high. Seven individuals total are in the greenhouse, grown from either from collected seed or seedlings removed from the field.

Seed Storage Research: One small collection was made in 2001 from Pahipahi‘ālua for storage testing. Results indicate that seeds may be desiccation-sensitive and not be able to store long-term. Five collections have been made by the State Horticulturist from a plant at Pahole Mid-Elevation Nursery this year, totaling 19 seeds. One collection of two seeds were sown, and then the remainder were used to indicate survival at various conditions for one year. All results are pending. Each of the four remaining collections received a different storage treatment to be tested after one year for survival. With such a low number of seeds collected, determining if seeds survive a treatment is all that can be determined at this time. Due to prior storage data that might suggest seeds are desiccation-sensitive, as well as seed size and no evidence of physical dormancy, it is unlikely that seeds will ever be a viable genetic storage option.

Genetic Storage: Currently, it is unlikely that seed will be utilized to meet genetic storage goals. Therefore, collected seed and air layers will be propagated in the nursery with the intent to outplant or create an *inter situ* site if a location becomes available. If next year’s tests indicate seed survival at one of the storage treatments tested, the genetic storage strategy will need to be revised.

Unique Species Observations

The ‘ōhi‘a rust was first observed in Hawaii in April 2005 and by August 2005 had spread throughout the State. In March 2006, NRS observed ‘ōhi‘a rust damage on *E. koolauensis* at Pahipahi‘ālua. The rust subsequently was found at Kaunala and West ‘Ō‘io. The entire Kahuku Training Area contains significant stands of *Syzigium jambos* (rose apple), a primary carrier of the ‘ōhi‘a rust. Other hosts are also abundant, including *Metrosideros polymorpha*, *Eucalyptus robusta*, and *Melaleuca quinqueveria*. Some of the trees at Pahipahi‘ālua exhibit less rust damage. This is possibly due to less constant exposure as the rose apple stands are further away. 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 loss of over a

thousand seedlings at Pahipahiʻālua may be due to a combination of rust, drought and aggressive weed control in the past which dried the area out too quickly for the seedlings to survive.

Outplanting Issues
No outplantings are planned for this species. When successful propagation methods are developed, NRS will consider establishing ex situ collections at botanic gardens, such as Waimea and Hoʻomaluhia where plants can be more consistently monitored and treated for rust and other problems. Reintroduction goals may change if threats to the species increase.

Research Issues
The largest threat currently facing *E. koolauensis* is the ʻōhiʻa rust fungus. NRS is in the process of funding rust control research by Dr. Janice Uchida at UH Mānoa. Some of the work proposed by Dr. Uchida includes the following:

1) Greenhouse propagation of disease free *Eugenia koolauensis* and rose apple.
2) Experimentation to document the protective effect of different fungicides, including Heritage, an environmentally friendly fungicide on rose apple plants, a bioassay plant.
3) Experimentation to treat rare endangered severely diseased *E. koolauensis* in the forest.
4) Experimentation to confirm the efficacy of fungicides on *E. koolauensis* in greenhouse tests.
5) Experimentation to register effective fungicides in Hawai'i and to obtained related EPA data needed.
6) Experimentation to rush a special local needs permit for fungicide use on *E. koolauensis*.
7) Develop a clean disease free stock of *E. koolauensis* potted plants for future propagation.
8) Communication of results with other researchers, forest health professional, conservation environmentalist, ecologist, etc as results are obtained. This will be through community meetings and short research up-dates as data is gathered.
9) The ultimate goal is to provide chemical tools to protect the endangered species and cultivars in the native forests and those in propagation.

Complicating the rust problem is the lack of detailed knowledge about the life history of this species. More information is needed on its growth rate and light requirements. Propagation techniques also need to be refined. A number of the cuttings are still in the greenhouse, but have not rooted. This species is naturally very slow growing and more research is needed on methods to quicken rooting.

Surveys
During census monitoring around the three MFS populations, additional plants will likely be found in the immediate area outside the three fences.

2.2.6 *Gardenia mannii*

Requirements for Stability

- 3 population units (PUs)
- 25 reproducing individuals (long-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Tier 1 stabilization priority

Taxon Level Discussion

The following are three Manage for Stability (MFS) Population Units (PU) for this taxon: Haleʻauʻau, Helemano and ʻŌpaeʻula, and Helemano and Poamoho. The Kaluaʻa and Maunauna PU is designated for genetic storage collection. This and the Haleʻauʻau PUs are the only known location of plants in the Waiʻanae Mountain Range. Numbers listed in Taxon Summary Report reflect initial OIP numbers reported in 2005. More surveys need to be done in order to confirm other sites known by former TNC staff. Current numbers differ from 2005 numbers due to reorganization of plant populations within individual PUs. No status in PUs with any management designation changed in the last year. Plants occur across a wide range in the Koolaus, and the areas with the highest densities of plants have been selected as MFS PUs. NRS are focusing propagation efforts and management in the Waiʻanae Mountains because numbers of individuals are so low.

The proposed Lower Peʻahināiʻa exclosure has been expanded and will now protect approximately 19 individuals. The Haleʻauʻau plants are also fenced, and weeding took place around trees within the exclosure this year. Limited military access has made management for this PU difficult. Revisitation of population sites for this taxon in the Koʻolaus is infrequent as small population sites are distributed across the Koʻolaus in currently unmanaged areas. For some populations, estimates are from 1993. NRS will focus on monitoring populations that are in Manage for Stability PUs.

Major Highlights/Issues in Urgent Actions

- Successfully airlayered two of three plants in Haleʻauʻau this year; installed airlayer on the third.
- Airlayers installed on two Kaluaʻa plants; monitoring shows airlayers should take.

Plans for OIP Year 1

- Revisit population sites in MFS PUs to ensure more accurate population numbers.
- Continue airlayering until all plants in Haleʻauʻau and Kaluaʻa and Maunauna PUs are represented.

Table 2.2.6a Taxon Status Summary

Action Area: In

TaxonName: Cyanea crispa — TaxonCode: CyaCri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kawaiiki	Manage for stability	2	8	0	0	0	0	8	0	0	2	8	0	A thorough cencus showed a change in the population #s
	Total for Taxon:	2	8	0	0	0	0	8	0	0	2	8	0	

Action Area: Out

TaxonName: Cyanea crispa — TaxonCode: CyaCri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Aihualama	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Kahana and Makaua (Makaua portion)	N/A	0	0	0	0	0	0	25	0	0	0	0	0	No monitoring in the last year
Kahana portion of Kahana and Makaua	Manage for stability	6	0	0	0	0	0	30	0	0	6	0	0	No monitoring in the last year
Kaipapau	N/A	0	0	0	0	0	0	3	0	0	0	0	0	No monitoring in the last year
Kapakahi	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Kawaipapa	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Maakua	N/A	0	0	0	0	0	0	2	0	0	0	0	0	No monitoring in the last year
Maunawili	N/A	0	0	0	0	0	0	1	0	0	0	0	0	No monitoring in the last year
Pia	N/A	0	0	0	0	0	0	20	0	0	0	0	0	No monitoring in the last year
Pukele	N/A	0	0	0	0	0	0	6	0	0	0	0	0	No monitoring in the last year
Wailupe	Manage for stability	0	0	0	0	0	0	15	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	6	0	0	0	0	0	105	0	0	6	0	0	

Propagation and Genetic Storage
Individuals in Haleʻauʻau PU still show no sign of viable seed production. In the Koʻolaus, fruits have been collected in the past from Lower Peʻahināiʻa. Seeds were viable plants were successfully propagated. NRS will monitor phenology and study pollination biology of MFS populations in the Waiʻanaes to better understand collection potential. NRS will make an effort at as many population sites as possible to observe morphology and timing this next flowering season to determine how likely pollination is occurring, either through outcrossing or selfing of flower. NRS will attempt to record pollinator visitation through timed observations throughout the day and evening. Seeds from collections will be utilized to determine viability and storage longevity. These tests will allow us to determine whether or not seed is useful genetic storage option for this PU.

NRS attempted to air layer plants from Haleʻauʻau this year in response to the lack of seed production. Three air layers were put on two plants in the Haleʻauʻau population in September, 2006. Healthy air layers were harvested with many roots in August of this year. An additional air layer was installed on a third plant this year with an innovative climbing device. Air layers have been installed on the two known plants in Kaluaʻa. One of these was recently installed, and the other has root formation and will be ready for collection in a couple months. 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.

Research Issues
The main priority for research is seed storage of this species.

Surveys
No surveys were done specifically for *G. mannii* this year, however three new plants were found in the Koʻolaus while surveying for other taxa.

2.2.7 *Huperzia nutans*

Requirements for Stability

- 3 Population Units (PU)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from all occurrences when propagation techniques become available
- Tier 2 stabilization priority

Taxon Level Discussion

There are four PUs with eight plants known from the Koʻolau Mountains. Both the South Kaukonahua and portions of the Kahana and North Kaukonahua PU are in the Action Area (AA) for Schofield Barracks East Range (SBE). The Kawainui-Koloa Summit Ridge PU is in the Kawailoa Training Area (KLOA) AA. These three PUs are designated as Manage for Stability (MFS). To date, no more than two plants have been found at a single location and plants are often solitary. The gametophytes of *H. nutans* have not been studied and propagation techniques are not developed. All PUs will require augmentation to achieve the numbers of reproducing individuals required for stability. The major threat to the known sites is from pig damage and no PUs are fenced. Large fences are planned for Koloa and the North and South Kaukonahua MUs. These will protect many known *in situ* sites and secure outplanting sites. The habitat at all known PUs is primarily native and weeds are not considered a significant threat. Since so few individuals are known at this time, developing an *ex situ* conservation plan and surveys are the highest priority.

Major Highlights/Issues in Urgent Actions

- Cuttings of *Huperzia phyllantha* have begun to establish roots, new growing tips and strobili.
- Surveys at one of the sites in the Kahana and North Kaukonahua PU rediscovered a plant that was previously assumed to be dead.

Plans for OIP Year 1

- Collect cuttings and divisions of *H. phyllantha*
- Monitor known sites for mature fertile tips for spore collection
- Surveys in Kaipapaʻu and Kahana

Table 2.2.7a Taxon Status Summary

Action Area: In

TaxonName: Huperzia nutans — TaxonCode: HupNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahana and North Kaukonahua	Manage for stability	4	0	0	0	0	0	4	0	0	**4**	**0**	**0**	One known plant was not observed during monitoring in the last year and is considered dead
Kawainui-Koloa Summit Ridge	Manage for stability	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	No monitoring in the last year
South Kaukonahua	Manage for stability	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	6	0	0	0	0	0	6	0	0	**6**	**0**	**0**	

Action Area: Out

TaxonName: Huperzia nutans — TaxonCode: HupNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaipapau	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	

Propagation and Genetic Storage

In order to develop propagation protocols, NRS made collections of cuttings from *H. phyllantha* from the Poamoho Trail in February 2007. From the collected material, 13 smaller cuttings, two to three inches in length, were divided into three different propagation techniques. These techniques were determined based on correspondence with Chad Hubsy, a fern ecophysiologist at Florida International University. C. Husby also recommended the website of the Australian National Botanic Gardens (ANBG 2006). Five cuttings were propagated vertically with the cut end buried and the growing tip exposed. Five cuttings were propagated vertically with the growing tip buried and the cut end exposed. Three cuttings were laid across the media and both ends were covered with media. All three cuttings that were laid on their side produced roots, new vegetative growth, and are developing strobili. None of the cuttings that were placed upside down have produced new growth and appear to be dying. Three of the five upright cuttings have developed new vegetative growth, immature strobili, and roots. One additional cutting appears to have produced roots from the growing tip but appears t be slowly dying. The media used was a mix of perlite and vermiculite. Cuttings have remained on the Army Nursery mist bench, and growth was noticed as early as August 2007. These results are very encouraging. Therefore, NRS will continue to collect *H. phyllantha* in the coming year to continue to develop propagation techniques.

Figure 2.2.7a Developing roots on cutting material from *Huperzia phyllantha*

Research Issues

The main priority for research is developing propagation techniques. Due to the low number of extant individuals and the risk of removing material from the known plants, more testing should be done on the more common *H. phyllantha*. Vegetative-propagation techniques will continue to be tested at the Army Nursery. Strobili collections will also be made to experiment with spore germination at the Lyon Arboretum Micropropagation Laboratory.

2.2.8 *Labordia cyrtandrae*

Requirements for Stability

- 2 Population Units (PU)
- 100 reproducing individuals from East Makaleha to North Mohiakea & 50 reproducing individuals from the Manana area (long-lived perennial; dioecious; low seed set)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Tier 1 stabilization priority

Taxon-specific issues

There are two Manage for Stability (MFS) PUs for *Labordia cyrtandrae.* The plants from East Makaleha to North Mohiakea in the Waiʻanae Mountains are in one PU. These plants occur over a large area but are considered one PU. The other MFS PU is Manana Gulch in the Koʻolau Mountains where one mature plant is known. There are still large under-surveyed areas of appropriate habitat for this taxon in both ranges, but especially in the Koʻolau Mountains where only one site is known. Although some individuals may occasionally produce perfect flowers, more female plants than male plants have been observed. Juvenile and seedling plants are rarely seen in the wild, but two seedlings were observed in the last year. Natural Resource Staff (NRS) consider *Labordia cyrtandrae* to be functionally dioecious so NRS have developed an *ex situ* propagation plan to obtain collections from *in situ* plants via air layering and pollen storage. These e*x situ* collections and plants grown in *inter situ* sites will be used for seed production. Seeds grown from these plants will then be used to establish and supplement reintroductions. NRS has stored pollen collected from the Manana plant by the Oahu Plant Extinction Prevention (PEP) program which will be used to pollinate plants from the Waiʻanae PU in the greenhouse in the coming year.

Major Highlights/Issues in Urgent Actions

- Pollen was collected from wild and reintroduced plants by PEP and NRS. It was stored for the short-term for hand pollinations and long-term for viability testing.
- Hand pollination trial of greenhouse and reintroduced plants begun; immature fruit currently developing on plants
- Air layers were installed on 14 additional *in situ* founders
- An additional plant was discovered in East Makaleha

Plans for OIP Year 1

- Establish a living collection of clones in the greenhouse from each *in situ* founder
- Produce seed for storage testing, genetic storage and propagation for outplanting through natural and hand pollination from living collections and the three reintroductions on State land
- Survey around historic sites in the Koʻolau Mountains (Manana and Kaʻalaea)
- Survey around new areas at Mt. Kaʻala (Waiʻanae Kai and Makaleha)
- Identify new potential reintroduction sites inside the Kaʻala Management Unit (MU)

Table 2.2.8a Taxon Status Summary

Action Area: In

TaxonName: Labordia cyrtandrae TaxonCode: LabCyr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaleha to Mohiakea	Manage for stability	46	1	2	14	19	0	44	1	0	**60**	**20**	**2**	
	Total for Taxon:	46	1	2	14	19	0	44	1	0	**60**	**20**	**2**	

Action Area: Out

TaxonName: Labordia cyrtandrae TaxonCode: LabCyr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Manana	Manage for stability	1	0	0	0	0	0	1	1	0	**1**	**0**	**0**	
	Total for Taxon:	1	0	0	0	0	0	1	1	0	**1**	**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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Air layers	Living Collection	No	Yes – living collections

Collection: NRS has collected fruit, cuttings and air-layers from *in situ* plants. Cuttings have never been successful. Fruit collection has been difficult for several reasons. First, the fruit take several months to develop and it is difficult to determine maturity. Second, fruit appear to be bored by an insect and seed predation is commonly observed. Third, plants are dioecious, and many fruit have been observed intact (seed predation absent) with empty seeds (no embryos). This suggests that females may produce fruit regardless of fertilization. With pollen dispersal and range unknown, it is not clear how regularly female individuals are pollinated, regardless of male proximity. Viable seed is rarely observed.

Propagation: Viable mature and immature seed delivered to the Harold L. Lyon Micropropagation Lab has been germinated, propagated *in vitro*, grown in the greenhouse, and successfully outplanted. Mature seed has also been propagated without tissue culture techniques. Half of the air layers collected have been successfully established *ex situ*.

Seed Storage Research: Further studies are necessary. All seed produced this year from greenhouse and reintroduction pollinations will be used for extensive storage testing. Viability testing on two collections stored dry at 4C for four years yielded no survival. There was germination for one of these collections after two years. No initial viability tests were conducted on these collections, so the seed quality of these two collections remains uncertain.

Genetic Storage: NRS was successful this year at collecting pollen from individuals *in situ* and at outplantings for immediate hand-pollinations of reintroduction and *ex situ* stock. Any and all seeds produced by these pollinations will be used for long-term storage viability testing. Collections and pollinations were made throughout May and June 2007. Pollen was collected from one *in situ* plant and three separate reintroduced individuals (representing two founders), at one of the Ka'ala outplantings on State land (ALA-A). One plant at this site and one at another nearby outplanting on State land (ALA-B) were pollinated immediately with the collected pollen. Another individual at ALA-B was pollinated three weeks later. All three plants currently have immature fruit. The pollen was also used to pollinate five plants in the greenhouse. Pollen was one to seven weeks old. Fifty-two flowers were pollinated. Four months later, 26 immature fruit are developing on the plants. The remaining pollen was dried to 20% RH and stored at -18C to test viability during next year's flowering season.

There are 48 plants that NRS consider potential *in situ* founders. Of these 48, 21 are known female, five are male including the Manana plant and 22 are still unknown. NRS propose to establish a living collection grown from air layers of all 48 founders. Prioritization of air layer installation is as follows: 1) all males; 2) unknowns in underrepresented sites; 3) unknowns in represented sites; 4) collect from females not within an ungulate fence; 5) collect from females to accomplish even representation throughout sites. Since there are so few males, NRS anticipates

that focusing efforts on unknowns may increase the number of known males. Including the flowering females already present in the greenhouse, this approach will hopefully create a living collection with sufficient flower production for hand pollination trials and enough seed for storage research. NRS has focused collections on the priorities discussed above and have installed air layers on 14 additional founders in the last year. Plants represented by clones in outplantings will be collected there.

Table 2.2.8b 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
Labordia cyrtandrae							
Makaleha to Mohiakea	46	1	1	0	3	5	3
Manana	1	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	3	5	3

Outplanting Issues

Four outplanting sites have been established inside the Ka‘ala MU to augment the East Makaleha to North Mohiakea PU. Three are on State land and the other site is planted on Army land on Schofield Barracks West Range (SBW). The stock was grown from both seed and air layers collected from plants in the East Makaleha to North Mohiakea PU. No stock from the Makaleha section of this PU has been outplanted yet. Survivorship in all sites has been high (33/38) and plants grown from air-layers have begun to flower. NRS will continue to augment the site on SBW and will search for additional outplanting sites in the coming year. As discussed in the Propagation and Genetic Storage section above, the stock from hand-pollinated fruit in the reintroduction sites and the greenhouse will be used for propagation and storage testing. Once germinated, the plants will be used to supplement the SBW reintroduction.

Research Issues

Research on the black twig borer may help protect this species (Chapter 5.1). This threat and other insect predation may contribute to the little/ low recruitment.

Surveys

In the next year, NRS will work to survey appropriate habitat on Ka‘ala at the summits of Wai‘anae Kai and Mākaha Valleys. Surveys in historic Ko‘olau Mountain sites are needed to determine the full extent of those PUs.

Taxon Threats

Threats to *Labordia cyrtandrae* include pigs, goats, black twig borer, seed predation, and competition with non-native plant species such as *Rubus argutus*. The plants inside the Ka‘ala MU are protected from ungulates and the individuals in East Makaleha will be protected from ungulates within the East Makaleha MU. Those that fall outside these two MUs will be

protected with strategic fencing or clones will be outplanted into the MUs. Weed control is conducted throughout the Ka‘ala MU and will continue. The plant at Manana does not need a fence at this time but will be protected in the Manana MU fence which will secure habitat for outplanting.

Table 2.2.8c Population Unit Threat Control Summary

Action Area: In

TaxonName: Labordia cyrtandrae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaleha to Mohiakea	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Labordia cyrtandrae

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Manana	Manage for stability	No	No	No

2.2.9 *Lobelia gaudichaudii* subsp. *koolauensis*

Requirements for Stability

- 3 Population Units (PU)
- 75 reproducing individuals (short-lived perennial; monocarpic; inconsistent flowering)
- Stable population structure
- Threats controlled
- Genetic storage collections from Pus managed for stability
- Tier 3 stabilization priority

Taxon Level Discussion

Lobelia gaudichaudii subsp. *koolauensis* has been reported from six sites in the Koʻolau Mountains on Oʻahu. There are three Manage for Stability (MFS) PUs that cover the full geographic range of this taxon. This taxon is monocarpic and only a small fraction of each population may flower in any given year. Monitoring data and stabilization targets will reflect this life-cycle. Most plants will be counted as immature and mature plants will be only counted as they flower and die. In addition, two of the PUs are known to have both *L. gaudichaudii* subsp. *gaudichaudii* and *L. gaudichaudii* subsp. *koolauensis*. The current population estimate for the Kīpapa PU includes immature *L. gaudichaudii* subsp. *gaudichaudii* in addition to *L. gaudichaudii* subsp. *koolauensis.* The Kawai Iki PU has both sub-species but only two mature plants of *L. gaudichaudii* subsp. *koolauensis* have ever been observed amongst the many *L. gaudichaudii* subsp. *gaudichaudii*. The major threat is from ungulates. Fences are planned for the three MFS PUs and weed control will begin once fences are complete. The Kaukonahua and Kīpapa PUs will need to be augmented once Management Unit (MU) fences are complete.

Major Highlights/Issues in Urgent Actions

- Population estimates and monitoring data has been for all known PUs

Plans for OIP Year 1

- Begin planning small PU fences around the Kaukonahua and Kīpapa PUs
- Monitor PUs for mature plants and collect seed for genetic storage

Figure 2.2.9a Mature plants at the Kawai Iki PU

Table 2.2.9a Taxon Status Summary

Action Area: In

TaxonName: Lobelia gaudichaudii subsp. koolauensis **TaxonCode: LobGauKoo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaukonahua	Manage for stability	3	45	2	0	0	0	3	45	2	**3**	**45**	**2**	No observations in the last year
Kawaiiki	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	No observations in the last year
	Total for Taxon:	5	45	2	0	0	0	5	45	2	**5**	**45**	**2**	

Action Area: Out

TaxonName: Lobelia gaudichaudii subsp. koolauensis **TaxonCode: LobGauKoo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kipapa	Manage for stability	0	100	20	0	0	0	0	100	20	**0**	**100**	**20**	No observations in the last year
Waiawa portion of Waiawa to Waimano	Manage for stability	0	80	0	0	0	0	0	80	0	**0**	**80**	**0**	No observations in the last year
	Total for Taxon:	0	180	20	0	0	0	0	180	20	**0**	**180**	**20**	

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Seed	Seed	Yes	No

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 display similar storage traits as other lobelioids, as seeds do not survive -18C storage but remain viable at 4C. This is yet another species that would benefit from lipid analyses as well as starting storage treatments at -80C and/or -150C when more seed becomes available (see 2.00 Seed Storage Research). 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. Cuttings and airlayers are not considered to be viable options for propagation since most plants are single stemmed. Seeds are being stored from two founders from the Kawai Iki PU and four founders in the Kaukonahua PU.

Table 2.2.9b 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
Lobelia gaudichaudii subsp. koolauensis							
Kaukonahua	3	45	0	4	0	0	3
Kawaiiki	2	0	0	2	0	0	2
Kipapa	0	100	0	0	0	0	0
Waiawa portion of Waiawa to Waimano	0	80	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**
				6	0	0	5

Research Issues

Outstanding research issues include studies of possible hybridization between the two subspecies, development of techniques to differentiate immature plants of the subspecies from each other and life history research for *L. gaudichaudii* subsp. *koolauensis*.

Table 2.2.9c Threat Control Summary

Action Area: In

TaxonName: Lobelia gaudichaudii subsp. koolauensis

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaukonahua	Manage for stability	No	No	No
Kawaiiki	Genetic Storage	Yes	No	No

Action Area: Out

TaxonName: Lobelia gaudichaudii subsp. koolauensis

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kipapa	Manage for stability	No	No	No
Waiawa portion of Waiawa to Waimano	Manage for stability	No	No	No

2.2.10 *Melicope lydgatei*

Requirements for Stability

- 3 population units (PUs)
- 25 reproducing individuals (long-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from all PUs
- Tier 2 stabilization priority

Taxon Level Discussion

There are two Manage for Stability (MFS) Population Units (PU) for this taxon: Kaiwikoʻele to Kawai Nui Ridge and Kawai Iki and ʻŌpaeʻula. All but three known plants occur in the Kawai Iki and ʻŌpaeʻula PU. Most of these plants have not been monitored in many years. NRS are currently securing permission from Kamehameha Schools in order to begin building a large scale fence the Lower Peahinaīʻa MU. Since finding 22 more individuals of this taxon two years ago, the proposed fence was expanded to include a total of 31 plants. Weed control in this exclosure will also be crucial given that weeds such as *C. hirta* and *P. cattleianum* are abundant.

Few surveys been conducted in the Kaiwikoʻele to Kawai Nui Ridge PU thus far. This year NRS will survey to locate more individuals. No fences are currently planned for this PU, however NRS are looking for means of storing and propagating material of this population until the populations can be secured by fencing. Two cuttings collected from wild plants in this PU were successfully grown in the Pahole Nursery. Fruit was collected from these plants and processed for germination, but have not yet germinated. Several seeds were also collected from two different plants last year for germination.

Major Highlights/Issues in Urgent Actions

- Fruit from greenhouse plant collected. Currently waiting for seed germination.
- Fruit germinated from *in situ* plant collected in Kaiwikoʻele to Kawai Nui Ridge PU.

Plans for OIP Year 1

- Conduct surveys in the Kaiwikoʻele to Kawai Nui Ridge PU.
- Continue propagation and genetic storage research on this taxon.
- Surveys to find one additional PU

Table 2.2.10a Taxon Status Summary

Action Area: In

TaxonName: Melicope lydgatei TaxonCode: MelLyd

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaiwikoele-Kawainui Ridge	Manage for stability	3	0	0	0	0	0	3	0	0	3	0	0	Numbers of plants in 2006 inaccurate. No change in population this year.
Kawaiiki and Opaeula	Manage for stability	38	0	0	0	0	0	45	0	0	38	0	0	Population not monitored this year.
	Total for Taxon:	41	0	0	0	0	0	48	0	0	41	0	0	

Propagation and Genetic Storage

NRS has had difficulty germinating taxa in Rutaceae. Seeds likely have some type of dormancy, yet this is hard to determine as large amounts of seed are not possible to collect. *M. lydgatei* has a very thick seed coat, which suggests that it is water impermeable and may have physical dormancy. Often seeds that are scarified (as seeds coat is very thick) rot quickly, where seeds left untreated may take months to germinate or not germinate at all. Seeds may have some combination of morphological and physical dormancy, and scarification prior to complete embryo development may inhibit germination. NRS will continue to try to collect seeds, either *in situ* or *ex situ*, to determine germination protocols. NRS will focus collection efforts on more common species of *Melicope* on which to practice proposed germination techniques. Only after germination and dormancy is understood will storage testing commence. Seeds may also be intermediate in storage behavior, where seeds may not be tolerant of really dry or cold conditions. Several other agencies, including the Lyon Micropropagation Lab, the National Center for Genetic Resource Preservation and the Royal Botanical Garden, Kew, continually work on other species in this family and information will hopefully be available to guide NRS efforts.

Two propagation highlights occurred this year. First, one out of five seeds collected from two individuals in the Kawai Iki and ‘Ōpae‘ula PU in August 2006 germinated in May 2007. It took one month from radicle emergence to complete germination (radicle + cotyledons emergence). Second, two cuttings that have been established in the greenhouse have flowered year round, and a few seed have been collected. The seeds were sown in January of this year and have still not germinated. There is less fruit produced than the number of flowers observed on this nursery stock. These highlights support the practicality of attempting to gain a better understanding of dormancy issues for this taxon.

Surveys

No surveys were conducted specifically for this taxon this year. A trip was planned to the Kawailoa trail to collect from two individuals there, but the trip was canceled due to weather conditions. NRS will continue to pursue cuttings from this population, and keep vigilant for more plants.

2.2.11 *Phyllostegia hirsuta*

Requirements for Stability

- 3 Population Units (PUs)
- 75 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Tier 1 stabilization priority

Major Highlights/Issues in Urgent Actions

- New population North of Pu‘u Kalena
- New immature plant or a new growth from stolon at Pālāwai gulch site that was thought to be extripated
- Last remaining seedling at Huliwai population removed to ex-situ site
- Kalena Notch (SBW-B) population extripated

Plans for OIP Year 1

- Continue to monitor and collect stock for reintroduction from all PUs
- Install weather stations to monitor microsite conditions at wild populations to create a criteria for selecting reintroduction sites
- Control priority weeds at MFS PUs.
- Survey Hale‘au‘au to Pu‘u Kalena

Figure 2.2.11a *Phyllostegia hirsuta* inflorescence

Table 2.2.11a Taxon Status Summary

Action Area: In

TaxonName: Phyllostegia hirsuta TaxonCode: PhyHir

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Waieli	Genetic Storage	8	5	3	0	0	0	8	5	3	**8**	**5**	**3**	formerly known as Waieli, one site observed and is healthy
Haleauau	Genetic Storage	0	3	0	0	0	0	0	3	0	**0**	**3**	**0**	formerly Mohiakea-Haleauau, two sites were moved out of this PU
Helemano and Opeaula	Genetic Storage	7	9	0	0	0	0	7	9	0	**7**	**9**	**0**	There were no observations in the last year
Kaipapau-Kawainui Summit Ridge	Genetic Storage	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	There were no observations in the last year
Kaukonahua	Genetic Storage	4	2	0	0	0	0	4	2	0	**4**	**2**	**0**	There were no observations in the last year
Kawai Iki	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	There were no observations in the last year
Mohiakea	Genetic Storage	50	0	0	0	0	0	50	0	0	**50**	**0**	**0**	Site was formerly in thePU Mohiakea- Haleauau. There were no observations in the last year
South Central Haleauau	Manage for stability	3	8	1	0	0	0	25	25	25	**3**	**8**	**1**	old site extirpated, new site found, formerly found in Mohiakea-Haleauau PU
South Helemano	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	There were no observations in the last year
	Total for Taxon:	80	27	4	0	0	0	102	44	28	**80**	**27**	**4**	

Table 2.2.11a Taxon Status Summary

Action Area: Out

TaxonName: Phyllostegia hirsuta TaxonCode: PhyHir

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	Plants are dead
Huliwai	Genetic Storage	0	0	0	0	0	0	3	9	0	**0**	**0**	**0**	heavy decline, last seedling brought into greenhouse
Kaipapau Gulch	N/A	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	There were no observations in the last year
Kaluaa to South Waieli	Manage for stability	1	13	3	0	0	0	2	20	12	**1**	**13**	**3**	formerly known as just Kaluaa, one site extirpated, others declining
Kaluanui	N/A	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	There were no observations in the last year
Koloa	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	future reintroduction site
Makaha-Waianae Kai Ridge	N/A	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	This is a population known only by Joel Lau
Palawai	Genetic Storage	0	1	0	0	0	0	0	0	0	**0**	**1**	**0**	regrowth or new plant at old site observed
	Total for Taxon:	9	14	3	0	0	0	13	29	12	**9**	**14**	**3**	

Taxon Level Discussion

On Oʻahu, this species is found in both the Waiʻanae and Koʻolau Mountains. In the Waiʻanae Mountains it is found from Haleʻauʻau to ʻĒkahanui, and in the Koʻolau 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. Preferred habitat varies from wet forest in the Koʻolau Mountains to mesic-wet talus slopes in the Waiʻanae Mountains. In the Waiʻanae Mountains this species has been known to occur in large groups. Many of these large population 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 many PUs are likely to disappear. In the next year NRS will begin to collect cuttings from every known living individual in order to establish living collections and provide stock for reintroductions at the three MFS PUs (See Table 2.2.10a and Outplanting Issues). The Waiʻanae sites will be the first priority due to the decline in populations. As seed storage is currently not feasible (see Propagation and Genetic Storage), NRS will use the Lyon Micropropagation Lab and the Pahole Mid-elevation Nursery 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 grow vigorously. Seeds have been germinated at the Lyon Micropropagation Lab and plants can be subcultured and maintained *in vitro*. Storage viability for this taxon is unknown, but based on other species of *Phyllostegia*, it is likely that seeds will be able to be stored to meet genetic storage goals. A large collection of seed, hopefully from an increasing living collection, will need to be tested. If seeds can be stored, the living collection can serve as the seed source. Until seed storage is determined, tissue culture and a living collection will serve to meet genetic storage goals. Seeds were collected from the Waiʻeli population the previous report year. Stock from Kaluaʻā, Poamoho, ʻĒkahanui and ʻŌpaeʻula PUs are currently represented in the greenhouse. A new population was discovered at Puʻu Kalena, but all the mature plants were vegetative at the time of discovery. One immature plant has emerged in Pālāwai at a site thought to be extirpated, and may be brought into the greenhouse at a later date.

Table 2.2.11b Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			Storage Goals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Phyllostegia hirsuta							
Central Waieli	8	5	0	1	1	1	1
Haleauau	0	3	0	0	1	0	1
Helemano and Opeaula	7	9	1	0	0	1	0
Huliwai	0	0	1	0	0	1	0
Kaipapau	1	0	0	0	0	0	0
Kaipapau-Kawainui Summit Ridge	5	0	0	0	0	0	0
Kaluaa to South Waieli	1	13	0	0	0	1	1
Kaluanui	5	0	0	0	0	0	0
Kaukonahua	4	2	0	0	0	0	0
Kawaiiki	2	0	0	0	0	0	0
Makaha-Waianae Kai Ridge	2	0	0	0	0	0	0
Mohiakea	50	0	0	0	0	0	0
North Ekahanui	0	0	0	0	0	0	0
Palawai	0	1	0	0	0	1	1
South Central Haleauau	3	8	0	0	0	0	0
South Helemano	1	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**
				1	2	5	4

Unique Species Observations

In the Koʻolau range this species is generally found as only single individuals or very small populations growing in wet forest. However, in the Waiʻanae Mountains population sizes are observed to be larger and growing on steep rocky slopes in mesic-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 AA (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 Koʻolau PUs. As information is gathered NRS will have the IT review plans.

The Mohiākea and South Central Haleʻauʻau PUs will be reintroduced into a proposed fenced area within the Kalena-Kaʻala Ridge MU. The Haleʻauʻau PU (and possibly Mākaha-Waiʻanae Kai ridge PU) will be reintroduced into the Kaʻala MU. There are fenced sites on the slopes of Kaʻala where

this species should thrive. The PUs that occur South of Kolekole pass (Central Waiʻeli, Kaluaʻā to South Waiʻeli, Huliwai, and Pālāwai) with living stock will be incorporated into a reintroduction in the Kaluaʻā and Waiʻeli Subunit IIb MU. In the next year NRS will make collections from PUs for a trial outplanting next winter (Figure 2.2.10b).

Figure 2.2.11b *Phyllostegia hirsuta* PU Groupings for Reintroduction

It should be noted that TNCH has outplanted *P. hirsuta* three times at three sites in the Kalua'ā to South Waiʻeli PU over the last four 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 a year and a half old and its success or failure remains to be seen, however some individuals have survived to maturity and have fruited. Conditions at this site may be a bit wetter and cooler then previously used sites. This fairly short lived species seems to rely on high seed production and replacement as a primary reproductive strategy. Reasons for the outplanting failure may lie with improper micro-site conditions resulting in poor vigor or lack of sufficient number of plants outplanted and not enough plants surviving to maturity to produce a viable seed bank. However, limited monitoring of the outplantings occurred so any conclusions about success or failure may be premature. The problems TNCH faced with its outplantings underscore 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 TNCH Honouliuli Preserve were revisited to update population numbers and monitor threats. An immature plant from a known site in the Pālāwai PU was discovered. The last individuals seen before this one was in 2002. A survey during October 2006 found the SBW-B population within the South Central Haleʻauʻau PU had been extirpated. However, a new population was discovered within this PU, just North of Puʻu Kalena, on a survey of SBW in July 2007.

Population Unit Level Discussion

Manage for Stability PUs

South Central Haleʻauʻau: This PU contains the sites at Puʻu Kalena and Kalena Notch that used to be in the Mohiākea – Haleʻauʻau PU, was divided up due to geographic isolation of the sites. The site at Kalena Notch (SBW-B) was visited and found extirpated, but a new site with 12 plants was found just North of Puʻu Kalena. This PU lies within a proposed fenced area for the Kalena-Kaʻala Ridge MU, but the start date for construction is undetermined due to the complexities of access to the range, UXO, etc.

Kaluaʻā to South Waiʻeli: This PU was formerly known just as Kaluaʻā but the name was changed because some of the sites fall in Waiʻeli. There are four sites within this PU. All sites were visited in the past two years and one appears to have been extirpated. At the three remaining sites plants are not vigorous and there has been a steady decline, likely the result of weed competition as well as land slides. The wild plants in Central Kaluaʻā (KAL-A) are fenced, the plants in Waiʻeli are not.

Koloa: NRS are still 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 pursue a Koloa MU fence. This action is considered the highest management priority for this taxon in the Koʻolau Mountains. Once the fence is complete NRS will develop a reintroduction plan for the site (see Outplanting Issues). In the meantime, NRS will work to fully survey the area and determine if there are any naturally occurring populations.

Other PUs

Haleʻauʻau: This PU, formerly known as Mohiākea-Haleʻauʻau, was made up of four sites: Haleʻauʻau, Puʻu Kalena, Kalena Notch, and North Mohiākea. This PU now only consists of the population in central Haleʻauʻau. The site had three immature plants in August 2002, but has not been visited since. NRS will revisit the site and make collections for storage and reintroduction within the Kaʻala MU(see outplanting issues section above).

Mohiākea: This PU, formerly included in the Mohiākea-Haleʻauʻau PU, now only consists of the population in North Mohiākea. The site has not been visited in a number of years and its current status is unknown, however it is a high priority area for NRS to resurvey.

Central Waiʻeli: There are two sites within this PU. NRS discovered one of these sites in the previous report year. One mature plant occurs at this site and seeds and cuttings were collected from this single healthy individual. There are now eight propagules in the greenhouse from this source. The second site has not been visited since May 2003. NRS will return in the next year to determine the extent of both sites and collect stock to reintroduce at the Kaluaʻā and Waiʻeli Subunit II B MU (see Outplanting Issues).

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).

Kaipapaʻu-Kawainui Summit Ridge: There are two sites within this PU, one of which NRS and Joel Lau discovered in February of 2006. Only the Joel Lau is familiar with the other site. NRS will work to collect from these sites 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).

Helemano and Opaeula: There are four sites in this PU. These sites have been visited at various times over the past four years. NRS will work to collect from these sites in the next couple years for reintroduction into the Koloa PU. The site near the Lower Peʻahināiʻa trail (KLO-G) 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 Joel Lau and the IT regarding the significance of this difference and whether or not it should influence outplanting plans for the Koloa PU (see Outplanting Issues).

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.

ʻĒkahanui: There are two sites within this PU. The North ʻĒkahanui population died during the previous report year and another historic location in South ʻĒkahanui was resurveyed this year and found to be extirpated as well. NRS will monitor the sites in the coming year and search for any regeneration.

Mākaha-Waiʻanae Kai Ridge: This is a population known only by Joel Lau. 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 BWS watershed planner and considered for inclusion into the reintroduction site in the Kaʻala MU.

Huliwai: This PU contains one site that was last visited in June of 2007. This population has been declining over the past several years due to landslides, ungulate activity, and the small number of mature individuals. Only one small immature was observed during the June visit. After reviewing all threats and options, NRS decided to remove the plant from the wild and place it in the greenhouse, where it is currently thriving. NRS will propagate the Huliwai stock for reintroduction at the Kaluaʻā and Waiʻeli Subunit II B MU. NRS will also revisit this site in the spring of 2008 to monitor for additional seedlings.

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.

Pālāwai: This site was thought to be extirpated until NRS found an immature plant in early 2007. This plant may be a resprout from a stolon of one of the plants observed in 2002 as it is in the general area of the previous observed plants, though it is unclear. NRS will continue to monitor the site and collect for genetic storage when the plant has sufficient growth or has matured.

2.2.12 *Phyllostegia mollis*

Requirements for Stability

- 3 population units (PUs)
- 75 reproducing individuals (short-lived perennial, with tendency for large declines or fluctuations in population size)
- Stable population structure
- Threats controlled
- Genetic storage collection for full genetic representation
- Tier 1 stabilization priority

Major Highlights/Issues in Urgent Actions

- Puali‘i fence completed by TNC last fall will be used for reintroduction site.
- New individual found in Central Kalua‘a.
- All remaining individuals from the Mohiākea PU (Schofield Barracks West Range) died this past year of unknown causes.

Plans for OIP Year 1

- Continue balancing founders at existing reintroduction and/or augmentation sites and begin new reintroduction at Puali‘i.
- Continue genetic storage and propagation work for large outplantings.
- Complete the larger ‘Ēkahanui fence for more outplanting sites.
- Some survey work at old sites and adjacent areas for new founders as time permits.
- Weed control at some old sites to hopefully stimulate germination of new founders as time permits.

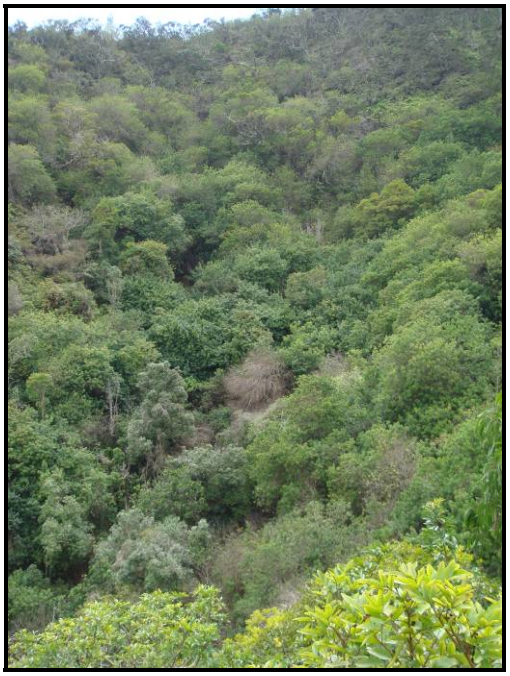


Figure 2.2.12a Central Kalua‘ā outplanting and wild site (Gulch 3)

Table 2.2.12a Taxon Status Summary

Action Area: In

TaxonName: Phyllostegia mollis **TaxonCode: PhyMol**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Mohiakea	Genetic Storage	0	0	0	0	0	0	0	1	2	**0**	**0**	**0**	
	Total for Taxon:	0	0	0	0	0	0	0	1	2	**0**	**0**	**0**	

Action Area: Out

TaxonName: Phyllostegia mollis **TaxonCode: PhyMol**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	0	0	0	13	0	0	0	0	0	**13**	**0**	**0**	
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	
Kaluaa	Manage for stability	0	1	0	15	36	0	14	0	0	**15**	**37**	**0**	
Pualii	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	
Waieli	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	
	Total for Taxon:	1	1	0	28	36	0	15	0	0	**29**	**37**	**0**	

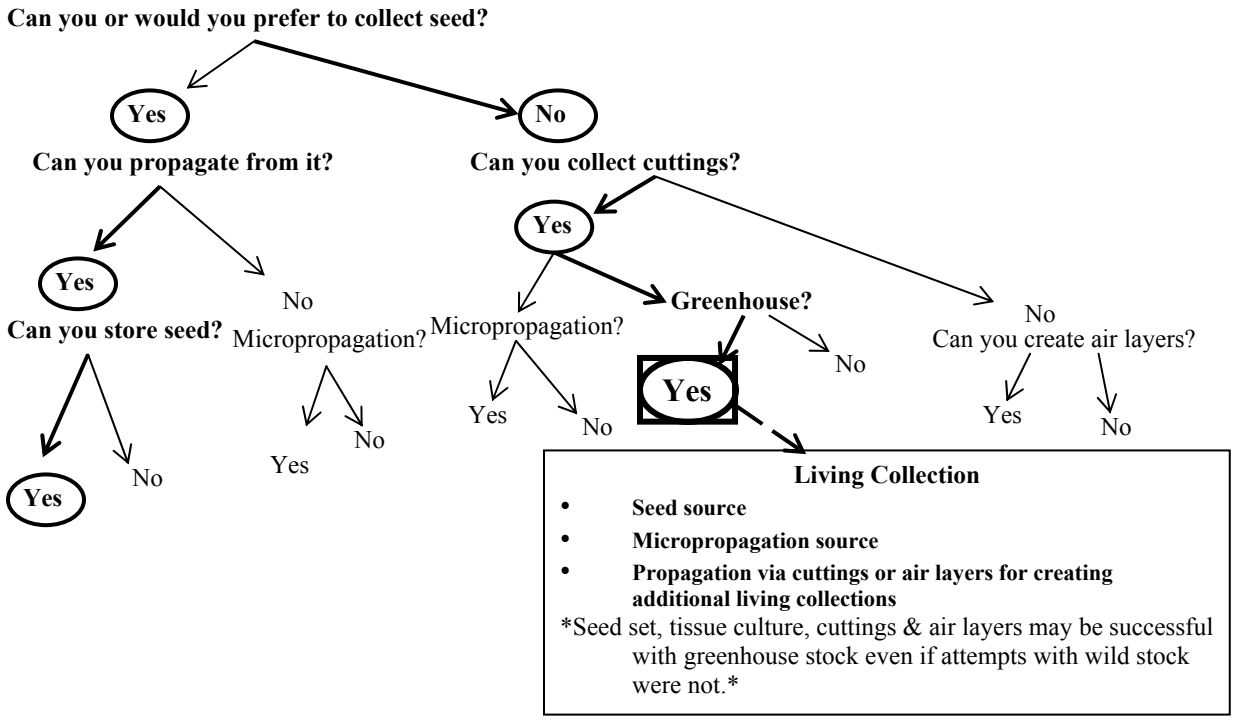
Taxon Level Discussion

The current status of this taxon is still very bleak. Plants are extirpated from all but two of the six known sites. The two remaining sites are at Schofield Barracks South Range (SBS) and a newly discovered location at Central Kalua‘a gulch in TNC’s Honouliuli Preserve. Augmentation must be used to achieve stabilization for this taxon. NRS will not report on PUs with no remaining individuals next year unless a change in status occurs.

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) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection	No	Yes, further pollination studies needed

Prioritizing Genetic Storage & Propagation Techniques



Collection: Cuttings are the preferred collection method for tissue culture and greenhouse propagation. Seed production rates are often low even from older, mature plants.

Propagation: This species is easily propagated from tip cuttings as well as seeds. There are no special germination requirements. Germination from fresh seeds is high.

Seed Storage Research: Soil seed bank potential was tested in the lab with a dark, imbibed treatment. Seeds show no decrease in viability after one year in the dark, imbibed. No aging was detected in seeds stored dry at -18C after 19 months of storage.

Genetic Storage: Seven additional founders have been established in tissue culture this year. NRS will continue to maintain all stock as a living collection and in tissue culture. Any seeds produced in the greenhouse will be collected for seed storage testing or storage.

Table 2.2.12b 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
Phyllostegia mollis							
Ekahanui	0	0	1	0	1	1	1
Huliwai	0	0	1	1	1	1	1
Kaluaa	0	1	0	0	0	0	0
Mohiakea	0	0	12	1	4	5	5
Pualii	0	0	1	0	0	1	1
Waieli	1	0	4	3	5	5	5
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				5	11	13	13

With the exception of stock from Mohiākea PU, genetic storage goals have largely been met for this species. Cuttings from the immature plant at Kaluaʻā will likely be made this year.

Table 2.2.12c Founders Represented in Outplantings

TaxonName: Phyllostegia mollis **TaxonCode: PhyMol**

Total Num Plants based upon Plants that have been numbered

PopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Ekahanui	Manage for stability	1	1
Huliwai	Genetic Storage	1	1
Kaluaa	Manage for stability	1	0
Mohiakea	Genetic Storage	12	3
Pualii	Manage for stability	1	0
Waieli	Genetic Storage	5	5
	Total for Taxon:	**21**	**10**

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

Unique Species Observations

This species looks very similar to *Phyllostegia parviflora* var. *lydgatei*. *P. parviflora* and *P. mollis* once co-occurred in Pālāwai, Pualiʻi and ʻĒkahanui 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. at Mānoa conducted genetic analyses. The results were not completely conclusive but do indicate that the Pualii plant in question is likely a hybrid. 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. Three TNC reintroduced populations of *P. parviflora* var. *lydgatei* are doing fairly well in the Palikea, Kalua‘a and South Puali‘i fence areas with vegetative reproduction occurring at two of the three reintroduction sites. This small success of the TNC reintroductions offers hope that future Army reintroductions will also be successful.

Outplanting Issues

As with other Hawaiian mint species, *P. mollis* is a short-lived perennial species relying on vegetative and sexual reproduction for population replacement. A key factor for population growth over time is the individual plant’s microsite. This species appears to prefer loose granular soil in semi-disturbed sun gaps along the lower gulch bottom slopes. This type of habitat is now mostly degraded limiting overall potential for recruitment over time. Outplanting sites may require weed control at least one year prior to outplanting in order to stabilize the habitat by re-opening the canopy, removing subsequent weeds that will invade this semi-disturbed habitat, and allowing native colonizing species (e.g. *Pipturus albidus*) to stabilize the habitat. Large numbers of outplantings will also likely be needed at each site (e.g. 200 individuals) in order to obtain a stabilized target population of 75 plants given the dynamic nature of populations of this species. See also the Kalua‘ā MFS PU section below for further discussion on outplanting issues specific to those sites.

Discussion of Management Designations

The strategy for this taxon involves substantial reintroductions. The MFS augmentations and reintroductions will be conducted in three zones. Figure 2.2.12b below, shows the designated population reference codes to be planted into the three core management sites, Kalua‘ā, ‘Ēkahanui and Puali‘i. Each population reference code represents the location of the source material (e.g. KAL = Kalua‘ā).

Map removed,
available upon request

Figure 2.2.12b Outplanting Zones for *Phyllostegia mollis*

Research Issues
Outplanting techniques and site selection require some research as reintroduction survival rates over time are low for this taxon. Perhaps research in the area of drought and fungal 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. Slug control research will also benefit this species.

Surveys
No surveys have been conducted recently for this taxon. In the next year NRS will direct some staff time to survey for additional populations. Revisiting historical locations and searching adjacent sites will be the highest priority. The newly discovered plant in Central Kaluaʻā offers some hope that additional plants can still be found.

Manage for Stability PUs

Kaluaʻā

Kaluaʻā, Waieli, and Mohiākea stock is available for use in this MU. The newly discovered Kaluaʻā individual is not yet in propagation as it is still too small for cuttings to be taken. 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. The KAL-B reintroduction was initiated in 2002 with 26 plants. All plants from this effort have since died. No recruitment was ever observed at the KAL-B site although a number of the outplants flowered and fruited. Plants were planted in possibly too much shade for them to thrive and produce a lot of seeds or new stolons before senescing. The KAL-C site was first established in February 2006 with 16 plants. 14 of those 16 plants died quickly in the space of two months in the summer of 2006. NRS suspect that powdery mildew and/or a virus caused the quick decline as rainfall was more than adequate and plants were healthy just prior to dying. More frequent monitoring will hopefully detect any future declines in time for a management response. In early 2007, 51 plants were added to the KAL-C site, at the same location of the 2006 outplanting, and at another location approximately 100m up gulch. As of July 2007 only two plants have died from this last reintroduction. Overall survivorship at the KAL-C site is 76% over the last two years. Based on stock availability, an additional site may be established within the adjacent Waieli exclosure. Weed control is on going at the Kaluaʻā reintroduction sites, see Chapter 1 for weed control details.

ʻĒkahanui

All the wild plants from this zone are extirpated. Stock from the ʻĒkahanui and Huliwai PUs were used for a reintroduction in the past year. This initial effort consisted of 13 individuals and more plants will supplement this site in the coming year.

Subunit I of the ʻĒkahanui MU contains some suitable habitat for this taxon. The NRS fencing crew expect to have Subunit II of this MU completed sometime by Spring 2008. This will increase the available habitat for *P. mollis* reintroductions in ʻĒkahanui significantly. One potential reintroduction site was weeded last year by TNC. Substantial reintroductions are planned for the coming year into this MU.

Pualiʻi

TNC completed a new exclosure in Pualiʻi gulch last fall and reintroduced a mixed outplanting of *P. mollis* and *P. parviflora var. lydgatei* last November in the upper reach of South Pualiʻi. The NRS reintroduction will be in North Pualiʻi at a site geographically distinct from the existing TNC reintroduction. Weed control at this planned reintroduction site is already ongoing by TNC and NRS staff.

Other PUs

Waieli

NRS continue to monitor the wild site in North Waiʻeli (SBS-A). One mature individual still exists at 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).

Mohiākea
Range restrictions limit the access to this site. Unfortunately, all six remaining plants died at this site of unknown causes. This population had been declining over the past several years despite fencing. Limited range access made more frequent monitoring difficult. NRS will continue monitoring this site periodically for any new seedlings.

Figure 2.2.12c *Phyllostegia mollis* formerly at Mohiākea

2.2.13 *Pteris lidgatei*

Requirements for Stability

- 3 Population Units (PU)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from PUs managed for stability
- Tier 3 stabilization priority

Taxon Level Discussion

There are three Manage for Stability (MFS) PUs for *Pteris lidgatei*. Two of the MFS PUs are within the Action Area (AA) for Schofield Barracks East Range (SBE) and the other is inside the Kawailoa Training Area (KLOA) AA. There are currently no plants known from the North Kaukonahua PU, so the Helemano and Kawa‘iki PUs have been identified as two backup sites. Since there is little potential impact to *Pteris lidgatei* from Army actions it has been a low priority to schedule management in the last year. This species is threatened by pigs and weeds but most sites occur along steep stream banks and waterfalls and are not directly threatened by pigs. NRS has monitored all the O‘ahu PUs except the South Kaukonahua and Kaluanui PUs in the last two years. These PUs and the North Kaukonahua PU will be the priorities for monitoring and surveys in the coming year. Propagation methods have not yet been developed and NRS will search for appropriate material while monitoring PUs.

Major Highlights/Issues in Urgent Actions

- No NRS monitoring in the last year
- *Pteris lidgatei* was discovered on Moloka‘i by Steve Perlman and Hank Oppenheimer. Previously, it was known only from O‘ahu and West Maui.

Plans for OIP Year 1

- Monitor the known sites in the South Kaukonahua PU
- Survey for additional plants in the North Kaukonahua, Helemano and Kawai Nui PUs
- Collect mature sori for propagation trials

Table 2.2.13a Taxon Status Summary

Action Area: In

TaxonName: Pteris lidgatei **TaxonCode: PteLid**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano	Manage for stability (backup site)	2	2	0	0	0	0	2	2	0	**2**	**2**	**0**	No observations in the last year
Kawaiiki	Manage for stability (backup site)	3	0	0	0	0	0	3	0	0	**3**	**0**	**0**	No observations in the last year
Kawainui	Manage for stability	0	1	0	0	0	0	0	1	0	**0**	**1**	**0**	No observations in the last year
North Kaukonahua	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No observations in the last year
South Kaukonahua	Manage for stability	6	0	0	0	0	0	6	0	0	**6**	**0**	**0**	No observations in the last year
	Total for Taxon:	11	3	0	0	0	0	11	3	0	**11**	**3**	**0**	

Action Area: Out

TaxonName: Pteris lidgatei **TaxonCode: PteLid**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Waimano	Genetic Storage	0	2	0	0	0	0	0	2	0	**0**	**2**	**0**	No observations in the last year
	Total for Taxon:	0	2	0	0	0	0	0	2	0	**0**	**2**	**0**	

Propagation and Genetic Storage
This species has not been successfully propagated. NRS plan to collect mature sori for propagation this year if any material is available.

Outplanting Issues
All three MFS PUs will require augmentation to achieve the numbers needed for stability. NRS will develop propagation techniques once mature sori are collected. Outplanting *P. lidgatei* into the waterfall and stream bank habitat where they are found may be challenging.

Research Issues
The biology of this species is not well known and research on the gametophyte and sporophyte generation is needed. Propagation methods are not developed.

Surveys
No surveys have been conducted in the last year. Additional surveys would be beneficial as habitat for this species is largely under surveyed. NRS will contact Maui PEP in the coming year to get an update on the Maui PUs and potential propagation techniques.

Figure 2.2.13a An immature frond of a plant in the Helemano PU

2.2.14 *Sanicula purpurea*

Requirements for Stability

- 3 Population Units (PU)
- 100 reproducing individuals (short-lived perennial; inconsistent flowering)
- Stable population structure
- Threats controlled
- Genetic storage collections from Pus managed for stability
- Tier 2 stabilization priority

Taxon Level Discussion

There are three Manage for Stability (MFS) PUs for *Sanicula purpurea.* Two are inside the Kawailoa Training Area (KLOA) Action Area (AA) and the third is inside the Schofield Barracks East Range (SBE) AA. These three MFS PUs contain all but four of the known plants on O‘ahu. There are several hundred plants known from West Maui. None of the O‘ahu PUs have more than 25 plants and the goal for each MFS PU is to have 100 reproducing plants. Augmentation will be necessary at all three MFS PUs to achieve stability. Few mature plants have been observed in the wild. Observations of inconsistent flowering indicate that this species may be difficult to monitor and determine population trends. Ongoing research with *Sanicula mariversa* may provide insight into how to adapt to these difficulties. NRS has grown plants from the Helemano-Punalu‘u Summit stock and outplanted four plants in 2000. One of these plants was observed flowering at the reintroduction site in May 2006 and seedling recruitment was observed in July 2006. Pigs and weeds especially *Axonopus fisifolius* are the major threats at all PUs.

Major Highlights/Issues in Urgent Actions

- A thorough monitoring of the Helemano-Punalu‘u Summit Ridge PU found more plants
- NRS began intense monitoring of *Sanicula mariversa* PUs which may help guide stabilization targets and strategies for this taxon as well

Plans for OIP Year 1

- Monitor and determine fenceline at the Kaukonahua-Punalu‘u Summit Ridge PU
- Collect mature seed from any PUs for propagation in the greenhouse for seed production

Table 2.2.14a Taxon Status Summary

Action Area: In

TaxonName: Sanicula purpurea TaxonCode: SanPur

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano-Punaluu Summit Ridge	Manage for stability	2	10	12	0	0	0	0	10	0	**2**	**10**	**12**	Monitoring revised estimates in the last year
Kahana-Kaukonahua Summit Ridge	Manage for stability	0	21	0	0	0	0	0	21	0	**0**	**21**	**0**	No monitoring in the last year
Kaukonahua-Punaluu Summit Ridge	Manage for stability	0	21	0	0	0	0	0	21	0	**0**	**21**	**0**	Monitoring showed no change in the last year
	Total for Taxon:	2	52	12	0	0	0	0	52	0	**2**	**52**	**12**	

Propagation and Genetic Storage
Fruit collected from the Helemano-Punalu‘u Summit population were successfully propagated in the greenhouse and outplanted at the ‘Ōpae‘ula Summit. *Sanicula purpurea* will likely mimic its congener *S. mariversa* in dormancy and germination behavior and storage potential. Seeds collected form this reintroduction last year took eight months to germinate. 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.*

Figure 2.2.14a A plant reintroduced in 2000 was observed flowering again in the last year

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 may need to mimic the saturated conditions at wild sites.

2.2.14 *Schiedea trinervis*

Requirements for Stability

- 1 Population Unit (PU) of at least 150 reproducing individuals throughout the range of the species
- Stable population structure
- Threats controlled
- Genetic storage collections from 50 plants across the range of the species
- Tier 1 stabilization priority

Taxon Level Discussion

There are several hundred *Schiedea trinervis* known from 28 sites in the wet forest habitat around Mt. Ka‘ala and Pu‘u Kalena. Most known sites are within the Schofield Barracks West Range (SBW) Action Area (AA). The majority of plants are also within the Mt. Ka‘ala Management Unit (MU) and are inside a fence where weed control is ongoing. All other sites are not fenced and pigs are the major threat. Juvenile and seedling plants are found at most sites and the PU has more than the required number of reproducing plants. Additional fences are planned for the East Makaleha and Kalena-Ka‘ala Ridge MUs and these will protect the plants in those areas. NRS will consider building small fences for any plants outside these MU fences if needed to collect for genetic storage. NRS will continue to work with State of Hawai‘i Natural Area Reserve System and Forestry and Wildlife staff to exclude pigs from the Mt. Ka‘ala MU and to begin control of the goats near plants along the ridge between Mt. Ka‘ala and Pu‘u Kalena. NRS are controlling *Psidium cattleianum* and *Hedychium gardernarium* across the Mt. Ka‘ala MU, which are the most significant weed threats to this taxon. New sites were discovered in the last year and additional surveys would likely discover more plants. Genetic storage collections are ongoing and collections will continue prioritizing unprotected areas. NRS expect to meet the goal to have 50 seeds from 50 plants in storage in the coming year. Limited experimental reintroduction has been conducted with this taxon but no further planting is planned.

Major Highlights/Issues in Urgent Actions

- New plants were found at Pu‘u Kalena and in East Makaleha
- Monitoring data was revised to display the best estimates of smaller size classes

Plans for OIP Year 1

- Collect mature seed for genetic storage from 15 additional founders. Priority will be given to plants in unprotected and outlying areas
- Survey for additional plants in East Makaleha

Table 2.2.15a Taxon Status Summary

Action Area: In

TaxonName: Schiedea trinervis TaxonCode: SchTri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kalena to East Makaleha	Manage for stability	169	206	322	6	37	0	166	169	0	**175**	**243**	**322**	
	Total for Taxon:	169	206	322	6	37	0	166	169	0	**175**	**243**	**322**	

Propagation and Genetic Storage

Plants are easily propagated from seed. There is no detected 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.

Table 2.2.15b 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 trinervis							
Kalena to East Makaleha	169	206	15	36	1	0	35
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				36	1	0	35

Surveys

There were no surveys targeting *Schiedea trinervis* in the last year, but a few new sites were discovered. These sites were at the southern and northern end of the PU at Pu‘u Kalena and Kaumoku nui Gulch, where fewer plants are known. NRS will continue to note new locations and surveys will be done in East Makaleha in the coming year.

2.2.16 *Stenogyne kanehoana*

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Genetic storage collections from all individuals
- Tier 1 stabilization priority

Major Highlights/Issues in Urgent Actions

- A new reintroduction was established at Pu‘u Hapapa for the Kalua‘ā stock.
- One Kalua‘ā stock plant in the nursery flowered.

Plans for OIP Year 1

- Carefully monitor nursery stock for flowering.
- Continue to reintroduce at established reintroduction sites.

Figure 2.2.16a Flowering *Stenogyne kanehoana* in the greenhouse

Table 2.2.16a Taxon Status Summary

Action Area: In

TaxonName: Stenogyne kanehoana TaxonCode: SteKan

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haleauau	Manage for stability	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change in the last year.
	Total for Taxon:	1	0	0	0	0	0	1	0	0	1	0	0	

Action Area: Out

TaxonName: Stenogyne kanehoana TaxonCode: SteKan

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2006	NRS Immature 2006	NRS Seedling 2006	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa (Gulch 2)	Manage reintroduction for stability	0	0	0	0	18	0	0	0	0	0	18	0	This reintroduction is new this year.
Central Kaluaa (South Fenceline)	Manage for stability	0	0	0	0	36	0	0	30	0	0	36	0	A few of plants from last year's reintroduction died and some new plantings were conducted.
	Total for Taxon:	0	0	0	0	54	0	0	30	0	0	54	0	

Taxon Level Discussion
This taxon is extremely rare. Until three years ago, it was extant at only one site. 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

1) At this time, what is the preferred propagation technique?	2) At this time, what is the preferred genetic storage technique?	3) Has a successful storage method been determined?	4) Are additional steps required for obtaining enough seed?
Cuttings	Living Collection & Tissue Culture	No	Yes, collect from ex situ stock

Collection & Propagation: Cuttings are the preferred method of propagation.

Genetic Storage: Both wild populations are represented *ex situ* at Lyon Arboretum *in vitro* and in the Army Nursery. For almost the entire month of April 2007, one Kaluaʻā stock plant began to flower at the TNC nursery. This plant was transported to the Army Nursery for pollination observations. The plant produced fifteen flowers. NRS studied floral morphology and attempted hand-selfing nine flowers. Anthers emerged from the corolla tube and dehisced prior to elongation of the style and possible stigma receptivity. Pollen was collected and used throughout the month to add to stigmas on elongated styles. Excess pollen was dried and is stored at -18C. Pollen will be tested if plants continue to flower or pollen tube germination trials may be conducted to monitor viability. The taxon flowers so infrequently that NRS hoped to obtain as much information as possible on its reproductive biology. Initially, three fruit began to swell and develop. It seemed promising that some fruit could be collected. Then the flowering stem began to die and all the fruit aborted. The flowering stem was heavy and hung over the edge of its pot putting strain on the stem. In the future, NRS will construct a support for the stem to avoid this occurring again.

Unique Species Observations
Primarily, this taxon reproduces vegetatively. Very seldomly have plants been observed with flowers or fruit. The Haleʻauʻau population has yet to be observed reproducing sexually.

Research Issues
Reproductive biology studies were conducted as discussed above in the propagation and genetic storage section. NRS will research ways to stimulate flowering in the greenhouse so that seed collections can be secured and cross pollination can be done. It has been suggested that treating plants fertilizer containing fish emulsion should be tried to stimulate flowering.

Surveys
No surveys were conducted for this taxon during this reporting period.

Population Unit Level Discussion

Table 2.2.16b Threat Control Summary

Action Area: In

TaxonName: Stenogyne kanehoana

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Haleauau	Manage for stability	Yes	Yes	No

Action Area: Out

TaxonName: Stenogyne kanehoana

PopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Kaluaa (Gulch 2)	Manage reintroduction for stability	Yes	Yes	No
Central Kaluaa (South Fenceline)	Manage for stability	Yes	Yes	No

Manage for Stability PUs

Hale‘au‘au

This population was discovered in June 2004. A 30 x 20 meter fence was constructed to protect it from pigs. NRS conducted weed control at this site once in the last year. NRS are careful that weed control efforts have minimal impact on the *S. kanehoana*. NRS have observed that the *S. kanehoana* canes do best when supported by other vegetation. Therefore, NRS are very deliberate in their choice of weeds to remove. *Acacia koa* growing within the fence will likely provide some shade for the *S. kanehoana* in the near future. Access restrictions continue to limit the number of visits to this population. Clones of plants from this population have been reintroduced into Kalua‘ā and are represented in the nursery and micropropagation.

Central Kalua‘ā (South Fenceline)

The only wild plant in this population died in March 2005. NRS augmented this PU approximately 100 meters from the site of the original wild plant along the south Kalua‘ā fenceline with stock from both Kalua‘ā and Hale‘au‘au. Stock from this PU is represented in reintroductions, in the nursery and at the Lyon Micropropagation Lab. In the last year, a nursery plant of this stock flowered.

Two augmentations have been conducted over the last two years along the south Kalua‘ā fenceline. Reintroduction survivorship numbers are listed in Table 2.2.16d. Only three of the plants reintroduced in 2006 remained at last monitoring. So far all the 2007 plantings have survived and look healthy. The plants that look the healthiest are those that are buried in the uluhe fern. NRS will apply this planting approach to future outplantings. A number of the outplants are now reproducing vegetatively.

Table 2.2.16c Reintroduction Survivorship Summary

SteKan.KAL-B	Kalua'a Reintro			DateLastMonitored: (Current/Accurate obs)	2007-08-01
Year Planted	Num. Plants Planted	Number Dead	Number Remaining	%Remaining	
2006	35	27	8	22.86%	
2007	28	0	28	100.00%	
Total for Site:	63	27	36	57.14%	
SteKan.KAL-C	**Central Kaluaa (Gulch 2)**			**DateLastMonitored: (Current/Accurate obs)**	**2007-08-29**
Year Planted	Num. Plants Planted	Number Dead	Number Remaining	%Remaining	
2007	23	6	17	73.91%	
Total for Site:	23	6	17	73.91%	

Central Kaluaʻā (Gulch 2)

The Gulch 2 planting was established based on determinations by NRS and the IT that there should be a site where pure Kaluaʻā stock is represented. This site was selected because of the intact uluhe (*Dicranopteris linearis*) fern cover presence. Planting operations involved clearing small openings in the uluhe. A total of 18 *S. kanehoana* were planted in March 2007. Many of these plants were damaged during transport. The drop zone selected was very sloped and the plant transport box flipped on its side. Although all the *S. kanehoana* are still alive, most of them have either poor or moderate vigor. The uluhe clearing may have contributed to this poor plant performance. This clearing caused the site to dry out and more uluhe along the perimeter of the clearings to die. For future reintroductions, care will be taken to minimize damage to uluhe during planting and make openings just large enough for the plants. The site may also be suffering because of the drought conditions that Hawaiʻi is experiencing. Perhaps the uluhe and *S. kanehoana* will improve after winter rains.

Chapter 3.1: *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 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. Threat control is underway at seven of the eight populations designated for management and at the eighth, monitoring is underway in order to direct management action. Five of the eight are protected within MU ungulate fences. In the next year, at least one more MU fence 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 ongoing at seven of the eight manage for stability populations. All eight sites are represented in captive propagation at the UH Snail Laboratory. Research regarding of *A. mustelina* dispersal and habitat utilization is ongoing as well as research about *Euglandina rosea* habitat utilization and feeding patterns. In addition, rat density and home range research is underway in ESU-A and will begin shortly in ESU-D2. The top priority management work recommended in last year's report was to expand the management of ESU-C because snail numbers are incredibly reduced here. Rat baiting grid expansion around Schofield Barracks West Range (SBW) sites was only accomplished recently due to access limitations. Habitat protection fences at these sites are being constructed and will be completed in September 2007. The biggest priority for the next year is to complete the ESU-F fence and work to establish predator control for ESU-B2 sites. In addition, NRS will work with researchers at the UH Snail Laboratory to pursue important *Achatinella* genetics work.

Grouping of *A. mustelina* sites into ESUs

The ESU areas have been updated based on additional genetic sampling conducted this year (Figure 3.1.1). 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.

Map removed,
available upon request

Figure 3.1.1 Grouping of *Achatinella mustelina* sampling sites into six ESUs

Captive Propagation

One of the requirements outlined in the MIP stabilization plan is to represent, in captive propagation, snails from each of the six ESUs and from two extra sites in ESU-B and ESU-D. ESU-B and ESU-D are very large therefore two sites were selected from each in order to represent the geographic extent of the ESUs. All sites are represented at the UH Snail Lab. Detailed snail captive propagation data is shown in Table 3.1.1.

Table 3.1.1 Captive Snail Propagation Summary for *Achatinella mustelina*

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**
		7/2007	0	9	2	**11**
‘Ōhikilolo – 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**
		7/2007	1	9	1	**11**
‘Ōhikilolo – 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**
		7/2007	0	12	1	**13**
Ka‘ala 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**
		7/2007	0	4	1	**5**
Alaiheihe 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**
		7/2007	2	21	0	**23**
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**
		7/2007	0	22	2	**24**

Population	ESU	Date	# juv	# sub	# adult	# Individuals
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**
		7/2007	2	28	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**
		7/2007	7	14	4	**25**
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**
		7/2007	0	21	0	**21**
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**
		7/2007	5	17	0	**22**
ʻĒkahanui - Honoʻuliʻuli	E	2003	0	0	10	**10**
		4/2004	24	2	3	**29**
		9/2005	22	2	0	**24**
		8/2006	7	9	0	**16**
		7/2007	2	9	1	**12**
Palikea Lunch / former Pālehua	F	1997	1	0	0	**1**
		4/2004	4	0	4	**8**
		9/2005	20	0	2	**22**
		8/2006	5	14	0	**19**
		7/2007	1	15	0	**16**
TOTAL		2003	**--**	**--**	**--**	**138**
TOTAL		4/2004	**--**	**--**	**--**	**303**
TOTAL		9/2005	**--**	**--**	**--**	**299**
TOTAL		8/2006	**--**	**--**	**--**	**253**
TOTAL		7/2007	**--**	**--**	**--**	**213**

Juvenile=<10mm, Subadult=>10mm no thickened lip, Adult=thickened lip

NRS have looked at these data to determine if collecting additional wild snails to bolster lab population numbers is necessary. NRS and the UH Snail Lab may experiment with introducing adult snails to the lab for a short time and then returning them to the wild. This would minimize the adult death observed in the *A. mustelina* lab populations in the past. NRS will consider a lab population a candidate for recollection if any of the following three criteria are met: 1) there are

<3 adult snails, 2) there are < 20 total snails, or 3) there has been no increase in snail numbers for two years. The more criteria a population meets, the higher priority it will be for field collection. Next field population statistics will be considered. NRS will consider whether a particular field site is sufficiently large to withstand removal of adult snails to the lab. NRS will not remove more than 20% of the adults from any given site to avoid negative impacts on the wild population. Also, in the ESU section of this chapter, only sites that are designated as Manage for Stability (MFS) will be considered for recollection. Until genetic data are presented that show mixing intra-ESU is not genetically harmful, NRS will refocus captive rearing support for those sites that fall within fences and in areas with planned long-term management.

Over the next year, NRS will pursue obtaining additional collections. If any one criterion is met, NRS will attempt to collect three wild adults for the lab. If the one criterion is that the lab population has not increased over the last two years, NRS will continue to monitor lab trends closely for one year and take appropriate action if any additional criteria are met during this time. If two of the criteria are met for any population, NRS will attempt to collect five adult snails for the lab. If all three are met, NRS will attempt to make collections of 7-10 snails for the lab.

In order to illustrate this decision making process, NRS will review the lab status of the Mākaha lab population.

The Mākaha population has zero adult snails, > 20 total snails, and has not shown an increase in the last two years. This means that two of the three criteria are met. This site is designated as MFS. Therefore, NRS would pursue collecting five adult snails from a wild site to supplement the lab population. This recommendation can then be refined to consider specific population numbers at the reference sites in ESU D2. For Mākaha, the challenge is that there are four population reference sites, each with limited numbers of adult snails. The largest number of adults is 21. Taking 20% of these adults would be only four snails. In this case it will not be possible to collect five wild adults from one site within the ESU. NRS may choose to collect a few adult snails from one site and the remaining number from the next closest site in order to achieve the five total or may consider four adults from one site adequate. These specific determinations will be made based on all the best available information. No one formula can be applied to these varied field situations. Returning adults to wild after birthing also remains an option.

The captive laboratory populations show alarming trends of many more deaths than births (Table 3.1.2). UH Tree Snail Laboratory Staff are working on determining the causal factors involved in these trends.

Table 3.1.2 *Achatinella mustelina* Laboratory Population Deaths 2004-2007

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 (Alaʻiheʻihe 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 (ʻŌhikilolo 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 (Mākaha) chamber 5 top	1/0/2	2/0/2	2/0/1	1/0/2	0/1/0	0/1/0
A. mustelina (ʻĒkahanui Gulch) chamber 5 bottom	4/1/4	1/0/2	0/0/0	2/1/0	1/2/0	2/1/0
A. mustelina (ʻŌhikilolo 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

Genetic Issues

The results of genetic studies can be a very useful tool in guiding management decisions. Microsatellites have been developed for *Achatinella,* which allows for more refined analyses of genetic variation. The highest priority genetic study for *A. mustelina* is to analyze the intra-ESU variation through microsatellite techniques. Results of this study can guide the prioritization of collections for captive propagation and also help to determine where reintroductions of lab snails should occur. The Army has been funding genetics staff at the UH Snail Laboratory for the last four years and will continue to support this work.

Monitoring

NRS hired a Monitoring Program Manager in October 2005. She worked with OANRP for one year and in that time developed a ground shell plot (GSP) methodology (Appendix 3-1). NRS adapted this methodology from Dr. Hadfield's standard 5 x 5 meter plots. The monitoring objective of the GSPs is to detect presence/absence of *Euglandina rosea* and rat predation and possibly detect any increases in predation rates for a management response. Ground shell plots are placed in high density areas within managed ESUs. The first plot reading 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. One problem with the GSP

methodology is that they do not detect 'caches' of shells in trees. Rat predation may in fact be occurring but not be detected.

Since the Monitoring Manager vacated the position, NRS have continued to establish ground shell plots at proposed locations and re-monitor existing ones. New monitoring projects have been on hold. This winter, NRS plan to work with the U.S. Geological Survey Botanist, Jim Jacobi to expand monitoring projects for *A. mustelina*.

Six new GSPs were established in this reporting period. A total of 14 GSPs are present, covering six of the eight managed sites. In addition, a UH graduate student has been conducting mark and recapture studies at two sites within two ESUs. Ground shell plots have been installed in six of the eight field sites being managed for the MIP (Table 3.1.3).

Table 3.1.3 Current and Future *Achatinella mustelina* Ground Shell Plots

ESU	Pop. Ref. Code	GSP Status	GSP Size	Frequency
A	MMR-C	MMR-C-1	5 x 5 m	Annually
	MMR-C	MMR-C-2	5 x 5 m	Quarterly
	PAH-B	Dr. Hadfield's	5 x 5 m	Quarterly
B1	MMR-F	MMR-F -1	~ 5 x 5 m	Quarterly
	MMR-F	MMR-F-2	~ 2 x 2 m	Quarterly
	MMR-F	MMR-F -3	~ 2 x 2 m	Quarterly
B2	LEH-C	LEH-C-1	~ 5 x 5 m	Quarterly
	LEH-D	LEH-D-1	~ 5 x 5 m	Quarterly
C	Various*	Planned for '08	N/A	Quarterly
D1	KAL-A	KAL-A-1	5 x 5 m	Annually
	SBS-B	SBS-B-1	~ 5 x 5 m	Annually
D2	Various*	Planned for '08	N/A	Quarterly
E	EKA-A	EKA-A-1	~3 x 3 m	Annually
F	PAK-A	PAK-A-3	~3 x 3 m	Annually
	PAK-G	PAK-G-1	~3 x 4 m	Annually
	PAK-G	PAK-G-2	~3 x 3 m	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.

Reintroduction

NRS spearheaded drafting rare snail reintroduction protocols in collaboration with the State of Hawai'i, the Navy, UH Snail experts and the U.S. Fish and Wildlife Service (USFWS). In May, a final draft of these Rare Snail Reintroduction Guidelines was provided to the USFWS for approval as official guidelines. The draft guidelines are included as Appendix 3.2. After this is approved, NRS will have a framework under which to pursue reintroductions.

Permits

The Army requested that the Army's USFWS, Threatened and Endangered Species permit be amended to include activities related to monitoring and management of *Achatinella* within MIP and OIP Management Units (MU). This permit was re-issued in November 2006 authorizing NRS to conduct mark and recapture studies using techniques developed by Dr. Hadfield's lab. In addition, it authorizes NRS to conduct ground shell searches and for those shells to be

maintained in a reference collection. The acquisition of this permit alleviates some of the current permit restrictions under Dr. Hadfield's permit and allows for senior staff to be involved in these activities in their management areas.

Threat Control Development

This year the Department of Defense (DOD), Legacy Program provided funding to Island Conservation to develop an implementation plan for predator proof fencing on Hawai‘i DOD lands. In order to accomplish this, each branch of DOD submitted descriptions of candidate sites where predator proof fencing would benefit natural resources. These descriptions were then scored based on the numbers of listed species included at the proposed site, the quality of the habitat, the significance of the threat to species and habitat and the logistical feasibility of the fence. NRS proposed five sites, Kahanahāiki, Kaluakauila, Poamoho Summit, Wai‘eli Bench and Mt. Ka‘ala. Mt. Ka‘ala was proposed jointly with the Air Force. Site visits were coordinated with predator fence company staff from Xcluder, New Zealand. They determined whether predator fencing was feasible at each of the sites. For example, Mt. Ka‘ala was proposed as a candidate site but when Xcluder visited they thought clearing a track for the fence would be extremely damaging and the soil too soft to build a structurally sound fence. Two of the O‘ahu Army proposed sites, one in ESU-A (Kahanahāiki) and one in ESU-D (Wai‘eli Bench) were selected to receive a full implementation plan. Island Conservation will pursue funding to build the top projects in the coming year.

NRS put out a request for designs for new and innovative *Euglandina* barriers but had very few applicants. This summer, a UH Hawaiian Intern Program Student tested some alternative designs for *E. rosea* exclosures (Appendix 3-3). Two small testing boxes were fabricated. One incorporated screen mesh and the other copper mesh. These meshes had spacing with different widths. Both of the meshes were cut and inserted into plywood such that it made what amounted to a wire brush (Figure 3.1.2.). Both designs were successful at deterring *E. rosea* escape. Only one *E. rosea* escaped after seven days within the screen brush box. No *E. rosea* escaped the copper mesh box in the seven days of observations. Although snails escaped the one box, the design presented the worst case scenario of placing starving *E. rosea* into a small, confined space which forced them to try to escape. In a field scenario, *E. rosea* would not experience high pressure to pass the barrier. The goal of this project was to find a design that is effective and requires little to no maintenance as does a salt trough and even more an electric fence. This design definitely is low maintenance and was effective in these trials.

Figure 3.1.2 *Euglandina* exclosure testing boxes

Research

OANRP funded the following three research projects:

1) UH PhD Candidate, Marty Meyer, completed his second year of research on *Euglandina rosea* habitat utilization. He observed high mortality of the *E. rosea* which he was tracking. Predation of *E. rosea* by rats was suspected but never confirmed. Other initial results show that *E. rosea* did not move very far from their starting point, none have moved further than seven meters. It also appears that *E. rosea* prefer leaf litter habitat. These results are presented in detail in Appendix 3-4. The third year of his research includes determining how this habitat utilization information can be used to guide management and in controlling *E. rosea*. Specifically, he will look at population densities and life history characteristics of *E. rosea*, and test different control methods. This research will hopefully provide information necessary for the implementation of informed management programs.

2) Kevin Hall, a PhD candidate at UH, continued his research this year studying the movement and dispersal patterns of *Achatinella*. He discovered, through the use of harmonic radar tracking techniques, that *Achatinella* show site and tree fidelity, sometimes moving significant total distances in a single tree but returning to a spot close to their original location after all this movement. In addition, he observed homing movements of snails when removed by high winds from their original tree. He has submitted this work for publication.

3) Aaron Shiels, a PhD candidate at UH, conducted extensive rat research within the Kahanahāiki gulch MU over this reporting period. A research summary of his work this year is included in Appendix 3-5. His work on determining rat home range and density in O‘ahu mesic forest habitat is critical in evaluating the effectiveness, of current rat baiting efforts. Bait station spacing for rodenticide use in Hawai‘i is based on research from Hawai‘i Island wet forest habitat and may not best fill the needs of O‘ahu mesic and wet forest habitats. NRS will use the results of this study and adapt current management or recommend changes to the current

rodenticide label for Hawai‘i. Mr. Shiels work is also important to the development of a label for aerial rat bait dispersal.

Database

In the last year, NRS worked with the Hawai‘i Biodiversity and Mapping Program to develop a rare snail database. The database includes all snail observation data since the inception of the Army NR Program in 1995. The database tracks all the field data that is included on the Rare Snail Monitoring Form. This form has been expanded and revised in the last year and is included as Appendix 3-1. It was modified to be more similar to the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form; which includes more population level information and habitat characteristics data. Automated reports were also developed in order to aid in annual reporting and internal management review.

ESU Updates

The tables used in this section are in a new format. They are developed through queries from the newly completed Microsoft Access database for snail data tracking.

Population Reference Site
The first column lists the population reference code for each field site. This consists of a three-letter abbreviation for the gulch or area name. For example, MMR stands for Mākua Military Reservation. Next, a letter code is applied in alphabetic order according to the order of population discovery. This coding system allows NRS to track each field site as a unique entity. This code is also linked to the Army Natural Resource geodatabase. In addition, the "common name" for the site is listed as this name is often easier to remember than the population reference code.

Management Designation
In the next column, the management designation is listed for each field site. The tables used in this report only display the sites chosen for MFS, where NRS is actively conducting management. These sites are generally the most robust sites in terms of snail numbers, habitat quality, and manageability. Other field sites where NRS has observed snails are tracked in the database but under the designation 'no management.' In general, these sites include only a few snails in degraded habitat where management is logistically challenging. The combined total for sites designated as MFS should be a minimum of 300 total snails in order to meet stability requirements.

Population Numbers
The most current and most accurate monitoring data from each field site are used to populate the 'total snails' observed column and the numbers reported by 'size class' columns. In some cases, complete monitoring has not been conducted within this reporting period because of staff time constraints, therefore, older data are used. Some snail monitoring forms do not divide numbers of snails counted into size classes, therefore, size class is recorded as 'unknown.'

Threat Control

It is assumed that ungulate, weed, rat and *Euglandina* threats are problems at all the managed sites. If this is not true of a site, special discussion in the text will be included. If a threat is being managed at all in the vicinity of *A. mustelina* or affecting the habitat occupied by *A. mustelina*, a "Yes" designation is assigned. The "No" designation is assigned when there is no ongoing threat control at the field site.

ESU-A Pahole to Kahanahāiki

Table 3.1.4 *Achatinella mustelina* in ESU-A Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
KAP-C **One Acre Site**	Manage for stability	24	2006-08-09	21	0	3	0	No	Yes	No	No
MMR-A **Kahanahaiki Exclosure**	Manage for stability	70	2004-07-14	50	20	0	0	Yes	Yes	Yes	Yes
MMR-C **Maile Flats**	Manage for stability	317	2007-08-27	149	114	54	0	Yes	Yes	No	No
PAH-B **Pahole Exclosure**	Manage for stability	29	2007-06-01	20	5	4	0	Yes	Yes	Yes	Yes
	ESU Total :	440		240	139	61	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- The number of marked snails in the MMR-C portion of ESU-A is many more than on all previous counts.
- A *Euglandina rosea* exclosure site was surveyed at Kapuna Gulch.
- Significant upgrade and maintenance was conducted at the Pahole Snail Exclosure. Rat bait stations and snap traps were deployed.

Plans for Year 4

- Secure collections for captive propagation at UH from the Maile Flats portion of this ESU as it is not currently represented.
- Outplant at the Pahole exclosure site to increase canopy closure.
- Sample lab snails to determine if the Kapuna Gulch lab collection is indeed in ESU-A.
- Pursue construction of the *Euglandina* exclosure proposed for the Kapuna Gulch site with the State of Hawaii.
- Continue to work with Island Conservation on design and construction plans for a predator exclosure around the Kahanahāiki Flats (MMR-A, MMR-C) portion of this ESU.

There are well over 300 snails in ESU A as shown in Table 3.1.4, therefore, this ESU meets stabilization goals. Over this reporting period, the Kahanahāiki MU has been 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 every six weeks near the Kahanahāiki and Pahole snail exclosure but not across the entire MU. Snails do occur across large portions of the MU.

In the Kapuna portion of this ESU, one site is designated as MFS, KAP-C. One subunit of the planned Kapuna MU fencing was completed this year and some construction on the remaining subunits was done. Currently, no ungulate fencing is in place to protect these snails, but with the completion of the additional subunits planned for this year, these snail locations will be protected. This site was discussed as the next site for constructing a new *Euglandina* exclosure, and as a trial reintroduction/augmentation site. These plans are on hold until the rare snail reintroduction guidelines are approved by the USFWS and until a new *Euglandina* exclosure design is chosen (See Chapter 3.1 Introduction for details). Also construction is contingent on State permissions.

In the last year, NRS worked with Island Conservation to determine the best route for a New Zealand style predator-proof fence. The Kahanahāiki Flats portion of ESU-A was chosen as a high priority site that will receive a full implementation plan (see introduction section on threat control development). The proposed route is shown in Figure 3.1.3. This fence would utilize the existing ungulate fence corridors on three sides and one new corridor would need to be cleared on the northern side of the proposed fence. This would greatly improve NRS ability to control rats across the Kahanahāiki Flats *A. mustelina* population.

Details of each population are discussed in the following sections organized by NRS population reference code.

<u>KAP-C Kapuna Gulch (One-acre Site)</u>
There are no significant updates related to this site since last year's report. The only action taken at this site in the last year was a site visit with Dr. Hadfield and NARs Specialist to determine the best route for the proposed new *Euglandina* exclosure here. The proposed fence will protect approximately 400 square-meters. A site was agreed upon by all parties. NRS will install a ground shell plot at the location within this reference code where the highest density of snails exists. The data from this GSP will be used to determine if a rat baiting grid should be established to protect *A. mustelina* at this site. If deemed necessary, NRS will request permission from the NARS commission to conduct this work.

There are snails from "Peacock Flats" represented at the UH Snail Lab. This name is synonymous with the Kapuna Gulch site. This collection was established in 1995 and needs refreshing with more wild stock. The problem is that wild stock is limited. Also, NRS are not certain that this lab collection was ever sampled and, thus, its status in ESU-A is not confirmed. NRS will facilitate necessary sampling of this stock. Regardless, this Kapuna Gulch collection only represents one small cluster of the *A. mustelina* from this ESU.

Map removed, available upon request

Figure 3.1.3 *Achatinella mustelina* distribution in the Kahanahāiki portion of ESU-A

MMR-A Kahanahāiki Exclosure

NRS continue to maintain and monitor the Kahanahāiki exclosure quarterly. Currently the electrical barrier is not functioning and NRS are trying to repair it or to retrofit the exclosure with the new brush design barriers. A rat control grid maintained around the exclosure serves as an additional barrier to rats and also protects the numerous *A. mustelina* located just outside the exclosure. This rat baiting area is shown in Figure 3.1.3. A summary of rat control data for this grid is shown in Table 3.1.5. Bait stations and snap traps are maintained every four to six weeks. There was a slight reduction in bait taken this year, this may be due to the reduced frequency of restocking bait, the bait condition and bait attractiveness.

Table 3.1.5 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
2006-2007	6	886	553	62%	36	12	12

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. Two GSPs, MMR-C-1 and MMR-C-2 (shown in Figure 3.1.3), are being monitored in order to detect rat predation if it does occur. No rat predation was observed during this reporting period. The total number of snails observed for this reference code was increased based on numbers of snails tagged by Kevin Hall. Counts from 2004 surveys were used for the number observed in the Southeast, Southwest, Middle East, Northeast, Northwest quads (Figure 3.1.3). Kevin Hall's number replaced the 2004 count for the Middle West quad. His total is the total number of snails that he has tagged in that quad since January 2006. Note that this number does not account for mortality that has occurred between January 2006 and August 2007. NRS chose to use his count despite this limitation as we feel it better represents the number of snails truly within this quad. Kevin Hall is working on an estimate of mortality rate for the MW quad site and this will be taken into account in next year's report.

Currently, the highest density area of this ESU (Kahanahāiki Flats) is currently not represented in the lab. NRS propose to collect from the Kahanahāiki Flats portion of ESU-A to better represent this high concentration of individuals where management is focused.

PAH-B Pahole Exclosure

The number of snails in Table 3.1.4 for the Pahole Exclosure was obtained from Dr. Hadfield's staff based on a survey conducted in June. The 29 snails they observed were counted in only two person hours of searching. They intend to do an exhaustive survey in the coming year. NRS will assist. This is a three dimensional plot not a two dimensional plot like the GSPs. In addition, Dr. Hadfield's staff conducted quarterly monitoring within a 5x5 meter quadrat within the Pahole Exclosure. Table 3.1.6 shows the decline in numbers counted within this quadrat since 2001.

Table 3.1.6 *Achatinella mustelina* within 5x5m quadrat at MMR-B

Year	2001	2002	2003	2004	2005	2006	2007
Counted Snails	22	23	16	12	n/a	10	3

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.

In December 2006, NRS installed a rat baiting grid of six bait stations and 12 snap traps around the Pahole Snail Exclosure and have been restocking the grid every four to six weeks. Due to continued high bait take, the number of bait stations and snap traps was increased in June and July 2007. There are currently eight bait stations and 24 snap traps. Table 3.1.7 shows rat control data for this site. NRS are astounded by the high rat density around the Pahole Exclosure. Ninety-four rats were snapped in less that one year's time. NRS expect there to be a peak in rat captures when rat control is first initiated but these numbers are higher than those normally observed proportional to the number of snap traps deployed. NRS will consider decreasing the guava stands around the site to reduce the food supply for rats in the area. NRS will also communicate this data to the UH graduate student studying rats in this ESU.

NRS also conducted significant maintenance on the exclosure which included pruning of overhanging vegetation, caulking holes in the corrugated siding, and general refurbishing. In addition, NRS conducted weed control four times during this reporting period in and around the exclosure. Species controlled include, *Clidemia hirta, Buddleia asiatica, Lantana camara* and *Schinus terebinthefolius*. NRS also sprayed the alien grasses *Paspalum conjugatum* and *Melinus minutiflora* within and around the exclosure. In addition, NRS continue to treat the incipient population of *Erharta stipoides* grass within the exclosure. Three control visits were made during this reporting period and no mature *E. stipioides* plants were observed. See ICA report in Chapter One. The NRS horticulturist and the NARS Horticulturist are propagating common native trees favored by *A. mustelina* for out planting within the Pahole Snail Exclosure.

Table 3.1.7 Pahole 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
2007	8	992	858	86%	94	24	10

ESU-B

ESU-B is a very large ESU. For management purposes it has been split into two portions. ESU-B1 includes snail occurrences on ‘Ōhikilolo Ridge and B2 includes occurrences in Central and East Makaleha. Each are discussed separately. The current status of snails at each MFS population reference code in ESU-B1 is shown in Table 3.1.8 and ESU-B2 status in Table 3.1.10.

ESU-B1 ‘Ōhikilolo

Table 3.1.8 *Achatinella mustelina* in ESU-B1 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MMR-E **Ohikilolo Mauka**	Manage for stability	77	2004-08-11	62	8	7	0	Yes	Yes	Yes	No
MMR-F **Ohikilolo Makai**	Manage for stability	240	2004-08-10	190	25	25	0	Yes	Yes	No	No
MMR-G **Ohikilolo Alemac Site**	Manage for stability	28	2002-06-04	24	0	4	0	Yes	Yes	No	No
MMR-H **Ohikilolo Koiahi Prikaa Reintro Site**	Manage for stability	17	2004-06-16	10	7	0	0	Yes	Yes	No	No
	ESU Total :	362		286	40	36	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Rat control was maintained.
- Ground Shell plots were monitored showing no signs of rat or *Euglandina* predation.

Plans for Year 4

- Conduct a survey at MMR-H and establish a baiting grid if necessary.

Table 3.1.7 summarizes the current information about each population reference code within ESU B1. Figure 3.1.4 shows the sites within ESU B1 where active management is underway and the sites where NRS are not conducting management.

Management of this ESU continues as it has in years past. The ʻŌhikilolo ridgeline goat exclusion fence continues to be maintained, monitored and is goat free. Weed control is conducted in the forest surrounding most of the snail sites within this ESU for both canopy and understory weeds (including introduced grasses). In addition, restoration has been conducted with suitable host trees for *A. mustelina*. *A. mustelina* have been observed on some of the oldest plantings of *Myrsine lessertiana* on ʻŌhikilolo. Rat control via snap traps and rat baiting continues to be maintained at least quarterly in areas where rat predation has been observed.

The three GSPs (MMR-F-1, MMR-F-2, and MMR-F-3) in this ESU were monitored according to schedule this year (Figure 3.1.5). No rat predation was observed during this reporting period. Although *Euglandina* are listed as a threat at this ESU, no *E. rosea* have ever been observed. NRS will continue to be vigilant when importing gear and equipment into this ESU to avoid its inadvertent introduction.

Map removed,
available upon request

Figure 3.1.4 Location of ESU-B1 ʻŌhikilolo *Achatinella mustelina*

Map removed, available upon request

Figure 3.1.5 ESU-B1 ‘Ōhikilolo Ground Shell Plots

MMR-E ‘Ōhikilolo Mauka

Figure 3.1.5 shows the location of each population reference code within ESU-B1. A rat grid of 14 bait stations and 14 snap traps is being maintained at this site. Table 3.1.9 below shows rat control data from this site. Weather and training conflicts interfered with access to ‘Ōhikilolo over the reporting period. Thus, the number of site visits made was reduced from four to three. This affected the quality of rat control in this grid. When the rat control grid was restocked in December, there was 100% take meaning for a period of time there was no rat control occurring at this site. Extensive weed control is ongoing. Restoration with *Acacia koa* has been conducted as the canopy is fairly open. NRS plan to supplement this restoration work with additional outplantings. A ground shell plot will be installed within the ‘Ōhikilolo mauka grid and monitored annually.

Table 3.1.9 ‘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
2006-2007	14	448	402	90%	14	7	2

MMR-F ʻŌhikilolo Makai

There are three GSPs here and NRS found no significant signs of predation. In addition, the ungulate exclosure constructed to protect habitat around the site is monitored and maintained quarterly. Many hours are spent conducting weed control at this site. The habitat at this site is the most native area at ʻŌhikilolo. NRS have observed significant recruitment of *M. lessertiana*, a favored host tree at this site.

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, and a few snails were observed. In the last report, NRS recommended conducting an exhaustive survey in the area and beginning rat control if appropriate. This work was not performed last year but will be a high priority for this year.

ESU-B2 East and Central Makaleha

Table 3.1.10 *Achatinella mustelina* in ESU-B2 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
LEH-C East Branch of East Makaleha (culvert 69)	Manage for stability	423	2006-05-23	241	119	63	0	No	No	No	No
LEH-D East Branch of East Makaleha (culvert 73)	Manage for stability	39	2006-05-01	20	16	3	0	No	No	No	No
LEH-J East Makaleha (culvert 69 - lower down	Manage for stability	2	2006-11-16	2	0	0	0	No	No	No	No
	ESU Total :	464		263	135	66	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Two ground shell plots were installed and monitored quarterly.

Plans for Year 4

- Collect from the East Makaleha portion of this ESU for representation in the UH Tree Snail Lab.
- Control incipient canopy weeds in the ESU.

- Collect additional genetics samples for determining intra-ESU genetic variation.
- Determine best destination for S-Ridge (LEH-A) laboratory stock.

This portion of ESU-B covers a wide geographic area. *Achatinella mustelina* exist on almost every ridge from Central to East Makaleha. Due to management limitations and the geographic spread of these sites, NRS only plan to manage two of the sites within the proposed East Makaleha MU fence. There are sufficient numbers of snails encompassed within this MU to achieve stability goals. Table 3.1.10 shows the numbers of snails found at these two MFS sites. The priority management action for protecting snails in this ESU is the construction of the East Makaleha MU fence. This fence construction is pending a formal agreement with the State of Hawaii regarding our management work on State lands. Ecosystem-altering weeds such as *Psidium cattelianum* are present in very low densities although some incipient canopy weeds such as *Toona ciliata* are moving in and should be controlled before they become established. Rat control is not being conducted because of the damage that rat baiting trails would cause to this habitat, which is dominated by *Dicranopteris linearis*. In order to monitor rat impacts, two GSPs (LEH-C-1 and LEH-D-1) were installed during this reporting period and are monitored quarterly. NRS will respond with rat control if predation is observed. The monitoring activity and trail use during GSP reading trips is very extensive and NRS area concerned that pig activity will follow our activity if a fence is not in place. 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 existing in ESU-A.

Genetic analyses using microsatellite techniques were planned for this ESU in order to determine intra-population variation. This data was to be used to guide management decisions related to mixing snails from the same ESU but from different ridges in captive propagation. This question has not been answered as genetic work has taken longer than expected. In addition, more collections are required to get enough data to be able to answer the question. For microsatellite analyses, collections from between 8-10 snails are recommended from each sampled site within the ESU. Collections of only three snails per each field site have been made based on requirements established for CO1 analysis. Additional collections are required to address the question of intra-ESU variation and more samples will be collected in the next year.

A special discussion is warranted for the S-ridge (LEH-A) non-MFS site in ESU-B2. The only laboratory representation of ESU-B2 is from S-ridge in Central Makaleha. Collections were made in 2003. This site is not designated as a MFS. NRS decided not to recollect to supplement this lab population. Instead, NRS will collect 7-10 adults from the biggest concentration of *A. mustelina* within the proposed East Makaleha MU. The five remaining snails in the lab from S-ridge are good candidates to return to the original wild site.

Map removed,
available upon request

Figure 3.1.6 ESU-B2 East Branch of East Makaleha

LEH-C Culvert 69 and LEH-D Culvery 73
There are no specific issues related to this site that have not been covered in the general ESU B2 section above. No predation was detected at the GSPs here.

ESU-C Schofield Barracks West Range (SBW), Ala‘ihe‘ihe and Palikea Gulches

Table 3.1.11 *Achatinella mustelina* in ESU-C Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
ALI-A Palikea gulch	Manage for stability	0	2004-09-01	0	0	0	0	No	No	No	No
ALI-B Palikea gulch west. Just east of Alaiheihe/Palikea dividing ridge.	Manage for stability	6	2005-03-23	4	1	1	0	No	No	No	No
ANU-A Manuwai gulch	Manage for stability	1	2004-06-02	0	1	0	0	No	No	No	No
IHE-A Alaiheihe Gulch Western Most Site	Manage for stability	0	2005-03-22	0	0	0	0	No	No	No	No
IHE-B Alaiheihe middle site "Ptemac Site"	Manage for stability	27	2003-02-05	23	4	0	0	No	No	No	No
IHE-C Alaiheihe below Nalu's LZ, TT's spot	Manage for stability	0	2005-03-22	0	0	0	0	No	No	No	No
SBW-A North Haleauau Hame Ridge	Manage for stability	28	2007-08-22	18	6	4	0	No	No	Yes	No
SBW-B North Haleauau one ridge north of Hame	Manage for stability	0	2007-08-20	0	0	0	0	No	No	No	No
SBW-C North Haleauau just above Pouteria pair territory	Manage for stability	7	2007-08-21	4	3	0	0	No	No	Yes	No
	ESU Total :	69		49	15	5	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	<8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Rat control grids were installed within SBW-A and SBW-C where *A. mustelina* are still extant.
- Fences have been surveyed and permissions acquired for construction in September at SBW-A.
- Surveys this year revealed more snails than had been observed in recent years at SBW-A.
- A new site was discovered on the slopes of Mt. Ka‘ala (SBW-R) which may fall within ESU-C. Genetic samples were secured.

Plans for Year 4

- Determine the ESU designation for the new SBW-R population on the slopes of Mt. Ka‘ala via genetic testing. Adjust management plans for the ESU accordingly.
- Complete fence to protect SBW-A in September 2007.
- Resurvey sites within Mt. Ka‘ala NAR that have not been visited recently.
- Secure additional collections to bolster lab population as necessary.
- Continue rat control

The number of snails in this ESU is extremely low (see Table 3.1.11). 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 SBW (Figure 3.1.7).

The Mt. Ka‘ala NAR populations in this ESU are difficult to get to and have not been monitored in the last year. Management options at these sites are limited by extremely steep terrain and degraded habitat. In the next year, it is a high priority for NRS to re-monitor these sites because of their extremely rare and thus vulnerable status. In August, a large fire burned into the lower reaches of Mt. Ka‘ala NAR but did not threaten any sites where *A. mustelina* are known.

A new population of 61 *A. mustelina* (SBW-R) was discovered at higher elevations on the slopes of Mt. Ka‘ala in SBW (Figure 3.1.7). Snails from this site were sampled in hopes that this site may fall within ESU-C. If genetic analyses show that this population falls within ESU-C, NRS will adjust management plans to include this site and the total number of snails known within this ESU would double.

Map removed, available upon request

Figure 3.1.7 ESU-C Schofield Barracks West Range, Ala‘ihe‘ihe and Palikea Gulches

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. Re-surveying sites and re-collecting for captive propagation should be the highest priority for the populations within Mt. Kaʻala NAR. It was proposed last year that NRS secure habitat from ungulates for *A. mustelina* in Mt. Kaʻala NAR. The most manageable habitat within Mt. Kaʻala NAR is in upper Palikea gulch and this was proposed for protection in last year's report. This fence is lower priority than most of the other fences proposed in the MIP and OIP because there are not actually any snails extant at the site. NRS have added this fence to plans. Once intra-ESU genetic studies are complete, these data can be used to guide options for managing the small numbers of *A. mustelina* that remain in Mt. Kaʻala NAR.

Map removed, available upon request

Figure 3.1.8 ESU-C Schofield Barracks West Range Management

Schofield Barracks West Range SBW-A, B, and C
The current progress at this portion of ESU-C is covered above in the general ESU-C discussion. It is worth noting that there was a large increase in the number of snails observed at SBW-A in this reporting period. The number of snails observed almost doubled from 15 total snails in 2005 to 28 total snails in August 2007. Rat baiting grids were established in SBW-A and SBW-C in August 2007. NRS will continue to restock baiting grids as range access permits.

This summer, NRS took advantage of a break in training at Schofield in order to overcome some of these management hurdles. NRS planned and will construct two ungulate fences to protect SBW-A and SBW-B sites (see Figure 3.1.8). SBW-B does not currently have any extant snails.

In addition, this extra time provided an opportunity to establish permanent rat baiting grids and conduct more thorough snail searches at the sites. Four new bait stations were deployed in SBW-A and six at SBW-C. They will be monitored as access allows. Figure 3.1.8 shows the ground shell plot proposed for installation after the ungulate fences are complete. Without ungulate fences, these plots would be difficult to monitor due to the intense pig digging in the area. The terrain at both of these sites is favorable for constructing a *Euglandina* exclosure. This may be pursued in the future as access allows and especially as NRS develop new, lower maintenance, exclosure designs.

ESU-D North Kaluaʻā , Waiʻeli, Puʻu Hāpapa, SBS, and Mākaha

ESU-D is by far the geographically largest ESU. For management purposes it has been split into two portions. D1 includes North Kaluaʻā, Waiʻeli, Puʻu Hāpapa, and SBS. D2 includes Mākaha. The current status of snails at each population reference code in ESU D1 is shown in Table 3.1.12.

It is worth noting that surveys have been conducted near Puʻu Kalena ESU-D over the last year. During these surveys, over 139 new *A. mustelina* have been discovered. Although these snails are not apart of a MFS site, the habitat for these snails will receive protection via the OIP. The OIP Kalena-Kaʻala MU fence is slated for construction to protect a number of rare plant populations in the area. NRS may revisit this new concentration of snails for management after Mākaha receives more survey attention. If the numbers of snails observed does not increase, NRS may propose shifting management to the Puʻu Kalena area.

ESU D1 North Kaluaʻā , Waiʻeli, Puʻu Hāpapa and SBS

Table 3.1.12 *Achatinella mustelina* in ESU-D1 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
KAL-A **Land of 10,000 snails**	Manage for stability	430	2006-11-28	207	160	63	0	Yes	Yes	Yes	No
SBS-B **Puu Hapapa**	Manage for stability	196	2004-07-06	131	44	21	0	No	Yes	Yes	No
	ESU Total :	626		338	204	84	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Installed one new ground shell plot.
- Maintained rat control grid twice per quarter.
- Determined the best route for a predator fence for the KAL-A site with Island Conservation.

- Determined that snails sampled at SBS-D were *A. mustelina* and not *A. concavospira*.

Plans for Year 4

- Continue rat grid maintenance and ground shell plot monitoring
- Assist Island Conservation in securing funding for the predator fence at KAL-A

Only sites designated as MFS are included in the population status table for this ESU (Table 3.1.12). Figure 3.1.9 shows the sites with this designation in addition to those sites designated as 'No Management.' In the last reporting period, there have been no major changes to population numbers.

In ESU D1 over the last year, ungulate fences have been maintained and kept pig free, snail habitat has been weeded and rat baiting and snap trapping has continued. A total of 20 bait stations and 40 snap traps are re-set every six weeks in order to provide rat protection for *A. mustelina* in this ESU.

Two ground shell plots are monitored annually within this ESU. No rat predated shells were recovered at these plots in the last year.

Map removed, available upon request

Figure 3.1.9 ESU-D1 Kaluaʻā, Waiʻeli and Puʻu Hāpapa

<u>KAL-A, Kaluaʻā and Waiʻeli (Land of 10,000 Snails)</u>
A more current number was used in the population status table for this ESU for KAL-A. This number is smaller than the number reported in 2006. This can be attributed to a shorter

combined survey time. The Kaluaʻā and Waiʻeli rat control data is listed in Table 3.1.13. Bait was available all year and access for re-stocking was regular and predictable, allowing NRS to provide year round rat control to protect *A. mustelina*. No *E. rosea* were observed this year in GSP. Live *E. rosea* have been collected in the past.

A predator exclusion fence is being planned to protect the core snail habitat at KAL-A (see Chapter Introduction: Predator Fences). In the last year, NRS wrote a proposal for Island Conservation to assess the feasibility of building a predator fence at this site. Island Conservation is compiling a full implementation plan including costs for construction, predator removal and maintenance at the KAL-A site. Staff from Xcluder fence, New Zealand surveyed the KAL-A site and outlined a route approximately 500 meters long where predator fencing would be feasible. Island Conservation will pursue funding to construct this proposed fence in 2009.

Table 3.1.13 Kaluaʻā and Waiʻeli 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
2006-2007	16	1576	993	63%	10	24	8

SBS-B Puʻu Hāpapa

The snail numbers reported for this site are the same as those used in last year's report. NRS recommended surveying for possible strategic fencing that could allow the removal of pigs from this portion of ESU D1 but because of a backlog of fences, NRS did not pursue this action in the last year. Access was not reliable over the last year. This fence is on the list of fencing projects being pursued by the Army NR fence crew but will be a lower priority than most of the other planned MU fences as over 300 snails are known from within the already fenced portion of this ESU. Weed control projects should be investigated and initiated. Table 3.1.14 is a summary of the rat control data since work began in 2000. Rat bait was available all year long in stations thus effecting protection for *A. mustelina* at this site. Access to the baiting grid was regular and predictable this year which is an improvement since last year.

Table 3.1.14 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
2006-2007	8	826	314	38%	12	14	8

SBS-D North of Urekaa

This site was discussed in last year's report because genetic collections had been made to determine if snails here are *A. mustelina* or *A. concavospira*. Results show that the snails are *A. mustelina*, therefore, this site will not be discussed in future reports as it is designated as a 'No Management' site.

SBS-A Moho Gulch

This site was previously managed to protect *A. mustelina* and other native ground shell species. For five years, NRS maintained a predator control grid here. NRS abandoned these efforts in the last year because rare snail populations are no longer present at the site. A few *A. mustelina* still remain but do not warrant the separate baiting effort. This site has shifted from a MFS site to a 'No Management' site.

ESU D2 Mākaha

Table 3.1.15 *Achatinella mustelina* in ESU-D2 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MAK-A **Isolau ridge**	Manage for stability	31	2006-12-13	18	6	7	0	Yes	Yes	No	No
MAK-B **Kumaipo ridge crest**	Manage for stability	32	2000-05-03	0	0	0	32	Yes	No	No	No
MAK-C **Near pinnacle rocks. Includes Hesarb ridge.**	Manage for stability	2	2005-04-07	2	0	0	0	Yes	No	No	No
MAK-D **On ledge below ridge crest above MAK-A site.**	Manage for stability	27	2005-06-29	21	3	3	0	Yes	No	No	No
	ESU Total :	92		41	9	10	32				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Completed Mākaha Subunit I MU fence and are removing pigs within it.
- Conducted weed control in areas where *A. mustelina* is known.

Plans for Year 4

- Install rat control grids at high density *A. mustelina* sites within the new fence. Restock bait every six weeks.
- Install two ground shell plots at these sites.
- Coordinate with Aaron Shiels from UH regarding rat studies within the fence unit.
- Continue surveys along crestline and Makai Ridge fenceline.

This ESU will be discussed as one unit because very little management specific to *A. mustelina* is currently underway. Table 3.1.15 shows the current population numbers for ESU-D2. Figure 3.1.10 shows the current known distribution of *A. mustelina* in Mākaha Valley. The most noteworthy management highlight for this ESU is that the MU fence was completed this year. It protects 60 of the 92 snails or 65% at designated MFS sites. Surveys may reveal additional snails within the fence. GSPs and rat grids will be established now that the fence is complete.

Aaron Shiels, a PhD student from U.H, will initiate rat home range and rat density studies within the Mākaha fence now that it is complete. He has already established protocols for his research in Kahanahāiki MU over the last year. He will be implementing these same protocols in Mākaha. What he learns at Mākaha will aid in designing the best rat control program for the MU. NRS funded his research almost exclusively.

<u>Mākaha MAK-A, B, C, D</u>
The only small change in population status at the ESU was at MAK-A where the number of snails observed during this reporting period increased from 24 to 31.

Map removed, available upon request

Figure 3.1.10 ESU-D2 Mākaha

ESU-E Pu‘u Kaua/‘Ēkahanui

Table 3.1.16 *Achatinella mustelina* in ESU-E Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
EKA-A **Mamane Ridge and Near Plapripri EKA-A**	Manage for stability	183	2004-10-13	93	30	60	0	No	Yes	Yes	No
EKA-B **Below north population of Tetlep. Between Plapri EKA-A and EKA-C**	Manage for stability	55	2004-10-14	46	6	3	0	No	Yes	Yes	No
EKA-C **At Plapripri EKA-C site**	Manage for stability	6	2004-10-14	6	0	0	0	No	Yes	Yes	No
EKA-D **Puu Kaua**	Manage for stability	202	2004-10-12	158	31	13	0	No	No	No	No
EKA-E **Amastra site**	Manage for stability	13	2004-10-05	9	3	1	0	Yes	Yes	Yes	No
EKA-F **from Plapri-C head along blue trail under cliffs mauka**	Manage for stability	3	2006-02-01	2	1	0	0	No	Yes	Yes	No
	ESU Total :	462		314	71	77	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Cleared the large subunit fence corridor and began fence construction.
- Conducted weed control at sites with *A. mustelina*.
- Continued to restock rat bait grids.
- Monitored ground shell plots.

Plans for Year 4

- Complete construction of the large subunit fence.
- Continue rat control.
- Monitor ground shell plots.
- Investigate installing predator control at MAK-D.

No new surveys were conducted during this reporting period, therefore, the numbers of snails reported this year are identical to last year. Table 3.1.16 summarizes the current population numbers for each reference code within this ESU. Some of the sites designated as MFS are located within the existing ungulate exclosure and others will be protected when ‘Ēkahanui Subunit II is constructed. The fenceline for this subunit has been cleared and construction has begun in the lower elevations. There was a setback in construction due to fence vandalism and

the need for additional fence materials. NRS hope construction will be completed during the upcoming reporting period. Rat management is underway at all the known ESU-E sites with the exception of EKA-D and EKA-F. Figure 3.1.11 shows the geographical distribution of sites, rat baiting areas, and GSPs within this ESU.

Map removed, available upon request

Figure 3.1.11 ESU-E Puʻu Kaua/ʻĒkahanui

ʻĒkahanui EKA-A, B, C, and E

Rat control continues at this ESU with a total of 21 bait stations and 31 snap traps. Rat data is presented in Table 3.1.17. Rat bait was available all year long in stations. Increasing numbers of site visits has yielded high counts of rats trapped. The percent of bait taken has increased slightly in the last year due to more frequent checks. No rat predation or *E. rosea* were observed at GSPs in the last year within this ESU.

Table 3.1.17 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
2006-2007	21	2338	1479	63%	42	27	8

Pu‘u Kaua EKA-D
Last year a recommendation was made to investigate rat baiting options at Pu’u Kaua. NRS determined that rat control should wait until ‘Ēkahanui Subunit II is completed due to possible pig interference with predator control efforts.

EKA-F (*Amastra* site in northerly gulch)
Additional surveys were recommended in last year’s report but this was not done. These surveys are not a high priority as baiting at this site may not be initiated until the ‘Ēkahanui Subunit II fence is complete.

ESU-F Pu‘u Palikea/Mauna Kapu (Palehua)

The discussion for this ESU is combined for sites where rat control is being conducted, PAK-A-I and MAU-A. The management conducted is very similar for these sites. The geographical distribution and an overlay of the management underway at these sites are shown in Figure 3.1.12. Rat control is being conducted at all sites in this ESU except for PAK-D and PAK-J because these sites are outliers. There will not be a specific discussion about these sites. The status of all MFS populations within ESU-F are shown in Table 3.1.18. Once the large-scale MU fence is completed all MFS sites will be protected from ungulates except the MAU-A site.

Major Highlights/Issues Year 3

- NRS installed three new ground shell plots in ESU-F.
- NRS expanded two rat baiting grid to better encompass snail trees.
- NRS cleared the MU fence corridor and began construction.
- NRS started rat control at Mauna Kapu (MAU-A) early July 2007.

Plans for Year 4

- Complete the Palikea MU fence.
- Conduct weed control at all ‘manage for stability’ snail sites.
- Collect additional snails for captive propagation to bolster laboratory numbers.
- Add two bait stations to extend the PAK-C grid to capture additional known snails.

Table 3.1.18 *Achatinella mustelina* in ESU-F Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MAU-A Mauna Kapu (Palehua)	Manage for stability	12	2005-03-14	4	8	0	0	No	No	Yes	No
PAK-A Puu Palikea-Ohia spot	Manage for stability	9	2004-08-11	5	2	2	0	No	Yes	Yes	No
PAK-B Iele Patch	Manage for stability	13	2004-08-10	11	1	1	0	No	No	Yes	No
PAK-C Steps spot	Manage for stability	19	2004-08-10	14	3	2	0	No	Yes	Yes	No
PAK-E Exogau site	Manage for stability	6	2004-08-10	4	1	1	0	No	Yes	Yes	No
PAK-F Dodonaea site	Manage for stability	5	2004-08-11	3	2	0	0	No	No	Yes	No
PAK-G Hame and Alani site just above Cyagri fence	Manage for stability	30	2006-01-25	13	11	6	0	No	Yes	Yes	No
PAK-H Mike Hadfield's study site at Puu Palikea	Manage for stability	7	2006-01-26	4	2	1	0	No	No	Yes	No
PAK-I One ridge truck side of E and F	Manage for stability	5	2006-01-26	4	0	1	0	No	Yes	Yes	No
	ESU Total :	106		62	30	14	0				

Size Class Definitions

Size Class	Def Size Class
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Map removed, available upon request

Figure 3.1.12 ESU-F Pu‘u Palikea

Pu‘u Palikea PAK-A-I (excluding PAK-D)

Rat control grids at Palikea and Mauna Kapu are re-stocked every four to six weeks. The Mauna Kapu site had rat control initiated in early July 2007. Rat control at Mauna Kapu was previously conducted by The Nature Conservancy prior to the start of 2007. There are a total of 35 baits stations and 55 snap traps in place at eight sites at Pu‘u Palikea and five bait stations and 10 snap traps at Mauna Kapu. Rat control data is combined for both sites and presented in Table 3.1.19. NRS will add additional bait stations and snap traps to the PAK-C site to the east and north of the Lunch Spot Pu’u to fully encompass the snails found at this location.

Table 3.1.19 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
2006 - 2007	40	4208	1738	41%	86	65	11

Weed control was conducted for both established and incipient weeds near these managed snail sites.

Chapter 3.2 OIP *Achatinella* sp. Management

The OIP outlines stabilization for several *Achatinella* species that occur within the O‘ahu Action Area (AA) in the Ko‘olau Mountains. Snail species in the OIP include: *A. apexfulva, A. bulimoides A. byronii, A. lila, A. livida,* and *A. sowerbyana.* With the OIP still in draft form, NRS have not initiated full stabilization of these taxa. The current Draft OIP categorizes all *Achatinella* in the Ko‘olau Mountains as Tier 2 priority (OANRP 2005a). This means that full stabilization efforts may not begin until Army training occurs in the upper reaches of Kawailoa Training Area (KLOA) or Schofield Barracks East Range (SBER). NRS expect to finalize the OIP in the beginning of 2008, at which time the program will determine what stabilization actions will begin based on status, threat, and funding. This past year, NRS have continued baseline management of the OIP snail taxa to include rodent control, genetic sampling, monitoring, and collection.

OIP *Achatinella* species Stabilization Plan Summary

Long Term Goals for all OIP *Achatinella* species:

- Manage extant population units (PUs) and additional reintroduction PUs, up to a total of six PUs within the action area to encompass the known geographical range of the species.
- Achieve at least 300 individuals in each PU to be Managed for Stability.
- Maintain captive propagation populations from each of the three PUs being Managed for Stability.
- Control all threats at each managed field location.
- Tier 2 stabilization priority.

Summary Discussion

Major Highlights for FY07

- Snail database was developed this year.
- Genetic sampling to determine *A. sowerbyana* ESUs continued
- Geographic Units (GUs) were created due to lack of ESU information at this time
- Genetic analyses determined that *Achatinella* in Schofield Barracks South Range are *A. mustelina* and not *A. concavospira*.
- Army-Kamehameha Schools license agreement progress close to completion
- Ground shell plot established at the Crispa *A. livida* site
- Live *A. livida* observed at Northern site for the first time in 2 years

Rodent control is being conducted at various sites in the Ko‘olau 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 inclement weather often interferes with scheduled helicopter operations, as was the case this year. In addition, NRS is working with UH PhD candidate, Aaron Shiels, to learn more about rat density and home range in O‘ahu forests (see Appendix 3-5). Management notes from the past year are organized by species below.

One of the major highlights of this year was the creation of the snail database. NRS are now better able to track each species by population reference code and Geographic Units (GUs). The GUs were created to help manage these species in the absence of genetically determined Evolutionarily Significant Units (ESUs). These GUs are drawn on the maps (Figures 3.2.3-3.2.6) and listed in the tables for each species and provide a look at how many sites and individuals are in each unit.

NRS has made progress toward a formal license agreement with Kamehameha Schools to cover conservation of rare species within leased portions of KLOA and Punaluʻu, Waiʻawa, Waimano, and Waiʻau Valleys on Oʻahu. Once this license agreement is signed, NRS will construct additional ungulate fencing in KLOA which will protect essential habitat for rare species including *Achatinella*.

Captive Propagation

NRS have been providing funding for the UH Snail Lab to maintain populations of OIP species in their captive propagation facilities. Some collections were made prior to the development of the OIP but progeny from these collections will hopefully be used in the conservation of these species both *in* and *ex situ*. Table 3.2.1 shows the current lab populations for these OIP taxa. As more lab populations are established NRS will present this data by GU for each species.

Table 3.2.1 Captive *Achatinella* Propagation Data for Koolau Taxa (August, 2007)

Species	# juv	# sub	# adult	# Individuals
A. lila	215	246	8	**470**
A. sowerbyana	4	14	3	**21**
A. livida	50	66	6	**122**
A. byronii	5	14	9	**28**
A. apexfulva	3	4	1	**8**
A. bulimoides	21	4	9	**34**

Genetic Sampling Status

Last year, NRS made a large effort to collect genetic samples from several OIP species 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* such as those made for *A. mustelina* (see chapter 3.1). As determinations are still being made, NRS aided the UH Snail Lab obtain a few additional samples this past year. NRS tried to collect genetic samples from the most northern known individuals of *A. sowerbyana* to help determine if this species is distinct from *A. livida* or if these are just extreme morphologies of one taxonomic entity (see *A. sowerbyana* discussion below). Table 3.2.2 outlines the genetic sampling efforts made to date. Once genetic analyses are 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 UH Snail Lab. Lab snails will be used for this purpose. Figure 3.2.2 shows locations where genetic samples were taken between 2005 and 2007.

Table 3.2.2 Genetic collections for OIP species and GU determinations in the Northern Koʻolau Mountains as of August 2007.

Species	Site	Army Pop Ref. Code	Date	Samples/ Chirality
A. byronii	Below Poamoho Monument	KLO-F	7/12/05	3 samples
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	Below Poamoho Monument	KLO-C	7/12/05	1 sample
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
A. sowerbyana	Poamoho Trail	KLO-GG	4/12/07	4 samples
A. sowerbyana	Shaka	KLO-M	5/16/07	9 dextral
A. sowerbyana	290	KLO-L	5/16/07	7 dextral
A. sowerbyana	East of Bloody Finger	KLO-MM	5/17/07	1 dextral

Figure 3.2.1 *Achatinella byronii* on Hame (*Antidesma platyphyllum)*

Map removed,
available upon request

Figure 3.2.2 Genetic sampling sites in the Koʻolau Mountains 2005-2007

Kevin Hall, a PhD candidate at UH, is partially supported by the Army and has collected numerous genetic samples from KLO-J and KLO-C. These will be incorporated into the study to determine ESUs for *A. sowerbyana*.

Surveys

NRS conducted one survey for *Achatinella* in the Koʻolau Mountains while doing genetic sampling surveys in May of 2007. NRS and U.H. snail lab surveyed for snails along the Koʻolau Summit Trail from ʻŌpaeʻula MU north along the Upper Kawai Iki ridge and the Lower Kawai Nui ridge. The focus of these surveys was to locate outlying individuals of *A. sowerbyana* to use in comparison to the other populations.

One of the areas revisited was *A. sowerbyana* KLO-R ʻFreckled Tooth Ridgeʼ, along the ridge between Kawai Nui and Kawai Iki gulches. Seven *A. sowerbyana* were counted here in August 2002 however during the recent survey no live snails were found, only old flagged trees were relocated. New areas, near the summit, were also surveyed and no snails were observed. One ridge further south is *A. sowerbyana* KLO-K ʻBloody Fingerʼ, where a total of 34 snails were counted in March 1999. Only one snail was seen in May 2007. *Achatinella sowerbyana* does seem to be in decline in these particular areas west of the Koʻolau summit. Generally speaking, the habitat is still very native and appears to be suitable snail habitat.

Achatinella apexfulva

In the spring of 2005, NRS collected the last known extant individual of *A. apexfulva* to add to the captive propagation population. This lab population currently consists of eight individuals (Table 3.2.1). These few individuals are the only representatives of this species known and all were originally from or are progeny from a population that occurred in KLOA. Therefore, NRS are committed to continuing surveys for this species each year. The relatively low elevation habitat known for this species is largely undersurveyed. NRS will focus on the most recently known wild sites for surveying (OIP 2005).

Achatinella byronii

The UH Sail Lab has one population of this species, comprised of 28 individuals, represented with mixed individuals from the Schofield-Waikāne Trail below KLO-E. This lab population was started in 1997. As the OIP will be finalized this year, NRS may want to refresh the lab population and begin collecting snails from some of the other designated Manage for Stability populations such as KLO-B, ʻPoamoho Cabinʼ and KLO-F, ʻNorth of Poamoho Trailʼ (Figure 3.2.2).

NRS did not conduct extensive surveys at *A. byronii* populations in the last year. However, a new site, KLO-I ʻEast of 290ʼ, was discovered this year. Population estimate information is listed in Table 3.2.3. The total numbers of individuals is greater than reported in the past, however, this is due more to the use of the database in keeping track of the most accurate counts rather than the most recent population visits (i.e. in some cases NRS have searched more thoroughly). This database allows us to track the ʻmanage for stabilityʼ populations and the level of threat control currently being conducted at these sites.

The database shows that approximately 250 *A. byronii* occur within proposed or existing MUs. The Poamoho PU is partially protected within a rat baiting grid that is restocked every six weeks along the Poamoho summit. This population is protected from rats and contains approximately 45 individuals. Table 3.2.5 shows the amount of bait taken and rats trapped since the baiting grid was established. This year NRS visited this bating grid six times (double last year) and 700 bait blocks were available over the year. NRS doubled the number of snap traps in the area, however, the number of rats snapped was less than the three previous years. Figure 3.2.2 shows the populations that fall within proposed MUs and/or that NRS plan to Manage for Stability.

Map removed, available upon request

Figure 3.2.3 Management Designations for *Achatinella byronii*

Table 3.2.3 Numbers of *Achatinella byronnii* individuals by Geographic Unit.

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella byronii / decipiens											
GU: A East Range											
SBE-A	Manage for stability	0	2006-06-26	0	0	0	0	No	No	No	No
Middle Waikakalaua-South Kaukonahua dividing ridge											
SBE-B	Manage for stability	1	2001-02-26	1	0	0	0	No	No	No	No
South Kaukonahua stream											
SBE-C	Manage for stability	1	2001-02-26	1	0	0	0	No	No	No	No
East Waikakalaua-South Kaukonahua dividing ridge											
SBE-D	Manage for stability	1	2002-05-01	1	0	0	0	No	No	No	No
West Waikakalaua-South Kaukonahua dividing ridge											
SBE-E	Manage for stability	3	1997-09-25	1	1	1	0	No	No	No	No
North branch of South Kaukonahua											
	GU Total:	6		4	1	1	0				
GU: B Puu Pauao											
KLO-D	No Management	16	2006-08-22	15	1	0	0	No	No	No	No
Puu Pauao											
	GU Total:	16		15	1	0	0				
GU: C Poamoho											
KLO-A	Manage for stability	0	2004-12-01	0	0	0	0	No	No	No	No
South of Poamoho Trail											
KLO-B	Manage for stability	23	2006-04-18	18	3	2	0	No	No	No	No
Poamoho Cabin											
KLO-C	No Management	1	2001-06-13	0	0	0	1	No	No	No	No
South of Poamoho Cabin											
KLO-F	Manage for stability	45	2006-04-19	42	3	0	0	No	No	Yes	No
North of Poamoho Trail											
KLO-G	No Management	0	2007-08-31	0	0	0	0	No	No	No	No
Poamoho trail 1800 ft at A. apexfulva site											
	GU Total:	69		60	6	2	1				

GU: D	Punaluu cliffs										
KLO-H Windward cliffs opposite Peahinaia summit LZ	No Management	2	2006-05-04	2	0	0	0	No	No	No	No
KLO-I East of 290	No Management	1	2007-04-02	0	1	0	0	No	No	No	No
	GU Total:	3		2	1	0	0				
GU: E	**North Kaukonahua**										
KLO-E North Kaukonahua	Manage for stability	175	2002-08-21	120	40	15	0	No	No	No	No
	GU Total:	175		120	40	15	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

NRS continue to weigh the benefits and the cost of setting up a rodent control grid in the North Kaukonahua PU, which contains approximately 175 individuals. This area is relatively intact and highly susceptible to damage by NRS walking extensively in the area. However, the population is not well monitored at this time. In order to monitor for signs of increased rat predation, a ground shell plot would need to be checked on a quarterly basis. This frequency of monitoring may be just as destructive as restocking a rat baiting grid every six weeks and reading a ground shell plot once a year. NRS plan to visit this site in the next quarter to set up a ground shell plot and will assess the feasibility of setting up a rodent control grid relative to the impact to this sensitive habitat.

As mentioned (OANRP 2006), NRS have observed a dramatic reduction in snail numbers in the SBER populations. Up to 14 individuals were observed in the past at this site. Our current observations are just six individuals over four locations. NRS plan to revisit these sites in the next year and conduct surveys in the area to try to locate snails.

Table 3.2.4 Poamoho (KLO-F) *Achatinella 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
2006-2007	8	700	255	36%	6	16	6

*This baiting grid also protects *A. lila* (KLO-B) and *A. sowerbyana* (KLO-C, FF, and GG).

Achatinella bulimoides

NRS have not conducted additional surveys for *A. bulimoides* this year. However, there are large portions of the windward Ko‘olau cliff habitat that have not been surveyed and NRS expect to

find additional individuals. At this time NRS know of two *in situ* individuals. Once surveys are sufficient enough to determine the geographical extent of this population, a stabilization plan will be developed. The most recent locations of this species are known from within the KLOA AA but just outside the KLOA boundary within Kamehameha Schools land in Punalu‘u.

The lab populations of *A. bulimoides* have grown significantly in the last year. From the ten originally collected in 2006 there are now 34 individuals. This growth rate is high compared to some of the older lab populations of other species.

Achatinella concavospira

This species was not considered in either the MIP or OIP consultation. Over the last year some *A. concavospira*-like individuals within SBS were determined to be *A. mustelina.* Therefore, this species will continue to be outside of the MIP or OIP consultations. However, it is possible that this taxon may be discovered on Army lands in the future therefore it benefits NRS to track its status when observed while doing other management activities. Over the last year NRS have assisted the UH Snail Lab in the location of other known *A. concavospira* spots in the southern Wai‘anae Mountains while conducting other work or on volunteer time. These populations are all located within The Nature Conservancy of Hawai‘i's (TNCH) Honouliuli Preserve where NRS conduct other rare species or ecosystem management. NRS will continue to support the UH Sail Lab and TNCH in their conservation efforts for this species as it is extremely rare and is sometimes observed by NRS in the course of other management activities.

Achatinella lila

This species has been extremely prolific in captive propagation and the lab currently maintains 470 individuals. The lab population was originally founded with individuals collected from the Poamoho summit area. This year the UH Snail Lab determined the lab population was large enough to support a reintroduction near the original collection site within KLOA.
Prior to the reintroduction, the UH Snail Lab would like to compare the level of genetic variation of lab populations versus the wild populations and the degree of similarity within and among the lab and wild populations. In this reporting period, UH Snail Lab staff collected genetic samples from the Poamoho Summit area and from the Punaluu cliffs area to facilitate this comparison. This information will aid the development of a reintroduction plan for this species. This year NRS helped to organize a reintroduction protocol, to be utilized by any conservation agency, in anticipation of an *Achatinella mustelina* reintroduction in the Wai‘anae Mountains and will be used as a template for this *A. lila* reintroduction (see Appendix 3-2).

Table 3.2.5 Numbers of *Achatinella lila* individuals by Geographic Unit

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella lila											
GU: A	**Poamoho Summit**										
KLO-A	Manage for stability	5	2000-09-25	5	0	0	0	No	No	No	No
South of Poamoho Trail											
KLO-B	Manage for stability	34	2004-12-01	29	2	3	0	No	No	Yes	No
North of Poamoho Trail											
	GU Total:	39		34	2	3	0				
GU: B	**Peahinaia Summit**										
KLO-C	Manage for stability	2	2006-05-03	1	1	0	0	Yes	Yes	Yes	No
Peahinaia Summit											
KLO-F	Manage for stability	9	2006-05-04	8	1	0	0	No	No	No	No
Below Peahinaia Summit on windward side											
	GU Total:	11		9	2	0	0				
GU: C	**Opaeula-Punaluu Summit**										
KLO-D	Manage for stability	3	2006-05-03	1	1	1	0	No	No	No	No
Notch Site, Opaeula Fence											
KLO-E	Manage for stability	42	2006-05-03	32	8	2	0	No	No	No	No
Windward side below Sanpur outplanting											
	GU Total:	45		33	9	3	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

NRS have been baiting along the ʻŌpaeʻula summit KLO-C and D and North of the Poamoho Trail KLO-B sites. Rat control data for these sites is presented in Tables 3.2.4 and 3.2.6. NRS restocked the bait in the ʻŌpaeʻula area this area seven times over the past year and snapped a total of 25 rats. The increase in rats snapped is reflective of an increase in visits rather than a detected increase in rat numbers in the area. Figure 3.2.3 below shows that NRS plan to manage all known locations of *A. lila* for stability.

Map removed, available upon request

Figure 3.2.4 Management Designations and Geographic Units for *Achatinella lila*

Table 3.2.6 ‘Ōpae‘ula Summit (KLO-D) *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
2006-2007	4	560	177	32%	25	10	7

Achatinella livida

Table 3.2.7 Numbers of *Achatinella livida* individuals by Geographic Unit

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella lila											
GU: A	**Poamoho Summit**										
KLO-A	Manage for stability	5	2000-09-25	5	0	0	0	No	No	No	No
South of Poamoho Trail											
KLO-B	Manage for stability	34	2004-12-01	29	2	3	0	No	No	Yes	No
North of Poamoho Trail											
	GU Total:	39		34	2	3	0				
GU: B	**Peahinaia Summit**										
KLO-C	Manage for stability	2	2006-05-03	1	1	0	0	Yes	Yes	Yes	No
Peahinaia Summit											
KLO-F	Manage for stability	9	2006-05-04	8	1	0	0	No	No	No	No
Below Peahinaia Summit on windward side											
	GU Total:	11		9	2	0	0				
GU: C	**Opaeula-Punaluu Summit**										
KLO-D	Manage for stability	3	2005-05-03	1	1	1	0	No	No	No	No
Notch Site, Opaeula Fence											
KLO-E	Manage for stability	42	2006-05-03	32	8	2	0	No	No	No	No
Windward side below Sanpur outplanting											
	GU Total:	45		33	9	3	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

This species is currently known from only three sites in the Ko‘olau Mountains, referred to as Radio, Crispa and Northern by NRS. All three sites are designated as Mange for Stability and all three have ongoing rat control since 2000. NRS have not observed any snails on flagged trees within the grid over the last year. The baiting grid at Radio (KLO-C) will be revaluated with NRS staff most familiar with the distribution of this species at the site in the coming year. Bait station and snap trap locations will be relocated if necessary. Bait take has remained relatively similar over the past four years at these three sites (see Tables 3.2.8-10). A ground shell plot was installed at Crispa (KLO-A) in November 2006. The ground shell plot did not reveal any rat predated shells or high numbers of fresh dead individuals. This plot will be re-read annually because this site is currently baited for rats. NRS will continue to restock baiting grids twice per quarter (weather permitting) at each site in the coming year. Each baiting grid will be revaluated and expanded if necessary.

This year preliminary genetics research comparing sequences from CO1 (the same gene used to delineate ESUs in *A. mustelina*) revealed that individuals sampled within populations of *A. sowerbyana*, near the ʻŌpaeʻula exclosure, contained *A. livida* haplotypes. This is data is interesting because to date no *A. livida* have been known from this area and all snails sampled had dextral chirality, which is characteristic of *A. sowerbyana* in this area. However, more research needs to be conducted before any conclusions are made.

The UH Snail Lab currently has 122 individuals of *A. livida* that originated from two collections of individuals from Radio (KLO-C). NRS will consider starting additional lab populations for the other two extant populations, Crispa (KLO-A) and Northern (KLO-B). NRS reported that no snails had been observed at Northern (KLO-B) since 2004. However, this year two snails were seen while NRS were restocking baiting grid. NRS plan to do an overnight trip to count snails at this site in the coming year. Once a thorough search is conducted at this site NRS will determine how many individuals should be brought into the lab to secure the population from extinction.

Map removed, available upon request

Figure 3.2.5 Management Designations and Geographic Units for *Achatinella livida*

Table 3.2.8 Koloa (KLO-B, Northern LZ) *Achatinella 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
2006-2007	6	480	244	51%	18	12	5

Table 3.2.9 Kawai Iki II (KLO-C, Radio LZ) *Achatinella 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
2006-2007	6	480	149	31%	14	12	5

Table 3.2.10 Kawai Iki I (KLO-A, Crispa LZ) *Achatinella 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
2006-2007	6	472	259	55%	17	12	5

Achatinella sowerbyana

Table 3.2.11 Numbers of *Achatinella sowerbyana* by Geographic Unit

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella sowerbyana											
GU: A	**Kawainui Ridge**										
KLO-Q Pinch ridge	No Management	2	2001-09-05	2	0	0	0	No	No	No	No
KLO-R Freckled-Toothed Ridge	No Management	0	2007-05-15	0	0	0	0	No	No	No	No
	GU Total:	2		2	0	0	0				
GU: B	**Kawaiiki Ridge**										
KLO-K Bloody finger	No Management	2	2007-05-17	1	1	0	0	No	No	No	No
KLO-P Ptelid gulch upstream from the Ptelid	No Management	1	1997-08-06	1	0	0	0	No	No	No	No
	GU Total:	3		2	1	0	0				
GU: C	**Opaeula-Helemano**										
KLO-BB Below Peahinaia trail in Helemano	Manage for stability	3	2004-07-21	2	0	1	0	Yes	Yes	No	No
KLO-CC Helemano southwest of KLO-12 transect	Manage for stability	1	2004-07-21	0	1	0	0	Yes	No	No	No
KLO-D Peahinaia Summit	Manage for stability	6	1997-09-04	0	0	0	6	Yes	Yes	Yes	No
KLO-DD Helemano Southwest of KLO-12 transect, middle site.	Manage for stability	1	2004-07-21	0	1	0	0	Yes	No	No	No
KLO-E Cyrvir, photopoint pole pe`ahinai`a trail	Manage for stability	1	1998-05-28	0	0	0	1	Yes	Yes	No	No
KLO-EE Helemano Southwest of KLO 12 transect, eastern site.	Manage for stability	1	2004-07-21	0	1	0	0	Yes	No	No	No
KLO-F Pe`ahinai`a trail pulcherima like snails	Manage for stability	5	2006-07-18	2	3	0	0	Yes	No	No	No
KLO-G South ridge of Helemano fenceline	Manage for stability	1	2006-05-03	0	1	0	0	Yes	No	No	No
KLO-H Ilex spot near palm grass site at sta 260 KLO-12	Manage for stability	2	1997-06-06	1	0	1	0	Yes	Yes	No	No

KLO-HH	Manage for stability	5	2004-12-01	4	1	0	0	Yes	Yes	No	No
West Helemano, below Palm grass site											
KLO-I	Manage for stability	1	2003-08-27	1	0	0	0	Yes	Yes	No	No
Above goose wing											
KLO-II	Manage for stability	1	2004-12-01	1	0	0	0	Yes	No	No	No
West Helemano, above stream 30m, below large flat ridge											
KLO-J	Manage for stability	232	2007-09-18	60	142	30	0	Yes	Yes	Yes	No
Hypalon											
KLO-JJ	Manage for stability	6	2006-03-22	2	2	2	0	Yes	No	No	No
South Helemano fenceline											
KLO-KK	Manage for stability	2	2006-05-02	1	0	1	0	Yes	Yes	No	No
Second ridge off Peahinaia trail											
KLO-L	Manage for stability	30	2005-12-08	20	5	5	0	Yes	Yes	Yes	No
Sta 290 on summit trail along Pe'ahinaia fence											
KLO-LL	No Management	3	2007-04-02	3	0	0	0	No	No	No	No
East of 290											
KLO-M	Manage for stability	15	2007-05-16	10	4	1	0	Yes	Yes	Yes	No
Shaka											
KLO-N	Manage for stability	1	2005-01-05	1	0	0	0	Yes	Yes	Yes	No
Lizard-back ridge											
KLO-O	Manage for stability	3	2002-01-01	3	0	0	0	Yes	Yes	Yes	No
Close to shelter just above waterfall in Opaeula fence											
KLO-U	No Management	22	1997-12-11	0	0	0	22	No	No	No	No
Rich Ridge											
KLO-Y	No Management	1	2001-10-18	1	0	0	0	No	No	No	No
KST and Shelter ridge junction											
KLO-Z	Manage for stability	1	2003-08-27	0	0	0	1	Yes	Yes	No	No
Peahinaia south side of goose-head ridge											
	GU Total:	344		112	161	41	30				
GU: D	**Poamoho Summit & Trail**										
KLO-C	Manage for stability	177	2007-09-18	49	90	38	0	No	No	Yes	No
North of Poamoho Summit											
KLO-FF	Manage for stability	19	2003-03-18	0	0	0	19	No	No	No	No
South of Poamoho Summit											
KLO-GG	Manage for stability	106	2003-02-17	90	15	1	0	No	No	No	No
Poamoho trail upper 1/3											
	GU Total:	302		139	105	39	19				

GU: E	**Poamoho Pond**										
KLO-A	Manage for stability	90	2004-12-02	59	19	12	0	No	No	No	No
Poamoho Pond											
	GU Total:	90		59	19	12	0				
GU: F	**Poamoho-North Kaukonahua Ridge**										
KLO-AA	No Management	2	2004-05-19	2	0	0	0	No	No	No	No
Little Italy											
	GU Total:	2		2	0	0	0				
GU: G	**Lower Peahinaia**										
KLO-S	Manage for stability	35	2000-10-25	0	0	0	35	No	No	No	No
Puu Roberto											
KLO-T	Manage for stability	0	1996-08-31	0	0	0	0	No	No	No	No
Near Frog Pond											
KLO-V	Manage for stability	5	1999-12-13	0	0	0	5	No	No	No	No
Lower Peahinaia trail Hesarb site											
	GU Total:	40		0	0	0	40				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

This is by far the most abundant *Achatinella* species in the OIP. The numbers of individuals for this species reported for this year reflect the use of the NRS snail database and our ability to track the most current, accurate survey numbers and the preliminary population estimates for two study sites. Therefore, this year the total number of individuals for this species is 783 counted over 37 sites, while last year we reported a total of 335 individuals. Of these, 302 individuals (at 20 sites) occur within the ‘Ōpae‘ula-Helemano fenced management unit. Approximately 284 at ‘Ōpae‘ula-Helemano and 177 individuals along the Poamoho summit are protected within rat baiting grids. Figure 3.2.4 shows the current management designations for this species.

NRS currently fund UH PhD Candidate, Kevin Hall, who is studying the genetic variation, population size, and dispersal patterns of both *A. sowerbyana* and *A. mustelina*. This research will provide much needed information on the most common *Achatinella* remaining in the Ko‘olau Mountains. This research has provided higher population estimates for the KLO-J ‘Hypalon site’ within GU-C ‘Opaeula-Helemano’, and KLO-C ‘North of Poamoho Summit site’ within GU-D ‘Poamoho Summit & Trail’. However, these preliminary estimates do not account for mortality rates (see discussion in *A. mustelina*). In previous visits NRS had counted 69 individuals at KLO-J and 42 at KLO-C, compared to Kevin’s estimates of 232 and 177 for the two sites respectively. This data may indicate that current counts by NRS for *Achatinella* in other sites are under estimates.

Map removed, available upon request

Figure 3.2.6 Management Designations for *Achatinella sowerbyana*

NRS stated in the 2006 report that the morphology of *A. livida* from the three known sites was very similar to what was classified as *A. sowerbyana* by the Bishop Museum Malacology collections department. Unexpectedly, this genetic analysis also showed that some *A. sowerbyana* occurring within the Peahinaia summit area may be more genetically similar to *A. livida* populations found over 3,000 meters to the north (Bjorn Erickson pers. comm. 2007). These individuals within Peʻahinaiʻa are found within just a few meters of individuals that are genetically *A. sowerbyana*. This finding was considered unusual and NRS accompanied UH Snail Lab staff to do more genetic sampling in this area, although a second analysis provided the same conclusion. NRS will continue to treat all the morphologically identified *A. sowerbyana* at Peʻahinaiʻa as one population. However, NRS continue to fund genetic analyses by the UH snail Lab to determine ESUs. It is anticipated that microsatellite analyses will provide more insight.

The UH Snail Lab reports that there are just 21 *A. sowerbyana* individuals representing two wild populations, KLO-T ‘near from pond’ (lower Peʻahinaia) and KLO-F ‘Peʻahinaiʻa trail *pulcherrima*-like snails’ (Upper Peʻahinaia). These lab populations were established over 10 years ago and appear to be in decline. NRS feel it may be necessary to recycle some of the adult lab snails back into the wild while replenishing the lab stock with additional snails. Also, NRS may want to establish additional lab populations and will follow collection guidelines.

There are several sites within KLOA that NRS are currently baiting for rats and monitoring regularly. The summit of Poamoho (KLO-C) and the ‘Ōpae‘ula to Helemano MU (KLO-L, M, J) are restocked every six weeks. Recent surveys revealed high numbers of individuals which reinforces the need for rat control in the most recent rat bait grid (Table 3.10).

Table 3.2.12 ‘Ōpae‘ula to Helemano (KLO-L, 290) *Achatinella 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
2006-2007	6	625	124	20%	15	12	7

Table 3.2.13 ‘Ōpae‘ula to Helemano (KLO-M, Shaka) *Achatinella 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
2006-2007	6	636	233	37%	14	12	7

Table 3.2.14 ‘Ōpae‘ula to Helemano (KLO-J, Hypalon) *Achatinella 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
2006-2007	6	672	294	44%	23	6	7

Chapter 4.1: 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 4.1.1). A total of 15 territory holding birds have been observed over the past 10 years within MMR. Based on current survey and resight data over the past two years, only six birds (3 males and 3 females) are known from MMR. Of these birds, only two breeding pairs are known to exist. Seven birds within MMR have been captured and banded (Table 4.1.1). 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 beginning of 2007, the portion of the Mākua AA encompassing part of Mākaha Valley was realigned (Figure 4.1.2). The realignment occurred after fire modeling was revised for MMR in 2007. Forty-four individual birds including 10 pairs fell within the old Mākua AA boundary within Mākaha Valley. With the present realignment, seven single male territories and no pairs currently fall within the Mākaha Valley portion of the new Mākua AA (Figure 4.1.2). Currently, there are 15 birds (2 pairs, 10 single males, and 1 single female) known from within the Mākua AA. The two pairs are both found within Mākua Valley. Helicopter Landing Zones were approved for use in the back of Mākua Valley late in the 2007 breeding season. With Landing Zone approval in place for the 2008 breeding season, increased number of site visits will be possible for monitoring, surveys, and rodent control.

Kahanahāiki MU

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 4.1.1). Since that time, two of the banded males (ARRB and BGAW) have not been detected. Since these two birds have not been detected since prior to 2002, it is thought that they are dead. Of the remaining birds, no pairs are currently known. A breeding pair had existed at territory MMR-01 in Kahanahāiki Gulch for many years until the 2005 breeding season (Fig. 4.1.1). Since the start of the 2005 breeding season, the banded female BABW has remained solitarily in MMR-01 during the past three (2005, 2006, and 2007) breeding seasons. NRS will continue to monitor this territory in 2008.

Table 4.1.1 ‘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	02/02/07	Y	Y	M
BABW	03/04/96	MMR-01	02/03/07	02/03/07	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	07/31/07	Y	Y	M
ABBB	12/11/01	MMR-03	07/31/07	07/31/07	N	Y	M
AGWR	05/05/04	MMR-03	07/31/07	07/31/07	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)

‘Ōhikilolo MU

As of 2004, five ‘Elepaio were known from the ‘Ōhikilolo MU. Of these birds, there were three single males and one pair (Fig. 4.1.1). Two of the three single males were last sighted in 2000 and the third male was sighted in 2007. Of the one known breeding pair (MMR-02), the male was banded (ARGB) in 2002 and last resighted in January 2004 (Table 4.1.1). During a site visit to MMR-02 in February 2007, two unbanded birds were observed in the territory. It appears that the banded male ARGB has been replaced in this territory by an unbanded male. No breeding activity and/or success were observed for this pair during the 2007 breeding season.

East Rim Ungulate Control Area (UCA)

As of 2004, five ‘Elepaio are known from the UCA. These five birds consist of three single males and one pair (MMR-03). The three single males were last resighted in 2001, while the banded pair in territory MMR-03 was observed during the 2007 breeding season. The male of territory MMR-03 was banded (ABBB) in 2001 and the female was banded (AGWR) in 2004. The female had active avian pox lesions (wing and toes) when captured, but has survived and is still very active in the territory. During territory visits in February and July of this breeding season, both the male (ABBB) and female (AGWR) were observed in MMR-03. Prior to the 2007 breeding season, female AGWR was thought to be dead after not being observed for two breeding seasons. No breeding activity and/or success were observed for this pair during the 2007 breeding season.

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.

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 4.1.2). With the new alignment of the Mākua AA boundary within Mākaha Valley, no known pair territories fall within the AA. Twenty single males, 10 pairs, and four juvenile (hatch year) birds were located within the old Mākua AA boundary. Currently, seven single male territories are known to exist within the new Mākua AA of Mākaha Valley. In 2007, NRS conducted several follow up surveys in some of the single male territories during the breeding season in hopes of finding additional pairs, but none were located. NRS will continue to re-survey single male territories throughout Mākaha Valley to determine territory status.

Management Actions

‘Ōhikilolo MU & East Rim Ungulate Control Area (UCA)
In 2001, NRS initiated predator control efforts for the MMR-02 pair within the ‘Ōhikilolo MU. Predator control was initiated in 2002 for the MMR-03 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 (Figure 4.1.1). Predator control efforts during the ‘Elepaio breeding seasons from 2001 through 2007 are presented in Table 4.1.2. Six bait stations and 12 snap traps were baited and set in each territory starting in February for the 2007 breeding season. The high bait take that occurred during the last two breeding seasons can be attributed to the limited number of site visits. NRS will continue to conduct predator control in these two breeding territories, as well as in any new breeding pair territories that may possibly be found.

Table 4.1.2 ‘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
2007	12	384	365	95%	8	24	2

[A] = Only UCA pair baited in 2001.
[B] = No predator control or monitoring took place during the 2005 breeding season due to safety concerns by the Army Safety Office.

Kahanahāiki MU
NRS conducted predator control during each breeding season in territory MMR-01 from 1996 through 2005 (Table 4.1.3, data presented from 1998 to 2005). Predator control efforts have not been conducted during the past two breeding seasons (2006 and 2007) since this territory only contains a solitary female.

Table 4.1.3 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

Rat control efforts during the 2006 breeding season consisted of 10 pairs within the Mākua AA portion of Mākaha Valley and four pairs within the Mākaha MU. Rat control was conducted in all 14 known pair territories in Mākaha Valley to meet O‘ahu Implementation Plan (OIP) requirements. With the 2007 realignment of the Mākua AA boundary within Mākaha Valley, no pair territories fall within the new alignment. Predator control was conducted in seven pair territories that exist within the Mākaha MU during the 2007 breeding season. The results of predator control efforts can be found in the ‘Elepaio section of the 2007 OIP Status Update.

Map removed, available upon request

Figure 4.1.1 ‘Elepaio Distribution in Mākua Military Reservation (MMR)

Map removed, available upon request

Figure 4.1.2 ‘Elepaio Distribution in Mākaha Valley

Chapter 4.2 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 methods for the management of 75 pairs at SBMR. Any or all of the following 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 and snap traps in a larger number of ‘Elepaio pair territories than currently being managed to achieve 75 pairs managed on site; 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, aerial broadcast of rodenticide 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(s) agreed upon by NRS and USFWS biologists. NRS is currently pursuing management of ‘Elepaio on site at SBMR (~ 15 pairs) and offsite at five locations (~ 60 pairs).

In 2007, predator control was implemented during the breeding season in 93 ‘Elepaio territories at six locations (SBMR, Honouliuli Preserve, Mākaha Valley, Moanalua Valley, Waikāne Valley, Pālehua). NRS conducted rat control and monitoring of birds at SBMR, Waikāne Valley, and Pālehua. Pono Pacific was contracted to conduct rat control and monitoring of birds at the Honouliuli Preserve, 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, and new territories maybe found with either a single bird or a pair in the course of monitoring. During the 2007 breeding season, rat control was initiated in territories in which pairs were observed during the 2006 breeding season and in territories observed to have pairs just prior to the start of the 2007 breeding season. With these dynamic changes in territory status, the number of pairs actually protected during the 2007 breeding season was 78 pairs. Table 4.2.1 summarizes the monitoring data collected during the 2007 breeding season and includes the anticipated number of pairs to be protected during the 2008 breeding season. At least 49 young were successfully fledged from 43 pairs from among the six managed sites in 2007.

Over the years NRS have contributed banding data, monitoring data, and survey data that have led to peer reviewed publications:

VanderWerf, E. A., J. L. Rohrer, D. G. Smith, and M. D. Burt. 2001. Current distribution and abundance of the O‘ahu ‘Elepaio. Wilson Bulletin 113:10-16.

VanderWerf, E. A., M. D. Burt, J. L. Rohrer, and S. M. Mosher. 2006. Distribution and prevalence of mosquito-borne diseases in O‘ahu ‘Elepaio. Condor 108:770-777.

Table 4.2.1. Summary of ‘Elepaio Monitoring and Predator Control in 2007

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[5]	8	6	5	3	0	3(3)	3	6 - 16[7]
Honouliuli	23	18	13[6]	7	3(4)	8(10)[6]	14	18
Mākaha	12	10	6	11	4(4)	1(1)	5	10
Moanalua	27	26	22	18	7(8)	8(9)	17	26
Waikane	7	7	3	1	1(1)	2(2)	3	7
Palehua	16	11	8	6	3(3)	4(4)	7	11
Totals	93	78	57	46	18(20)	26(29)	49	78 - 88

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 fledglings from monitored nests and the number of fledglings observed in family groups.
5 = Due to range restrictions, only S. Mohiākea gulch was monitored in 2007.
6 = Two pairs were observed as family groups just prior to baiting was initiated, with each pair having two fledglings.
7 = Number of protected territories will depend on whether access is granted to one or four gulches.

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 an eleven year period in SBMR (Table 4.2.2). 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, 2007 – 8*, * = only one gulch accessed in 2007). Range access was only granted to S. Mohiākea gulch for ‘Elepaio management after the start of the 2007 breeding season. Three other gulches in which ‘Elepaio management usually takes place were off limits during the breeding season due to Army use of the firing range. 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. Four birds were banded during the 2007 breeding season. In 2007, NRS monitored 8 territories in S. Mohiākea in which 6 territories contained pairs (Figure 4.2.1).

Table 4.2.2. ‘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

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
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	08/22/07	Y	N	Hale‘au‘au	M
RBAB	08/30/96	HAL-06	08/30/96	09/18/07	Y	Y	Hale‘au‘au	F
BGAR	08/30/96	HAL-06	02/13/03	09/18/07	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
WGBA	09/02/96	HAL-07	09/02/96	08/22/07	Y	N	Hale‘au‘au	F
GBBA	02/14/97	HAL-05	02/18/02	08/21/07	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	08/21/07	08/21/07	N	Y	Hale‘au‘au	M
WARG	05/02/04	HAL-07	06/26/06	08/22/07	Y	Y	Hale‘au‘au	F
BBAR	05/02/04	HAL-07	05/02/04	08/22/07	N	Y	Hale‘au‘au	M
BBAG	05/02/04	HAL-04	09/24/07	09/24/07	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	08/22/07	N	Y	Hale‘au‘au	F
AWGR	02/23/05	HAL-06	04/17/05	09/18/07	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	08/22/07	N	N	Hale‘au‘au	M
BGWA	01/25/05	BAW-01	06/26/06	08/29/07	Y	N	Baby Water	M
AWGR	01/25/05	BAW-01	12/21/06	08/29/07	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	08/27/07	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	08/27/07	Y	N	N. Mohiākea	M
WGAR	11/20/98	BAN-01	02/26/00	08/27/07	N	Y	N. Mohiākea	M
RWBA	11/20/98	BAN-02	02/26/00	08/27/07	N	Y	N. Mohiākea	M
GAWW	11/20/98	BAN-01	07/13/01	08/27/07	N	Y	N. Mohiākea	F
BWGA	11/20/98	BAN-02	07/13/01	08/27/07	Y	N	N. Mohiākea	M
BABB	11/20/98	BAN-04	12/29/98	08/27/07	Y	N	N. Mohiākea	M
AGGW	08/28/02	BAN-02	08/27/07	08/27/07	N	N	N. Mohiākea	M
WARW	08/29/02	BAN-04	06/22/04	08/27/07	N	Y	N. Mohiākea	M
GABG	08/29/02	BAN-04	02/15/03	08/27/07	N	Y	N. Mohiākea	F
WRAR	08/29/02	BAN-05	08/29/02	08/27/07	N	N	N. Mohiākea	M
WWBA	01/24/05	BAN-03	08/27/07	08/27/07	N	N	N. Mohiākea	M
AWWB	01/24/05	BAN-04	01/24/05	08/27/07	N	Y	N. Mohiākea	M
RRAR	01/25/05	BAN-05	08/27/07	08/27/07	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	06/27/07	Y	N	S. Mohiākea	M
GAGB	06/15/97	MOH-08	01/30/06	06/27/07	N	Y	S. Mohiākea	M

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
GBAB	06/15/97	MOH-04	04/26/07	06/27/07	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	06/27/07	Y	Y	S. Mohiākea	M
RABB	01/17/00	MOH-02	03/27/02	06/27/07	N	N	S. Mohiākea	F
BWWA	01/17/00	MOH-07	04/26/07	06/27/07	Y	Y	S. Mohiākea	M
GRAR	01/17/00	MH-036	05/17/07	05/17/07	Y	N	S. Mohiākea	M
WRAB	01/17/00	MOH-09	05/18/03	06/27/07	N	N	S. Mohiākea	F
GARW	01/20/05	MOH-06	06/27/07	06/27/07	N	Y	S. Mohiākea	M
GBAW	12/26/06	MOH-02	02/08/07	06/27/07	N	Y	S. Mohiākea	M
ABKM	12/26/06	MOH-09	05/17/07	06/27/07	N	Y	S. Mohiākea	M
KABK	02/08/07	MOH-02	02/08/07	06/27/07	N	Y	S. Mohiākea	F
KGAR	02/08/07	MOH-03	06/04/07	06/27/07	N	Y	S. Mohiākea	M
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 six pairs being monitored in SBMR, only five were observed to have breeding activity occurring during NRS site visits (Table 4.2.3). A total of five nests were observed in various stages (building stage – 2 and nestling stage – 3). Nests were located in three introduced tree species (*Psidium cattleianum* - 2, *Schinus terebinthifolius* – 2, *Syzygium cumini* – 1). The two nests found during the building stage, subsequently had no activity at the nest during the next site visit. Of the three nests found in the nestling stage, one failed do to an unknown cause and the other two had undetermined outcomes. Three family groups (no prior nest found) were observed with one fledgling each. One pair was successful in fledging at least two nests, both successes were observed as family groups. Two of the six pairs (33%) were successful in fledgling young (3 fledglings, 0.5 fledglings per total number of pairs monitored in SBMR). The pair for which breeding activity was not observed, most likely attempted nesting, but was not detected by NRS due to timing of site visits or failure in nesting attempts.

Table 4.2.3. 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
2007	8	6	5	3	0	3(3)	2	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 4.2.1 ‘Elepaio Distribution on Schofield Barracks Military Reservation (SBMR)

Rodent Control

NRS initiated rat control for the 2007 breeding season from 26 December 2006 to 27 June 2007. Rat control was initiated in all four ‘Elepaio management gulches in December 2006, but only S. Mohiākea (MOH) continued through the breeding season. Twenty-eight Protecta® rodent bait stations and 48 Victor® rat traps were installed in eight ‘Elepaio territories in S. Mohiākea (Figure 4.2.1). 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 1246 blocks (35kg) 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 47%. A total of 67 rats were caught in snap traps with an average of 9.5 rats per monitoring trip (7 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 4.2.4). Over the past six years bait take has averaged 50% within the four gulches. Territories will continue to be added for protection as additional pairs are discovered.

Table 4.2.4 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 Rats Trapped	# of Snap Traps	# of Site Visits[2]
2001	NA	45	2520	1490	59%	22	60	2.3
2002	13	50	5263	3156	60%	71	88	3.7
2003	15	60	6096	2768	45%	115	120	4.0
2004	17	64	3887	2715	70%	97	120	2.7
2005	17	86	6763	1890	28%	210	164	5.7
2006	17	72	5635	2782	49%	212	136	5.3
2007	8	28	2636	1246	47%	67	48	7

1 = Number of ‘Elepaio territories being protected
2 = Average number of site visits (not all gulches are visited on the same day)

2008 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 six to 16 pairs depending on range access.

Offsite ‘Elepaio Areas

Currently there are five offsite locations (Mākaha Valley, ‘Ēkahanui area of Honouliuli Preserve, Pālehua, Moanalua Valley, Waikāne Valley) in which NRS conducts predator control and monitoring of ‘Elepaio. During the 2007 breeding season, Pono Pacific was contracted to conduct monitoring and predator control in Mākaha Valley, ‘Ēkahanui, and Moanalua Valley.

Predator control and monitoring were conducted by NRS in Waikāne Valley and at Pālehua in conjunction with The Nature Conservancy of Hawai‘i in 2007.

Mākaha Valley – Honolulu Board of Water Supply

For the past three breeding seasons the NRS has assisted the 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 and 2007 breeding season.

The sixth largest population of ‘Elepaio on O‘ahu is located in Mākaha Valley. The population was estimated at 123 birds, comprising roughly 56 breeding pairs (VanderWerf et al. 2001). NRS and Dr. VanderWerf have banded 14 birds since 1999 (Table 4.2.5). Nine of the 14 banded birds were observed in 2007. Extensive surveys were conducted in the first half of 2005 bringing the known number of birds to 62 individuals, which included 13 pairs at that time. During the 2007 breeding season 10 ‘Elepaio pairs were monitored (Figure 4.2.2). Single male territories between pair territories MAK-11 and MAK-14 were resurveyed in 2007 in hopes of finding new pairs, but no additional pairs were located (Figure 4.2.2).

Table 4.2.5 ‘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	02/23/07	05/11/07	N	N	M
ARGB	12/19/03	MK-011	01/11/05	01/11/05	N	N	M
ARWW	12/19/03	MAK-01	06/08/07	06/22/07	N	N	M
AWRB	12/19/03	MAK-03	05/09/07	06/22/07	Y	N	M
BARW	11/10/04	MAK-02	05/25/06	06/08/07	N	N	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	06/22/07	N	Y	F
GBAW	01/10/06	MAK-05	06/29/06	06/22/07	N	N	M
ARMB	01/10/06	MAK-07	06/01/07	06/22/07	Y	Y	M
GKAW	12/12/06	MAK-08	05/11/07	05/11/07	N	N	M
ARMK	12/12/06	MAK-15	04/20/07	06/22/07	N	Y	M
ABKR	12/12/06	MAK-11	02/01/07	06/22/07	Y	N	M
KKAR	12/13/06	MAK-05	03/30/07	06/22/07	N	Y	M
GGAW	12/14/06	MAK-16	05/25/07	06/08/07	N	N	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

Map removed, available upon request

Figure 4.2.2 ‘Elepaio Distribution in Mākaha Valley

Breeding Behavior

Of the 12 territories monitored during the breeding season, 10 were confirmed as being pairs. Six of the 10 pairs were observed to have breeding activity occurring during site visits (Table 4.2.6). A total of 13 nests were found from five pairs at different stages (building stage – 9, incubation stage – 1, nestling stage – 2, inactive – 1). Nests were located within five introduced tree species (*Psidium cattleianum* – 8, *Psidium guajava* – 2, *Aleutrites moluccana* – 1, *Fraxinus uhdei* – 1, *Coffea arabica* – 1). One nest found in the building stage was abandoned by the following site visit and one nest was inactive when found. Five nests failed during the incubation period and two during the nestling period. Four nests successfully fledged four young. One family group was located with one fledgling observed. Five of the 10 pairs (50%) were successful in fledging young (5 fledglings, 0.5 fledglings per total number of pairs monitored). The four 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 4.2.6 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
2007	12	10	6	11	4(4)	1(1)	5	5

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

Rat control was conducted during the 2007 breeding season from 01 January 2007 to 28 June 2007. The number of protected territories decreased from 14 to 12 in 2007. 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. Thirty-six rodent bait stations and 72 snap traps were installed in a total of 12 ‘Elepaio territories. A total of 1003 blocks (28kg) were taken from bait stations and 274 rats were caught in snap traps with an average of 16 rats per monitoring trip (17 monitoring trips; Table 4.2.7). Overall bait take was low at 14% during the breeding season in 2007, while the numbers of rats snap trapped remained constant through the season ending with almost double the total in 2006. Territories will continue to be added for protection as additional pairs are discovered.

Table 4.2.7 Mākaha Valley Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2005	8	28	2223	717	32%	145	28	9
2006	14	41	9628	2022	21%	155	78	17
2007	12	36	7164	1003	14%	274	72	17

1 = Number of ‘Elepaio territories being protected.

2008 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 2008 breeding season. The projected number of pairs to be protected during the upcoming breeding season is 10 pairs.

Honouliuli Preserve - The Nature Conservancy of Hawai‘i

For the past three breeding seasons NRS has assisted The Nature Conservancy of Hawai‘i (TNCH) with monitoring and managing ‘Elepaio pairs in the ‘Ēkahanui area of the Honouliuli Preserve, through contracting of Pono Pacific to conduct predator control and monitoring.

VanderWerf et al. (2001) estimated the Honouliuli Preserve to have the second largest population of ‘Elepaio on O‘ahu with an estimated of 418 birds, comprising roughly 209 breeding pairs. The ‘Ēkahanui area is located in the central region of the Honouliuli Preserve. Within the ‘Ēkahanui area, NRS and Dr. VanderWerf have banded 26 birds since 1999 (Table 4.2.8). Six of the 26 banded birds were observed in 2007. Twenty-three territories were managed in ‘Ēkahanui during this breeding season (Figure 4.2.3).

Table 4.2.8 ‘Elepaio Banding Data, ‘Ēkahanui, Honouliuli Preserve

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	04/24/07	06/26/07	N	Y	M
AGBG	01/10/00	EKA-07	04/2004	06/26/07	Y	N	M
WARB	01/10/00	EKA-13	04/25/06	06/26/07	N	Y	M
ABBR	01/10/00	EKA-06	04/2004	06/26/07	Y	Y	M
GWAG	01/10/00	EKA-14	04/22/05	06/26/07	Y	Y	M
BWRA	01/19/00	EKA-11	03/14/07	06/26/07	N	Y	M
BBWA	01/19/00	EKA-10	04/22/05	06/26/07	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	06/26/07	N	Y	F
GABB	10/22/03	EKA-20	05/19/06	06/26/07	N	Y	F
GARR	10/22/03	EKA-04	11/30/06	06/05/07	N	N	M
WRRA	10/22/03	EKA-21	05/15/07	06/12/07	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	06/26/07	Y	Y	F

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
WWAR	09/29/04	EKA-43	09/29/04	06/26/07	N	N	M
GRGA	12/14/04	EKA-22	04/17/07	06/26/07	N	N	M
WGRA	12/14/04	EKA-05	01/25/05	06/26/07	N	Y	M
WAWR	12/14/04	EKA-25	11/30/06	06/26/07	N	N	M
WAGG	12/15/04	EKA-23	05/08/07	06/26/07	N	Y	M
RAWG	12/20/04	EKA-17	04/03/07	06/26/07	N	N	M
BWAW	12/28/04	EKA-04	02/21/06	06/05/07	N	Y	F
BWBA	02/28/05	EKA-41	02/28/05	06/26/07	N	Y	M
AMMW	12/28/05	EKA-16	12/28/05	12/28/05	Y	N	M
MAMM	12/28/05	EKA-43	12/27/06	06/26/07	N	N	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 23 territories monitored during the breeding season, 18 were confirmed as being pairs. Thirteen of the 18 pairs were observed to have breeding activity occurring during site visits (Table 4.2.9). Nine nests were located within seven territories in various stages (building – 6, incubating – 1, nestling stage – 2). Nests were located in two introduced tree species (*Psidium cattleianum* – 8 and *Aleutrites moluccana* – 1). Two nests found during the building stage were abandoned by the following site visit. Seven active nests were located during the breeding season (fledged – 3, undetermined outcome – 3, failed – 1). Eight family groups were located with six pairs having one fledgling each and two pairs having two fledglings each. Two of the eight family groups were located just prior to the initiation of rat control at the beginning of the breeding season. Eleven of 18 pairs (61%) were successful in fledging at least one young (14 fledglings, 0.78 fledglings per total number of pairs monitored). The three nests with undetermined outcomes may have fledged young, since the time interval between site visits was sufficient for nests to fledge young. The five 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.

Map removed, available upon request

Figure 4.2.3 Distribution of ‘Elepaio in ‘Ēkahanui

Table 4.2.9 ‘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
2007	23	18	13[5]	7	3(4)	8(10)[5]	11[5]	14[5]

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 = Two pairs were observed as family groups just prior to baiting was initiated, with each pair having two fledglings.

Predator Control

Predator control was conducted from 28 December 2006 to 26 June 2007. Fifty-one bait stations and 80 rat traps were installed in 23 ‘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 most territories. A total of 4,745 blocks (135kg) were taken from bait stations. The amount of bait taken versus the amount of bait available was 32%. A total of 131 rats were caught in snap traps with an average of 8.2 rats per monitoring trip (16 monitoring trips).

Table 4.2.10 ‘Ēkahani Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2005	24	61	12371	1496	12%	127	99	16
2006	25	63	12756	3582	28%	142	98	18
2007	23	59	14659	4745	32%	131	80	16

1 = Number of ‘Elepaio territories being protected

2008 Breeding Season

Predator control and ‘Elepaio monitoring will be contracted to Pono Pacific for the 2008 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 upcoming breeding season is 18 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 4.2.11). Seven of the 19 banded birds were resighted in 2007. During the 2007 breeding season Pono Pacific managed 26 pairs (Figure 4.2.5).

Table 4.2.11 ‘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-40	06/04/06	06/04/06	N	Y	M
AWBB	10/01/04	MOA-15	06/07/07	06/27/07	N	N	M
RWWA	10/01/04	MOA-15	06/04/06	06/27/07	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	06/07/07	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	05/02/07	Y	Y	M
BAWW	12/16/04	MOA-11	02/08/06	06/27/07	N	Y	M
RAWR	12/16/04	MOA-30	06/07/07	06/27/07	N	N	M
ABRR	12/16/04	MOA-10	05/02/07	06/20/07	Y	Y	M
WAGB	12/29/04	MOA-13	04/25/07	06/07/07	N	Y	M
WGGA	09/20/05	MA-062	09/20/05	09/20/05	Y	N	M
RMKA	09/20/05	MOA-08	05/09/07	06/07/07	N	Y	M
KAGK	01/03/06	MOA-21	05/23/07	06/27/07	N	Y	M
MAMK	01/03/06	MOA-17	04/18/07	06/27/07	N	Y	M
KAWK	01/04/06	MOA-31	01/04/06	06/27/07	N	Y	M
ARKR	01/05/06	MOA-32	06/15/06	05/30/07	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 26 pairs managed, 22 were observed to have breeding activity occurring during site visits (Table 4.2.12). At total of 28 nests were located in various stages (building – 20, incubating – 7, nestling - 1). Nests were located in five introduced and one native tree species (*Psidium cattleianum* – 11, *Aleurites moluccana* – 6, *Syzygium malaccense* – 6, *Hibiscus tiliaceus* – 2, *Psidium guajava* – 1, *Metrosideros polymorpha* – 1). The 28 nests were located within 16 territories. Seven nests found during the building stage were abandoned by the following site visit. Three additional nests located during the building stage were found on the ground during the following site visits, with the cause of the downed nests being attributed to high winds. Of the 28 nests located, 18 were active nests (fledged – 7, failed – 10, undetermined outcome – 1). The one nest with an undetermined outcome may have fledged young, since the time interval between site visits was sufficient for the nest to fledge young. Eight family groups were located with a total of nine fledglings. Four pairs exhibited no breeding activity during site visits.

Fifteen of 26 pairs (58%) successfully fledged 17 young (0.65 fledglings per total number of pairs monitored). The four 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 4.2.12 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
2007	27	26	22	18	7(8)	8(9)	15	17

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

Rat control was conducted from 02 January 2007 to 27 June 2007. Eighty-one rodent bait stations and 162 rat traps were installed in 27 ‘Elepaio territories in the Moanalua Valley. Each protected territory consisted of three bait stations and six snap traps. A total of 1707 rodenticide blocks (48kg) were taken from bait stations. The amount of bait taken versus the amount of bait available was 12% for the season (Table 4.2.13). Monthly bait take was very low throughout the breeding season. A total of 348 rats were caught in snap traps with an average of 21.8 rats per monitoring trip (16 monitoring trips).

Table 4.2.13 Moanalua Valley Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2006	26	66	16276	2340	14%	316	125	20
2007	27	81	14185	1707	12%	348	162	16

1 = Number of ‘Elepaio territories being protected

Map removed, available upon request

Figure 4.2.4 Distribution of ‘Elepaio in Moanalua Valley

2008 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 2008 breeding season. The projected number of pairs to be protected during theup coming breeding season is 26 pairs

Pālehua – Campbell Estate

This population of ‘Elepaio was discovered by Dr. VanderWerf in the fall of 2006. The population is located at Pālehua (Campbell Estate land) in the southern Wai‘anae Mts. between Makakilo and Palikea (Figure 4.2.4). NRS in conjunction with The Nature Conservancy initiated management for ‘Elepaio during the 2007 breeding season. This site was included for management because of its accessibility and its ecological significance of being the southern most known population of ‘Elepaio in the Wai‘anae range. The current number of birds known at this site is 36 individuals (11 pairs, 7 single males, 7 hatch year birds) from 18 territories. Dr. VanderWerf banded eight birds during late 2006 and early 2007 (Table 4.2.14).

Table 4.2.14 ‘Elepaio Banding Data, Pāhehua

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
AWKW	09/09/06	HU-007	05/31/07	05/31/07	N	N	M
BRAK	09/18/06	HUA-08	05/04/07	05/31/07	N	N	M
AGRK	09/18/06	HUA-13	NA	NA	N	Y	F
KGGA	09/18/06	HUA-02	05/17/07	06/21/07	N	Y	M
AKBR	02/20/07	HUA-13	06/21/07	06/21/07	Y	Y	M
RARK	02/20/07	HUA-12	05/17/07	05/17/07	Y	N	M
AMBW	02/20/07	HUA-13	05/17/07	05/31/07	N	N	M
RARK	03/22/07	HUA-08	05/31/07	05/31/07	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 18 territories monitored during the breeding season, 11 were confirmed as being pairs. Eight of the 11 pairs were observed to have breeding activity occurring during site visits (Table 4.2.15). A total of seven nests were found from four pairs at different stages (building – 2, incubation – 1, nestling – 4). Nests were located within three introduced tree species (*Psidium cattleianum* – 5, *Aleurites moluccana* – 1, *Persea americana* – 1). One nest found in the building stage was abandoned by the following site visit. Three nests failed during the nestling period and three nests successfully fledged three young. Four family groups were located with four fledglings observed. One family group (HUA-15) that was located did not have predator control within its territory during this season. Seven of the 11 pairs (63%) were successful in fledging at least one young (7 fledglings, 0.6 fledglings per total number of pairs monitored). 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. The male of territory HUA-01 was found dead near the side of the Pālehua Road on 19 April. The bird was collected

and given to the USGS Wildlife Disease Specialist, Dr. Thierry Work, at the National Wildlife Health Center-Honolulu Field Station to determine the cause of death. The necropsy revealed that the bird died from a systemic fungal infection of the liver and kidney. No management actions were suggested since fungal infections in birds are generally opportunistic.

Table 4.2.15 Pālehua ‘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
2007	16	11	8	6	3(3)	4(4)	7	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)

Predator Control

NRS and TNC conducted rat control and monitoring during the 2007 breeding season from 27 January 2007 to 26 June 2007. Each managed territory contained two bait stations and two snap traps. Thirty-two rodent bait stations and 33 rat traps were installed in a total of 16 ‘Elepaio territories. A total of 1729 blocks (49kg) were taken from bait stations and 120 rats were caught in snap traps with an average of seven rats per monitoring trip (17 monitoring trips; Table 4.2.16). Territories will continue to be added for protection as additional pairs are discovered.

Table 4.2.16 Pālehua Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2007	16	32	5518	1729	31%	120	33	17

Map removed, available upon request

Figure 4.2.5 Distribution of ‘Elepaio in Pālehua

2008 Breeding Season

NRS and TNC will continue to survey this area to locate additional pairs and continue to band birds to assess survival. The projected number of pairs to be protected during the up coming breeding season is 11 pairs.

Waikāne Valley/ Kahana Valley

The fourth largest population of ‘Elepaio on O‘ahu is located in Waikāne/Kahana Valleys. The population for the two valleys is estimated at 242 birds, comprising roughly 121 breeding pairs (VanderWerf et al. 2001). NRS and Dr. VanderWerf have banded seven birds since 2005 (Table 4.2.17). Five of the seven banded birds were resighted in 2007. During the 2007 breeding season NRS managed seven pairs in Waikāne Valley (Figure 4.2.6). This breeding season was the first time predator control and monitoring has taken place at this site.

Table 4.2.17 ‘Elepaio Banding Data, Waikāne Valley

Bird[1]	Date Banded	Territory	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Sex
AKBK	07/23/05	WAI-03	05/08/07	06/28/07	N	Y	F
WABG	07/23/05	WAI-04	07/23/05	06/28/07	N	NA	M
WAGW	07/23/05	WAI-02	05/08/07	06/28/07	N	N	M
AWWR	07/23/05	WAI-03	06/28/07	06/28/07	N	Y	M
WKBA	01/25/07	WAI-01	05/08/07	06/28/07	N	N	M
RGAK	01/25/07	WAI-04	05/08/07	06/28/07	N	Y	M
MBAB	01/25/07	WAI-09	01/25/07	06/28/07	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

All seven territories monitored during the breeding season were confirmed as being pairs. Three of the seven pairs were observed to have breeding activity occurring during site visits (Table 4.2.18). One nest was found complete when initially found with no activity, but later observed with nestlings on the following site visit. The nest was located within the introduced tree *Bishofia javanica*. The nest fledged one nestling. Two family groups were located with two fledgling each observed. Three of the seven pairs (43%) were successful in fledgling young (3 fledglings, 0.4 fledglings per total number of pairs monitored). The four 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 4.2.18 Waikāne 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
2007	7	7	3	1	1(1)	2(2)	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)

Predator Control

NRS conducted rat control during the 2007 breeding season from 01 March 2007 to 28 June 2007. Two snap traps per bait station were deployed in each territory being protected. Thirty-two rodent bait stations and 64 rat traps were installed in a total of seven ‘Elepaio territories. A total of 753 blocks (21kg) were taken from bait stations and 154 rats were caught in snap traps with an average of 19.2 rats per monitoring trip (8 monitoring trips; Table 4.2.19). Overall bait take was 29% during the breeding season. Territories will continue to be added for protection as additional pairs are discovered.

Table 4.2.19 Waikāne Valley Rat Control Data

Year	# of Territories[1]	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2007	7	32	2640	753	29%	154	64	8

2008 Breeding Season

NRS will continue to survey the valley for additional pairs, band pairs to assess survival and protect breeding pairs during the breeding season. The projected number of pairs to be protected during the up coming breeding season is seven.

Map removed, available upon request

Figure 4.2.6 Distribution of ‘Elepaio in Waikāne Valley / Kahana Valley

Chapter 5: Research Activities

With the exception of section 5.4 (*Drosophila* surveys), this chapter describes the status and outcome of actions proposed in the OANRP 2005-2006 (6.1-6.13) and carried out under the direction of the program's Research Specialist (RS). The OANRP 2005-2006 included many planned projects initiated by the RS. Its purpose was to introduce the research program, then in its first year. This chapter, by contrast, includes only brief descriptions of future work in order to focus on completed and on-going work. Of necessity, some information, from the OANRP 2005-2006 is restated here in order to better understand results. Otherwise, justification, background and basic information on research projects can be found in the OANRP 2005-2006 (6.1-6.13).

Program objectives outlined in 2005-2006 centered on improving control methods for slugs (Mollusca: Gastropoda) and the black twig borer (*Xylosandrus compactus*). Work summaries are organized by actions proposed in 2005-2006 and executed in 2007. Findings from completed research projects, when available, are provided separately following the general summary. Future work appears at the end of each section. All statistical analyses were performed with Minitab® Release 14 software of Minitab Inc. (Ryan *et al*. 2005). Significance during hypothesis testing was characterized by p-values less than 0.05. Nonparametric statistical methods were used to analyze datasets with non-normally distributed residuals and dissimilar variation between groups, otherwise parametric methods were used.

Chapter 5.1 Black Twig Borer Repellent Study

Proposed action: The anti-aggregation pheromone Verbenone® (Phero Tech Inc., Point Roberts, WA) successfully deters *X. compactus*, from entering traps baited with an ethanol lure (Dudley *et al.* 2006). Whether it similarly repels *X. compactus* from damaging target tree species is unknown. With cooperators Nick Dudley (Forester, Hawai'i Agriculture Research Center Forester) and Nancy Gillette, (Entomologist, U.S. Forest Service) test Verbenone's ability to reduce damage caused by *X. compactus* on outplanted *Flueggea neowawraea* in Kahanhāiki Management Unit (KMU).

Status: This project is currently delayed. It was postponed after National Tropical Botanical (NTBG) Staff observed a slight *increase* in *X. compactus* activity around, and damage to, *F. neowawraea* trees following Verbenone deployment (William Hunt, *pers. comm*.). Regrettably, few to no *X. compactus* were recorded in passive, unbaited, traps deployed throughout the study area (N. Gillette, *pers. comm*.). Because traps were the primary means by which researchers hoped to evaluate Verbenone performance, conclusions as to its efficacy as a repellent (or attractant) remain speculative. Nonetheless, this study made clear Verbenone is not likely to be the panacea hoped for by resource managers. In light of this, NRS is looking into alternative control strategies which might work in lieu of, or in conjunction with, Verbenone, to protect rare plants.

Future research: The distressing possibility that Verbenone may attract *X. compactus* has led to the postponement of *F. neowawraea* tests until *X. compactus* behavior is better understood. *Xylosandrus compactus* response to Verbenone might be more safely tested in a less vulnerable

plant population, such as coffee. If such a trial takes place and results show no risk of increased plant damage, NRS plans to resume testing on *F. neowawraea*. In the meantime, one strategy currently under investigation by NRS is whether saturation of an area with baited traps can reduce damage to *F. neowawraea* by acting as a sink for *X. compactus*. A field trial testing the efficacy of this method is currently underway. Rings of traps have been placed around randomly selected *F. neowawraea* (Fig. 5.1.1) and damage to these trees compared against trees without traps. High release ethanol baits (Aptiv Inc. Marylhurst, OR) are being used as lures in this study. They are effective for 45 days.

Figure 5.1.1 Ring of traps placed around a *Flueggea neowawraea* in an effort to capture *Xylosandrus compactus* prior to gallery construction.

Chapter 5.2 Black Twig Borer Population Monitoring

Proposed action: Effective control is hampered by a lack of basic methodology needed to evaluate the efficacy of potential treatments. This lack was made clear in the difficulties

encountered by researchers at NTBG. NRS seeks to improve sampling protocol by clarifying the relationship between *X. compactus* found in traps and numbers of new galleries recorded on *F. neowawraea*. If closely associated, NRS plans to discontinue damage assessments which are both more labor intensive and prone to observer bias than traps. Little is known regarding *X. compactus* densities or population response to seasonal cues. NRS will monitor *X. compactus* abundance using both methods and identify patterns, if any.

Status: A year long monitoring program using both traps and damage assessments has provided insights into *X. compactus* behavior and identified potential seasonal triggers. Baseline damage rates have also been established for *F. neowawraea* outplanted in the KMU. Whether damage rates will decline, increase or remain static in the upcoming year can only be determined through continued monitoring... The results and conclusions presented below are preliminary.

Study: Damage caused to *F. neowawraea* by *X. compactus* at two sites and seasonal changes in pest abundance for the year 2007

Methods: Work took place at two *F. neowawraea* stands, 250 m apart, located within the KMU at an elevation of 2000 ft (Fig. 5.2.1). The two sites, referred to here as Up Gulch (UG) and Down Gulch (DG), provide habitat for 37 and 24 trees respectively. Trees were reared in the greenhouse and planted by NRS on 2/17/2005, 2/22/2006 (UG) and 1/2/2007 (DG). DG contains 24 trees, seven of which were transplanted from a nearby site, Pteralyxia Gulch (PG), where they had been doing poorly. These seven, plus an additional 19 plants were originally planted at PG on 12/10/2003. UG monitoring commenced August 2006. Monitoring DG did not occur until January 2007, when planting occurred. Comparisons between the UG and DG sites, therefore, include data collected UG only *after* 1/1/2007.

Map removed,
available upon request

Figure 5.2.1 *Flueggea neowawraea* stands with number of trees listed

Xylosandrus compactus were lured to Japanese beetle traps (Trece Inc., Adair, OK) using ethanol. One fl. oz. of 100% ethanol was dispensed into a vial plugged with cotton mounted on the trap. An insecticidal strip (Vaportape II™, Hercon® Environmental, Emigsville, PA) in the collection cup killed any insect entering the trap. Trapped *X. compactus* were counted weekly and ethanol replenished. This type of trap has been used successfully elsewhere in Hawai‘i (Dudley *et al*., 2006) and is the same one pictured in Figure 5.1a with the exception of the type of lure. Six traps were deployed UG on 10/12/2006 and six DG on 12/24/2006. When intra-trap variation proved high, three traps were added to each site on 6/26/2007. Subsequent data analysis made use of the mean rather than absolute number of *X. compactus* per trap. Here, we refer to the former as “trap catch” and represent it with the notation $\overline{X}$ BTB/trap.

As in a previous study (Gillette *et al*. 2006) *X. compactus* entry holes were counted and marked on *F. neowawraea* trees to determine attack rates. Damage was measured using the following formula:

$$o/h/t$$

Where *o* is the number of new (unmarked) holes (+0.0001, see below), *h* is the height of the tree (m) and *t* is the time elapsed (days) since holes were last counted and marked. In order to eliminate zeros +0.0001 holes were added to each damage assessment at 30 day intervals.

Analysis: Damage was assessed approximately once a month while traps were counted much more frequently. Rainfall measurements were recorded approximately 15 times per month using a gauge stationed at the Nike greenhouse (Fig. 5.2.1). Frequently collected data, such as rainfall, was averaged prior to comparison with smaller datasets such as damage. Regression and correlation analyses were used to identify associations between variables.

Results and discussion: Figure 5.2.2 shows damage over time at both sites. When grouped by site, data was not normal and variance was dissimilar between groups. Though it would have been desirable to look at the effects of both time and site on damage, only site is considered here and all values between 1/2007 and 9/2007 are pooled. Transformation was attempted, but data remained in violation of assumptions intrinsic to parametric two-factor statistics. The RS continues to investigate whether a nonparametric alternative exists to the two-way ANOVA or repeated measures analysis.

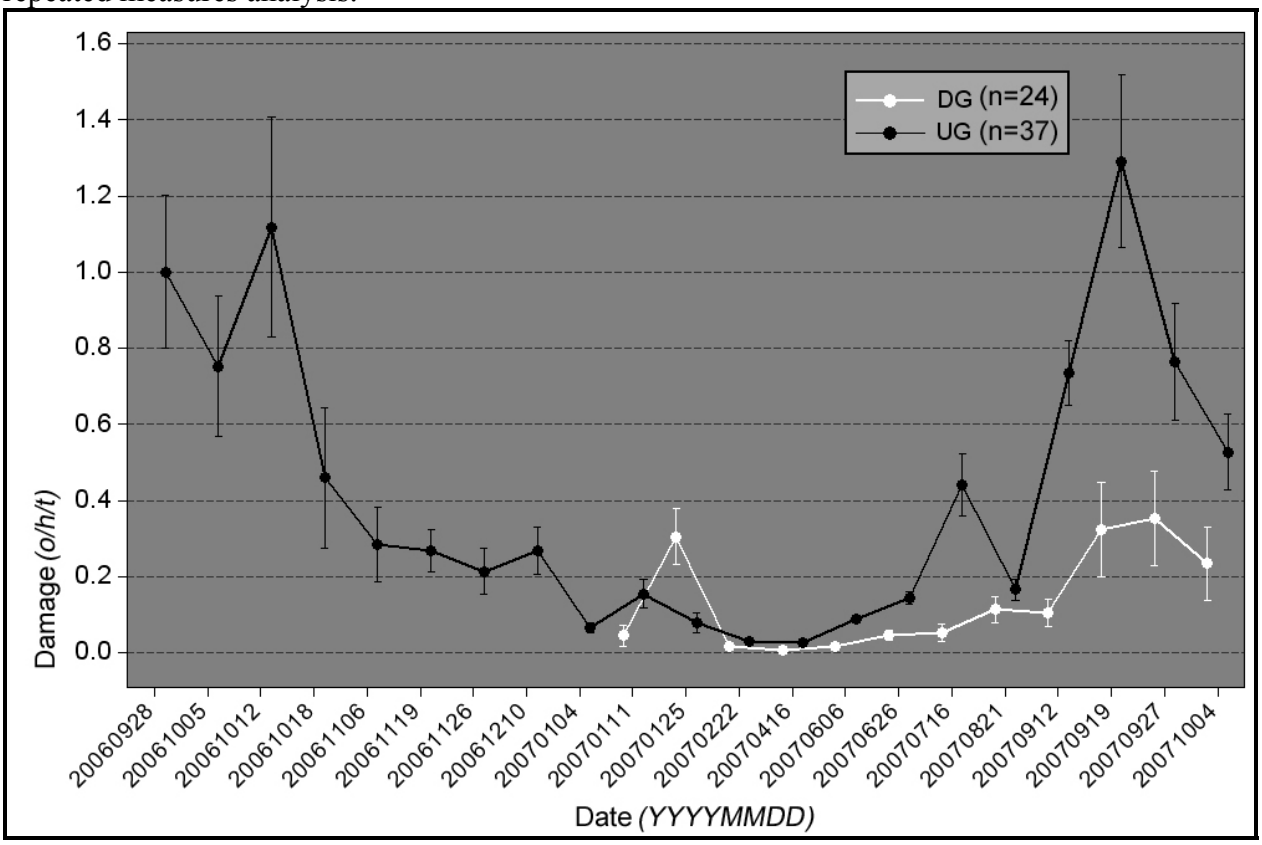


Figure 5.2.2 Damage to *Flueggea neowawraea* (n = number of trees) over time by site. Bars are ± 1 SEM.

Trees UG sustained significantly higher levels of damage than those DG (Mann-Whitney U Test: $p < 0.0001$). Possible reasons for this discrepancy may include factors intrinsic to the tree itself (*e.g.*, age, health) and/or extrinsic factors (*e.g.* tree spacing, proximity to other *X. compactus* host plant species). The tree population UG is both larger (*e.g.* more numerous), and, on average,

older than that DG. Possibly, *X. compactus* has reached its carrying capacity UG while the population DG is yet expanding. In addition, the role initial level of infestation plays in subsequent damage accumulation has not been adequately controlled for in this study. For example, a tree with a high number of holes at the outset may have a greater chance of gaining even more holes in the future relative to a tree with few nor no galleries. The number of *F. neowawraea* at each site may prove important as well, especially if *X. compactus* is unable to disperse long distances. Just as a large, densely packed population facilitates disease transmission, the number and spacing of trees may encourage or hinder *X. compactus* colonization.

A seasonal pattern of damage is evident at both sites (Fig. 5.2.2) with relatively low levels prevailing between January and July and increasing thereafter. Damage at the UG site peaked in late September in both 2006 and 2007. Such symmetry only makes sense if *X. compactus* activity is driven by seasonal factors. Of note is the anomalous spike in attacks witnessed among the DG trees two weeks after planting. It was the only time damage DG surpassed damage UG. Among the possible explanations for this spike, three are immediately apparent. First, it may result from *X. compactus* taking advantage of a new resource. Second, recently planted *F. neowawraea* may have fewer defenses relative to older outplantings. This deficiency is sometimes caused by stress associated with transplanting or by greenhouse conditions that fail to prepare the plant adequately for harsh conditions encountered in the wild. The roughly, similar levels of damage at both sites over time suggest a third possibility. When compared to those observed UG, fluctuations are generally later and less pronounced in the DG population. This may result when slight changes to temperature, humidly, or rainfall produce favorable conditions for *X. compactus* at one site but not at another until later in the season. Based on anecdotal observations, DG is sunnier, warmer and drier with more native canopy trees than the area UG. Also notable, is the abundance of heavily infested *Buddleia asiatica* at the latter site, which appear to thrive despite attack by *X. compactus*. Any or all of these factors may explain the observed discrepancies between sites.

The trend in mean number of *X. compactus* per trap was remarkably similar between sites (Fig. 5.2.3). As with damage, trap catch was slightly higher UG. Unlike damage, changes in trap catch occurred earlier DG than UG, and, when pooled did not differ significantly between sites (Mann-Whitney U Test: $p = 0.5368$).

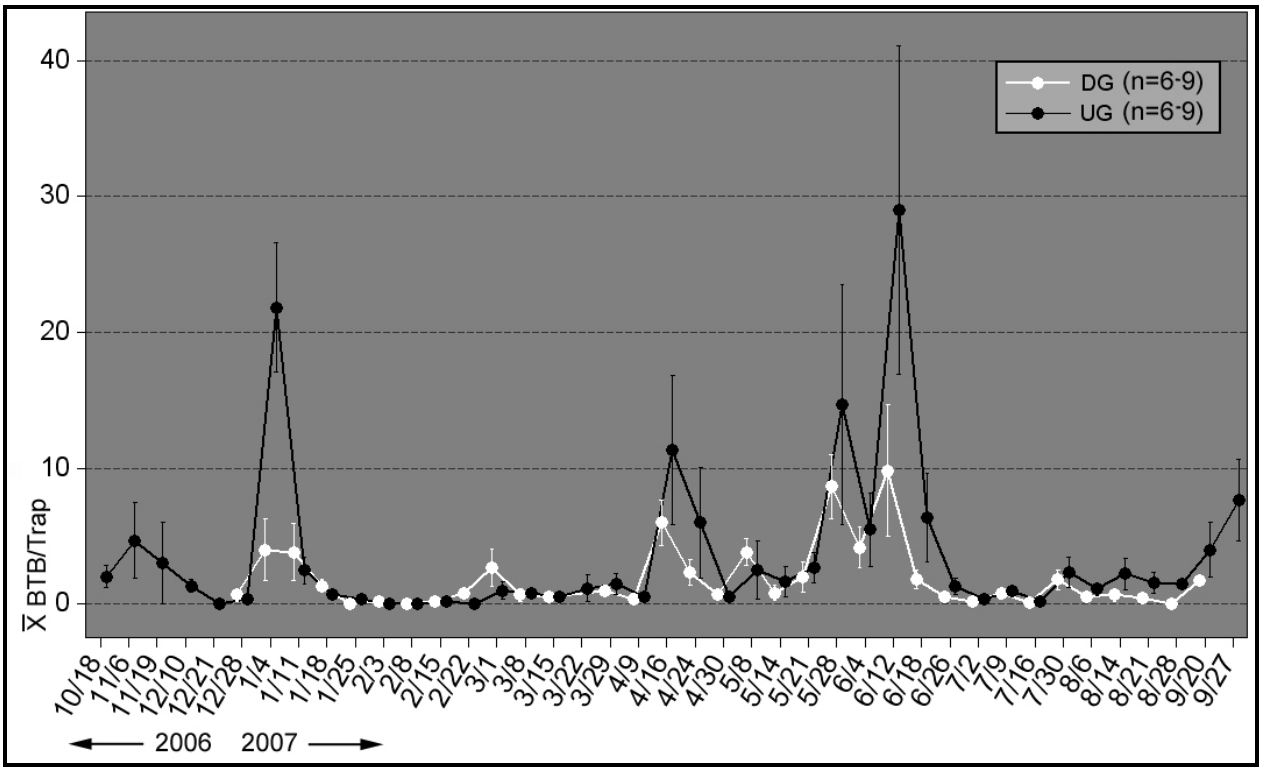


Figure 5.2.3 Average number of *X. compactus* found per trap by site (n = total number of traps before and after 6/26/07). Bars are ± 1 SEM.

The relationship between trap catch and damage was unclear and no significant association was found (Pearson correlation: $p = 0.895$). Despite this failure, the higher overall values of both factors at the UG site relative to the DG site, as well as consistent changes over time regardless of site, are suggestive. Perhaps both are tied to *X. compactus* population size, but each measures a different behavior with a different environmental trigger. For example, perhaps trap catch better explains *X. compactus* dispersal behavior while damage assessment is a better measure of activities related to nest building, or egg laying. Interestingly damage appeared to track rainfall, but again, this relationship was not significant (Fig. 5.2.4). Further analysis of the data using multivariate statistics should shed light on the relationship between trap catch, site, rainfall and damage.

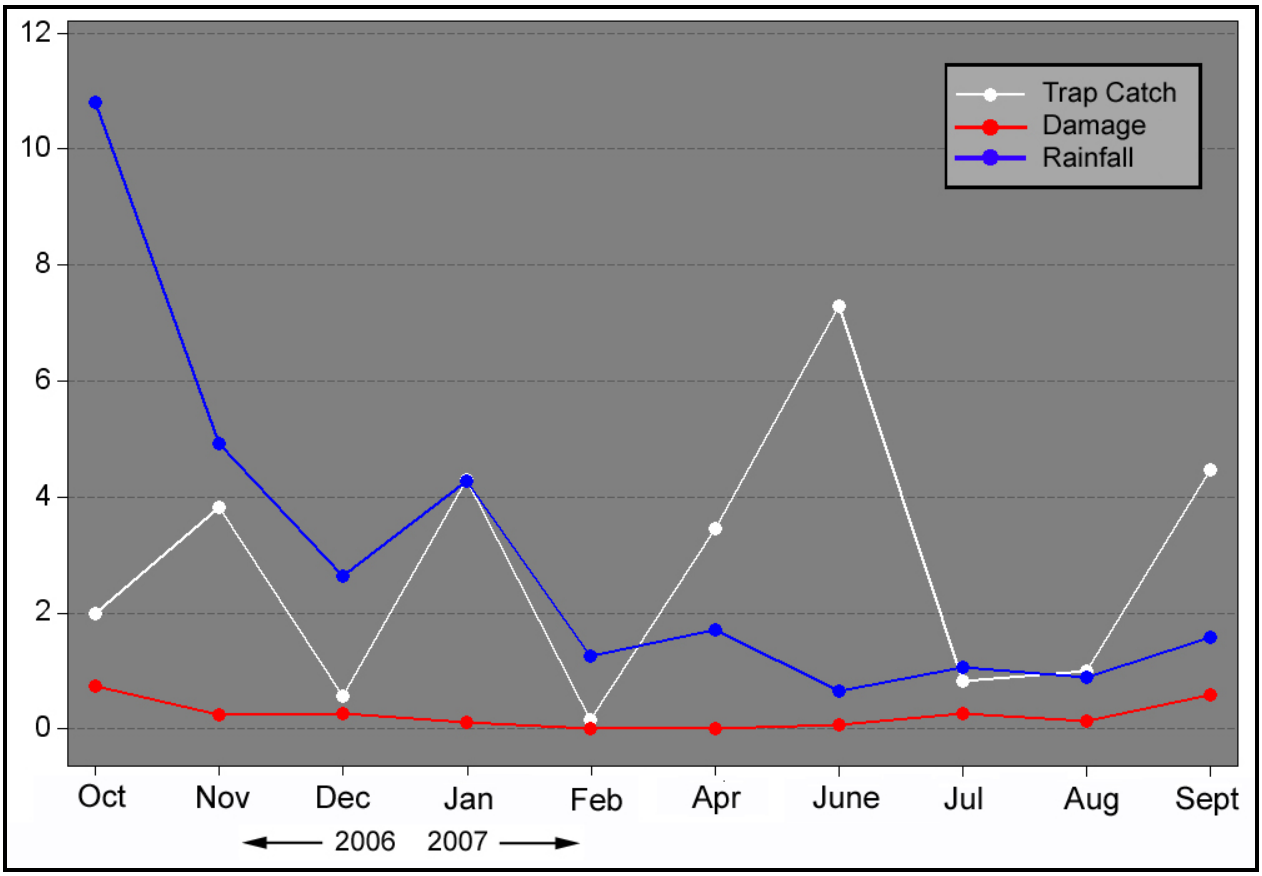


Figure 5.2.4 Damage and trap catch plotted against rainfall. Values are given as monthly averages and both sites were pooled. Y axis units follow for each variable: inches/month (rainfall); $\overline{X}$ BTB/trap (trap catch); *o/h/t* (damage).

Future research: NRS will continue monitoring *X. compactus* numbers in the field and at Nike using traps. These traps will only need to be checked once a month as they will be baited with a high release, long-lasting ethanol lure. Ten traps will be placed at each site and serve as sentinels, altering NRS to times of year when *X. compactus* is abundant. In addition, the ten largest trees at each site will be assessed once a month for damage. These data should better clarify the relationship between seasonal cures and *X. compactus* behavior as well as facilitate better prediction of *X. compactus* activity in the future.

Chapter 5.3 Molluscicide Field Test

Proposed action: 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.

Status: NRS carried out work supporting the development of an ecologically based area-wide control program for slugs in forested areas. Under an Experimental Use Permit (EUP) granted February 2007 and valid through February 2008, NRS carried out a field trial testing the safety and efficacy of the organic molluscicide, Sluggo® (Neudorff, Germany), in the KMU. Results summarized below were also presented as a poster at the 2007 Hawai‘i Conservation Conference (HCC). In fulfillment of the obligations stipulated in the EUP, NRS is currently preparing a document describing project conclusions for the Hawai‘i Department of Agriculture (HDOA) and the USFWS. This research is part of an effort to obtain Special Local Needs Labeling for Sluggo in Hawai‘i.

The purpose of the following study was to establish whether application of Sluggo in mixed native forest controlled slugs without adverse affects to common, native, non-endangered snails (Achatinellidae subfam. Tornatellidinae) hereafter referred to as “Tornatellids.”

Study: Safety and efficacy of Sluggo Deployment in Natural Areas

Methods: A grid of 12 plots, each 225m^2 and a minimum of 20m from its closest neighbor, was established in a gulch roughly 2ha in size within the KMU on February 2007. Pre-treatment monitoring confirmed both slugs and native Tornatellid snails were present at similar numbers in all plots and *Achatinella mustelina* absent. Six plots were randomly chosen to receive Sluggo treatments, those remaining served as controls. Sluggo was deployed a total of four times at two week intervals. At one week post-treatment and for two months after the final treatment (on April 11, 2007) slugs and Tornatellid snails were counted inside plots using the following methods.

1. a 20-minute timed search by the same person throughout the trial (McCoy 1999);
2. ten, 9 oz. pitfall cups baited with 6 oz. of beer (Cranshaw 1997);
3. six 0.5m^2, squares of moistened cardboard which serve as daytime refuge (Hawkins *et al.*1998).

Slug and snail counts from all three methods were summed prior to analysis. For the remainder of this document, “slug count” and “snail count” is used to refer to the sum of animals recorded using these three methods in combination.

Slug counts continued for an additional four months until June 12, 2007, when it became evident Sluggo was suppressing numbers in the treatment plots.

Analysis: Differences in slug response due to treatment over four months, and for snail response over two months, was undertaken using a general linear model (GLM).

Results and conclusions: Relative slug abundance over time in treated and untreated plots is shown in Figure 5.3a. Sluggo application significantly reduced slug numbers in treatment plots (P=0.007). GLM results show slug numbers were also significantly affected by time (P=0.001) and that there was no interaction between time and treatment (P=0.299). In other words, after the first Sluggo treatment, repeated applications did not appreciably improve suppression. Slug numbers remained significantly lower in treated plots two months after the final application on April 17. The failure of slugs to recover during this time was perhaps due to repeated applications.

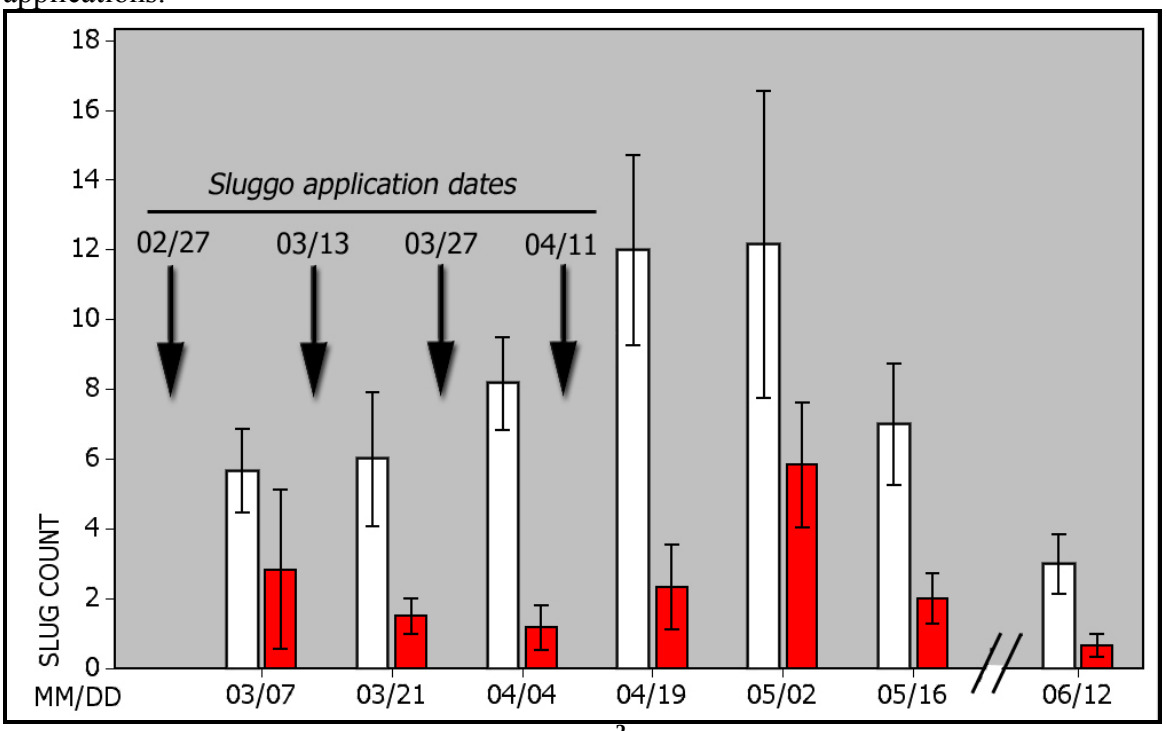


Figure 5.3.1 Mean number of slugs per 225m^2 plot over time in treated (red bars) vs. control (white bars) plots (N=6). Slug count refers to the sum of slugs counted using all three survey methods. Treatment significantly (P<0.05) reduced slug numbers. Bars are ± one SEM.

In contrast, snail numbers were not significantly affected by treatment (P=0.616) (Fig. 5.3.2) nor were they affected by any interaction between time and treatment (P=0.458). Though three methods were employed to asses Tornatellid abundance, snails were found during timed searches, presumably because they are arboreal. Thus, estimates of snail abundance are likely less accurate than those for slugs.

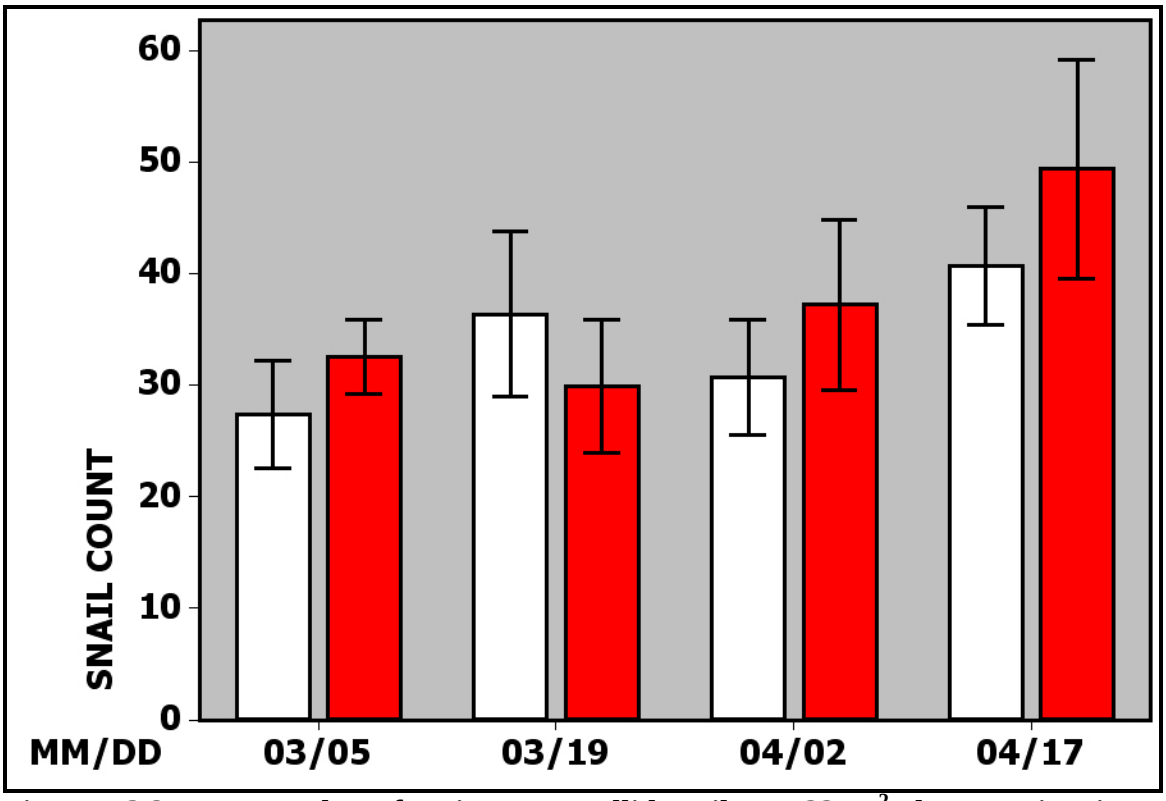


Figure 5.3.2 Mean number of native Tornatellid snails per 225m^2 plot over time in treated (red bars) vs. control (white bars) plots (N=6). Treatment did not significantly (P>0.05) affect snail numbers. Bars are ± one SEM.

As with the slugs, snail numbers were significantly influenced by time (P= 0.033) generally showing an upward trend between March and April. The significant effect of season on slug and snail numbers is unsurprising given that mollusks respond to changes in temperature and moisture (Nystrand and Granström 1997).

Though complete eradication of slugs was not achieved, Sluggo was responsible for, on average, a four-fold decrease in slug numbers in treatment plots. Slug numbers declined through two Sluggo applications but reached a plateau by the third and forth treatments. This suggests that repeated applications may be effective in preventing recovery over time, but do not play a role in the initial knockdown. Future tests will determine whether one or two treatments may be adequate in achieving the same reduction in slug numbers over time.

Future research: Of particular interest to NRS is whether Sluggo application can enhance seedling germination. This hypothesis will be tested in a six week trial beginning in December 2007 and ending before February 2008. Seeds from five species: *Cyanea superba, Cyrtandra dentata, Deiissea subcordata, Schiedea kaalae* and *Schiedea obovata* will be sown into a subplot 4m^2 located at the center of 12, 15 x 15 m plots. Germination and survival of seedlings will be recorded on a weekly basis with the expectation that a greater number will germinate and survive in those plots receiving treatment with Sluggo.

Chapter 5.4 *Drosophila* Surveys

Six species of Picture Wing flies (*Drosophila* spp.), endemic to O‘ahu were listed as endangered on 9 May 2006 in the Federal Register (USFWS 2006). The listed endangered Drosophila from O‘ahu are *D. aglaia, D. hemipeza, D. montgomeryi, D. obatai, D. substenoptera, D. tarphytrichia.* Army training lands contain habitat suitable for these flies. NRS contracted Dr. Steven Montgomery, prominent Hawaiian Entomologist and *Drosophila* expert, to conduct surveys. Appendix 5-1 is a survey summary prepared by Dr. Montgomery. Surveys began in December 2006 and will continue until NRS feel satisfied that all the prime habitats for the listed *Drosophila* have been adequately surveyed. A total of 20 field survey days were completed during this reporting period at 13 locations. Native *Drosophila* were observed at seven of the 13 locations. Figure 5.4.1 shows the survey locations. The numbered locations on the map are sites where native *Drosophila* were observed. Also shown on the map are sites where additional surveys are proposed.

Map removed, available upon request

Figure 5.4.1 *Drosophila* Surveys in the Wai‘anae Mountains

Table 5.4.1 shows the results of the surveys by location as indicated in Figure 5.4.1. This is the first *Drosophila* survey work conducted on Army land on Oahu and therefore these data are important to show the current range of the endangered and non-endangered *Drosophila* taxa.

Table 5.4.1 *Drosophila* observed by location

Map Survey Number	Location	*Drosophila* observed
1	Mohiakea South Fork	*Drosophila gradata*
		Drosophila oahuensis
		Drosohila haleakalae
		Drosophila inedita
		Drosophila crucigea
2	ʻŌhikilolo	*Drosophila gradata*
		Drosophila punalua
		Drosophila crucigea
3	Central Waiʻeli, SB South	*Drosophila ambochila*
		Drosophila punalua
		Drosophila crucigea
4	Kahanahāiki	*Drosophila crucigea*
		Drosophila hexachaetae
		Drosophila ambochila
		Drosophila inedita
		Drosophila punalua
5	Kaʻala	*Drosophila oahuensis*
6	Puʻu Hapapa	*Drosophila ambochila*
		Drosophila crucigea
		Drosophila distinguenda
		Drosophila punalua
7	Puʻu Kalena, SB West	*Drosophila montgomeryi**
		Drosophila inflatus
		Drosophila crucigera
		Drosophila punalua

*listed endangered

On field surveys, Dr. Montgomery sometimes collected *Drosophila* maggots to rear in lab conditions. This allowed him the opportunity to document taxa which were not observed in adult form. Some of the taxa identified in Table 5.4.1 were reared from maggots.

NRS apprenticed with Dr. Montgomery in order to build in-house capacity for conducting surveys and recognizing wing patterns of some native picture-wing flies. Dr. Montgomery provided our staff a "How-To-Fly" protocol that includes details of preparing bait and bait placement. This document is included as Appendix 5-1.

Map removed,
available upon request

Figure 5.4.2 *Drosophila* Surveys in the Koʻolau Mountains

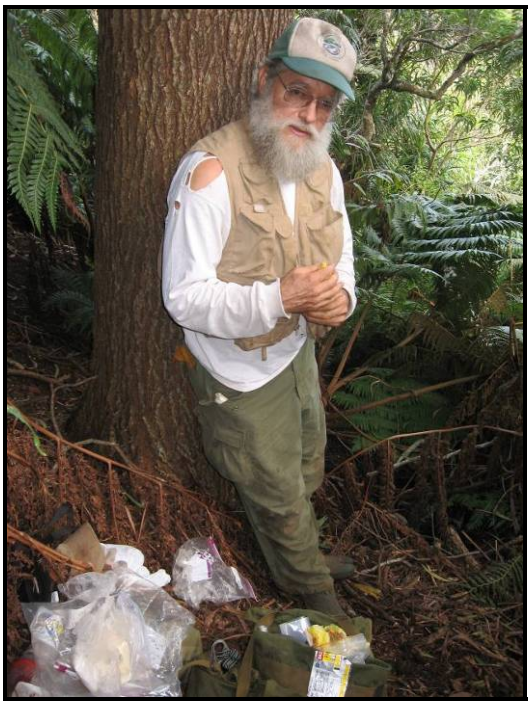


Figure 5.4.3 Dr. Steven Montgomery surveying for *Drosophila* and baited sponges

The most significant find was made near Puʻu Kalena, in Schofield Barracks, West Range. One possible *Drosophila montgomeryi*, a listed endangered picture-wing, was observed on baits near patches of *Urera glabra*. It could not be confirmed as it flew off when approached and Dr. Montgomery was unable to capture it for photos and to make detailed notes. The only other native *Drosophila* that has a similar wing pattern is associated with *Pisonia* and there were no

Pisonia in the baiting area. *Drosophila montgomeryi* is associated with *U. glabra* and there were approximately 30 trees in the area. Another survey will be conducted at this location in the wet season. In addition, NRS will secure some field microscopes for closer examination and will take along a digital camera with a macro function.

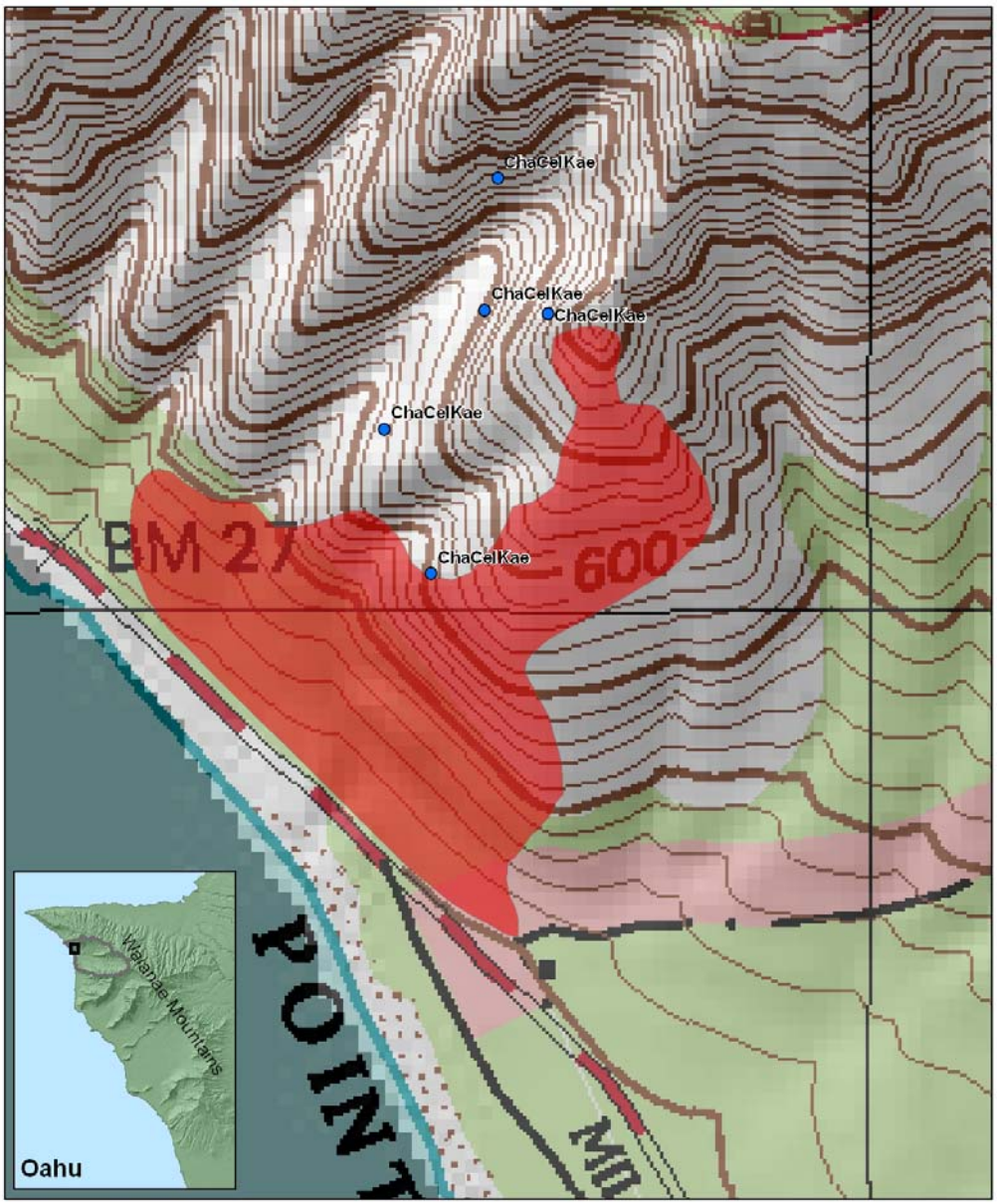
APVG-GWV (200-3) 20 August 2007

MEMORANDUM FOR RECORD

SUBJECT: Reconnaissance for the August 10 2007 fire on Makua Military Reservation.

On August 13 2007, Matt Keir, Stephen Mosher (Army Natural Resources), and Dawn Greenlee (Biologist, US Fish and Wildlife Service) conducted a survey of the damage done by a fire at Makua Military Reservation on August 10 2007. The purpose of the survey was to complete an exact map of the extent of the fire and to assess impacts upon federally listed species.

1. Extent of Fire. See the map and Photo 4 below showing the extent of the fire. The fire burned a total of 19.5 acres. The fire burned from Farrington Highway up into MMR.



August 10, 2007 Makua Military Reservation Fire

Legend
Rare Plants
Aug. 10, 2007 Burn Area

Total Acres Burned: 19.5

0 45 90 Meters

N

Oahu Army Natural Resources

2. <u>Natural Resource Impact.</u> The fire burned through a population of *Chamaesyce celastroides* var. *kaenana* a federally listed plant and came very close to a second population further up the ridge. Damage from the fire was observed on two individuals in the lower site, and one sustained significant damage. The photos below illustrate the damage to the habitat and the *C. celastroides*. Photo 1 shows damage done to the flowers and developing fruit of a plant. Photo 2 shows damage done to a small juvenile plant. This damage is significant and this plant will be monitored to determine if it has survived. Photo 3 shows the fire damage to the native shrub land habitat that supports the *Chaesyce celastroides* var. *kaenana* at the upper population. Photo 4 is of ordnance found between the lower population and the Highway. Photo 5 shows an overview of the area and especially the proximity of the fire to the second upper site.

Photo 1: Fire damage to the flowers and developing fruits of a mature plant in the lower population.

Photo 2: Significant fire damage to a juvenile plant in the lower population.

Photo 3: Damage to the native habitat near the upper population.

Photo 4 Ordnance found during survey.

Photo 5: Showing the proximity of the fire to two of the populations on Puaakanoa Ridge.

The following is a list of Native and Alien plant species surveyed in the burn area.

Native Plant Species	**Alien Plant Species**
Chamaesyce celastroides var. *kaenana*	*Acacia farnesiana*
Dodonaea viscosa	*Andropogon virginicus*
Psydrax odoratum	*Cenchrus ciliaris*
Sida fallax	*Hyptis pectinata*
Waltheria indica	*Leucaena leucocephala*
	Melinus minutiflora
	Panicum maximum
	Pluchea symphytifolia
	Rhynchelytrum repens

3. POC is the undersigned, 656-7641/7741.

KAPUA KAWELO
Biologist, Environmental Division

Kaukonahua Fire Report
Draft 1
September 6, 2007

APVG-GWV (200-3)

MEMORANDUM FOR RECORD

SUBJECT: This report was complied following three days of field surveys. Over these three days, NRS surveyed eight gulches containing rare species; Kaumoku Nui, Kaumoku Iki, Manuwai, Ala`iheihe, Ka`imuhole, Palikea, Kihakapu and Pu`ulu. NRS spent 120 person hours conducting fire surveys to date. NRS visited 85 rare plant sites across the region and documented fire impact. Rare species impacts are summarized in the table below. The "Number Prior" column indicates the total number of mature/immature/seedling plants in the area of the burn before the fire. Most of these population estimates were made during surveys in 2003-2004 and NRS had not been to many of the sites since collecting cuttings in 2005. The "Number Impacted" column totals the number of plants that NRS observed as either being killed by the fire or are assumed to have been significantly impacted such that NRS is not certain that they will survive. As the table indicates, the fire significantly affected many endangered species, particularly *Hibiscus brackenridgei* subsp. *mokuleianus*. NRS has observed this species in other areas that are known to have burned in the past, most notably in Makua where a population of *Hibiscus* was discovered in an area that is known to have burned many times. It is possible that some of the burned plants seen in a few areas surveyed will recover from the fire. It is likely that seeds on or in the soil have survived and may come back when conditions improve. Approximately 90% of the known *H brackenridgei* subsp. *mokuleianus* on Oahu were impacted by this fire.

Species potentially impacted by the fire	Federal Status	Number Prior	Number Impacted
Abutilon sandwicensis	Endangered	37/70/0	8/5/0
Bobea sandwicensis	Vulnerable	1/0/0	0
Bonamia menziesii	Endangered	2/0/0	2/0/0
Colubrina oppositifolia	Endangered	25/0/0	0
Eugenia koolauensis	Endangered	2/0/2	2/0/2
Euphorbia haeleeleana	Endangered	5/0/0	4/0/0
Hibiscus brackenridgei subsp. *mokuleianus*	Endangered	28/546/65	28/532/58
Nototrichium humile	Endangered	57/7/0	7/3/0
Schiedea hookeri	Endangered	17/0/0	17/0/0

NRS also mapped the perimeter of the burn near the rare species sites visited. Initial maps of fire damage were approximated after aerial surveys. The map below shows the revised fire boundary, and is the most accurate map of the fire to date. In many cases, surveys resulted in the expansion of the fire perimeter, particularly deeper into the gulches. The burned area around agricultural and residential areas and in regions lacking significant natural resources have not been surveyed from the ground. In all, the fire consumed approximately 5,655 acres.

Map removed, available upon request

General Observations

Photopoints:
NRS established several photopoints along the Lower Kaala contour road and on one ridge below the road. The photopoints are marked by orange painted PVC and are labeled with aluminum tags. They will help to document changes in the region over time. The location of the points is noted on the map above.

Ungulates:
The fire burned fences, displaced many animals, and reduced grazing area on ranching land. Both feral and farmed livestock were affected by the fire, and as a result, both may have significant impacts to natural resources post-fire. Some domestic cattle were pushed to high elevation areas. During the surveys, NRS observed animals, browsed plants and tracks in areas distant from the usual pasture lands. In particular, cattle sign was seen at one of the burned *Hibiscus* sites in Ka`imuhole gulch. The cattle are likely taking advantage of prime grazing offered by young *Panicum maximum* shoots. It is unclear if cattle will remain in the area once the *P. maximum* matures and chokes the gulch slopes once more. However, cattle grazing definitely will negatively impact any native seedling recruitment which may occur, particularly *Hibiscus* recruitment.


Right: Marked by the yellow circle, a cow grazes on newly sprouted *Panicum maximum* on the rige between Ka`imuhole and Ala`iheihe gulches, at approximately 1100ft elevation.
Left: Fresh hoof prints on the ridge between Ka`imuhole and Ala`iheihe.

Both feral pigs and goats were present in the burned area. Due to the dry habitat and lack of water, pig populations were always low in the area. However, on previous visits to the region, NRS observed significant numbers of feral goats, as well as goat damage to some rare species populations. It is likely that the fire pushed both goats and pigs higher, above the contour road and into the Lower Ka‘ala Natural Area Reserve (LKNAR). This is a concern as there is much more native vegetation in the LKNAR. NRS plan on visiting the upper portion of the LKNAR later in September and will investigate the presence of domestic and feral animals. It is unclear what future impacts feral animal movements may have in both the short and long term. It is also unclear what the State and private landowners plan to do about the domestic animals that are no longer contained. NRS will cooperate with the state and private landowners to address these issues.

Weed Regrowth:

NRS was impressed by the rate of re-growth shown by *P. maximum*. Areas that were completely charred only two weeks prior already have blades up to two feet long. The rebound of grass in these areas shows the invasive nature of this community type. NRS strongly believe that with current conservation resource management techniques, large scale vegetation management is not practical. As a comparison, NRS manage a 5 acre area in Makua that would otherwise be dominated by *P. maximum*. It requires approximately 32 person days a year to maintain this five acre area. If grass control and/or suppression is identified as a goal by the State of Hawaii and private landowners, methods they could pursue include: mechanized firebreak construction and maintenance, aerial herbicide application, prescribed burning, installation of living firebreaks to include agriculture crops and large scale irrigation, grazing for fuel management.

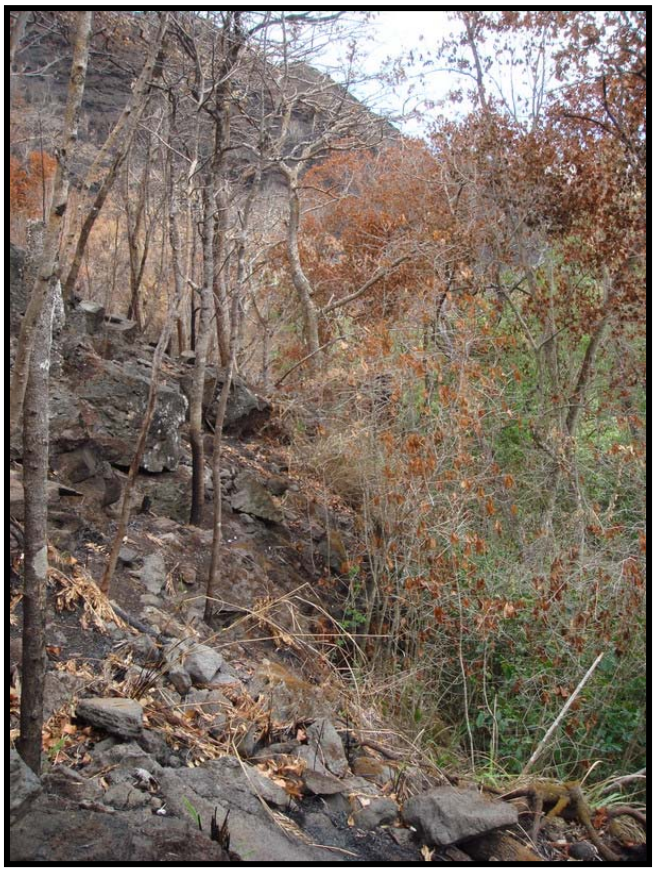

Left: Grazed shoots of *Panicum maximum*. **Right:** Re-growth of burned *P. maximum*.

In addition to *P. maximum*, a host of other weeds have the potential to thrive in the post-fire environment. Prominent among these is *Leucaena leucocephala*, which is prevalent in other dry, fire-prone areas. *L. leucocephala* alters microsite conditions by using lots of water. Other weeds of concern include *Caesalpinia decapetala* (cats claw), *Melia azedarach*, and *Eucalyptus robusta*. While re-vegetation by weeds is already occurring, much of the region is denuded and erosion is already having an impact on topsoil.


Left: new growth on *Leucaena leucocephala* **Right:** Erosion at the base of a cliff

Coffee:

Some of the gulches surveyed had significant populations of *Coffee arabica* infesting the gulch bottoms. In these gulches, it appeared that the fire did not penetrate to the same degree as in areas with other vegetation types. This confirms previous theories held by NRS and Mr. Joel Lau. While the edge of the coffee stands did burn, the fire did not penetrate far into the stands and the only *Hibiscus* found alive grew at the edge of a coffee stand. Previous observation indicated that very few other species thrive in coffee stands, including *P. maximum*, thus reducing the fuel load present. Although coffee is invasive, it has the benefit of creating less fire-prone zones. More research should be done on this species, as it may have some potential to be used as a living fire break in appropriate areas.



Right: Note the narrow burned edge of coffee.

Impacts to Common Natives:

While the burned area was dominated by alien vegetation, some small pockets of native species were hidden in some of the gulches. Dominated by alahe`e, a`ali`i, lama, and the beleaguered and long-suffering wiliwili, these dry forest remnants were severely affected by the fire. It is unlikely that these long-lived and slow-growing canopy species will replace themselves, given stiff competition from such invasive powerhouses as *P. maximum* and *L. leucocephala*.

Burned native forest remnant in Kaimuhole Gulch. Note the large wiliwili above and the burned *Hibiscus* below.


Left: Pleomele forbsii **Right:** Seedlings beneath a burned lama forest

It is unclear how the native seed bank will respond post-fire. NRS collected a partially burned wiliwili seed have sowed it as a trial. In the field, NRS observed seedings germinating in a burned lama forest. While the seedlings are too young to be conclusively identified, it is likely they are lama seedlings. However, in 98% of the surveyed area, no native seedlings were found. It will be interesting to see what seedlings germinate during the rainy season.


Right: Burned wiliwili trunk. This tree may recover as it was on the edge of the fire. **Left:** Burned wiliwili seed.

In the following section NRS presents findings of the ground surveys organized by gulch.

Pu‘ulu Gulch

Right: NRS member George Akau laments the loss of native resources in Pu‘ulu. **Left:** The intensity of the fire in Pu‘ulu was such that the base of this *Fraxinus uhdei* was completely incinerated.

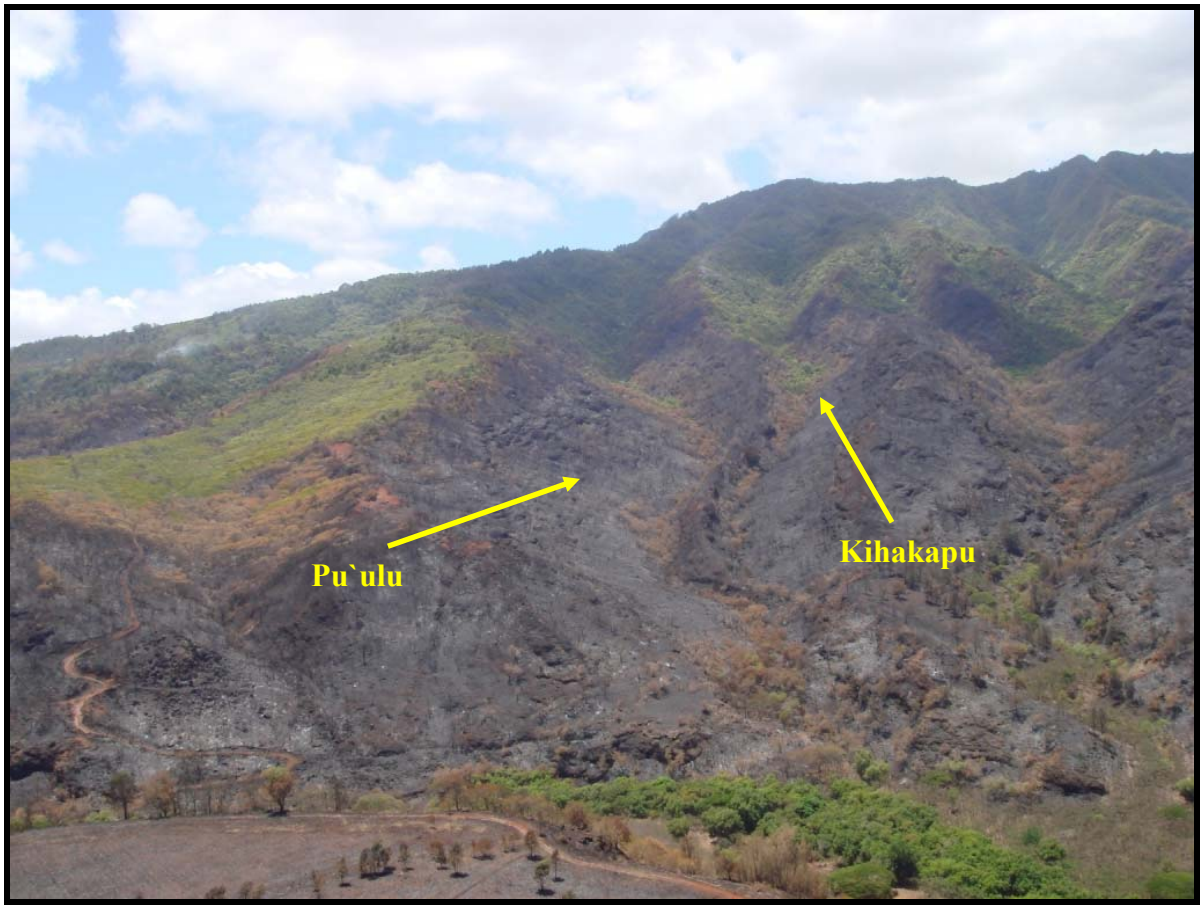
Pu‘ulu Gulch is the eastern most gulch that had important native resources at risk from the fire. There are six known sites with *Hibiscus brackenridgei* subsp. *mokuleianus* in the area below the contour road.

In the table below and for all that follow; Point # refers to the location indicated on the map, Species lists the code (first three letters of the genera and first three letters of the species) for the species, PRC refers to the population reference code (unique database code), Number Prior is the number of plants known in the area prior to the fire in the following order Mature/Immature/Seedlings, Number Impacted the number of plants not expected to survive the fire and in the last column any pertinent notes.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
80	Hibbramok	PUU-A	0/55/17	0	
81	Hibbramok	PUU-A	0/2/0	0	
82	Hibbramok	PUU-A	0/10/0	0	
83	Hibbramok	PUU-B	3/40/0	0	
84	Hibbramok	PUU-B	0/3/0	0	
85	Hibbramok	PUU-B	1/73/6	0	

Unfortunately, Pu‘ulu was severely burned by the fire, as the fire reached 1720 ft on the West side of the gulch and 1400 ft on the Eastern side. Fuels appeared to be mostly *Panicum maximum*, *Leucaena leucocephala*, and *Fraxinus uhdei*. Small patches of native forest on the alien dominated slopes comprised of wiliwili, lama, and alahe‘e were almost completely consumed, with only the large wiliwili left standing, albeit badly burned. All *Hibiscus* populations within Pu‘ulu were within the burned area, and no identifiable plants were recovered during the survey. Portions of the gulch bottom that contained *Coffee arabica* were not burned by the fire, unfortunately none of the *Hibiscus* populations were within those areas.

Map removed,
available upon request



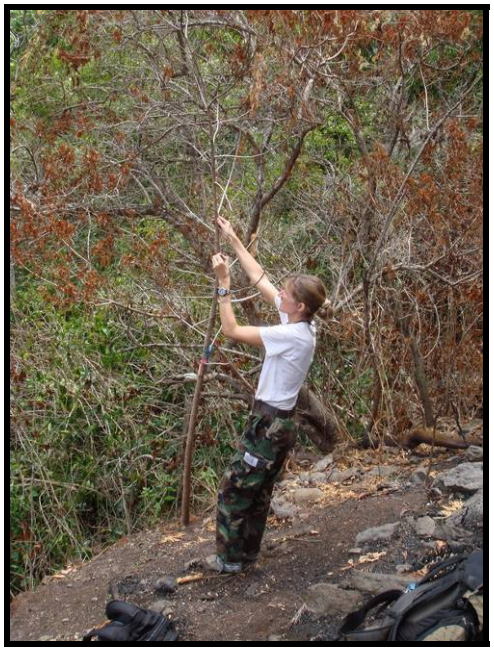
Puulu and Kihakapu Gulches

Kihakapu Gulch

In Kihakapu there are four known sites with *Hibiscus brackenridgei* subsp. *mokuleianus* and one with *Abutilon sandwicensis* below the contour road. As the table below shows, all were severely affected by the fire. Much more of this gulch burned that was previously estimated.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
75	Hibbramok	KIH-A	0/12/0	0	
76	Hibbramok	KIH-A	0/11/1	0	
77	Hibbramok	KIH-A	2/94/33	3	1 unburned plant, 2 partially burned plants (unknown if will survive)
78	Hibbramok	KIH-A	0/16/0	0	
79	Abusan	KIH-A	3/5/0	0	

Only one site had any surviving plants. At this site, 77, the *Hibiscus* population bordered a coffee infestation. As described in General Observations above, the coffee appears to have slowed the fire, thus providing some protection for the *Hibiscus*. Only one plant survived the fire totally unscathed; NRS observed new leaves on this plant. Two other plants were partially burned, but cambium scrapes revealed green tissue. It is likely that these plants will recover. One of the two partially burned plants had seeds, which NRS collected. The viability of these seeds is currently being evaluated.



Left: Dawn Greenlee (FWS) assists NRS in collecting seed from a partially burned *Hibiscus*. Note the coffee in the gulch below. **Right:** Partially burned *Hibiscus*. Note the brown cambium on the left, where the fire was hottest, and the green cambium on the right, away from the fire.

Burned slope of Kihakapu. Several *Hibiscus* sites burned in the bottom region of this photo

Map removed,
available upon request

Palikea Gulch

There are ten known sites below the contour road with *Hibiscus brackenridgei* subsp. *mokuleianus*, and all but two were impacted by fire. Six sites with *Abutilon sandwicensis* were known from this gulch and three were burned. One site each with *Colubrina oppositifolia* was known and the tree was not burned. *Eugenia koolauensis* was known from one site that was observed burned but the trees were not located. *Nototrichium humile* was burned at one sites but not at the other larger site. Most of the sites known to have rare species were burned and some were assumed to have burned from observations made in the field but have not been visited. NRS will revisit this area in the coming months to complete the survey.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
30	Hibbramok	ALI-D	0/2/0	0	
31	Hibbramok	ALI-D	1/34/0	0	
32	Eugkoo	LKN-A	2/0/2	0	
33	Nothum	LKN-A	7/3/0	0	
34	Hibbramok	ALI-C	1/18/0	0	
35	Abusan	ALI-C	1/0/0	0	
36	Hibbramok	ALI-C	0/2/0	0	
37	Hibbramok	ALI-C	3/98/some	0	Didn't get to but looked burned
38	Abusan	ALI-C	1/0/0	0	Didn't get to but looked burned
39	Hibbramok	ALI-C	0/14/3	0/14/3	Didn't get to but looked OK
40	Abusan	ALI-C	7/0/0	7/0/0	
41	Abusan	ALI-A	1/0/0	0	Did not burn but plant is dead
42	Colopp	LKN-A	1/0/0	1/0/0	
43	Abusan	ALI-A	1/0/0	0	Did not burn but plant is dead
44	Hibbramok	ALI-A	1/0/0	0	
45	Hibbramok	LKN-A	0/0/4	0/0/4	
46	Abusan	ALI-A	1/0/0	0	
47	Hibbramok	ALI-A	0/2/0	0	
48	Hibbramok	ALI-B	1/0/0	0	
49	Nothum	LKN-C	50/4/0	50/4/0	

NRS directed water drops to many of the sites in Palikea Gulch and likely stopped the fire from burning through at least sites #41-45. Most of the *Hibiscus* sites were burned, however it is noteworthy that the large population of *Nototrichium humile* and the *Colubrina oppositifolia* did not. The area surrounding the *Eugenia koolauensis* and the smaller *Nototrichium humile* was burned however the trees were not located. Another small group of seven *Hibiscus* that was not previously known was discovered however 4 were severely damaged by the fire.

The burned area around site #37 and 38 is shown in the bottom right of this photo.

NRS staff shown inspecting mature and immature plants that were burned at site #31

Photo showing a burned plant in a new site discovered during the survey

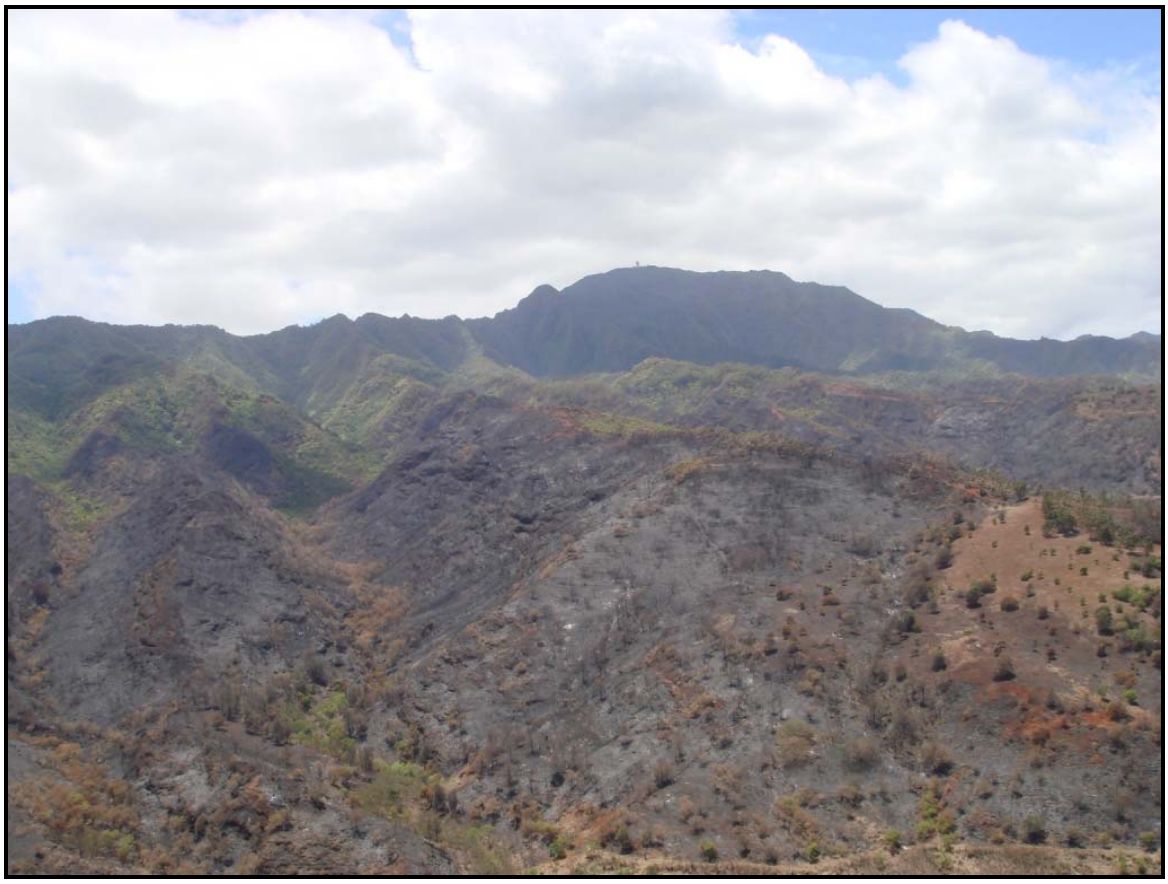


Photo showing lower Palikea Gulch


Photo showing the contour road in upper Palikea Gulch

Map removed, available upon request

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available upon request

Ka‘imuhole Gulch

NRS know of two sites below the contour road with *Hibiscus brackenridgei* subsp. *mokuleianus*, and one site each with *Nototrichium humile* and *Euphorbia haeleeleana*. Five other rare plant sites are present above the road. As the table below illustrates, all the sites above the road did not burn, while most of the sites below the road were burnt.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
21	Euphae	IMU-A	2/0/0	0	
22	Hibbramok	IMU-A	1/54/0	0	
23	Hibbramok	IMU-B	0/6/1	0	
24	Nothum	IMU-A	1/0/0	0	
25	Abusan	IMU-A	1/0/0	1/0/0	Did not burn
26	Nespol	LKN-A	1/0/0	1/0/0	Did not burn
27	Abusan	IMU-A	1/0/0	1/0/0	Did not burn
28	Caekav	LKN-B	0/0/0	0/0/0	Did not burn
29	Abusan	IMU-A	2/2/0	2/2/0	Did not burn

The fire burned much further into the gulch than anticipated. The only site to escape the fire’s fury was the *Nototrichium humile* site. This plant was protected by a short steep cliff that blocked the fire’s path into the gulch bottom. The *Hibiscus* and *Euphorbia* sites, while located on cliffs, were surrounded by *P. maxium*, and were all burned. It is unlikely that any of these plants will survive. NRS observed cattle tracks and scat directly beneath the cliff sites. Cattle presence may affect potential recruitment at these sites.

Left: Cattle scat at *Hibiscus* site 22. **Right:** Burned *Euphorbia* trunk. **Below:** Surviving *Nototrichium*.


Ka`imuhole Gulch, looking towards Kaukonahua Road.

Map removed, available upon request

Photo showing Kaimuhole and Alaiheihe Gulch

Ala‘ihe‘ihe Gulch

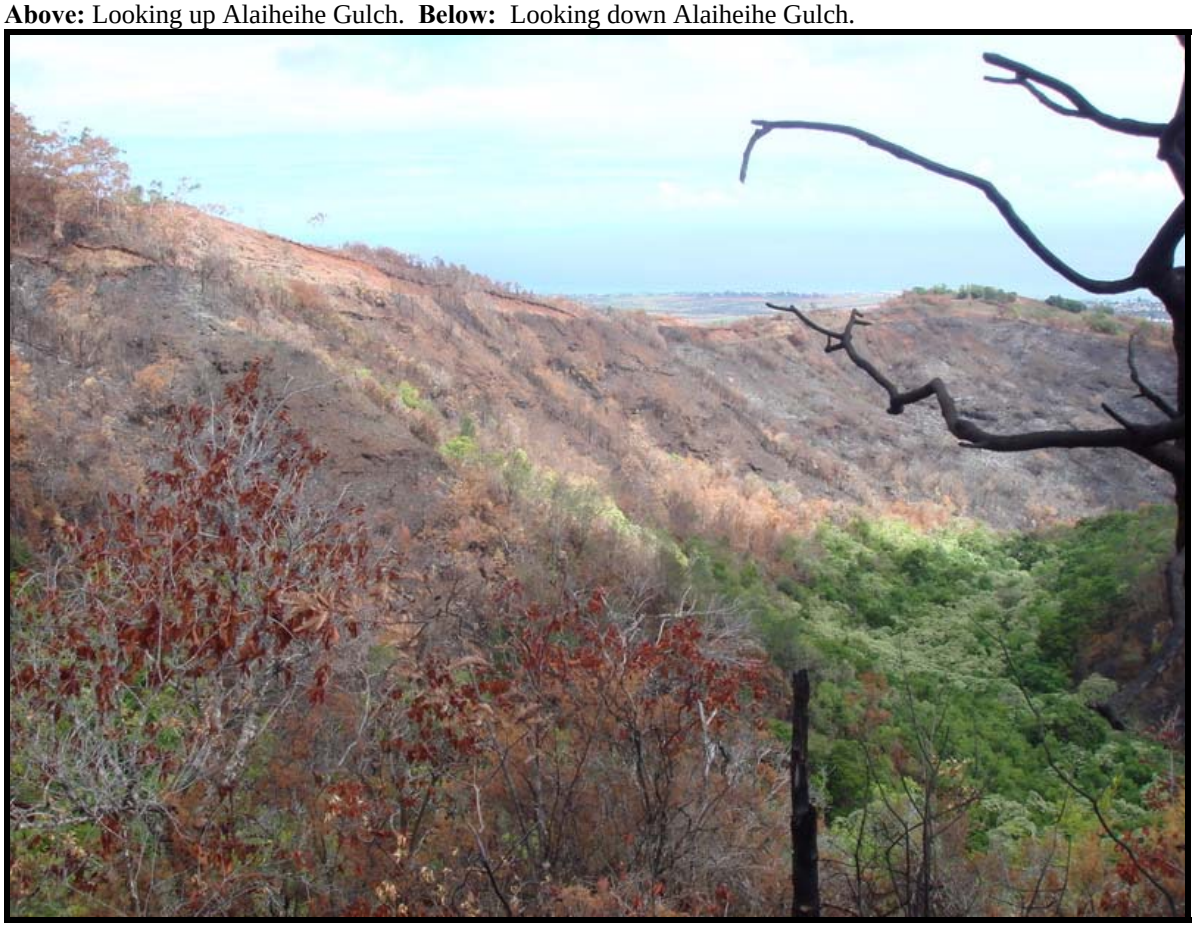
NRS know of two sites below the contour road with *Euphorbia haeleeleana*, and one site each with *Bonamia menziesii* and *Schidea hookeri*. Above the road, only one rare species is known, *Diellia falcata*. While the fire covered a greater area than anticipated at lower elevations, it did not penetrate all the way to the road. The only burned sites were the *Euphorbias* and *Bonamia*.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
16	Euphae	IHE-A	1/0/0	0	
17	Euphae	LKN-A	???	0	
18	Bonmen	LKN-A	2/0/0	0	
19	Schhoo	LKN-C	10/0/0	10/0/0	Did not burn
20	Diefal	LKN-A	60/30/0	60/30/0	Did not burn

NRS had not visited either of the two *Euphorbia* sites prior to the post-fire survey. Both were located by Mr. Joel Lau. However, large regions around both sites were burned, and NRS assume that both were affected. In addition, a lama stand around site 16 was also burned, as discussed in General Observations above.

Left: Burned *Euphorbia* at site 16.

Above: Looking up Alaiheihe Gulch. **Below:** Looking down Alaiheihe Gulch.



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available upon request

Manuwai Gulch

NRS know of five sites with *Abutilon sandwicensis,* three sites with *Schiedea hookeri,* two sites with *Colubrina oppositifolia* and one site each for *Neraudia angulata* and *Bobea sandwicensis* in Manuwai Gulch. When NRS mapped the fire perimeter in this region from the air, NRS thought that all of these resources had burned. Ground surveys revealed that these resources were not as impacted as first thought. The table below shows a damage summary of numbers impacted. Only one plant of *Colubrina oppositifolia* was impacted by the fire. NRS did not visit all of the points listed in the table below but observed the proximity of the fire to the points and that their locations were spared by the fire. The map of Manuwai below shows that there were two spot fires mauka of the main fire edge near points 5, 6 and 7. These small burned sites are good candidates for restoration because they are surrounded by intact native forest. This forest edge will serve to seed the impacted area and also to limit the *Panicum maximum* success. Spot fire locations near rare species are good candidates for grass control and restoration.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
5	Abusan	ANU-A	0/10/0	0/10/0	
6	Colopp	LKN-B	21/0/0	21/0/0	One tree was singed at the base but still had green leaves and likely will survive.
7	Schhoo	LKN-B	3/0/0	3/0/0	
8	Colopp	LKN-B	Same as 6	Same as 6	
9	Abusan	ANU-A	1/8/0	1/8/0	
10	Abusan	LKN-B	11/0/0	11/0/0	
11	Schhoo	LKN-B	4/0/0	4/0/0	
12	Abusan	LKN-B	3/0/0	3/0/0	
13	Nerang	ANU-A	0/0/0	0/0/0	
14	Bobsan	ANU-A	1/0/0	1/0/0	
15	Abusan	LKN-B	2/30/some	2/30/some	

Map removed, available upon request

Above: Photo showing Manuwai Gulch

Above: The burned base of a *Colubrina oppositifolia* tree. Staff member at base of C. oppositifolia near edge of burn.

Kaumoku‘iki Gulch

NRS know of one site with *Abutilon sandwicensis* in the area impacted by the fire. These plants were last visited in 2003. One NRS and two USFWS staff searched the area in an attempt to rediscover the plants. After surveying the area it was determined that the fire did not reach the plants but none of the *Abutilon* were found to confirm there health.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
3	Abusan	IKI-A	1/15/0	1/15/0	Site not seen but assumed unaffected by fire
4	Colopp	IKI-A	3/0/0	3/0/0	

Map removed,
available upon request

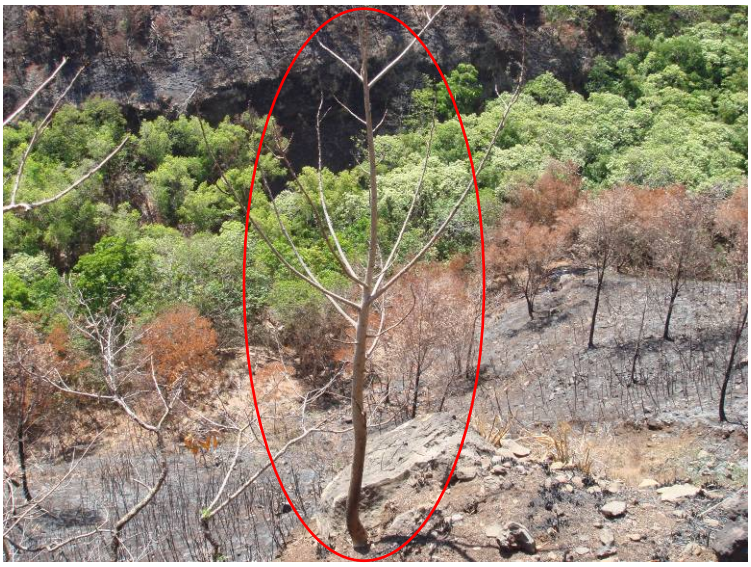
Above: Circled points were the areas that were surveyed

Photo showing Kaumoku iki, Kaumoku nui, Kaawa and Pamoa Gulch

Kaumoku nui, Ka‘awa and Pāmoa Gulch

This area is the western most extent of the fire. NRS know of one site each for *Hibiscus brackenridgei* subsp. *mokuleianus*, *Euphorbia haeleeleana* and *Abutilon sandwicensis* in Kaumoku nui Gulch. One NRS and two USFWS staff surveyed the sites for *Hibiscus* and the *Euphorbia* to determine there status. The entire *Hibiscus* site was burned and all plants seem dead. Although the *Euphorbia* was burned they are still displaying some signs of life.

Point #	Species	Pop. Ref. Code	Number Prior	Number Remaining	Notes
1	Hibbramok	KAO-A	14/0/0	0	
2	Euphae	KAO-A	1/3/0	1/3/0	Plant burned, but looks like will survive



Above: *Hibiscus* in Kamokunui gulch that was overrun by the fire

Above: Fenced area that once protected *Hibiscus*

Above: *Euphorbia* that was burned in the fire

Map removed, available upon request

Circled points were the sites that were surveyed

Photo showing Kaawa and Pamoa Gulch

Photo showing the western most extent of the fire in Pamoa Gulch

8/14/07 JB VC watching SBW end of fire (1)

10:53am - crossed to top & just over ridge past Wahiawa / Waialua line @ approx 200' 1100 ft. Bottom of fire a little behind but by 10:54 bottom mostly at ridge line too

11:00am - bottom of line wrapped around ridge & starting down other side

11:03am - bottom in ~~[illegible]~~ bowl before largest next ridge from Pane. @ 11:06, heard SG Range saying fire has crossed over

11:18am - gulch blowing up! prob on road side of gulch too. According to MK, Pane still clear

11:25am fire on McCartney flats

11:29am - Range closes W. Range (Non fire) line fire training, & clearing all Army/personnel

11:32am - flames high on this side, getting up to top of gulch on roadside of Kaukonahua

11:40am - flare up b/t Poamoho estates & Kaukonahua - Wilikina jnc in pineapple fields. HFD responding

11:50am Range cleared; fire burning up gulch into Schofield

11:55am Well est in gulch below range in F[illegible]

864 - 2005 (2)

12:44pm well into SB gulch, 1/2 m beyond the flats, burning fast & dark, earlier heard 2 explosions

1:02pm looks like fire in gulch below. & approaching Dragon X. Doesn't appear to have wrapped around behind Pane, but some big smoke rising, so not sure

1:12pm heard explosions. Fire not quite @ Dragon X - which has gulches running on 2 sides of it - so definitely a concern. Smoke coming out of gulch below 2000 pun ~~[illegible]~~ by 121 heard total of 4 explosions (since 1:12)

1:23 wind Δed direc a little while ago, kind of coming out of west,

1:39 Fire continuing to move below Dragon X, but not quite as fast cause wind to ave now. Burning back into W Range flats

2:02 SBW really smoky, 1st 2 ridges towards Pane - gulches are smoking. Also, plume coming from back of Schofield, but can't see what from.

2:24 back gulches of SBW blowing up @ base of Pane

2:28 looks like fire hit gulch along side of Dragon X, moving towards Kolekole [illegible]

Chinook ~~||||~~ ~~||||~~ ~~||||~~ | about 2½ min per drop

(3)

2:34 Chinook arrive, start water drops 3 by 2:42, then 4th by 2:44, 5th by 2:46, 6th by 2:49, 7th by 2:51, 8th by 2:53, 9th by 2:55, 10th by 2:57, 11th by 2:59, 12th by 3:02, 13th by 3:06, 14th by 3:12, 15th by 3:15. Chinook left at 3:16

(2:50, 2nd Chinook arrives + goes down below)
→ went to pond by Helemano to refuel, 16th by 3:24?? looked like bird sat down, then maybe 17th ? Can't tell if the 16th + 17th drops occurred. Min 15, max 17. Heli flew to wheeler + didn't come back.

about 2½-3 min per load.

(4)

flew up Kaukonahua to SB W, circled

[322] → Kaukonahua below Dragon X
- Helemano gulch + 9.308 Charred
- on sides, but only tONE is on flats
burned above Dragon X

[323] → nw edge in gulch, firefighters
- Rinse
- McCarthy flats burned
spotty on slopes towards Pane [324]
slopes of Tine OK - [325]

[326] - down Pane towards plain
326 + 325 are finger up pane

[327] - on ridge + road
burned up LKN road to where it begins contour
- crested Dupont, below 2nd gate on Kaala
burned to Kaupakuhaile

[328] - top edge to W side of Kaumokunui / iki confluence
→ bottom of this ↑

[329] - top edge ↑
- didn't burn Kaukonahua gulch bottom
- stopped on Pane ridge
burned bottom + up ridge

Initial Kaena Fire report
August 28, 2007

APVG-GWV (200-3)

MEMORANDUM FOR RECORD

SUBJECT: This is an initial summary of events and observations of the Kaena fire of August 2007. At this stage NRS has not yet conducted a final ground reconnaissance of the fire damage however NRS were on site during the fire mop up and did a preliminary assessment of the burn area.

Wednesday August 15 2007

At approximately 2:30 am Wednesday morning a fire was started in the vicinity of Kaena State Park, NRS are unaware of the exact location of the ignition though were told by HFD that the fire was intentionally set. At 0630 NRMC Mike Walker, on duty as a lookout for the Kaukonahua-Waialua fire, was directed to proceed to Kaena Point to work with Reuben Mateo (Oahu NARS) to assess the level of threat that the new fire posed to known native resources in the area. When NRMC Walker arrived the fire was still active on the Eastern edge but was being controlled by HFD. NRMC Walker and Mateo proceeded to the Western extent of the burn area, the area closest to priority natural resources to assess the damage. The fire was essentially contained but the burn area was far from cold as several smoldering trees and small patches of unburned fuels within the burn area were flaring up. NRMC Walker reported that the fire had burned close to a site with many *Chamaesyce celastroides* var. *kaenana* plants and NRS decided to dispatch additional resources to finish fighting the fire. Five fire fighting-trained personnel packed up water, tools and arrived at Kaena Point at 1000. NRS and Mateo were joined by DOFAW staff Greg Mansker. Crews spread out along the Western and Mauka extents of the burn area to control flare ups and smoldering trees that could potentially send embers into unburned fuels. Around 1200 an area of unburned koa haole and grass to the East of NRS flared up and began burning East, into the wind. NRMC Walker informed NRMC Rohrer via radio and requested air support. HFD dispatched a helicopter and within a few drops the flare up was contained. The rest of the day the crew continued to control smoldering trees and small flare ups in the burned area that threatened unburned fuels, as well as call in air support for flare ups on the cliffs that ground personnel were unable to attend to. Crews departed the area at 1630, as fire activity had dropped off and all ground accessible flare ups had been controlled.

Operation	Personel	Time (hours)	Cost
Advise DLNR/IC	JR	12	$205
Mop up operations	MW, JB, SC, DS, VC, DF	54	$918
Recon Hughs 500	Mr. Allen	1	$700
Total			$1823

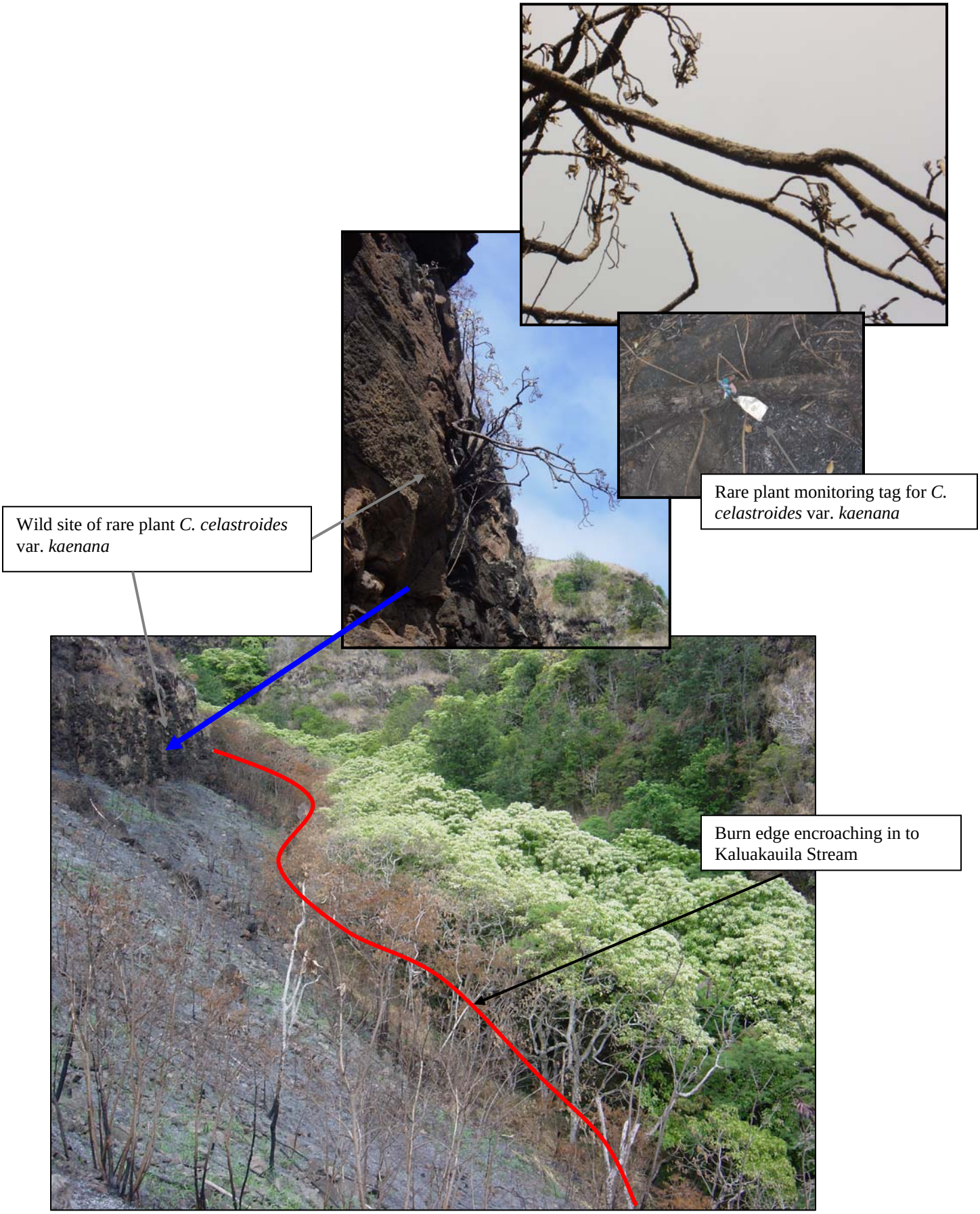
Thursday August 16 2007

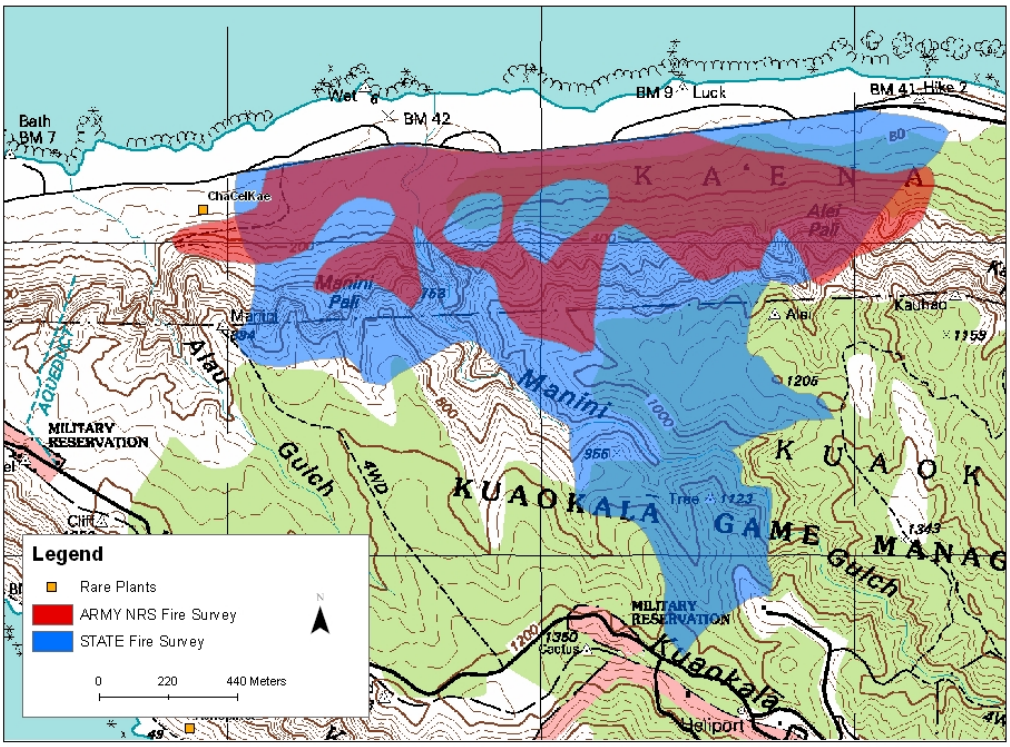
NRMC Walker was monitoring radio traffic throughout the day and was requested to assess the Kaena fire at 1500. NRMC Walker informed NRMC Rohrer that the Eastern front of the fire was active again, burning slowly into the wind. HFD dispatched a truck which arrived on scene soon after. NRMC Walker met with DOFAW Mansker on his way out. DOFAW Mansker reported small flare ups occurred through the day that he controlled, as well as a flare up on the cliffs that he was unable to get air support for. DOFAW Mankser had no way of contacting HFD-ICS on his radio.

Friday August 17 2007

NRS had personnel on standby. NRMC Rohrer received a call from DOFAW Peralta at approximately 11:00. At this time DOFAW Peralta indicated that the fire had flared up on the crest in the GMA and that approximately 60 acres had burned. The Chinook had actively fought the fire and there were federal fire units on scene. NRMC Rohrer discussed the situation with Army

Biologist Kawelo and decided that NRS would not mobilize any resources as the fire was not impacting natural resources under the programs purview. No flare ups were noted above or beyond the Western edge of the fire were NRS had conducted mop up operations with DOFAW staff. This was the area with resources of concern for NRS.

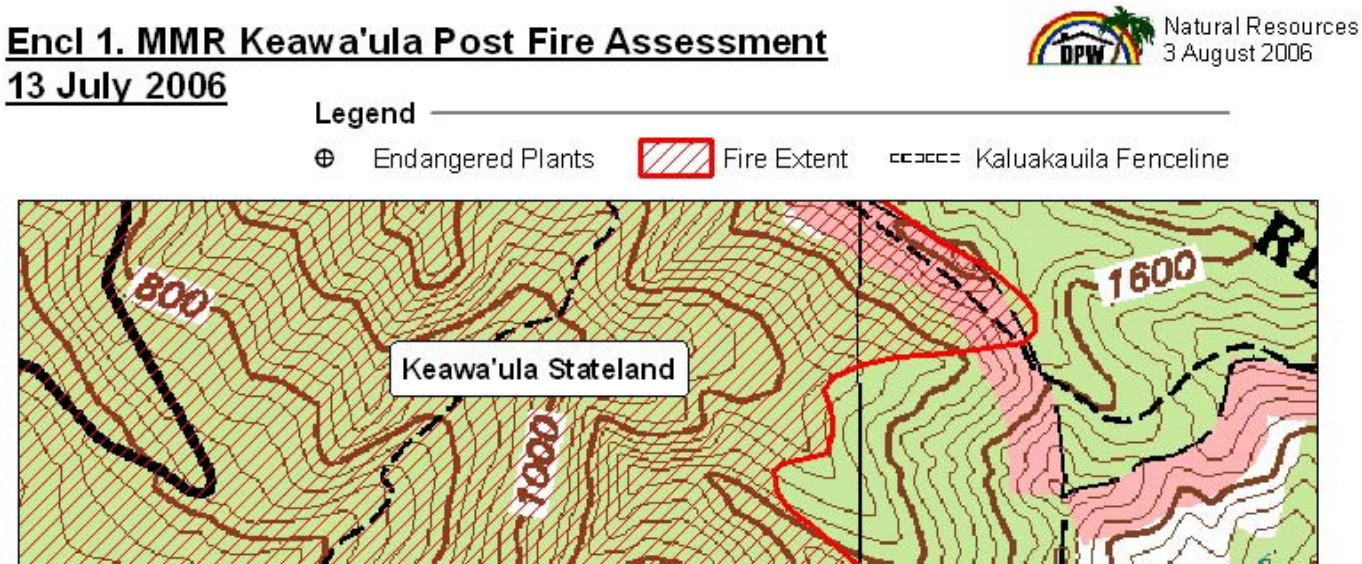




The following is a list of Native and Alien plant species surveyed in the burn area.

Native Plant Species	**Alien Plant Species**
Diospyros sandwicensis	*Leucaena leucocephala*
Santalum ellipticum	*Panicum maximum*
Dodonaea viscosa	
Erythrina sandwicensis	
Sida fallax	
Psydrax odoratum	
Myoporum sandwicense	
Sesbania tomentosa	
Chamaesyce celastroides var. *kaenana*	

Take Home Points:



Appendix 1-1: 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

Appendix 1-1: Taxa Abbreviations

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 1-1: 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.

Appendix 1-1: Taxa Abbreviations

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

New Population? Y / N
_____Entered into GIS?

Rare Snail Observation Form

Scientific Name: _____ **Pop Ref Code:** _____ **Date:** _____
Observers: _____ **Start time**:_____ **End Time**:_____
Photo? Y / N **GPS?** Y / N Coordinates: _____ & _____
Cloud Cover: **Rain:** **Wind:** **Elevation**: _____ft/m

Cloud Cover	Rain	Wind
___Sunny	___None	___0-15
___Partly cloudy	___Mist/ occas.	___15-25
___Overcast	___Rain	___25+

Observer Directions / Comments / Next time: (Flagging Scheme=orange/blue, note if different):
_____
_____
_____
_____

Observation Type:
___ Incidental Obs. (snail seen in passing)
___ Host Tree Search (searched known host plants)
___ Sweep: **Area =_____ (**swept all vegetation in area)
___ Genetic Sampling
___ Snail Collection
___ Other _____

Population Structure

Small	Medium	Large

Ach mus: S ≤ 8 mm, M 8-18 mm, L ≥ 18 mm
Koolau *Ach sp.*: S ≤ 7 mm, M 7-15 mm, L ≥15 mm

Host Species	# of host species	# Small Snails	# Med. Snails	# Large Snails	Comments (tag #)

Associated Species (in order of abundance)
Canopy:_____
Subcanopy:_____

New Population? Y / N
_____Entered into GIS?

Habitat Characteristics:

Overstory Closure >2m	Overstory height	Understory Closure <2m	Habitat Continuity	Topography	Moisture Class	Slope (degrees)
Closed75-100%	2-5m	Closed 75-100%	Dense	crest	Dry <25”/yr	flat 0-10°
Intermediate25-75%	5-10m	Intermediate 25-75%		upper slope	Dry-Mesic 25-50”/yr	moderate 10-45°
Open 0-25%	>10m	Open 0-25%		mid slope	Mesic 50-75”/yr	steep 45-70°
			Patchy	lower slope	Wet-Mesic 75-100”/yr	vertical 70-90°
				gulch bottom	Wet >100”/yr	
				plateau-flat		

Substrate:_____ **Aspect**: _____

Threats: Check all that apply

Rat	**Eugros**	**Slug**	**Weed**	**Ungulate (specify)**	**Fire**	**Erosion**	**Twig Borer**	**Human**	**Other(specify)**

Collection Information:

Propagule type:	**# of Propagule:**	**Purpose:**	**Destination:**
___ **Live Snail (size____)**	_____	___**Genetic analysis**	_____
___ **Shell Intact**	_____	___ **Propagation**	
___ **Shell Fragment**	_____	___ **Reference Collection**	
___ **Tissue**	_____	___ **Other**	
___ **Other**	_____		

SKETCH MAP OF SITE (indicate area ground searched):

Oahu Rare Snail Working Group Reintroduction Guidelines

FINAL DRAFT April 2007

These guidelines address issues regarding the reintroduction of rare snails. Reintroduction should be a supplement to habitat management not a substitute. The final goal of a reintroduction being not the success of an individual snail, but the establishment of a viable population where natural reproduction can occur and in which genetic variation is maintained. Any process of rare snail reintroduction should consider the following guidelines. Many steps in these guidelines require coordination with species experts, land managers and snail propagation facilities. Included at the end of these guidelines is a list of resources who may be contacted to consult on reintroductions. These guidelines have been broken into sections guiding actions before, during, and following the actual reintroduction of a snail.

Considerations Prior to a Reintroduction

Prior to the initiation of a snail reintroduction project, there are some issues that should be considered to ensure the health of the species, the individual reintroduced snail, any other snails existing in the reintroduction location, and the surrounding habitat.

1) Purpose: Determining the purpose and anticipated end result of a reintroduction effort is the most essential first step in any rare snail reintroduction project. For example, the purpose of a reintroduction may be to reintroduce surplus snails to relieve over-crowding issues at snail captive propagation facilities. Another goal may be to stabilize a population which has been greatly reduced in number by any number of factors such as stochastic environmental occurrence, predation, or disease (Hadfield, Miller, and Carwile 1993; Coote et al. 2004). Different goals will result in different management strategies, objectives, and expectations. Regardless of the purpose, it should be stated clearly and made clear to all participants and cooperating agencies so that no misunderstandings occur.

2) Reintroduction scenarios: Sites for reintroduction can be placed in at least three categories each having special considerations.

- *Reintroduction of a species within historical range.* This involves the reintroduction of a species back into a site where it had been previously observed but where it is not close enough to any wild sites for there to be genetic communication between the new reintroduction and the existing population.
- *Augmentations of an existing wild population.* This involves introducing snails into existing wild populations. This type of reintroduction must be considered on a case-by-case basis for each species, utilizing all available genetic data. This type of reintroduction must be done with extreme caution and special attention to sanitation so as to not harm the existing population genetically or via the inadvertent introduction of pathogens from the lab. Augmentation may negatively alter the genetic composition of a population if snails from a single parent or snails from lab selected populations are used.

- *Introduction of a species to a site outside the known historical range.* Agencies or individuals considering this type of introduction need also to consider the possible negative effects on the species. Establishment of a healthy viable population may be hindered by loss of genetic variation being at a site away from other populations. Possible hybridization may occur when bringing a species outside its historical range and into the range of another related species. A site outside the known historical range may lack the habitat characteristics necessary for establishing a healthy population. Contrarily a site outside of the known historical range of the species may be the only place safe from the threats that brought the species to the remnant state we find them in today. In some cases, these sites may also offer the best management option for a particular species.
- *Relocation of snails into a predator free site*. Threat control is difficult to conduct across a population with scattered few individuals. A management option for managers is to construct a predator exclosure and relocate snails into this protected site. If using this management option, genetic issues should be considered. The genetic relatedness of relocated individuals should be similar to individuals at destination site.

3) Contacting Federal and State Agencies: The USFWS and the State Department of Land and Natural Resources must be contacted once the purpose of a reintroduction has been determined. Obtaining the required permits should be a consideration in any reintroduction effort. Federal and State permit should be submitted 3-6 months prior to doing a reintroduction. For a list of snail reintroduction contacts see Enclosure 4.

4) Genetic Stock: The agency or individual that is reintroducing snails should coordinate with the agencies or individuals responsible for the collection and propagation of that snail to ensure a healthy and balanced genetic composition. It must be determined if the reintroduction of snails will be augmenting numbers at an existing population or creating a new one. In addition, a population geneticist may be consulted about strategies and alternatives when dealing with especially rare species. For example, if numbers of snails available to begin a new population are limited and stock is available from a number of wild sites, the decision may be made to mix these stocks. Detrimental effects of mixing should be considered closely and may require the use of genetic analyses in making a determination. This is, of course, of special concern when dealing with depleted wild populations with remnant genetic stock. Snails used in reintroductions should be from geographically close sites to the destination site. Genetic investigations may be used to determine Evolutionary Significant Units (ESUs) to identify diversity within a species (Holland and Hadfield 2002) or develop a genetic strategy in establishing new populations. Reintroductions should be conducted using only surplus lab stock. In special cases it may be necessary to move small numbers of remnant snails into a protected area. Back up collections essential to preventing population or species' extinctions should never be used as reintroduction stock. It should be the shared responsibility of all agencies and individuals involved to leave an easy-to-follow paper trail back to the source population (*i.e.*, Rare Snail Monitoring Form (RSMF) (Enclosure 1), captive propagation inventory records). Snails that have been in the lab for multiple

generations may be adapted for different conditions than the reintroduction site and may have high attrition rates when reintroduced. Care should be taken not to mix gene pools that may be distinct and have local or microhabitat adaptations. A site with mixed stock should not be close to a population in which the goal is to preserve representatives of geographically isolated subsets.

5) Mapping: Prior to the reintroduction of a species, the area should be precisely mapped. Maps should include the historical and present range of the species, locations of known populations and proposed reintroduction sites. A GIS database should be used to establish a permanent record of snail reintroduction efforts. A copy of this data should be deposited at the U.H. Tree Snail Laboratory. Copies of reintroduction data should be provided to the U.S. Fish and Wildlife Service and the State of Hawaii, Division of Forestry and Wildlife if a project involves endangered snails.

6) Site Selection: Once the historical range of the species is known and a management strategy is established, a suitable site must be selected. A site should be chosen according to the biotic and abiotic elements that comprise appropriate habitat. A careful review of the RSMFs may provide a great deal of information on habitat of the source population but experts should also be consulted. Important characteristics to consider include potential host tree species, substrate type, elevation, aspect, slope, humidity, rainfall, canopy, and understory species cover. It may also be important to note the presence or absence of other native snail species (i.e. *Auriculella*, *Philonesia*, *Amastra*, *Succinea*) that can be used as indicators of a habitat able to support other snail species. The size of the reintroduction site must be considered. Specifically, adequate number of host trees must be present to support the proposed population number. In this, consideration should be given to the natural density of snails in particular habitats. For example, the population at the Pahole site which was dominated by *Pisonia sandwichensis* was approximately 300 total snails in a 5x5 meter area (Hadfield et al., 1993). Prior to reintroduction, weather monitoring stations may be utilized to confirm the suitability of selected sites.

7) Site Preparation: Once a proper site has been selected there are steps that should be taken to prepare it for reintroduction. This preparation includes essential actions such as removal of rats and *Euglandina rosea*. Ideal threat abatement would also include control of feral ungulates, and weeds. Common native plantings may be conducted in combination with weed control as needed. Diphacinone rat bait deployment in tamper proof bait stations can effect good rat control. Rat control should be underway at the site for at least three months prior to release of snails. A complementary method for controlling rats and *Euglandina* is to construct a predator exclosure. Two such exclosures currently exist on Oahu. The design for such exclosures can vary and is still somewhat experimental. In general, terrain at a field site must be relatively flat to construct such an exclosure. The feasibility of constructing a predator exclosure at a proposed reintroduction site should be assessed in early planning stages as these exclosures are both time-consuming and costly to design and construct. If it is not feasible to construct a predator exclosure, the reintroduction site should be exhaustively searched under favorable weather conditions.

8) Lab Preparation: The propagation lab should know well in advance prior to reintroduction, snails should be maintained on leaves from plants at the proposed reintroduction site so they can adjust to the new food supply for at least a month. Fungus plates provided normally in the lab will be removed during this same period. To ensure adequate food supply, snails will be kept at lower densities in terraria. Environmental conditions in the chamber should be set to mimic destination field site conditions as determined by on site weather data collection. All snails destined for reintroduction should be marked with unique alpha-numeric codes in order to track the survivorship of individual snails. Only snails larger than 10 mm can be marked using the hole-punch and superglue tagging technique. The lab should know well in advance of a planned reintroduction. Additionally, to increase lab populations, wild snails can be brought into the lab for short periods of time to promote births (Hadfield pers comm. 2007) and then returned to the wild.

When selecting the snails to be used in reintroduction, one must consider the age of the individual snails and year lab population was collected. The age class of snails proposed for reintroduction should be carefully considered. Considerations should include the survivorship of different age classes in prior reintroduction efforts and lab survivorship trends. In the lab, the sub-adult age class is the most robust (Hadfield pers comm. 2007). It is recommended that no fewer than ten snails be used to start a new population. The number of snails to reintroduce should be based on the total snails available of appropriate stock and the available habitat in the reintroduction. Reintroductions should be conducted conservatively at first until methods are refined.

Considerations During a Reintroduction

The successful reintroduction of snails from the lab to the wild or translocation of wild snails requires several issues to be taken into account.

1) Sanitation: Coordination with the propagator is necessary to ensure that all aspects of rare snail handling are done with attention to sanitation to prevent the inadvertent transfer of pathogens. The attached Best Management Practices (BMPs) (Enclosure 2) should be followed at rare snail propagation facilities. BMPs should be revised based on any new research/information. Agencies and individuals involved with reintroduction need to coordinate with the lab staff before the reintroduction date. A quarantine chamber will be used to isolate snails slated for reintroduction from others in the lab. Snails will be isolated in this chamber for at least three to four months prior to release.

2) Transport: Use caution when transporting snails to field sites. Snails should be transported in terrarium/Tupperware that is kept in a small hard-walled cooler to maintain stable environmental conditions (temperature not to exceed 80°F), see photo below of possible transport set up. Containers will be adequately ventilated during transport. No more than ten snails should be kept in a container the size of the one in the photo below (approximately 4”x 6”x 3”). Stabilize the terrarium in the cooler to avoid shifting.

Snails can be kept overnight at a staging site as stable temperatures are maintained. Snails may be flown in the passenger compartment of a helicopter and secured.


Snail transport container

3) Release: Reintroductions should be conducted during periods of ample rainfall to minimize the chance of snail desiccation from extended dry periods. For example, in the Waianae Mountains, releases may be conducted during high rainfall months between December and March, but for the Koolau Mountains may be more flexible. If crawling, snails will be placed directly on the leaves of an appropriate host tree. Otherwise, snails will be placed in small screened baskets (see photo below) hung in host trees and containing leaves. In order to encourage the movement of snails from these containers into host trees, squirt bottles will be used to wet the container and vegetation. Snails will be released in close proximity to one another.


Screened snail release basket

When planning a reintroduction that will exceed 25 snails then you should begin the reintroduction effort with a test release of 25 snails to ensure site suitability. See monitoring section below to determine when to supplement these numbers.

Considerations after a Reintroduction

Following a reintroduction, monitoring is essential to maintain the health of the snails and the surrounding habitat, and to determine the level of success. A yearly evaluation of reintroduction activities will be included in year end reports and submitted to permitting agencies.

1) Monitoring: Following a reintroduction, the snails must monitored with mark and recapture methods monthly for the first six months. Data on the size length of shell and lipped condition of each snail will be recorded. Attached at Enclosure 3 is a Rare Snail Reintroduction Form. In addition, ground shell plots will be established within the reintroduction site to track mortality of snails. If survivorship declines more than 50% during this six month period if observed survivorship is <50% the release site will be reevaluated. Supplemental reintroduction will be postponed until further investigations are conducted. If survivorship is more than 50% then supplemental reintroductions may proceed. After the initial six month period, monitoring will continue on a quarterly basis.

2) Maintenance: Ground shell plot data will be used to guide threat control. Threat abatement efforts must continue following reintroduction and should be adapted based on monitoring data and site observations. Threat abatement will include predator exclosure maintenance at least quarterly if applicable.

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Rare Snail Observation Form **Enclosure 1**

Scientific Name: _____ Date: _____
Pop Ref Code: _____ Range: _____
Elevation: _____ft/m Observers: _____ Aspect: _____

Location/Flagging Scheme (orange/blue):
_____
_____
_____
_____
_____
_____

Weather: _____ Effort (people hours):
_____
GPS? Y / N Coordinates: _____ Photo Y / N?

Predation: Ground search conducted for fresh shells? Y / N Area searched: _____m^2
People Hours: _____ # intact_____ #rat damaged_____
Empty shells collected for reference? Y / N

Population Structure:

Small	Medium	Large

Achatinella mustelina: small $\leq$ 8 mm, medium 8-18 mm, large $\geq$ 18 mm
Koolau *Achatinella*: small $\leq$ 7 mm, medium 7-15 mm large $\geq$15 mm

Threats/Management Recommendations/Actions Taken/Notes:
_____
_____
__
_____
_
_____
_____
__

C**ount/Density**: _____SNAILS _____SNAILS/HOUR

SKETCH MAP OF SITE (indicate area ground searched):

Enclosure 2

Best Management Practices for Achatinelline Tree Snail Captive Propagation Protocols

Created: 2000 / K. Olival, R. Rundell
Last Updated: 4/2007 / J. Saufler

Incubators

Models- We currently have five environmental chambers in our captive propagation facility at the University of Hawaii, Manoa. The model names and numbers are as follows:
1 Revco Scientific (gray two-door) (Model # RI-50-555A),
4 Precision/ Thermo (low temperature, illuminated) (Model # 818).
All of the environmental chambers run on 120 volts. They are all capable of programmable day/night temperatures, programmable photoperiods, and are equipped with alarm set points in the event that the temperature within the incubator becomes too hot or cold.

Temperature- Five of our current chambers are set up to simulate upper-elevation temperatures, the oldest white chamber is set up with a warmer temperature regime for lower-elevation snails (some *A. mustelina*). For upper-elevation snails (2500+ ft.), temperature should be maintained at 20C during the day (light) cycle (12 hrs.) and 16C during the night (dark) cycle (12 hrs.). For lower-elevation snails (~2000 ft.), temperature should be set at 23C during the day and 18C at night. Ambient room temperature should be approximately 25C.

Water Spray- Plumbing within incubators is designed to provide simulated rainfall (one minute duration) three times per day, except for one day per week (simulating dry periods). The spraying times are currently set at 12:00am, 8:00am, and 4:00pm, with no watering scheduled on Sunday. Monitor rainfall frequently to catch any leaks or other problems. Terraria will dry out quickly if they don't receive water each day. Drier terraria should be identified and hand-sprayed until better rainfall can be provided to them.

Plumbing system- The plumbing system has been custom installed in each of our environmental chambers. Incubators have been modified to have two small holes; one at the top, one near the bottom. The top hole provides entry for incoming water; the lower hole provides for drainage. Hoses are connected to a water source and an electric watering timer is hooked up to these hoses. It is on this timer that the programming is done (i.e. one minute duration, three times a day). From the timer, the water-supply hose goes up to a manifold (near the top of the incubator). This manifold splits the water from one hose to several smaller latex tubes. Black latex tubing (1/8 inch internal diameter X 1/16 inch wall size) is used. It is important that the latex tubing is black, as this occludes light and prevents algae from growing within the tube and clogging it. In the ends of the tubes are spray/mist nozzles. These are mounted to a frame above the terraria.

Drainage- This is accomplished with water collection pans and drainage tubes. Terraria sit above these pans on a grate to prevent flooding (and drowning) of the snails. Connected to each collection pan is a hose that drains the water from it to a PVC pipe which leads to the floor drain.

Regular maintenance- Incubators should be checked daily for normal functioning. Temperature should be checked to assure that it is being properly maintained, and clocks should be checked to make sure they have not been reset. In the older incubators the clocks stop and do not restart after a power outage. These need to be re-set manually. The newer Precision models maintain their settings in the event of a power outage but must be double-checked. As mentioned above, the plumbing system should also be regularly checked for leaks, overflows, or clogged nozzles or drains.

Troubleshooting- Power outages are probably the most important problem to address here. A back-up power supply (generator) is the preferable means of avoiding this problem. Since no back-up power currently exists, one must always be wary of power outages. These outages are generally announced via e-mail for specific locations on campus at specific times. It is preferable that these outages be no more than 3 hours in duration. If the doors to the incubators remain closed during the outages, then they should be able to maintain a reasonable temperature for this length of time.
For longer power outages it is acceptable to place frozen "blue ice" blocks in the drainage trays of the incubators to try keeping the ambient temperatures low. These will need to be cycled regularly. Additionally since the drains will still function it is acceptable to place ice in the trays. Remember: If there is no power, there is also no air conditioning.
For long term or unexpected outages, a generator capable of running the incubators should be rented and utilized until city power is returned.
When power returns, the incubators need to be checked to insure that the proper settings (temperature and photoperiod) have come back. Clocks should be reset. The watering timer (hooked up to the solenoid valve) needs to be checked to ensure that the program settings have not been lost (there is a backup battery that will save the program settings for 24 hours). If needed, reset the watering timer and replace backup battery.

Snail terraria

Snail terraria can be made from clear plastic aquaria ("Critter Cages")or tupperware containers. The lids of Critter Cages are fitted with fiberglass (not aluminum) window screen, glued in place with a hot glue gun. Drainage holes are cut in the bottom of the cage and fitted with more screen (glued in place). Tupperware containers can also be modified similarly, making sure there are plenty of mesh-covered openings for water to come through at the top, and drain out through the bottom, however, the very clear Critter Cages are preferable. It is essential that terraria are designed so that there is complete drainage, with no pooling of water. A small pool of standing water will drown snails. To give an idea of size requirements: we currently house about 15 adult snails in a terrarium of the following dimensions: l=9, w=6, d=7.
Terraria should be regularly checked for leaks, holes and cracks, which generally can be repaired with a glue gun. Keiki snails can escape through the tiniest holes, so watch out!

(Later we will cover details on cleaning of the snail terraria.)

Food

Leaf Collection- Achatinelline tree snails do best when maintained on glabrous (shiny, round leaves) Ohia lehua (*Metrosideros polymorpha*) leaves. Branches can be searched out and cut using a tree trimmer. Hand clippers may also be useful. It is best to keep the branches as whole as possible, so that they will stay fresh. Freycinetia arborea (i`e i`e) is another snail favorite. Fronds can easily be acquired in the field. Pull them off the plant at the bases, instead of clipping them. They will stay fresher longer this way. Back in the lab, spray them down with water and refrigerate in a closed plastic trash bag. Leaf collection is done biweekly no more than a couple of days before cleaning and changing leaves in the terraria.

Fungus culture- Cultured fungus is an essential supplement to the snail diet. After snails acclimate to eating the fungus (usually 4-6 weeks), they will generally thrive on it. Currently we are maintaining a single line of *Cladosporium cladosporioides* that we feed to all of our snails. The Potato Dextrose Agar (Difco) medium on which the fungus grows is supplemented with calcium carbonate to help with shell maintenance and growth. See fungus culture protocol below.

Fungus protocol-

1. Use sterile, disposable petri dishes (available from VWR or Fisher Scientific). Glass petri plates can also be used, but in general are more likely to become contaminated.

2. Mix agar
The ratio is:
3.9g Difco Potato Dextrose agar,
0.08 g calcium carbonate per
100ml water.

We currently make 3500-4000 ml for 120-140 plates.(Two 2L flasks and three or four 1L flasks holding 1L and 500ml agar mixture, respectively). Use a graduated cylinder to measure water. Add about half of the water to flask initially, using a large funnel add agar, swirl (for ~30 sec), weigh and mix in calcium carbonate, add rest of water to wash down calcium from funnel, swirl again. Mix agar in by swirling (vortexing) by hand. Cover Erlenmeyer flask with foil.

3. Autoclave agar: 25 minutes, liquid cycle. Always use metal or Nalgene tray to catch overflow.

4. Swirl agar until cooled: After medium is removed from autoclave, vortex gently by swirling flask. Do this a couple of times until the media is cool enough to pour. This should keep the medium homogenous and allow it to cool evenly. Rule of thumb: pour when the medium still feels hot, but you can hold the flask without insulated gloves. Note: Calcium Carbonate will NOT completely dissolve in solution a white precipitate will remain and should be mixed thoroughly when pouring.

5. Lift cover, pour agar in dish to about halfway or less, replace cover, and stack plates. Re-sleeve the stacked plates and allow agar to harden. If not inoculating with fungus on the same

day, place the sealed sleeves in the refrigerator for storage. Agar-filled petri dishes can be stored in the refrigerator for a couple of weeks like this.

6. Inoculate plates using a contamination-free source plate. Work in the hood, sterilize wire between every plate, and minimize exposure to air. Fungus cultures take approximately a week (or less) to mature in the fungus incubator (24C). Inoculate stock plates separately and label.

Petri Dishes-Glass petri dishes are used as holding containers for snails while their terraria are being cleaned. They should be deep enough to allow the largest snails adequate crawling room (those shells can be tall). Large-diameter petri dishes (150 X 25mm size) are handy for holding 10 or more snails at a time.

Cleaning- All glass petri dishes should be regularly cleaned using a scrub pad and water; spray them with the 80% diluted alcohol solution and rinse or allow to air dry. Do not reuse a petri dish for more than one population of snails: wash, spray, and rinse before reusing. In order to maintain sterility and prevent the possible transmission of pathogens, ALL dishes should also be autoclaved once every month. Note that for fungus culture (above), petri dishes are always autoclaved.

Population monitoring

Snail populations are monitored for growth and decline. All births and deaths are recorded, and measurements taken of these individuals. Also, in some populations, individual snails are marked and are measured monthly to monitor growth rates. This enables us to produce summary statistics of population growth rates or declines, so that we can monitor the captive propagation program accordingly. It will also help contribute to our knowledge of the life-histories of these rare snails. Without these data we would have no scientific foundation on which to build a strong captive rearing program. Data are recorded separately for each population. All snails should be accounted for each time the snails are transferred to clear terraria with fresh leaves. On a regualr basis divide the snails into size classes (juvenile, sub-adult, adult) and update data sheets as necessary.

Terraria cleaning procedure

The following is the stepwise procedure for cleaning an individual snail terrarium.

Strict adherence to these steps is essential to the maintenance of healthy, growing populations of achatinelline tree snails.

The goal here is to minimize handling, thereby minimizing snail stress. Constantly stressed snail populations will not maintain population growth over the long-term.

Wipe working table clean using 80% EtOH (ethyl alcohol) and paper towels.
Make sure area is dry.
Supplies: clean petri dishes, fungus, fungus cutter, leaves, pruning shears, water spray bottle.

Open population logbook to the appropriate page.
Wash hands with Bacdown anti-microbial soap.
Remove a terrarium from an incubator and set terrarium on table.

Carefully remove terrarium cover (some snails tend to stick in the corners between the cover and the terrarium and could dislodge and fall or get crushed accidentally).

Carefully remove some of the vegetation and start removing snails.

Place snails in petri dish (use glass dish for larger snails). If snails are stuck to the sides of the terrarium, carefully dislodge them by gently scooping them with an Ohia leaf. **If snails are already stuck to leaves, it is best to carefully remove the leaf with the snail on it, rather than disturbing the snail.**

Do not overload the petri dish with snails. No more than 10-15 medium snails should occupy a single petri dish.

Continue process of searching every branch and **every single leaf** (front and back). Those keiki (and even the adults) can really hide. It is best to not unload all the vegetation from the terrarium at once, since snails may crawl away while you are searching.

Place the cover on the petri dish when your dish is full or you have collected all or most of the snails.

Count them carefully. Be certain not to crush any snails on the edges or trap larger snails under the lid. Snails can be gently prodded or moved using an Ohia leaf. Do not pull on the snails with your fingers.

Check how much fungus was eaten and record percentage. Check fungus for snails (sometimes they hide there). Remove fungus from side of terrarium and discard.

Check the terrarium and cover for snails once more.

If you find any deaths it is important that you wash your hands before resuming contact with live snails.
Dead snails should be placed temporarily into a plastic Petri dish, labeled with marker and set aside until the end of your shift. DEATHS ARE PROCESSED LAST, IN A SEPARATE AREA.

Take the terrarium and cover to the sink and wash in cold water with sponge/green scrubber. Make sure there are no traces of slime or snail feces left. Spray with 80% EtOH and rinse thoroughly with water. Rinse, rinse, rinse. Make sure there are no traces of alcohol left on the terrarium. Alcohol is very poisonous to snails. Let drain upside down for a minute or two.

Search leaves again. Look over branches again. If you are working with a partner, switch branches with her/him and check for snails again. Yes, this job takes patience! When you are confident that all snails have been found and that there are no newborns, discard old leaves in trash.

Wipe down table with 80% EtOH.
Wash hands with Bacdown.

Bring terrarium back to working counter and begin clipping fresh branches for the clean snail home. Try to keep branches as whole as will fit in the terrarium; they will last longer. Give the snails ample amounts of leafy branches, but don't pack the terrarium too full. Try to arrange the branches upright and as naturally as possible. Trim young shoots from the tips of the Ohia. These leaves generally do not last 2 weeks and can collect on the bottom of the terraria. These leaves can collect water and aid in snail drownings.

Cut the appropriate amount of fungus and stick it to the side of the terrarium in quarters or halves. Make sure the fungus sticks and that there are no air pockets.

Once everything is assembled, spray the whole terrarium lightly with water.
Place the snails back in their home by gently scooping them with Ohia leaves. It's a good idea to count them again as they go back in, as one last double-check. Make sure all snails are in the terrarium, and none have escaped from the petri dish or started to crawl down the sides of the terrarium.

Carefully place the cover back on the terrarium, taking care not to crush any snails. Make sure the cover fits snugly and there are no openings for escapes.

Place the terrarium back in the incubator, making sure plumbing is properly aligned to assure good rain exposure.

Fill in data sheet (Date, % fungus eaten, amount fungus fed, Births, Deaths, # snails, size class breakdown, Notes)

Wipe down table with 80% EtOH.

Wash hands with Bacdown.
Get the next terraria on your list.

Record births- Births are assumed to be the smallest snails in the dish. Measure these as accurately as possible using calipers. It is important not to squeeze or damage the young snails, so *you may need to just place the calipers next to the snail and estimate the length*. Length equals the furthest distance from the apex to the aperture. We generally don't measure the width of the newborns.

Record deaths- Dead snails are also measured (length x width; width equals the widest distance across the shell, measured with the aperture towards you, and the apex pointing up directly in the middle of the two sides of the caliper). Be sure that the snail is dead; this is sometimes obvious, since the body may have already liquefied and oozed out of the shell. However it may not be so obvious, and some live snails may be retracted and appear to be dead. A dissection scope can sometimes assist in determining whether or not snails are alive (smelling the snail may also help. Dead snails typically do not smell very good). Also, spraying water on a live snail can sometimes make them come out of their shell. If you are still uncertain, make a note and put the snail back in the terrarium until next time. If a snail is dead, inspect it under the dissection microscope (50X) to look for the presence of nematodes or any other organisms. Place dead snails in 90% EtOH in a glass vial. Label vial with species i.d., population, date the death was discovered, shell measurements, and any other special notes. Write on tape on outside of vial using permanent ink and/or include a label inside vial. Do not simply write on the glass or plastic, since this easily wipes off (even with permanent inks). Thoroughly clean caliper edges with ethanol to prevent potential transmission of bacteria/disease from dead snail to future measured snails.

When all of the terraria have been cleaned, go through each data sheet in the log book and double check that nothing was missed. Record all data on the incubator data sheets, in the computer and in the species log book.

Nick Reppun
Oahu Army Natural Resource Program
Euglandina Exclosure Project

Introduction:
The work conducted by the Oahu Army Natural Resource Program is essentially ecosystem management for the land owned and used by the US Army Garrison of Hawaii. This includes the maintenance of existing native populations of plants, animals and invertebrates, as well as the reintroduction of these into the field. The OANRP is a very important organization because they are responsible for the preservation of the large quantities of land owned and/or leased by the Army. Management activities specifically include: feral ungulate management, weed management, rare plant stabilization, *Achatinella mustelina* management, ‘elepaio management, and other research activities. Ungulate control involves fencing in areas of particular concern and then eradicating the animals by trapping and hunting. Weed management requires the constant field work of killing invasive species (often using specialized herbicides). Rare plant work requires native population protection from rats, as well as cultivation in the greenhouse and subsequent out planting, propagule collection, propagation, and seed storage. The ‘elepaio management consists of working to reduce rat populations during the breeding season to minimize predation on chicks and eggs. *A. mustelina* management at present consists of monitoring populations and minimizing rat populations in high population areas, also funding genetic studies to determine most effective means of managing this species, ie, which populations represent best the diversity of this species

My project is essentially to design a type of barrier that will prevent the *E. rosea* from getting to and eating the native *A. mustelina*. The native tree snail populations in Hawaii decreased dramatically with the popularization of shell collecting by early naturalists and hobbyists. This decline was furthered by the presence of and predation by rats and the *Euglandina rosea* (a carnivorous snail introduced as a biological control for the giant African snail). These two current predators are responsible for the continued decimation of *A. mustelina*. *A. mustelina* is considered important because it is an endangered species. The entire *Achatinella* genus was placed on the endangered species list, an uncommon occurence, and it is believed that 32 of the 41 species have become extinct. Within the species *A. mustelina*, there are several genetically distinct groups called evolutionary significant units, preserving these help to stabilize the taxon. The University of Hawaii has a lab where snails are reared in captive. The hope is that these snails can be reintroduced to augment the wild populations. But, population augmentations are impractical without a safe place to reintroduce the snails. It is within this context of trying to preserve this species that this project takes place.

The OANRP has established the locations of larger populations of *A. mustelina* and attempts have been made to create fences that keep the *E. rosea* away from these concentrated populations, but there have been problems with these existing exclosures, one exclosure done by the state, one by the army. The current method uses electric wire in combination with a salt tray to deter the snails. Problems have arisen with maintenance. Electrical equipment is difficult to keep working when left in the field. Also OANRP workers have reported finding a tree snail in the salt dish. Maintaining

both the electric equipment and salt trays requires regular visits to the sites to make sure there are no gaps where *E. rosea* could enter, and to ensure that both are working properly.

This project entails further developing and testing exclosure designs for *E. rosea*. This involves working with OANRP's fencing expert who helped developed the existing exclosure designs. The desired design will require less maintenance, relying on the physical properties of a barrier, rather than a chemical barrier. There is ongoing research being conducted (by UH grad students) to determine patterns of dispersal for *A. mustelina* (helpful for analyzing habitat fragmentation), as well as movement patterns for *E. rosea* that will be helpful for establishing how effective exclosures will be. If I am successful in creating an effective exclosure design, it will be a big step forward to protecting the tree snails. By simply conducting this project, I am helping OANRP to move forward on this area of research.

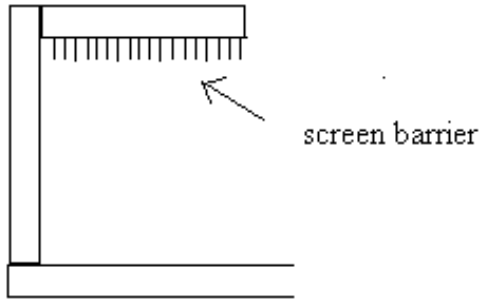
Methods:

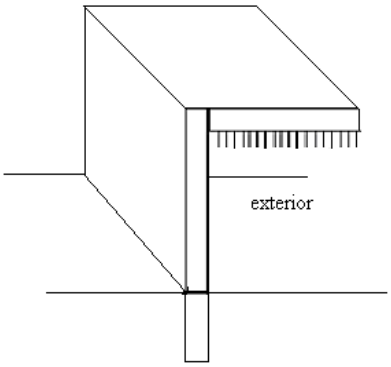
Because of the nature of this project, there were no specific methodologies that were followed. In lieu of a methods section I will give an overview of the process. For a more detailed account/journal, see section called Project Notes.

This project was put together to test a design for snail exclosures. The concept behind the design was to create a barrier that consisted of a series of miniature screen fences, grouped so that a snail would not be able to cross them. This series of screens, placed upside down would create essentially, an area of low surface area that snails will not be able to hold onto, and thus unable to cross. (see figure 1) Testing for this was done by putting the *Euglandina* in a box fitted with the barrier. The test was to see if the snails could escape from the box. A variety of sizes and materials (of the barrier) were tested. Tests involved observing the snails as they interacted with the barrier, monitoring snails over the days they were in the boxes, taking note of any discernable movement patterns. During this project, three versions of this design were tested: one narrow one, one wide, and one wide with copper screen. All were made with plywood; the first two used regular screen, and the third used copper screen. All the tests took place on a table on my porch. Dirt was placed in the bottom of the box to serve two purposes: simulate real habitat, and to retain moisture for the snails. The entire box was misted twice a day to give the snails moisture. All observations were made using automotive mirrors so as to not disturb the snails. The materials used in the models were plywood, but were it to be put into the field vinyl lumber should be used to make it more durable.

These are the final design dimensions:
box floor: 18 x 16 inches
walls: 6 inches
barrier width: 6 inches
screen spacing: ¼ inch
screen materials used: copper, aluminum

Figure 1 (left: box design) (right: field design)





Results:

Box Number One: (barrier width: ~2 ½ inches, aluminum screen)
Initially, 4 *Euglandina* were put in this box. They were put in at 8 am on July 13. By that evening 3 of the 4 snails were in the upper corners of the box next to the barrier. Two days later an African snail was put in the box as well, this was done at night. By the next morning, all of the snails had left the box. One *Euglandina* was found on the underside of the table, the other three vanished. The African snail was found on the ground. Only one large slime trail was found leading out of the box.

3 more *Euglandina* were found and placed with the remaining two, back in the box. One *E. rosea* became immediately active. I then observed this snail as it approached the barrier. Once up the wall and at the barrier, the snail slowly proceeded to probe/feel the screens. It kept slowly feeling its way along the wall/barrier as if looking for a gap in the screen. After a few minutes, it began feeling across the width of the barrier, all the while not actually grabbing onto the screens (it only held onto the wall). Once the snail located the far side of the barrier it grabbed hold and pulled itself off the wall and over the barrier. The snail was put back in the box, and it escaped two more times in the same manner. The snails shell was about 1 ¾ in. with a foot measuring at about 3 ½ inches. (see figures 2,3,4 to see snail crossing barrier)

Box Number Two: (barrier width: ~ 6 inches, aluminum screen)
7 *Euglandina* and 2 African snails were placed in the box on July 30. Snails were observed investigating the screen barrier (the same way the previous snail was observed), but none attempted to cross it. Snails were frequently observed (dormant) up against the barrier. After 7 days, one snail was missing. After a careful investigation of the box, a single slime trail was found, going over the screens and out of the box. The snail that was missing was of smaller size, shell length was approximately 1 ¼ inches.

Box Number 3: (barrier width: ~6 inches, copper screen)
The remaining snails were transferred to this box on August 7: two of the smaller snails possibly dead or cannibalized, 4 live *Euglandina*, and 2 live African snails. After two

days in box, the two snails were confirmed dead. The remaining snails did not escape from the box until the project end on 8/14.

Discussion:

I have come to the conclusion that the final design can be called a success. Based on my observations of the *E. rosea* that I was fortunate enough to watch escape, I can conclude that while the design is not snail proof, it will function as a strong enough deterrent to be effective. In my observations, it seemed that the snails did not like to touch the screens edges. I repeatedly observed snails approach it, feel it out, and turn away. This gave me the indication that the screen is a deterrent. The goal of this project was to find a design that is effective and requires little to no maintenance. This design definitely is low maintenance, and I feel confident in its effectiveness. While there was one snail that escaped the larger barrier w/ stainless screen, that was only after a long period of captivity and without food (possibly a cause for the snail try harder to escape). From my observations of the snails interacting with the barrier it seems that they did not like touching the screen edge. But, if driven by hunger, they can cross. Using copper wire should only improve the effectiveness of the barrier. In the field, when a snail encounters the barrier, it will present an obstacle not worth overcoming unless the snail is unable to locate any prey outside of the enclosure, which seems unlikely. This design would be labor intensive to implement, but, the only maintenance would be ensuring that there are no 'bridges' over the fence (ie. branches).

Although this design may be able to serve it purpose, it does require more testing. Ideally I would have been able to create a test environment that was more realistic, enabling me to gain a better understanding of the interaction between the snails and the barrier. For OANRP, I can recommend that they continue testing this design. Possibilities include using the copper screen in conjunction with zinc. This may be done by placing a band of zinc on the wall just below the screens, or by using zinc screen and alternating that with the copper screen. In my opinion, the existing design (the salt tray) has the potential to be the most secure barrier, the trade off is that it requires the most maintenance, and it can result in the death of endangered snails as well. In a practical sense, the barrier that was tested in this project has the potential to become the most efficient. Efficiency and effectiveness go hand in hand, so is the maintenance for the screen is less than the salt tray, the screen will be in the long run most effective. Regardless of barrier design, the real issue behind protecting *A. mustelina* is effort. Any type of barrier will require regular work to ensure that it is functioning properly and that there are no gaps or bridges. For an environmental agency to think that they can put in a barrier and walk away from it is misguided. The effort and continued support must be there in order for any type of barrier to be successful.

A note about the data/experiment:
The tests were conducted one after another, using some of the same snails. Also, there were no replicates done. African snails were used because of their size, to see if they were able to escape while the *E. rosea* could not. The snails were unfed, which may have made them more desperate to escape than they normally would be in the wild.

Resources:

Asquinth, Adam. "Alien Species and the Extinction Crisis of Hawaii's Invertebrates." Endangered Speceis UPDATE vol. 12 no. 6 (1995)

THE CONSERVATION AND MANAGEMENT OF ENDANGERED O`AHU TREE SNAILS (GENUS: ACHATINELLA. Department of Ecology, Evolution, and Environmental Biology, Columbia University: New York, 2004

United States. US Army Garrison, Directorate of Public Works, Environmental Division. Status Reports for the Mākua Implementation Plan and the Draft O'ahu Implementation Plan. Hawaii: Schofield Barracks, 2006

Figure 2

Figure 3

Figure 4

Project Notes:
7/2
info and advice from marty
-E. rosea have little linear movement, most of movement is back and forth between microhabitats
-prefer leaf litter as microhabitiat
-shell up to 5 cm long
-video interaction (snails tend to move at night, video so can actually see what they do when they encounter the barrier
-keep boxes small to maximize possibility of interaction w/ barrier
-bigger snails may need bigger (wider) barrier

7/9
-worked on jail w/ Dan Tanji, made a jail
-6 screens each separated by ¼ inch
-screen width ~ 1/2 inch
-walls 4 inches high
-floor 14 in x 12 in

7/12
-Marty looked at the jail
-recommended I make the walls higher so the snails can't reach it from the floor
-that way it forces them to go up the wall and meet the barrier
-raised the walls to 6 inches high

7/13
-put 4 E. rosea into jail @ 8 AM for 1st trial
-set up on a table on my porch
-3 of the 4 snails are up in the corners of the box by evening (up against the screen)

7/14
-snails still in jail
-low activity/movement
-PM put african snail in w/ the E. rosea

7/15
-AM all snails are gone from jail
-african snail found on floor below the table
-1 E. rosea found on underside of table
-3 other E. rosea gone (off table and off my porch)
-large slime trail out of box
-found 3 more E. rosea
-4 E. rosea and 1 african snail put back in jail
-1 euglandina very active: shell 1 ¾ in, foot ~3 ½ in

-snail immediately went to the wall
-observed snail approach barrier
-slowly proceeded to probe/feel the screens on the barrier
-slowly kept feeling until it found the wood at the edge
-grabbed onto edge and pulled itself over the screens and out
-put the snail back in jail and watched it repeat this process 2 more times, each time it seemed easier for the snail, it took less time investigating barrier
-appears that snail did not like touching screens edge

7/22
-rebuilt jail, wider barrier
-barrier 6 in wide
-screen spacing the same
-floor 18 x 16 in

7/30
-put snails in bigger jail
-7 E. rosea and 2 african snails
-also collected sand and set up sand barrier around the box (someone told me snails don't like sand
-sand barrier ~5 in wide strip of sand

8/3
-Dan Tanji built new jail using copper screen
-same dimensions as the previous one
-some snails may be dead

8/6
-1 snail escaped, shell ~1 ¼ in
-visible slime trail over the screens
-apparently they can climb over the screens in they need to

8/7
-transfered snails to jail w/ copper screen
-2 of the smaller euglandina dead (cannibalized?)
-6 snails alive, 4 euglandina, 2 african snails

8/14
-no snail escaped to date

Report to the U.S. Army Garrison Hawaii

Attn: Kapua Kawelo

Feeding ecology, microhabitat utilization, population size estimates, and possible control of the introduced predatory snail *Euglandina rosea* on Oahu, Hawaii

Year 2: Micro-habitat utilization and population structure of the introduced predatory snail *Euglandina rosea* in the Waianae Mountains, Oahu: Implications for Management

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Project period (Year 2): 08/01/06 – 07/31/07

Table of Contents

Introduction to Research (Year 2)

Introduced predators are considered to be one of the most important causes of decline and extinction of native species (Vitousek et al. 1997). They have been shown to have deleterious effects on not only prey populations but the entire community composition through interactions at multiple trophic levels (Schoener & Spiller 1996, 1999, Schoener et al. 2001). Unfortunately, islands are particularly vulnerable to introduced predators (Simberloff 1995, Schoener et al. 2001, Blackburn et al. 2004). The Hawaiian Islands have arguably suffered the most severe impacts and much of what remains of their unique flora and fauna are threatened (Solem 1990, Burney et al. 2001).

The situation is especially bad for the Hawaiian land snails. The native Hawaiian land snail fauna used to be extremely diverse (over 750 species) and exhibited extremely high endemism (over 99 %) (Cowie et al. 1995), but the majority of these unique species are now extinct (Cowie 1998, 2005), with estimates of extinction ranging from 65-75 % (Solem 1990) to as much as 90 % (Cowie 2002, Lydeard et al. 2004). For example, the Amastridae, an endemic Hawaiian family of more than 300 species (Cowie et al. 1995), may now be reduced to as few as 10 or so species existing in tiny, highly localized, remnant populations. The Endodontidae appear reduced to sparse populations on every island they formerly inhabited (Lydeard et al. 2004), although a population is known on Oahu (Meyer 2006).

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). 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 Hawaiian tree snails in the sub-family Achatinellinae (e.g., USFWS 1981, Hadfield & Mountain 1980, Hadfield et al. 1993, Holland & Hadfield 2002). 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. Although the prognosis is rather gloomy, land snail species still exist, and control of *E. rosea* may be possible with adequate ecological information.

The objective of the work reported here was to understand *E. rosea* dispersal and microhabitat preference by tracking individual *E. rosea*. Both the distance and pattern of dispersal are important since they affect the effective sizes and genetic structure of populations (Tomiyama & Nakane 1993). Understanding how far *E. rosea* moves will help managers determine the scale on which control measures should be implemented, while understanding how *E. rosea* uses

microhabitats within its range will help managers determine which snail species are likely to be the most threatened and where traps or searches that aim to trap/catch *E. rosea* as part of a control effort should be focused.

Tracking techniques have been used on many snail species to investigate various aspects of their ecology. For instance, tracking devises have been used to assess dispersal patterns (Tomiyama & Nakane 1993, Murphy 2002), life-history characteristics such as growth, mortality rates, and clutch sizes (Stringer et al. 2002), as well as various behaviors, e.g., mating and egg laying (Stringer et al. 2003), of a number of land snail species. Making these measurements and/or observations without tracking devises is often impossible for many land snails since many species are patchily distributed and difficult to find, making recapture unlikely (Stringer et al. 2003).

Studies that aim to track land snails have used a variety of tracking techniques. These techniques vary in both cost and quality of data that can be collected. For instance, the spool and line method uses the least complex technology and has many advantages. This method involves attaching a lightweight line to the snail while the other end of the line is wound around a spool that will easily release line as the snail moves (Pearce 1990). This technique is simple, low cost, and provides a rich data set since a detailed record of the movement is left. Murphy (2002) used a type of spool and line method in which, instead of the spool being stationary, the spool was attached to the snail and the line was attached to a stationary object at the initial tracking point (herein termed the 'bobbin' method). Other studies have used more elaborate techniques such as harmonic radar or Radio Frequency Identification (RFID) to relocate individuals using either a diode or a chip that reflects the signal from a receiver (Stringer et al. 2002). These techniques are more expensive and provide no data on how the snail had moved between observation periods. Instead, they just provide data on where the snail was found on each observation occasion (point data). Regardless of the technique deployed, it is imperative that the individual's movement is not interfered with.

This report consists of two sections. The first section is a report from a pilot study done at Lyon Arboretum to assess the effectiveness of three tracking techniques. The second section discuses the progress of the main study, a field tracking study that examines the movement patterns and microhabitat preferences of *E. rosea* in the Waianae Mountains, Oahu. Tracking studies will continue in conjunction with the work proposed for year 3. The pilot study was conducted since harmonic radar might not be appropriate for ground dwelling snails in Hawaii for two reasons: 1) the volcanic substrate, which is high in minerals, reflects the signal making it difficult for the receiver to distinguish the tag, which also deflects the signal from the receiver, from the background scatter, and 2) harmonic radar does not work well in dense vegetation (Kevin Hall personal communication). Radio frequency identification (RFID) was not considered since the technology, contrary to earlier expectations, can currently only receive signals at extremely close ranges (1 to 2 m maximum). The pilot study allowed the most appropriate tracking method to be chosen, which was then implemented in the main study of the microhabitat utilization and movement patterns of *E. rosea* in the Waianae Mountains.

Pilot Study: Utility of Snail Tracking Methods

Methods

Study Site

This pilot study was conducted at garden Q in the Harold Lyon Arboretum. This area was chosen because habitat complexity was high and of a similar level to that in the area planned for the full-scale experiment in the Waianae Mountains. The Lyon Arboretum site is characterized by many small low shrubs and ferns, thick tree litter that consists primarily of small twigs as opposed to leaves, and a dense canopy of palm trees. Larger downed logs and both open soil and rocky areas were also present but these microhabitats were much less common and widespread than the shrubs/ferns and litter microhabitats.

Tracking Techniques

The three tracking methods to be tested, the spool and line, bobbin, and glow in the dark paint methods, are described below. The spool and line and bobbin methods were tested on six *E. rosea*, while the glow in the dark method was tested on ten individuals (for reasons described below) from 5-13 November 2006. Observations were made at dusk for the spool and line and bobbin methods and at night for the glow in the dark method, on Days 1, 2, 3, 5, and 7.

Spool and Line Method: The spool and line method uses a lightweight line that is attached to the snail. The other end of the line is wound around a spool that will easily release line as the snail moves. The only potential difficulty associated with this method is that the line could become caught and limit the movement of the snails.

Bobbin Method: The bobbin method is similar to the spool and line method, except that in this case the spool is attached to the snail and the line is attached to a stationary object at the initial tracking point. The only potential difficulty with this method is keeping the weight of the bobbin low enough so movement of *E. rosea* is not restricted.

Glow in the Dark Method: The glow in the dark method uses a paint that reflects ultraviolet light. Once individual snails are painted, they should be easy to locate at night with use of a black light. However, it will be difficult to locate snails under leaves or in shrub/fern habitat using this technique. Since recapture rate using this technique was likely to be lower than for the other techniques, ten as opposed to six snails were used.

Both the spool and line and the bobbin techniques have two major advantages over the glow in the dark method because they leave a trace of where the snail moves. This not only allows the snail to be easily located, but allows for information on its movement between collection events to be recorded. Thus, total distance moved can be compared with a linear distance moved away from the initial starting point, and the habitat traversed between observations can be determined. The one advantage of the glow in the dark method is that the snail is not weighed down by any apparatus, nor constrained by a potentially tangled thread. No adverse effects of the paint were recorded for four *E. rosea* painted with the glow in the dark paint and observed prior to this pilot

study. The four individuals were kept alive in the lab for three weeks and exhibited similar feeding and movement patterns compared to control snails (not painted). Long term effects of the paint on the snail are unknown.

Analyses

The relative utility of each method was 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. An ANOVA tested for differences among the Euclidean (straight-line) distances snails moved using the three tracking methods. Since snails with glow in the dark paint have nothing inhibiting their movement, they were used as a control to see if snails being tracked with the other methods have similar movement patterns. For the spool and line and bobbin methods both the total distance moved and the T:E ratio (ratio of total distance to Euclidean distance) were compared using a Mann-Whitney U-test. To determine the utility of the three tracking techniques I recorded the time spent locating individual snails for each method and the number of snails found during each observation period. Microhabitats where individuals were found and mortality were also recorded.

Results

There was no significant difference in the Euclidean distance moved ($F= 0.78$, $df = 2$, $p = 0.48$) among the tracking treatments (Figure 1). There were significant differences between both the total distance moved and T:E ratio between the spool and line and bobbin method (Figures 2, 3) with snails tracked with the bobbin method moving significantly longer distances than snails tracked with the spool and line method. This difference was expected since it was noticed that many individuals tracked with the spool and line method were restricted in their movement by the tension created in the line when it was wrapped around multiple objects. Most snails tracked via the spool and line method became completely restricted in movement between observations.

There were obvious differences among treatments in the time required to locate the snails and the number of individuals observed. Only seven of the ten snails tracked with the glow in the dark method were seen again. Six of these snails were only seen once and the other snail was recorded only twice, for a total of eight of a possible 50 (10 snails, five occasions) possible records . An hour and a half was spent looking for the snails marked with the glow in the dark paint on each observation period but it took less than an hour to find and measure all snails tracked with the other two techniques.

Mortality was higher than expected. Only one of the six snails tracked by the spool and line method was still alive after the week of observations. One snail may have pulled free of the tape and glue that held the line to the snail, but it was unclear what caused the death of the other snails. It seems as the other four snails had been preyed upon since shells were found either crushed or in one instance the snail had been moved in a straight line for a long distance. Typically, when rats prey on snails they pick them up and take them in a straight line away from the capture location to a place where they eat them (Aaron Shiels personal communication). Three of the six snails tracked by the bobbin method were also dead by the end of the one week study and rats were also likely to have been the cause since rats were abundant at the site and the

snails were found crushed. Mortality of snails tracked by the glow in the dark method is unknown. However, seeds painted with the glow in the dark paint were not preyed upon by rats in other experiments at Lyon Arboretum, suggesting that rat predation may have been less when using this technique than when using the other (Aaron Shiels personal communication).

Snails were found in different microhabitats in the three treatments (Figure 4). Most snails tracked with the bobbin technique were found in the leaf litter. Snails tracked by the glow in the dark method and those tracked by the spool and line method were normally found on top of the litter.

Discussion

The bobbin method was the most useful tracking method. It was the only method in which the snail was free to move and could be easily recaptured. The spool and line technique severely hampered snail movements (Figures 2, 3) because of the tension in the line as it got wrapped around multiple objects. This problem was alleviated when the bobbin was carried by the snail. The bobbin apparatus used in this pilot study was bulky and a little heavier than preferred (just over 10 % of the snails' weight), but has now been upgraded and the weight can be easily adjusted (see Figure 5 for a picture of the apparatus used for the pilot study compared with the updated bobbin apparatus). The glow in the dark method allowed snails to move freely, but the recapture rate was so low that this method does not seem worth the effort. In addition, the bobbin method provides a trace of where the snail moves, allowing data to be collected on the actual paths followed by the snails and their relative preferences for different microhabitats.

The use of harmonic radar technology for tracking *E. rosea* may not be appropriate. If not restricted *E. rosea* is usually found in leaf litter or under small shrubs and ferns (Figure 4). Currently, the ability for the harmonic radar to penetrate the foliage is limited (Kevin Hall personal communication). This technology has been used on snails (Stringer et al. 2002, 2003), but these snails were larger (~ 7-8 cm shell length) than *E. rosea* and have shells that are more equidimensional (length to width ratio) than *E. rosea*, which is elongate (high length to width ratio). The transponder (diode and antennae) used were large and could not easily be attached to an *E. rosea* shell. The largest *E. rosea* would only be two-thirds of the size in terms of length and much less in terms of width of the species used in these other experiments. Additionally, the recapture rates in these other experiments were low despite the large transponder (Stringer et al. 2003), suggesting the need to mark many individuals with a harmonic radar tag to be assured of adequate data. Finding large numbers of *E. rosea* is difficult and may not be possible at some locations. And again, point data from each observation occasion tells us little about how the individual has moved between recapture events.

The high levels of mortality were surprising. Of the twelve snails tracked by the spool and line and bobbin methods only four remained at the end of the one week study. Although one individual may have escaped by pulling itself free of the tape and glue that attached the line to the snail, it is clear that the other snails were preyed upon. Evidence consisted of shell fragments left behind, and an individual pulled many meters in a strait line (a behavior typical of rats). I did see rats on many occasions while making my observations. This may present problems in tracking these snails over long periods of time, especially if rats are regularly consuming snails.

However, understanding mortality rates and the impact of rats and other predators on *E. rosea* populations is an important component of understanding the impact of *E. rosea* in the forests of Hawaii. It could be that rats and/or other introduced predators may control *E. rosea* populations.

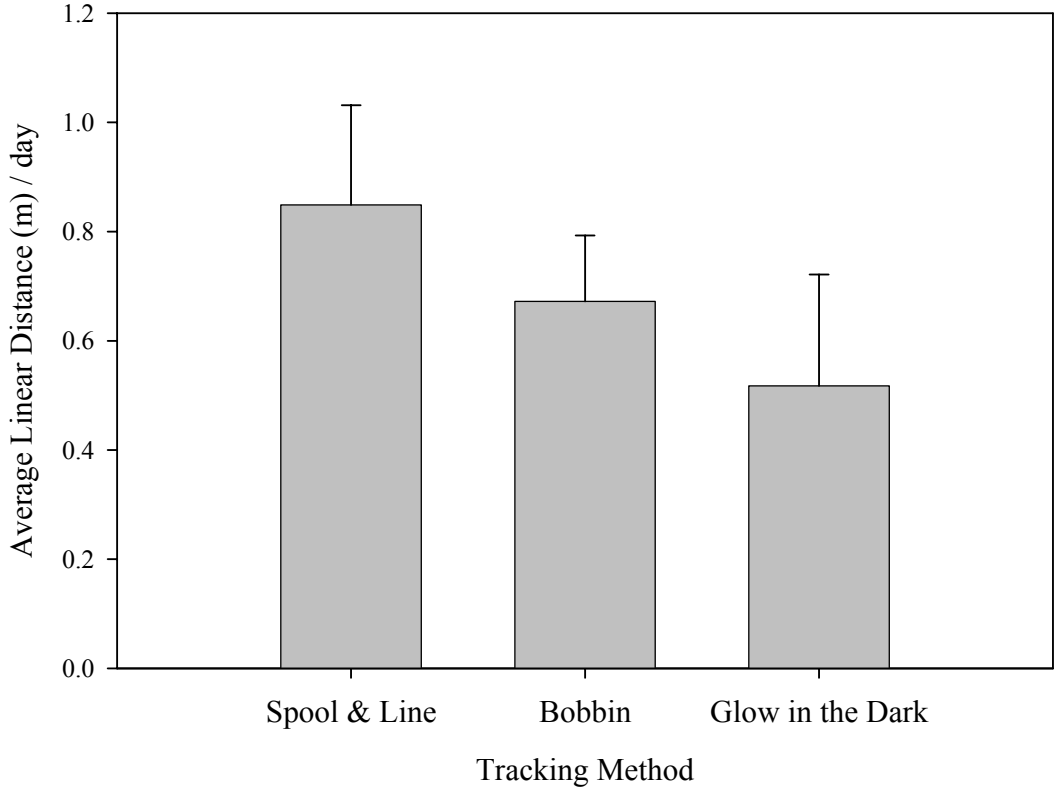

Figure 1: The average Euclidean (linear) distance (m) moved by individuals tracked by the three tracking methods. Bar heights represent mean values (error bars = 1 standard error). There were no significant differences in distance moved among tracking methods ($F = 0.78$, $df = 2$, $p = 0.48$).

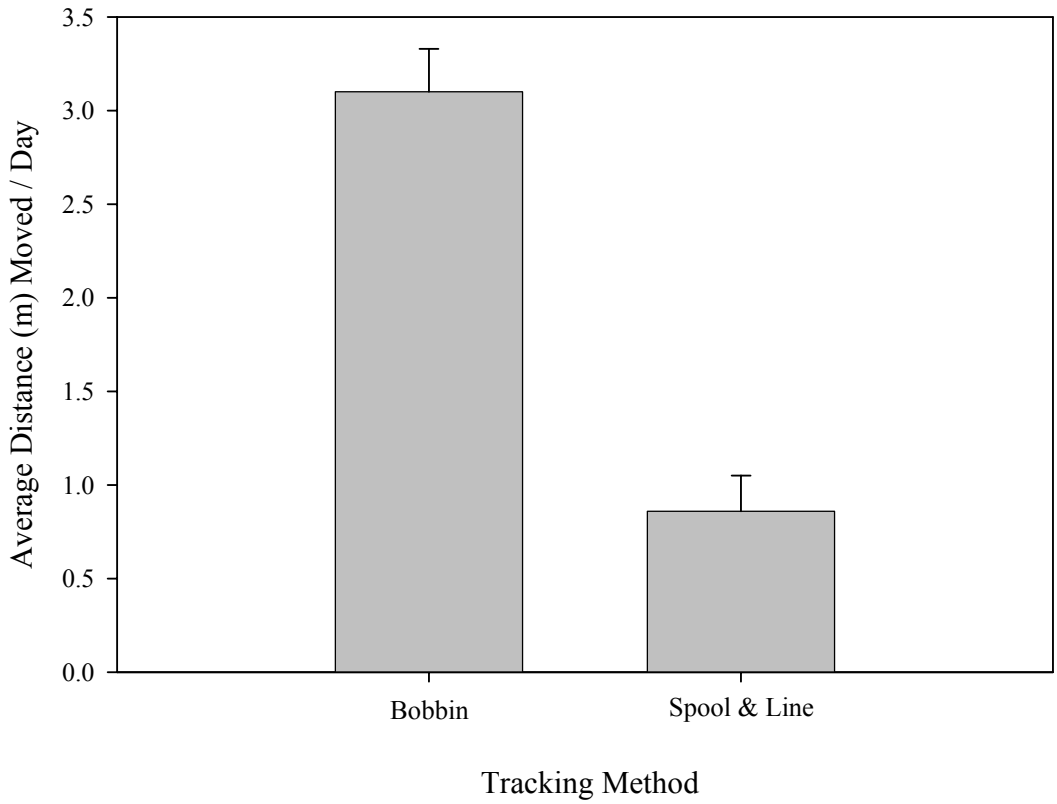

Figure 2: Average total distance (m) moved per day for the bobbin and spool and line methods as measured by the amount of string released. Bar heights represent mean values (error bars = 1 standard error). The difference between the two tracking methods was significant ($p < 0.001$).

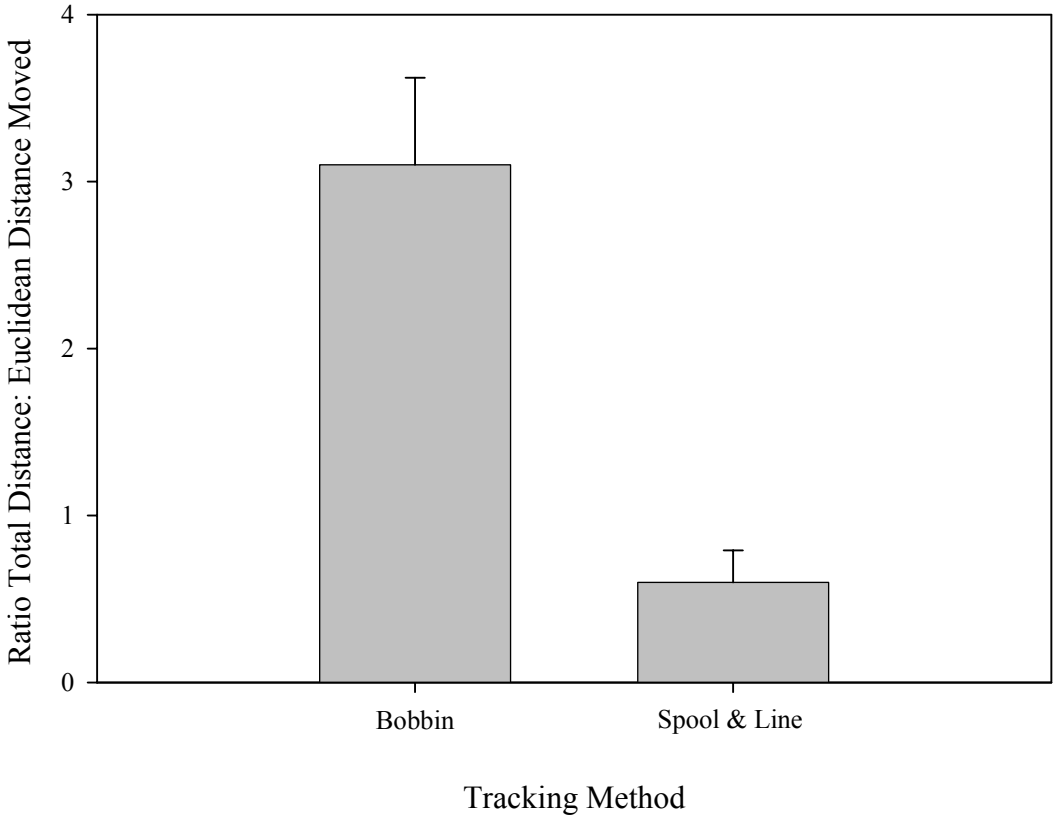

Figure 3: Ratio of total distance : Euclidean (linear) distance moved between the spool and line and bobbin tracking method. Bar heights represent mean values (error bars = 1 standard error). The difference between tracking methods was significant ($p < 0.001$).

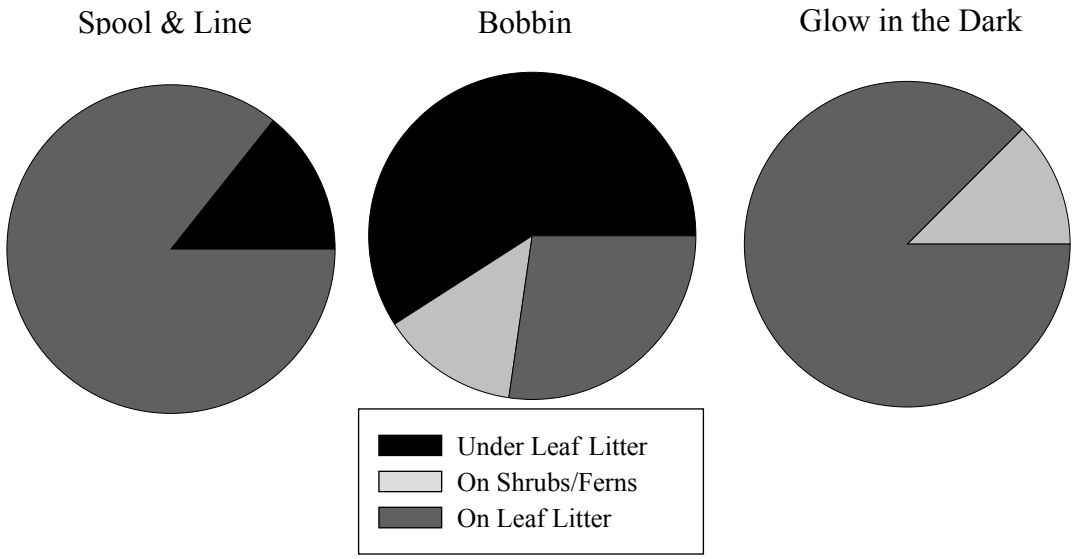

Figure 4: Proportions of different microhabitats where individuals tracked with the three different methods (spool and line, bobbin, and glow in the dark paint) were found. The three microhabitat categories were: 1) under leaf litter, 2) on shrubs and ferns, and 3) on top of litter; this last microhabitat included individuals found on open rock and soil without the presence of leaf litter. No snails used woody microhabitats such as downed logs.

(A) (B)

Figure 5: Pictures of the different bobbin apparatuses used. (A) is the bobbin apparatus used in the pilot study. (B) is the new bobbin apparatus used in the field tracking experiment. The new bobbin is lighter.

Main Study: Dispersal and Microhabitat Utilization of the Introduced Predatory Snail *Euglandina rosea*: Implications for Management and Control

Methods

Study Site

All work was conducted in Kahanaiki gulch starting on February 1, 2007. Kahanaiki gulch is on the North West side of the Waianae Mountains on Oahu (N 21° 54.205′, W 158° 19.646′). It has steep cliffs that rise roughly 100 m from the bottom of the gulch to the ridges either side. The ridges are ~ 550 to 750 m in elevation. The vegetation is mixed with both native and invasive species present. The introduced strawberry guava (*Psidium cattleianum*) is the most abundant tree in the gulch, but native trees such as ohia (*Metrosideros polymorpha*) and koa (*Acacia koa*) are present. The climate in the gulch is tropical with wet winters and dry summers (Juvick & Juvick 1998). The gulch bottom is usually cool and wet compared to the dry hot ridges on sunny days (personal observation).

Abiotic Characterization of Kahanaiki Gulch

To record the abiotic characteristics of Kanahaiki gulch six Log Tag HAXO-8 temperature and humidity loggers were placed at six sites, two in the gulch and two just below both the south and north facing ridges. They were placed more than 500 m apart and hung on the base of a tree in shady areas at a height of 0.25 m above the ground. They were placed in the field on April 13, 2007 and set to record data every 30 min. They are scheduled to be picked up on July 13, 2007. Temperature and humidity data will be used to compare abiotic conditions in the gulch to those on the ridges and to determine if there is any correlation between temperature and humidity and the movement patterns of *E. rosea*.

Patterns of Prey Density

To determine patterns of prey densities in the gulch, eighteen sites were surveyed for snails on two occasions (8-12 March 2007, 10-15 May 2007) by timed searches of the trees/shrubs and by the use of beer traps to trap ground-dwelling snail/slug species. In addition, trees were surveyed for listed *Achatinella* spp. to make sure there would be no deleterious impacts on these snails during this study. Six sites were in the gulch bottom and six were located 20 m below each of the north facing and south facing slopes (total 18 sites). At each site trees were surveyed for 10 min and ten beer traps (88 ml glass jars, 5.0 cm tall and 5.0 cm in diameter with a 2.5 cm diameter opening in the top, filled with beer) were buried into the soil so the top was flush with the soil were left for four days before collection. Each individual collected was counted and identified to species except in the case of the 'tornatellinids' (small Achatinellidae in subfamilies other than Achatinellinae), which were just recorded collectively.

Dispersal Patterns and Microhabitat Selection

Both movement patterns and microhabitat preference were determined by using the bobbin technique (see pilot study above) to follow the trails of individuals as they moved through different microhabitats through time. From March 29, 2007, adult *E. rosea* were fitted with a size

40-8-20 nylon thread bobbin from Imperial Threads™. Each bobbin was wrapped in Parafilm© and enough line was pulled from the bobbin until it weighed less than 0.5 g (less than 10% of the weight of an adult *E. rosea*). Bobbins were glued to the shells using SuperGlue©. The end of the line was attached to a dowel in a cement base. The line was tied and taped to the dowel. Eight *E. rosea* have been tracked successfully. Six *E. rosea* were not tracked successfully, mostly because the line was broken, and are not reported on here. After the line breaks, it is difficult to find the snail again. Sites where *E. rosea* were being trapped were visited once a week following attachment of bobbins to the snails.

Dispersal Patterns: To describe dispersal patterns of *E. rosea*, five measurements related to their movement were recorded for each individual on each observation occasion: 1) linear distance from initial release point, 2) compass angle from initial release point, 3) linear distance from point at which snail was most recently previously recorded, 4) compass angle from point at which previously recorded, and 5) total distance traveled (the length of line pulled from the spool).

Microhabitat Preference: To determine microhabitat preferences, the microhabitat used be each snail was categorized (see below) every 0.75 m along the line left by the snail and compared to the relative prevalence of the different microhabitats overall, as assessed by taking measurements at 1 m intervals along four transects that were run on randomly chosen compass headings from the point of initial release to the furthest linear distance moved by the particular snail from its initial release point. If at least 24 points were not scored along these four transects, additional transects were surveyed until the number of microhabitat data points exceeded 24. In addition, the habitats where the snails were actually found were recorded. Almost all snails were inactive when found suggesting that they move at night and during periods of wet weather. When following the line left during the movement of each individual, whether the snail was using arboreal or ground level habitats was first recorded. If this point was in an arboreal habitat (trees and shrubs higher that 0.5 m), the height above ground and species of plant was recorded and the plant was searched for potential *E. rosea* prey. If the point was on the ground, then the microhabitat was recorded as one of the following: 1) wood, consisting of downed logs greater that 10 cm in diameter, 2) open, consisting of all areas, including rock and open soil, where the individual can be easily seen, 3) shrub/fern, consisting of all habitat that has low shrubs or ferns that grow up to 0.5 m from the ground and block visual sight of the ground, and 4) leaf litter, consisting of areas with a thick covering of dead leaves and twigs without the cover of shrubs and ferns. When assessing the proportion of these microhabitats only ground level microhabitats were included. No quantitative measurement of plant density was attempted.

Analysis

Abiotic Characterization: To date no data have been collected from the data recorders. Once they are retrieved, temperature and humidity data will be compared among the gulch bottom and the two ridges. Snail movement patterns will be correlated with temperature and humidity.

Patterns of Prey Density: A two-factor ANOVA was used to test for differences in prey density among the gulch, south facing slope, and north facing slope sites. The fixed variable was location

(gulch, south facing slope, north facing slope). The other, random variable was collection date (1 and 2).

Dispersal Patterns: This section is descriptive. Distance traveled and number of trees climbed for each snail tracked are reported. I don't know of any study that has described the movements of this species, so all information will be new.

Microhabitat Preferences: To estimate habitat preference of *E. rosea*, Jacobs' selectivity indices (Jacobs 1974, and used by Sugiyama and Goto 2002) were calculated using the following formula:

$$D_{ia} = (r_i - p_a) / (r_i + p_a - 2\, r_i\, p_a)$$

where D_{ia} is the selectivity index of individual i for microhabitat a, r_i is the ratio of microhabitat type a use to all the other microhabitat types used by the individual, and p_a is the ratio of microhabitat a to all the other microhabitats available for the individual to use within the local area. As described above, r_i is determined for each snail by recording the microhabitat type at 0.75 m intervals along the path of each snail's trial, as determined from the line left from the bobbin, and p_a is determined from the data gathered at 1.0 m intervals along the four or more transects. If the individual preferentially uses a microhabitat the D_{ia} score will be positive, if it avoids a microhabitat the D_{ia} score will be negative.

To determine day time microhabitat preferences Jacobs' selectivity indices were also used. The proportion of times snails were found in each microhabitat was compared to the proportion of that microhabitat available to that individual in the local area. For day time microhabitat preferences data recorded for all individuals were combined.

Results

Abiotic Characterization

Data remain to be collected (see Methods section).

Patterns of Prey Density

There was a significant treatment effect for the three most abundant potential *E. rosea* prey items, *Limax maximus*, *Deroceras leave*, and the 'tornatellinids', with a majority of the individuals being found at the sites within the gulch (Table 1). In addition, a native *Philonesia* sp. was found at a gulch site. *Meghimatium striatum* was the only other species collected (also at a gulch site). The numbers collected for *Philonesia* sp. and *Meghimatium striatum* were too low to test for any differences among treatments.

Dispersal Patterns

The results are still preliminary as only a few snails have been tracked for more than a month. Surprisingly, the two snails tracked since March 29, 2007 have not moved further than 7 m in

linear distance from their initial release point. A complete synopsis of individual movements is provided in Table 2. Some individuals did climb trees (up to 2 m above the ground). Every tree climbed so far was a strawberry guava (*Psidium cattleianum*) and there were snails ('tornatellinids') found in each of the trees climbed. It is unclear what caused the death of individuals 3 and 6. Pictures of how they were found are shown in Figure 6. Only one snail was recorded active during a day and at that time it was raining.

Microhabitat Preference

The microhabitat preferences of the six *E. rosea* tracked were estimated from the Jacobs' index of selectivity. Selectivity indices were positive for all individuals in the leaf litter microhabitat suggesting that this microhabitat was preferred, since it was used more frequently than expected by random (Figure 7). Selectivity indices were negative for all individuals in open and fern/shrub microhabitats. Results were mixed for the wood microhabitat.

Leaf litter was preferred during the day (Figure 8), as it was the only microhabitat that had a positive selectivity score.

Discussion

The present study is the first investigation of the spatial patterns of dispersal and habitat use of one of Hawaii's worst invasive species, *Euglandina rosea*. This study provides detailed information about movement patterns and microhabitat preferences at the scale of the individual. So far, only a few individuals have been observed for only a short period of time (Table 2), so caution needs to be exercised when intepreting the results. Nevertheless, these data provide managers with an initial understanding of how *E. rosea* uses its environment. This study, in conjunction with work that will be completed in year 3 examining population densities in the gulch and life history characteristics of *E. rosea*, as well as the effectiveness of control methods, will hopefully provide information necessary for the implementation of informed management programs.

Abiotic Characterization of the Habitats

Many land snails have evolved to prevent desiccation (Cowie & Jones 1985, Arad et al. 1993, Copley 2000). The data have not yet been collected to characterize the temperature and humidity profiles of the gulch and the ridges either side of it. The gulch seems to be cooler and damper than the ridges on hot sunny days, but the difference between the gulch and the ridges may be slight on rainy days. Also, the abiotic conditions required by *E. rosea* are not known, although such knowledge would of great significance in evaluating its potential distribution. These data will provide information valuable to begin addressing whether *E. rosea* prefers gulch habitats and if ridges act as dispersal barriers. In year 3, surveys will be conducted in the gulch and on the ridges to compare density between these different habitats.

Patterns of Prey Density

Predators move to areas with the highest prey densities (Fauchald & Tveraa 2006). There were higher prey densities in the gulch compared to the ridges (Table 1). Areas with low prey densities may act as a dispersal barrier since predators may remain in areas where food capture requires less effort.

Understanding how prey are distributed within a mountain range and at smaller scales, e.g. within a gulch, is important to understanding how *E. rosea* may impact the remaining native snail populations. Native tree snails, *Achatinella* spp., are typically found on ridges (Holland and Hadfield 2002). Does the lower prey densities on the ridges limit *E. rosea* from moving into these areas, or does the lower prey densities in these areas force *E. rosea* to spend more time searching aboreal habitats for prey, including endangered *Achatinella* spp.?

Dispersal Patterns

The results of concerning the general dispersal patterns of *E. rosea* are quite surprising. It was expected that being a predator, *E. rosea* would move large distances compared to other snails. Studies examining the movement patterns of other snails suggest that some snails move much longer distances (e.g., Tomiyama & Nakane 1993 for *A. fulica*, Murphy 2002 for *Hedleyella falconeri*, an Australian predatory snail). *Euglandina rosea* is a smaller snail than these species. Nevertheless, as a predator it is surprising that the two snails tracked for more than 50 days have not moved further than 7 m in linear distance from the initial starting point (Table 2). Although the total distance moved for each snail is roughly five times greater than the linear distances moved, the data suggest that *E. rosea* does not disperse more than about 10 m (linear distance) in about two months. However, this pattern may result from the fact that all snails were tracked in the gulch where prey densities are high (Table 1); a different pattern may emerge for snails tracked in areas with lower prey densities. Further studies will track snails on ridges to compare the movements of snails among the two ridges and the gulch.

Two *E. rosea* were consumed (Table 2). In one instance part of the body was partially consumed and there was no damage to the shell. It is possible that this snail died to causes other than predation, but I had observed this snail alive and active two days before. The other snail had a large piece of the shell broken away and the whole body was missing (Figure 6). It is unknown what role other predators or diseases play in controlling *E. rosea* populations. Interactions among many of the introduced and native species in Hawaii may be complex. However, understanding these interactions is important in developing well-conceived control methods.

Microhabitat Preference

Versatility in use of habitat determines a species' ubiquity and distribution within its range (MacNally 1995). More versatile (generalized) species are able to maintain populations across a broader spectrum of habitats and exploit the resources available within those habitats (Tomblin & Adler 1998). Understanding the ecological factors that impact the distributions of organisms, particularly those species that have the potential to impact the structure of entire communities, is important in determining the effect of a species across a landscape. Also, understanding how a

predator uses microhabitats within its range will help managers determine which species are likely to be the most threatened and where traps or searches that aim to trap/catch an alien predator as part of a control effort should be focused.

Euglandina rosea chooses microhabitats with dense leaf litter in preference to open and fern/shrub habitats (Figure 7). The results for wood habitat are mixed, but it is possible that at the completion of the tracking study, wood habitats may be shown to be preferentially chosen since I often see slugs (potential prey items) in this microhabitat. Selectivity indices for wood were negative only in areas where the wood microhabitat was extremely rare, making encounters with this habitat less likely.

Leaf litter was also the preferred microhabitat during the day (Figure 8). *Euglandina rosea* is generally most active during the night and these sites may represent day time shelters. Leaf litter may be preferred for many reasons, including: 1) higher prey densities, 2) higher moisture retention, limiting desiccation, and 3) avoidance of predators. Assessment of prey density according to microhabitat was attempted by examining the beer trap data from the different microhabitats, but the variance was high and no pattern could be detected statistically. Desiccation is likely a major factor determining microhabitat selection (Cowie & Jones 1985, Arad et al. 1993, Copley 2000). However, the shrub/fern habitat was avoided (Figure 7) despite the high likelyhood that this microhabitat can retain moisture. Visual predators can affect prey distributions (Cain & Sheppard 1952). In leaf litter, *E. rosea* is extremely difficult to see since the red/brown shell matches the color of dead leaves. Therefore, visual predators may have a much harder time finding *E. rosea* in leaf litter habitats. The two individuals that died during this experiment (Figure 6) were found in fern/shrub habitat. Comparisons among the microhabitat utilization of *E. rosea*, rats, and other introduced mammal species in the same gulch (mammal data currently being collected by Aaron Shiels) may provide a way to assess whether these species use different microhabitats.

Implications for Management and Control

This study indicates. at least preliminarily, that *E. rosea* does not disperse long distances and is reliant on leaf litter for foraging, shelter, and egg laying (personal observations made over the last year). Since *E. rosea* does not disperse far, control methods may be successful in small areas, such as those where native snails are known to exist. An effective eradication method would have to be developed. Leaf litter is a major component of Oahu mountain habitats and is extremely important for many ecosystem processes. However, degradation or removal of this key microhabitat may significantly alter the behavior of *E. rosea*. For instance, a litter free barrier may be effective in preventing encroachment of *E. rosea*, although, there are probably many other factors that may also have to be altered to make such a barrier effective.

Understanding that *E. rosea* prefers leaf litter is a little alarming, since most *E. rosea* were collected in the open microhabitat (a microhabitat that is not preferred). This suggests that there may be more *E. rosea* than previously thought. A detailed study of *E. rosea* density in Kahanaiki gulch will begin in August 2007.

The results also suggest that a classical mark-recapture study can provide accurate information since the snails do not move long distances, making recapture relatively likely. The mark-recapture study that will begin in August 2007 will provide information on the life history and density of *E. rosea* in the gulch. Also, I hope to track juvenile *E. rosea* to determine their dispersal patterns, which may be different from those of adult *E. rosea*.

Because of the consequences of the introduction of *E. rosea*, it is important to understand the biology of this species. Only through such studies can informed decisions be made regarding which control methods might be successful.

Table 1: Numbers of possible prey items collected at six sites in each of three areas in Kahanaiki gulch (NF = north facing ridge, SF = south facing ridge, G = within gulch) on two occasions (March 8, 2007 and May 10, 2007). A two-factor ANOVA tested for differences in prey numbers among habitat types and on the two collection occasions.

Taxon	**NF**	**SF**	**G**	**Source**	**p-value**
'tornatellinids'	12	12	205	location	< 0.001
				time	0.333
				location*time	0.371
Limax maximus	40	17	133	location	0.141
				time	0.387
				location*time	0.421
Deroceras laeve	19	9	96	location	< 0.001
				time	0.382
				location*time	0.044
Meghimatium striatum	1	2	2	NA	
***Philonesia* sp.**	0	0	1	NA	

Table 2: Summary of dispersal patterns of the eight *E. rosea* tracked during the main experiment.

	E. rosea 1	*E. rosea* 2	*E. rosea* 3	*E. rosea* 4	*E. rosea* 5
Date of Release	29-March-07	29-March-07	11-April-07	3-May-07	3-May-07
No. of days tracked	54	54	15	19	19
Maximum linear distance (m) traveled from start point	6.34	6.94	1.89	5.80	13.53
Total distance (m) traveled from start point	39.64	36.40	6.66	21.38	77.2
No. trees climbed (No. trees with snails)	0	0	0	3 (3)	5 (5)
Still tracking	Yes	Yes	No (flatworm or *E. rosea* predation?)	Yes	Yes

Table 2 continued:

	E. rosea 6	*E. rosea* 7	*E. rosea* 8
Date of Release	3-May-07	17-May-07	17-May-07
No. of days tracked	0	5	5
Maximum linear distance (m) traveled from start point	0	6.12	3.46
Total distance (m) traveled from start point	0	9.13	8.83
No. trees climbed (No. trees with snails)	0	0	0
Still tracking	No (rat or bird predation?)	Yes	Yes

(A) (B)

Figure 6: Pictures of the two snails that were found dead. The *E. rosea* in (A) looked to be half consumed without any damage to the shell. However, it is possible that the snail was not preyed on and died due to unknow causes. It was seen alive two days before. The *E. rosea* in (B) has a large hole crunched out of the shell. Part of the body was left in the part of the shell on the other side of the hole.

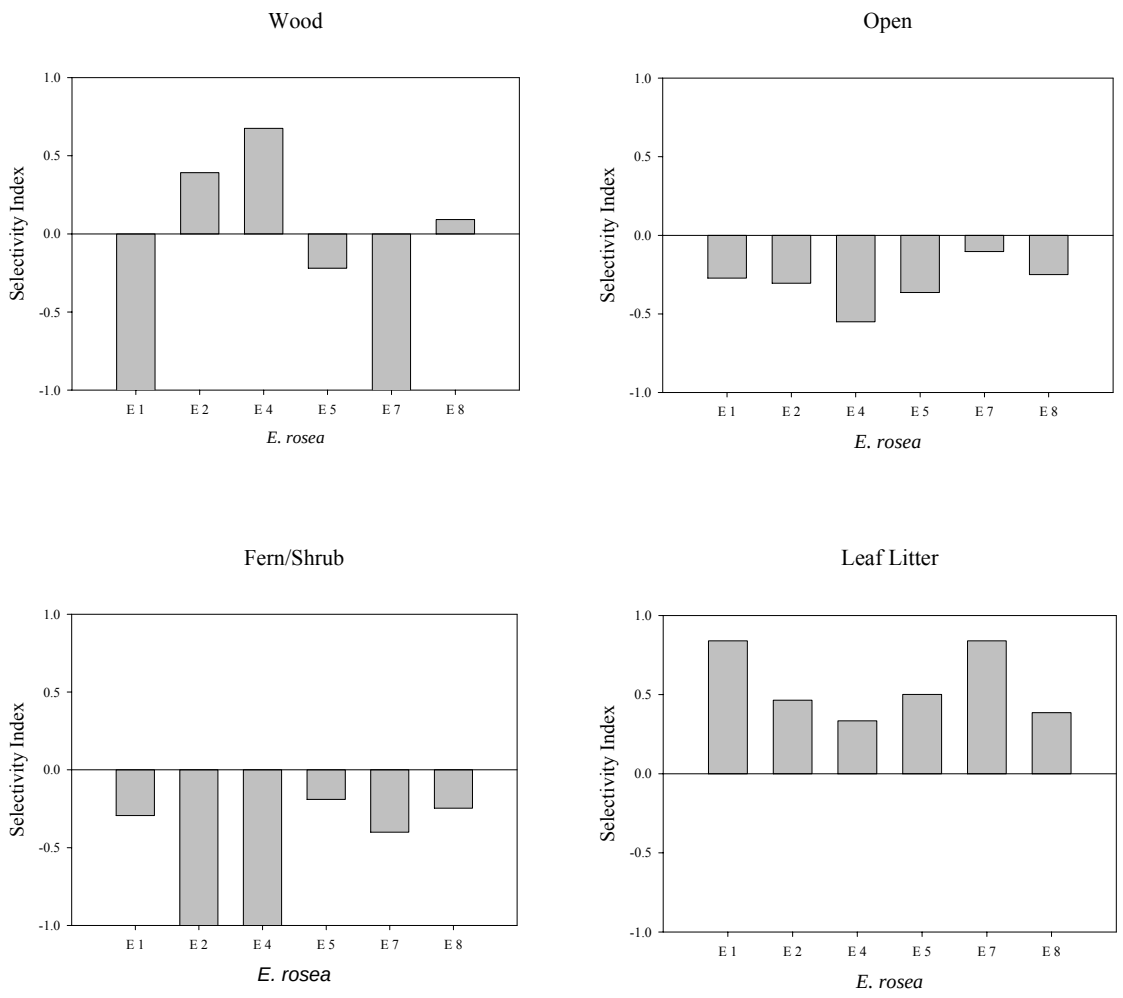

Figure 7: Microhabitat selection by six adult *E. rosea* in Kahanaiki gulch. Positive and negative values of the Jacobs' selectivity index indicate that different microhabitats were used more or less frequently, respectively, than expected by chance.

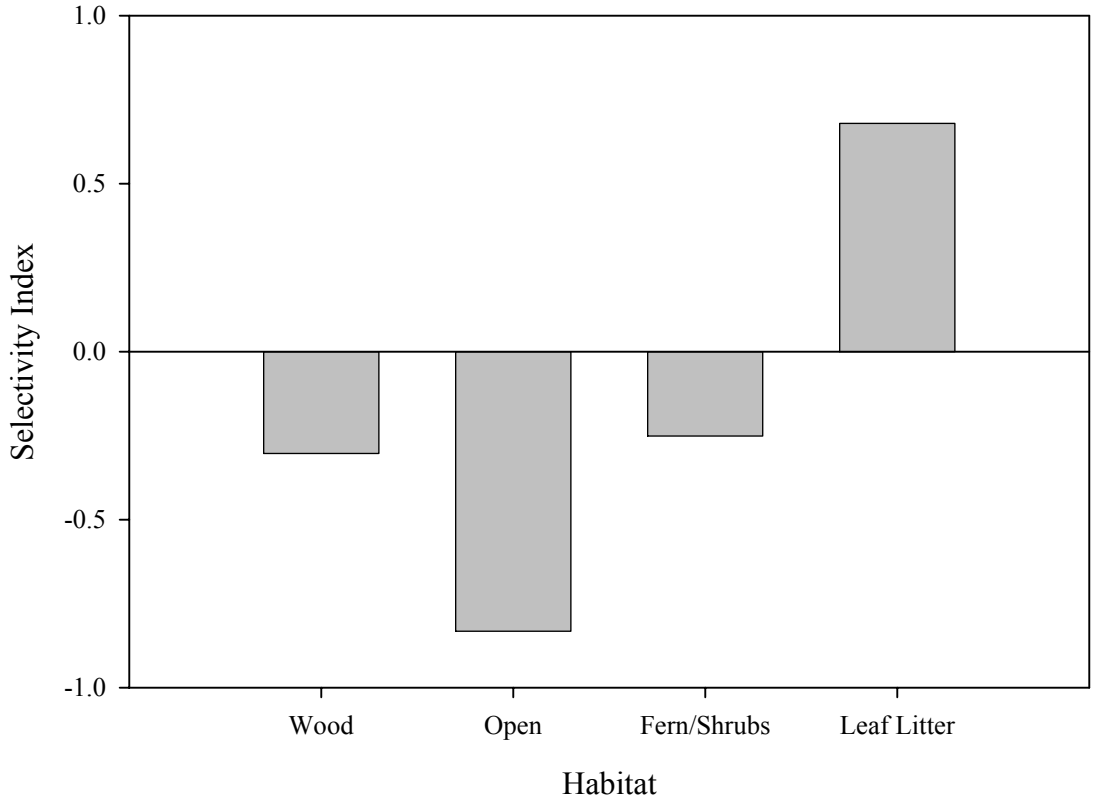

Figure 8: Day time habitat selection of six adult *E. rosea* in Kahanaiki gulch. Positive and negative values using the Jacobs' selectivity index indicate that different microhabitats were used more or less frequently, respectively, than expected by chance.

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Effects of alien rodents on Hawaiian mesic forest

Army Environmental Annual Report (Aug 2006-June 2007)

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Introduction

Four rodents were introduced to the Hawaiian Islands upon human settlement (*Rattus exulans* in 700 AD; *R. rattus*, *R. norvegicus*, and *Mus musculus* shortly after Captain Cook's arrival in 1778). Because the flora and fauna in Hawai`i did not evolve with any terrestrial mammals, there is strong potential for pronounced biotic change to result from the presence of alien rodents in Hawai`i. With such unique characteristics as arboreal and ground foraging, gnawing and destroying seeds, and high fecundity and population growth, rodents have the potential to alter Hawaiian ecosystems through their effects on plant recruitment.

My research is focused on completing the following: 1) Estimate rat densities, distribution, and habitat use, 2) Determine which fruits, seeds, and seedlings are vulnerable to rodents (particularly rats), and 3) Determine whether particular characteristics of fruits and seeds can predict vulnerability to rodents. Exploring these aspects will provide a better understanding of rodent biology in Hawai`i, and will assist in rodent control and Hawaiian natural resource management.

Methods

Study Site

This research occurs at three study sites in the Wai`anae Mountains, Oahu. Kahanahaiki (KHI) and Kaluaa at Honouliuli (HON) are the two sites that have been studied during this past year. Research at Makaha (MAK) will begin upon completion of the fence and ungulate extermination. All three sites are in mesic, montane forest at 500-660 m a.s.l., and all have a mixed flora that includes both native and alien plant species.

Density, Distribution, Habitat use

Distribution and abundance of rats at KHI and HON were assessed every two months from February-June 2007 using the mark-and-recapture technique (Seber 1982; Johnson 1994, Lindsay *et al.* 1999). Hagaruma live traps were set along transects at 25 m intervals. Four to six transects per site were established and each transect was approximately 50 m from adjacent transects. As a result, the total trapping area for KHI was 2.81 ha, whereas the trapping area for HON was 2.87 ha. A bi-monthly trapping event consisted of four consecutive trap nights where all 45 traps were opened. All traps were baited with fresh chunks of coconut and pre-baiting with shredded coconut took place 2-3 days prior to opening traps. Mice were also prevalent at both study sites, but because of the high abundance of rats captured at KHI there was insufficient time to process and tag all captured mice. Therefore, mice abundance and distribution was only determined for HON. On a single occasion, I attempted to use track tunnels to provide an index for rodent densities as the track tunnel could be compared to live-trap captures at KHI. This method will be improved and utilized in the future at KHI to assist with rodent estimates that do not require trapping or handling animals.

In order to estimate *R. rattus* home-range and habitat use at KHI, a subset of the captured rats were fitted with radio collars. Each radio collar was <4% of the animal's body weight (mean ± SE collar mass: 3.86 ± 0.10 g). Radio telemetry provides a coarse-scale estimate of habitat use. Nighttime radio telemetry was conducted using the triangulation method (Lindsay *et al.* 1999). Finer scale habitat use was determined using two additional methods: 1) track tunnels were placed on the ground and in trees at KHI to compare activity levels in the two habitats, and 2) string bobbins were attached to the backs of rats (at KHI and HON) and mice (at HON only) to determine microhabitat use (see Hoare *et al*. 2007 for methods).

Rat Effects on Plants

Twelve stations (3 treatments x 4 replicates) for each species, each 10 m apart, were established along transects at KHI to determine the vulnerability of fruit and seeds to rodents. Each station was randomly assigned one of the following treatments: 1) no-vertebrate-access, which consists of a wire metal mesh (1.2 cm aperture) open-bottom square box (30 x 30 x 30 cm; length x width x height) that excludes all potential vertebrate seed predators and dispersers (*e.g.*, rodents, pigs, cats, birds, mongoose) and acts as the control to compare subsequent treatments, 2) small-vertebrate-access, which is the same dimensions as the no-vertebrate-access but four holes (one on each of the side-walls; 10 x 10 cm each) allow small vertebrates (such as rodents) to access the interior but excludes the entry of other large animals (*i.e.*, pigs and cats), and 3) open forest floor, where all vertebrates are able to freely access the station. Each mesh exclosure was pushed into the ground *ca.* 1 cm and held in place using 8 cm long turf staples. In order to determine if rats versus other similar-sized vertebrates (mice, mongoose, birds) enter the small vertebrate access treatment, and/or the open treatment, motion-sensing cameras (Bushnell Sentry 2.1 MB or Multrie) were placed at a subset of these treatment stations. Fruits of *Sapindus oahuensis* and *Pouteria sandwicensis* were collected from the study site, placed within each treatment, and removal was quantified over a 25 d period.

Results

Density, Distribution, Habitat use

During the February through May samplings, 103 rats were captured, marked, measured, and released at HON and KHI. Only two *R. exulans* were captured (both at KHI), as the remainder (98%) of the rats were *R. rattus*. The majority (*ca.* 60%) of the rats captured were males, and juvenile rats represented <13% of the rats captured at either site (Figure 1). There was a pronounced difference in rat captures between the two sites, as KHI had 2-4 times more individuals captured than HON (Figure 2). There appears to be slightly more rats captured at both sites during May than March (Figure 2). Rats were only active during the night, as no rats but several mice were captured on three occasions where traps were opened during the day at each site.

Ten *R. rattus* were radio-collared and tracked from February through June 2007 (Table 1). The locations of collared rats were taken both during the daytime (inactive period) and nighttime (active period) approximately once a week. The home-ranges of each of the 10 rats are still being analyzed; however, all collared rats have home-ranges <1 ha, and movement distances appear to be relatively close to den sites (range: 7-145 m; Table 1). Rat den sites were located both in the ground and in trees (live and dead). The most common trees for rat den sites were aliens (*Grevillea robusta, Psidium cattleianum, Aleurites moluccana*), although one female rat had a short-term (<1 week) den site in a cavity of the native *Santalum paniculatum*. All collared rats at KHI changed den sites multiple times (1-6 times) and only two rats returned to previously-used den sites after selecting a new den site. There were no occasions where two

collared rats shared the same den site; however, home-ranges commonly overlapped. Additionally, two collared females had their collars chewed off, presumably by a mate, suggesting social interactions among these feral rats. Four of the 10 rats suffered predation (Table 1), as rat collars were retrieved on the forest floor with only a rat stomach remaining or in one case only part of the pelt present. Stomachs from rats that were not collared were found on two occasions at KHI, suggesting that the collars did not cause the mortality of radio-collared rats. There are a suite of predators at KHI, as motion-sensing cameras revealed at least one feral cat and several mongooses at KHI. Barn owls, another potential predator of rats, have been observed on several occasions during nighttime radio telemetry and the remains of one dead rat (non-collared individual) was characteristic of barn owl predation (S. Mosher, personal communication).

Bobbins that were attached to rats provided up to 210 m/indiv. of habitat use data. For all individuals with bobbins attached, rats did not travel further than 50 m from the trap site before the string ran out. There was not a clear partitioning of habitat for rats between the canopy and ground: rats that were caught on the ground used tree and ground habitat, and likewise, rats that were caught in the trees used both the tree and ground. Overall, rats appeared to use the ground habitat (79%) more than the trees (21%). When traveling above ground, rats were most often <1 m high, but in some cases they would climb to 12 m height. Bobbins were attached to mice that were caught on the ground at HON. Like the rats with bobbins attached, mice used both the canopy (up to 4.1 m) and the ground and traveled up to 55 m from the trap site while using up to 63 m of string.

Rat Effects on Plants

Both *Pouteria sandwicensis* and *Sapindus oahuensis* fruits were attractive to rats at KHI, as at least 25% of total fruit was removed after 5 d and 45% was removed after 25 d (Figure 3). Compared to the highly attractive *Pritchardia* fruits that were used in similar trials at Lyon Arboretum (wet forest), the two species used at KHI were removed less rapidly (Figure 3). All four species are relatively large-fruited Hawaiian natives (Table 2). Removal of *P. sandwincensis* was terminated after 25 d due to fruit rot. For both species of *Pritchardia*, and for *P. sandwincensis*, there was no difference ($P > 0.05$) in fruit removal between small-vertebrate-access treatments and open sites. However, *S. oahuensis* tended to have a higher fruit removal rate from small-vertebrate-access treatments than open sites. Therefore, at least in some cases, the wire mesh used for the exclosure treatments may act as an attractant to seed predators. Future trials will use a fourth treatment to test for cage effects. In all cases for these trials, the fruit remained in the no-vertebrate-access treatment. Motion sensing cameras did not capture any animals removing fruits at KHI during the trials.

Discussion

Density, Distribution, Habitat use

Rats are prevalent throughout both study sites, and *R. rattus* is the dominant rat species. Although *R. rattus* are commonly diurnally active on some islands in the Pacific, there were not any rats captured at KHI or HON when traps were open during the day. This is probably due to densities at my sites not reaching those on small islands that cause greater competition and a survival need to be active both diurnally and nocturnally. Densities of *R. rattus* at HON and KHI were similar to those sampled at lower elevation sites on Oahu from 1968-1970 (Tamarin & Malecha 1972). There is not a clear explanation for the 2-4 times greater density at KHI when compared to HON, although environmental conditions and variation in predator and/or food resources are possible explanations. The KHI rat densities (30 *R. rattus*/100 trap nights) are

similar to those reported for Paradise Park in Manoa Valley (24 *R. rattus*/100 trap nights; Tamarin & Malecha 1972). Although the HON site appears unreasonably low when compared to KHI (8 *R. rattus*/100 trap nights), it is nearly identical to the average densities of four of the five sites sampled across various wet-dry habitats on Oahu (*ca.* 8 *R. rattus*/100 trap nights; Tamarin & Malecha 1972). The densities of *R. rattus* at Hakalau Forest National Wildlife Refuge (11-25 *R. rattus*/100 trap nights; Lindsay *et al.* 1999) were also within the range of those reported in my study, yet the abundance of juvenile *R. rattus* (<13%) at my study sites is half that reported at Hakalau (26%; Lindsay *et al.* 1999). However, the highest proportion of juveniles at Hakalau was found during September-November, so it is possible that recruitment may be more similar when I sample these months at my sites. Both HON and KHI appear to exhibit a slight increase in rat densities in May compared to March, and such information can be useful for focusing rat control strategies when a year-long data set is completed.

Habitat use patterns for *R. rattus* at my study sites do not match those reported in Lindsay *et al.* (1999). Home-range estimates in my study are <1 ha, whereas those reported for *R. rattus* at Hakalau average 3.6 ha. Because the densities of rats are similar between my study and that of Lindsay *et al.* (1999), the greater area used by *R. rattus* at Hakalau compared to those at my sites may be a result of fewer food resources at Hakalau. Den sites were also different between the two studies as all *R. rattus* den sites at Hakalau were only in trees above ground, whereas den sites at KHI were both in the ground and in the trees. Comparison of the habitat use data between these two studies also suggests that *R. rattus* at HON and KHI do not use trees as much as *R. rattus* in the wetter, higher elevation forest of Hakalau. With surprisingly high predation rates at KHI (40% mortality during 4 months of sampling), it is surprising that rats do not use the canopy more than the ground.

Rat Effects on Plants

Rats removed fruits of all four plant species (Table 2, Figure 3). Only rats were photographed removing fruit of *Pritchardia*; however, cameras were not triggered when *Pouteria* and *Sapindus* were removed at stations in KHI. This may be a result of fewer cameras deployed during the trial period at KHI. At least 25% were removed within 7 days and three of the four species had over 60% fruit removed during the study. More species with a wider range of fruit and seed traits will be tested to determine which qualities are most attractive to rats. A better understanding of seed fates will help uncover specific impacts of rats as seed predators and/or seed dispersers. These current findings show that we cannot ignore alien rats in island ecosystems as they have the potential to alter plant composition through their effects on fruits and seeds.

Acknowledgements

This research was funded by the U.S. Army Garrison Environmental Division. I am particularly grateful for the cooperation and enthusiasm from the U.S. Army Environmental staff. Additionally, many people assisted me with this project's field work, including: Paula Capece, Don Drake, Michelle Elmore, Jakob Falk-Sorensen, Justin Fujimoto, Louise Giuseffi, Courtlin Holt, Steph Joe, Paul Klawinski, Ben Laws, Chris Lowrey, K. Nalani Mailheau, Bryce Masuda, Tia & Terry Meer, Steve Mosher, Jan Nakamura, Richard Pender, Derek Rueber, James Russell, Craig Shallahamer, Josh Shiels, Alex Wegmann, Laura Weiss, and Janet Wilmshurst

Goals for the next year:

-Begin analyzing rat diets: stomach contents and possibly stable isotope analysis from snap trapped rats. Analyze droppings for seed content.
-Continue to estimate rat abundance bimonthly at HON and KHI. Add MAK when pig free.
-Periodically use track tunnels at each site in attempt to associate live-trap densities with track tunnel activity.
-Continue field diaspore trials using exclosures and motion-sensing cameras at HON and KHI.
-Measure fruit/seed rain at KHI for 1 year.
-Set up plots to measure and permanently tag all plants >1 cm at all three sites.
-Begin captive feeding trials with rodents at Lyon Arboretum. I recently built a housing facility (see Figure 4) and received approval to conduct these trials during the next year.
-Take comprehensive exams.
-Submit *Pritchardia* manuscript, and begin preparing habitat-use manuscript.

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Table 1. *R. rattus* individuals with radio collars attached and tracked at Kahanahaiki during February to June, 2007.

Rat #	Sex	Den site	Max Den distance from trap	Tracking duration	Currently tracking	Reason dis-continued
.111	Male	Tree	81 m	62 days	No	Battery died
.1717	Male	Tree	89 m	65 days	No	Battery died
.212	Male	Ground	22 m	164 days	Yes	-
.0524	Male	Tree	38 m	60 days	No	Killed/ predation
.152	Female	Ground & Tree	7 m	50 days	No	Killed/ predation
.191	Female	Ground	145 m	40 days	No	Collar malfunction
.013	Female	Ground & Tree	31 m	78 days	Yes	-
.032	Female	Ground	20 m	8 days	No	Collar malfunction
.1324	Female	Ground & Tree	26 m	34 days	No	Killed/ predation
.0725	Female	Ground	39 m	14 days	No	Killed/ predation

Table 2. Fruit characteristics of the four native Hawaiian species used in the field trials (Mean ± SE; N = 4-20).

Species	Family	Mass (g) (fresh)	Length (cm)	Width (cm)	% water content
Pouteria sandwicensis	Sapotaceae	16.05 ± 1.91	3.42 ± 0.09	2.63 ± 0.09	62.48 ± 1.07
Pritchardia affinis	Arecaceae	6.15 ± 0.32	2.48 ± 0.04	2.15 ± 0.04	25.65 ± 0.91
Pritchardia hillebrandii	Arecaceae	2.50 ± 0.09	1.72 ± 0.02	1.69 ± 0.03	26.69 ± 0.79
Sapindus oahuensis	Sapindaceae	5.42 ± 0.44	2.90 ± 0.10	2.31 ± 0.08	28.90 ± 3.29

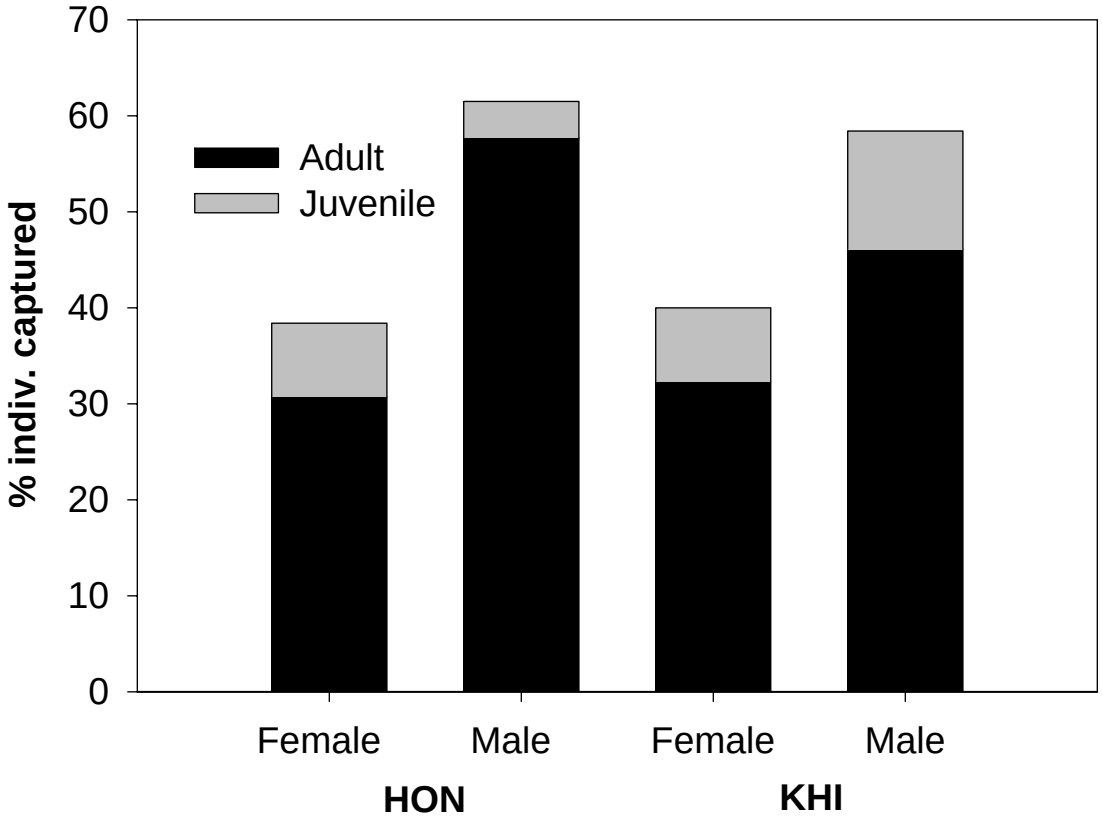


Figure 1. Proportion of adult and juvenile rats (*R. rattus*) captured at Honouliuli (HON) and Kahanhaiki (KHI) from February through April, 2007.

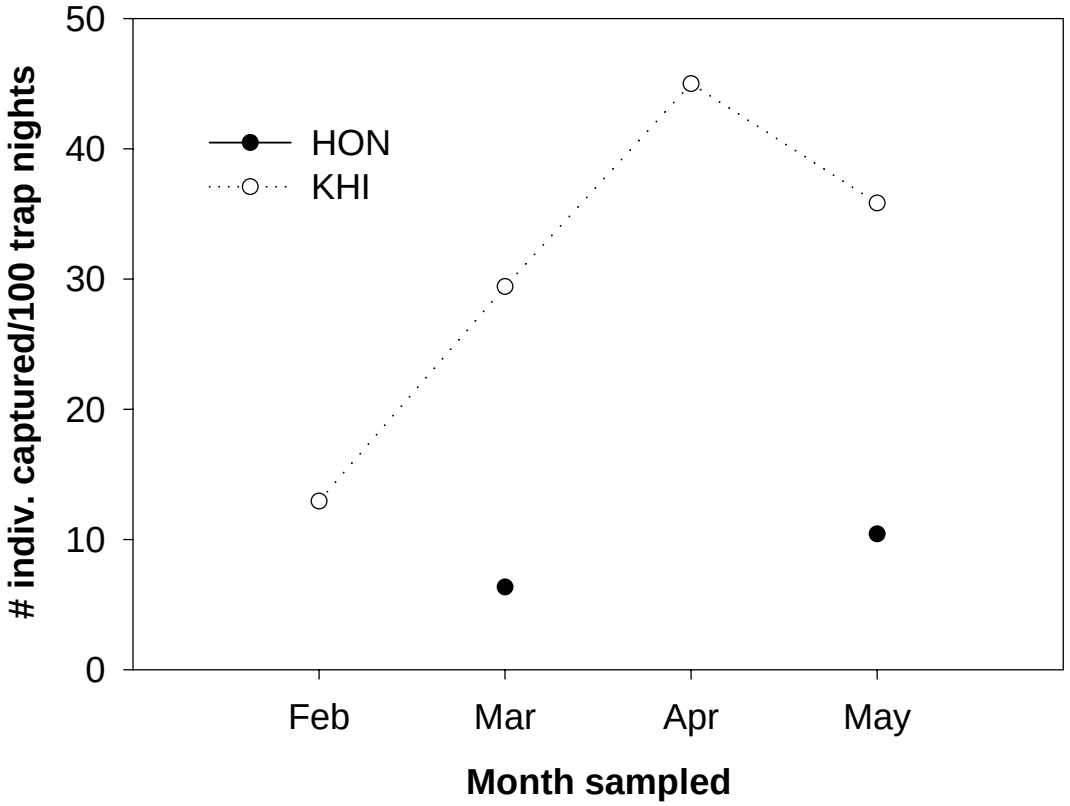


Figure 2. Capture rates (# indiv./100 trap nights) for *R. rattus* at HON and KHI during 2007.

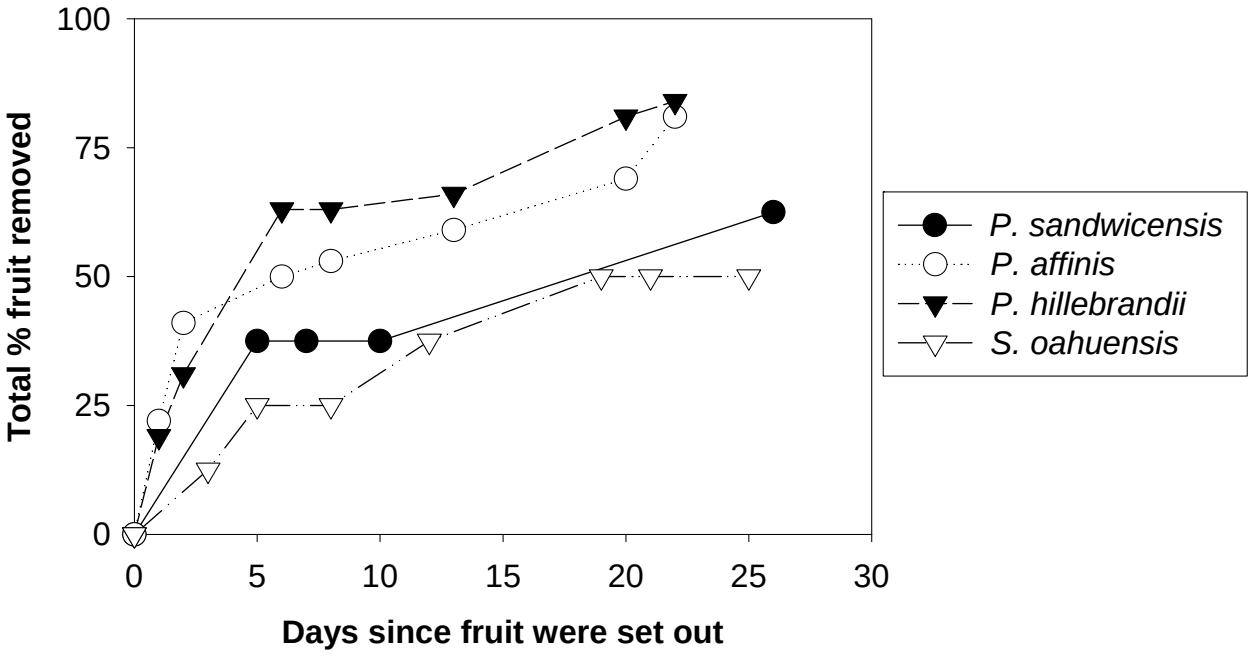


Figure 3. Total fruit removal from the forest floor of four native Hawaiian species (*Pouteria sandwicensis*, *Pritchardia affinis*, *Pritchardia hillebrandii*, *Sapindus oahuensis*). Trials for both species of *Pritchardia* were conducted in wet forest at Lyon arboretum, whereas trials for *Pouteria* and *Sapindus* were conducted in mesic forest at Kahanahaiki.

Figure 4. Relevant photographs and descriptions from field and laboratory.

Rodent Capture and Processing at Field Site

(Left) Photo of feral black rat (*Rattus rattus*) at field site. (Right) Anesthetizing procedure: a rodent trapped in a live-trap is placed in a large ziplock bag with a cotton ball containing isoflurane. The condition of the rodent can be easily monitored through the clear bag. This procedure allows for easy transfer to suspended rodent cages.

Laboratory Facilities – Lyon Arboretum Rodent Housing Facilities (LARHF)

Upper: (Left) Workshed at Lyon Arboretum. Notice padlocked door & screen-covered windows to allow airflow. Water spigot is on the far right side of this building. (Middle) Plastic partition that separates Lyon employee workspace from the rodent-housing facilities (located on the far side of the partition). (Right) Rodent-housing facility. Partition lets some ambient light penetrate.
Lower: (Left) Rodent hanging cages and plastic shelving. All wall-space is lined with black plastic. Notice the floor is gravel beneath the cages. (Middle) Close-up of cage showing removable pan for rodent waste collection and the cage's suspended flooring. (Right) Supplemental lighting and a fan to cool temperature (thermometer not shown) in the rodent-housing facility.

DROSOPHILA COLLECTING TECHNIQUES

Fly survey supplies:
<u>sheet sponges</u>: avoid sponges that claim they resist bacteria or are 'treated'; these will 'kill' the bait

based on experience flies appear to favor pink & yellow over blue & other colors

K Mart & Don Quixote have a version with little waffles on surface, this seems to help hold the bait juices

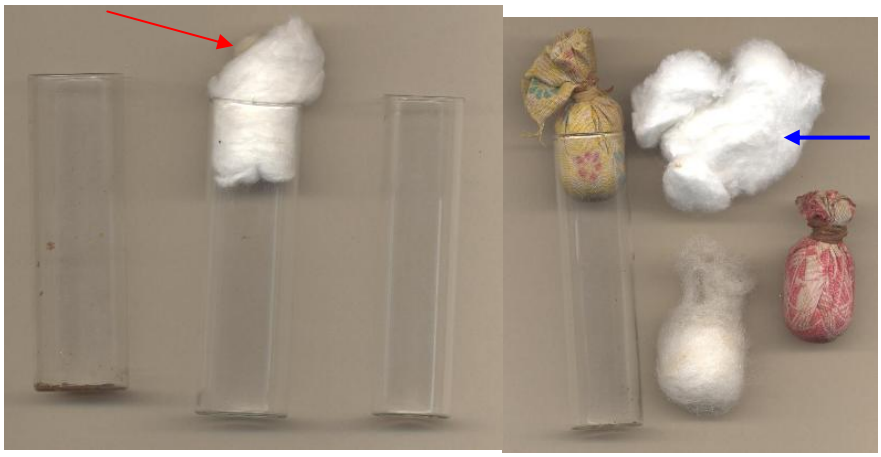
Cut sponge in half to make two oblong strips

<u>Yeast:</u>
classic or faster rising "rapid" as used in bread machines are both OK

<u>Bait base</u>:
two bait 'flavors' are proven attractants:
Banana baby food (commercial puree)
Mushrooms, aged white button type

<u>Vials</u>: glass works well, tubes should be long, kept very clean (so fly doesn't see them coming)

<u>Plugs</u>: raw cotton (red arrow) works well to keep fly in & ants out; if other material are used (e.g., bleached cotton such as comes in medicine bottles, blue arrow), a cotton cloth cover can make the plug tight



Other equipment:
Hand lens

Aspirator

Sweep net w/medium length handle

Bait Recipes:

Mushrooms, fresh white button type (flies don't seem to like the fancy mushrooms varieties or reconstituted dry types)

Allow to age at room temperature for about 5 days

Be sure to keep mushrooms in double bagging to prevent the alien flies getting into them & laying eggs; keeping them in sunlight also helps; if you are in a hurry, to speed up the process approach produce clerks & ask for discarded mushrooms, but ones with active mold are not good!

After aging, before use add bread yeast, allow mixture to grow and develop for about 1 hour.

Squeeze juice out; whole mushrooms may be placed on sponge to act as reservoirs of 'flavor'. These are easily retrieved when removing the sponges. The mixture & mushrooms can be recycled several times until they quit attracting.

Banana baby food (commercial puree); mix in yeast sprinkled over baby food [<u>be sure it has room to expand</u>] about 1 hour before use

Host plants to look for*: Pisonia, Charpentiera, Urera, Pleomele*
Sap exudates of *Acacia koa, Myoporum* / naio, *Nestegis* / olopua, *Sapindus* /aulu, lonomea
This might include looking under bark or at rotting parts of the plant favored by species for egg laying or larval stages.

If sap is oozing onto ground, collect any wet soil as this may include eggs or larvae

Watched for the large and visible Kamehameha butterfly (*Vanessa tameamea*) which may feed at the same sap exudates and fluxes known as host to *Drosophila* larvae. The aerial ballet of the Kamehameha provides an easily spotted guide to *Drosophila* nurseries.

Bait site choice:
GPS the bait station area

Find a shady spot without a strong breeze; preferably near rotting larval substrates as these are known breeding site for flies (soft tissue decay in Pisonia trunk, Charpentiera, Urera, Pleomele)

Tack sponge to plant with office push pin (or similar) at eye level where you will be able to see the sponge & collected off it easily

Spread the bait on strips of sponge; dispensing from squeeze bottle worked well (for example, a cleaned mustard bottle)

Other options are to spread bait thinly on sponges using tongue depressor or back side of plastic knife, or similar flat but dull utensil

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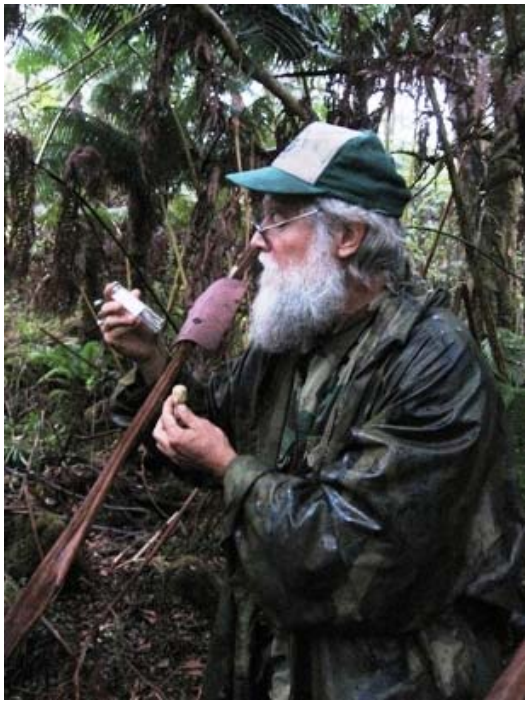

Collecting: check baits on a periodicly in a line or loop; Photograph flies on sponge with date / time stamp ON

Approach sponge with open vial and stealthily cover fly quickly with vial, insert plug

Keep vials cool, do not allow to overheat or get too cold to keep flies alive, transfer them to a sugar / agar vial to provide nutrition

Note taking: record the following

Weather

overall forest conditions
any specifics at bait locations
changes during the collecting period

Collection codes

For flies that will be reared in lab stocks, it is recommended to contact the University of Hawaii fly lab[1] to coordinate a system of note taking and a stock control number reference system to ensure consistent information is collected in a way most useful in future studies.

To understand factors affecting native fly survival

Record response by alien flies to baits (competition, predators)
Host plants and competing alien plants
Potential larval breeding sites
Overall forest botanical diversity native & non-natives
Non-fly native and non-native invertebrates, birds, mammals
Signs of enemies of native species such as rats, pigs, goats, deer, etc.

Collateral Activities

To extent practical pull weeds or liberate host plants from competitors

[1] University of Hawaii, Center for Conservation Research & Training, 3050 Maile Way, Gilmore Hall

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