2005 STATUS REPORT

MAKUA IMPLEMENTATION PLAN
ISLAND OF OAHU

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Executive Summary and Introduction

The Makua Implementation Plan (MIP) was finalized in May 2003. In January 2005, the Army submitted an Addendum which emphasized management of three population units (PUs) per plant taxon. In the last year, management has been initiated based on the priority actions put forth in this Addendum. This report serves as the annual status report to the Makua Implementation Team (MIT), and participating landowners on the MIP actions that have occurred between September 1, 2004 and August 31, 2005.

Current status of the Implementation Plan

The Army sent the MIP Addendum to the USFWS in January of 2005 with a request for their concurrence. The MIP Addendum is a re-prioritized version of the Final 2003 MIP with emphasis on the bottom line requirements for stability as stated in the 1999 Biological Opinion for training at Makua Military Reservation (MMR). It was written to guide Army efforts towards the MIP given limited funding and resources. At the January 2005 MIT meeting, the management priorities outlined in the Addendum were discussed. Changes were made to management priorities according to recommendations by MIT members.

In September of 2004, the USFWS issued the third Biological Opinion (BO) related to MMR training since 1999. This BO covers critical habitat designated within the Mākua Action Area (AA) for O‘ahu plants and O‘ahu ‘Elepaio. The USFWS is currently working on another BO for Mākua Valley which will analyze the use of additional weaponry at Mākua Valley and the Addendum. The Biological Assessment submitted by the Army initiating this consultation includes a change in the Mākua AA based on new fuel modeling results. The fourth BO related to MMR is expected in the spring of 2006. If the AA changes, it will have a significant effect on the species requiring additional stabilization. The MIP Addendum will be used to guide management until this BO is finalized.

The Army currently has Memorandums of Understanding (MOU) with Board of Water Supply (BWS) and The Nature Conservancy (TNC) to do management actions on their lands. These partnerships are proceeding well. At this time, the Army has one full-time person working at TNC doing MIP management actions at Honouliuli, and the Army is working with BWS on the environmental assessment for a large fence in Makaha and conducting weed control under a BWS Chemical Agreement Form signed June 2005. The Army is still pursuing MOUs with Dole Foods, Kamehameha Schools and the State of Hawai‘i (State). The Navy and Dillingham Ranch are not interested in participating in the MIP, and management actions have been revised to exclude these landowners.

The permitting and MOU situation with the State of Hawai‘i is worth special discussion and attention by the MIT because approximately 44% of the lands involved in the MIP are State of Hawai‘i lands, and no formal relationship has yet been established between the Army and the State. The State of Hawai‘i has been a participating member of the MIT since October 1999. The Army submitted a draft MOU to the State in December 2002. It was sent to the DOFAW administrator at that time and he did not respond formally regarding the MOU. At an MIT meeting in May of 2002, the Division of Forestry and Wildlife Administrator stated that they did not wish to sign until the Final MIP was approved. In the time between that meeting and August of 2004, the Army began coordinating informally with Natural Area Reserve System (NARS) staff on field projects. As coordination requests increased, the need to formalize the relationship became more pressing. In August of 2004, the State asked the Army to apply for a Natural Area Reserves Special Use Permit. The Army submitted this application in December of 2004, which became the topic of discussion at two of the Natural Area Reserve Commission Meetings since that time. The Army was asked to provide addition information to the State to help them approve the special use permit and the Army did so in June 2005. The Army was under the impression that once this information was provided, the NARS special use permit would be on the next NARS commission meeting and up for approval at that time, however, in July of 2005, the Army was asked to halt all work on State lands. On September 12, 2005 draft permits for work on State lands (including Forest Reserves, Natural Area Reserves, and a T&E Collection permit) were provided to the Army. The Army provided comments on these draft permits during October 2005. The Army has returned to work on State lands on a month to month basis on those actions that are considered urgent actions, such as rat baiting and weed control. Regardless of the outcome of the permitting process, it has become evident that there are some very important management objectives outlined for PUs on State lands in the MIP that the State does not agree with (i.e. weeding in certain areas, reintroductions, and collection of any plant material other than seeds from plants on State lands). Once the permits are granted, the Army will need the help of the IT to help determine the effect of any limitation imposed by the State on the potential success of managing the PUs on State lands. For the good of the native resources on State controlled lands and the success of the MIP, the Army will continue to work with the State towards securing a permit and developing a mutually agreed upon Memorandum of Understanding.

Also worth special discussion is the management future of Honouliuli Preserve. In January 2007, Campbell Estate is dissolving and liquidating its assets, Honouliuli Preserve included. In addition, at this juncture, the Nature Conservancy is planning to hand over management of the Preserve to another conservation-minded organization. They are currently fund-raising for the purchase and seeking a willing group to assume management of the Preserve. Honouliuli is a cornerstone in MIP management.

Natural Resource Staff (NRS) have drafted an Environmental Assessment (EA) for the MIP. This draft is being routed for signature within the Army Command. NRS hope to finalize this EA in the spring of 2006 and will be holding two open houses per the State's request. The intent of these open houses is to present MIP actions to the public with particular emphasis on proposed actions on public lands. Following the draft EA submittal, a Conservation District Use Application will be finalized and submitted.

<u>Status of fire management</u>
The Army has hired a fire management crew of five personnel as of September 2005. This fire crew will be on site at MMR for every training event. This crew will be working with Natural Resources Staff to assess fire threats at MIP management units. Additionally, fire management plans are being written for individual MUs by a fire analyst with Colorado State University.

This summer was a challenging fire season which began in May with a fire in Nanakuli. The cause of the fire was determined to be arson. This fire burned from the lower reaches of

Nānākuli in the direction of the Palikea MU, Honouliuli Preserve. Included in the Appendix is a Memorandum for Record (MFR) written about the fire response that occurred and outlining lessons learned. The Army assisted TNC in pre-suppression activities along the Palikea ridge crestline. The Army also hired Pacific Helicopters to fly water drops for almost an entire day at a cost of $12 K.

In August 2005 a fire occurred at MMR. It started within the south firebreak road and jumped the road to the southwest. The fire burned to the edge of the Lower *Chamaesyce* patch in the Lower ʻŌhikilolo Management Unit (MU) before it was stopped by fire fighting crews. In addition, this fire burned within the south firebreak just below the *Hibiscus* PU. Fire crews were able to keep the fire from crossing the road at this point. The cause of the fire was a white phosphorus dud that heated up and spontaneously combusted (see Appendix).

In early September, another fire started at the base of the main ʻĒkahanui MU trailhead. It burned in a forested area consisting mainly of Eucalyptus trees and was successfully halted. A total of 170 acres burned. This fire threatened Oʻahu ʻElepaio most closely but also threatened the fence and resources within the ʻĒkahanui MU. The cause of the fire has not been determined.

A number of lessons were learned this fire season. The MMR fire was effectively fought with Army, City and County and Federal fire-fighting resources. The Army committed Natural Resource helicopter time to fighting both offsite fires at Palikea and ʻĒkahanui. There are some complications related to requests for Army assistance that are grounded in fire fighting resource chain of command. Army staff will work with the Nature Conservancy, Army Fire Chief and other fire fighting agencies involved to streamline the process to request Army support in fighting off-site fires that threaten MIP MUs.

Funding and staffing levels

There are currently 16 field staff and field supervisors (including one person at TNC and one ungulate specialist), one implementation project manager (currently vacant), one administrative assistant, one horticulturist, one horticulture assistant, one research specialist, one monitoring program manager, one seed conservation program specialist, one *Achatinella* propagation assistant, one tissue culture assistant and one database/GIS specialist contracted through RCUH to do natural resources work on Army training areas. Year one of the MIP Addendum required seven additional field technicians, one additional implementation project manager, and a community outreach specialist but currently there is not funding to fill these positions. At the January 2005 MIT meeting, hiring a Monitoring Program Manager was identified as the highest priority position to fill and in October the position was filled. The Monitoring Program Manager will establish a monitoring program as outlined in the Final MIP. Data from this program will aide in communicating the results of MIP management to the USFWS and the MIT.

Full implementation of Year 1 actions from the MIP Addendum required $3,344,000 in funding, including overhead. The program received approximately $1,525,000 last fiscal year for MIP projects. The Environmental program's budget was slashed in order to fund the 'War on Terror'. Space to house the required increase in staff is also a concern. The Natural Resource Center in

Schofield Barracks East Range is stretched to the limit. New personnel being hired must fit into the same space. Thus, the Army will continue to house additional people at the current facility until space issues are resolved. NRS will look at rental space off post in order to meet our space requirements. In the last year, the Army's devoted and hard-working field staff have actually proven to be more efficient than was anticipated in cost estimates. Over the last year, initial cost analyses indicate that NRS implemented 32% more work than was predicted of them at the current funding level. Cost estimates will not be adjusted until a few years of implementation are behind us and the Army feels confident that the costs were overestimated.

Fencing Costs

The MIP requires the construction of Management Unit ungulate fences. In the past, the Army has contracted out fence construction projects to private fencing companies. Over the last few years, there has been a dramatic spike in the cost of contracting ungulate fence construction in Natural Areas in Hawaii. Quotes far exceeding the estimates in the final MIP have been received from a number of different contractors. In order to reduce fence construction costs related to the MIP, NRS are hiring an in-house fence crew. This crew will also work on Oahu Implementation Plan MU fences. In the long-term this will provide a great cost savings and more control over fence construction.

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Chapter 1: Feral Ungulate Management

There are two species of feral ungulates that inhabit Army lands, pigs (*Sus scrofa*) and goats (*Capra hircus*). The goal of the Army's ungulate program is to eliminate the impacts of feral ungulates on endangered species and native habitats by excluding ungulates from the MIP MUs. This is primarily accomplished by constructing large-scale fences. Prior to the construction of the fences, NRS will 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. Transects are used to assess ungulate impacts and gauge the effectiveness of ungulate control efforts within the MUs. Most of the MIP MUs require a fence, but there are some that do not or are protected by natural boundaries. The need for a fence is indicated via shading per specific MU in the Table 1.1 below. 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.

Table 1.1 Management Unit Status

Management Unit	Fenced	Ungulate Control
ARMY CONTROLLED LANDS		
Kahanahāiki	Partial	Subunit I is complete and ungulate free. Subunit II is proposed for construction later. In the meantime, snaring is performed in this unit to keep pig pressure off of the Subunit I fence line and to protect the native resources in Subunit II.
Kaluakauila	Yes	The priority MU is fenced and ungulate free.
Lower ʻŌhikilolo	Yes	The ʻŌhikilolo ridge fence and the strategic fence are both complete and the area is ungulate free
Lower ʻŌpaeʻula	No	The Koʻolau Mountains Watershed Partnership has acquired partial funding for fence construction. EA has not been submitted.
ʻŌhikilolo	Yes	ʻŌhikilolo ridge fence is complete and it appears that most if not all of the goats have been eradicated. There are three smaller PU fences that are completed and ungulate free. A fourth PU fence is slated for construction in 2006. The Lower Mākua fence is slated for construction in Year 7.
Puʻu Kumakaliʻi	No	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES		
East Makaleha	No	A 230 acre fence is proposed for construction in Year 4, awaiting permission from the DLNR. Limited goat control is underway in Central and East Makaleha and Lower Kaʻala NAR under the direction of NARS staff.
Haili to Keālia	No	None
Kaʻena	No	None
Kamaile`unu	No	Two PU fences have been scoped to encompass two populations of *Sanicula mariversa* and are awaiting approval.
Keaʻau and Makaha	No	Small PU fence slated for construction in year 5 awaiting approval.

Management Unit	Fenced	Ungulate Control
Manuwai	No	MU fence is slated for construction in Year 8. Urgent action fence awaiting approval. Nearby goat populations are managed in the meantime.
Pahole	Yes	MU perimeter fence is complete and ungulate free.
Upper Kapuna	Pending	The final configuration of the MU has been changed to be made up of four subunits. NARS staff have committed to constructing Unit I 2005-2006. NARS staff have also requested NRS to complete the construction of the other subunits.
Waiʻanae Kai	No	Four small PU fences have been proposed to protect three populations of *Neraudia angulata* (also includes *Tetramolopium filiforme* and *Nototrichium humile*) and one population of *Hesperomannia arbuscula*.
West Makaleha	Partial	Two PU fences have been completed protecting populations of *Alsinidendron obovatum* and *Cyanea grimesiana*. Completion of the whole fence is slated for Year 2. NRS and NARS staff control a small herd of goats that reside on the boundary between this and the Pahole NAR.
THE NATURE CONSERVANCY OF HAWAII		
ʻĒkahanui	Partial	Subunit I was completed by TNC and is ungulate free. The EA has been completed for Subunit II and is slated for construction in Year 3. In the meantime several PU fences have been constructed to protect at risk species.
Kaluaʻa and Waieli	Partial/ Pending	Subunit III was completed by TNC and is ungulate free. A large portion of Subunit II A and C will be constructed by the end of 2005. Subunit II B is slated for construction in Year 10.
Palikea	Partial	Small PU fences have been constructed in both Subunits IA and IB. Both of these subunits are slated for construction in Year 5. TNC staff control pig populations until fences can be built
BOARD OF WATER SUPPLY		
Mākaha	Pending	Subunit I is slated for construction in Makaha 2005-2006. Subunits II and III are slated for construction in Year 5.
DOLE FOOD COMPANY, INC.		
Kaimuhole	No	A 100 acre fence is proposed for construction in year 6, pending permission from Dole Food Company, Inc.
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.

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 does not provide information on ungulate population dynamics and densities. However, they 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. In Mākua, NRS monitor eight transects to help guide ungulate control activities.

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

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

Feral Ungulate Control

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.

Shooting/Hunting
Shooting operations are mainly used to control goats. All operations are preceded by scouting expeditions.

Aerial Shooting
Aerial shooting only occurs 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. As goat numbers declined and they became more wary of the helicopter, the cost effectiveness of this tool has severely decreased. NRS plan to conduct 1-2 aerial hunts in MMR during 2005-2006.

Radio-tracking
Radio and satellite tracking has only been used at MMR. To date, NRS have deployed five radio collard and one satellite collard goats. Of the four originally collard in 1999, two were purchased and two were caught in Lower Mākua. The two purchased goats did not move from their drop point for almost two years until one jumped over the fence to Kea‘au and the other herded up with a nanny and kid. All three were subsequently shot. The snared goats immediately united with others and NRS were able to track them down to eliminate some of their herd one time. After this, NRS found it very difficult to locate either animal easily as they strayed quite a distance from the original snare spot. NRS could approximate their location but due to terrain and access issues were unable to make visual verification. Hunters with the USDA Wildlife Services (WS) never utilized the “Judas Goats” in any of their hunting trips.

In 2004, NRS contracted WS to capture goats in Keaʻau using a net-gunning from a helicopter. Two animals were captured and collard, one with a radio collar and the other with a satellite collar then released into the ʻŌhikilolo MU. Unfortunately, this operation did not work as the radio collard individual escaped back over the fence to Keaʻau and the satellite collard one was subsequently snared upon release. NRS are rethinking using this method in MMR but would like to explore the option in Lower Kaʻala NAR in the future.

Hunting with Dogs

The use of hunting dogs has been implemented in Kaluakauila, Kaʻala 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 areas. This technique can be used as a means of eradicating animals within a fenced area or lowering pressure along a fence line. In 2004-2005, a total of 13 hunts were performed resulting in the removal of 28 animals. This equaled roughly 300 volunteer hours and comes out to 2.15 pigs caught per hunt which is extremely high.

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. Fencing projects can be very slow to implement because of the associated paperwork. The Army has prepared an Environmental Assessment (EA) to cover all the actions in the MIP. Additionally, an umbrella Conservation District Use Permit (CDUP) has been sought for management actions planned over the next three years (CDUPs are only issued for three-year time periods). Until that time, fence planning is proceeding at the rate of one large-scale fence per year. NRS are also hiring an in-house fencing crew to offset the prohibitive cost of contracting.

NRS also realize the importance of having coordination with the hunting community, especially when fencing in or near a public hunting area. NRS does this through working with various hunting clubs and associations.

Army Controlled Management Units

Makua Military Reservation

Ungulate management activities within MMR include snaring, staff ground hunts, aerial hunts, fence construction and transect monitoring. Since control work first began in 1995 a total of 1,137 goats and 303 pigs have been removed from MMR. NRS began using aerial hunting in 2000 and has successfully removed 97 goats with this technique. To date, there are seven ungulate-free exclosures within the MMR barrier fence, which is about 18.8 kilometers of fence.

Unfortunately, due to the discovery of Improved Conventional Munitions (ICM's) in an old burn pit just outside the northeastern edge of the south firebreak road, NRS and Wildlife Services have been unable to access the lower portions of the ʻŌhikilolo MU. It is fortunate that NRS feel that the goat population within MMR is eradicated. Lack of incidental sign and sign along transects combined with no recent snare captures and observations by contract and NRS hunters corroborate this assumption. NRS are seeking ways to access the area to verify the assumption or at least increase the amount of snares in the area to offset the lack of hunter presence. It appears that it will be an uphill battle to regain permission for access. NRS is hopeful that access will be granted to fly to the camp site in order to avoid crossing the restricted zone.

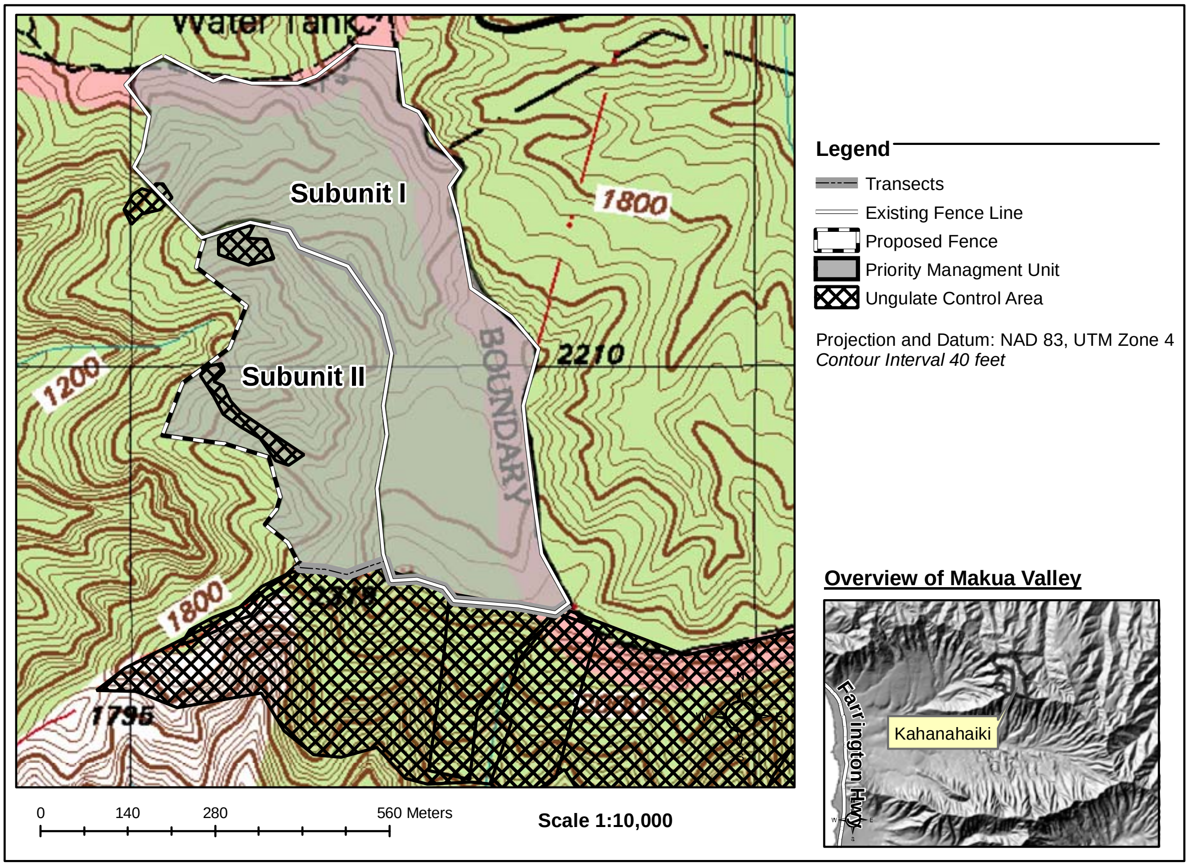


Figure 1.1 Kahanahāiki MU

Kahanahāiki

Subunit I has been completed and ungulate free since 1998. Ungulate sign is closely monitored along two permanent ungulate transects (MMR 10 and MMR 11) which run alongside the fence. Subunit II was considered a priority MU in the MIP Addendum, but since that time NRS has reassessed the value of the subunit. Only very small portions of the MIP PUs for *Alectryon macrococcus* var. *macrococcus*, *Cenchrus agrimoniodes* var. *agrimoniodes*, *Hedyotis degeneri* var. *degeneri*, and *Flueggea neowawraea* fall within this subunit and NRS has secured genetic material most of these taxa. In addition, the habitat within the subunit has been severely altered. Strawberry guava (*Psidium cattleianum*) and Christmas berry (*Schinus terebinthifolius*) dominate the canopy so only a very small portion of this subunit contains much native habitat. In order to protect the resources still extant within the subunit a total of four snare groups have been installed. These groups have been very effective, removing 155 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 200 animals (120 goats and 80 pigs)

Initially, there appeared to be a downward trend in the percent of ungulate sign observed (Figure 1.2) that seemed to be associated with removal. Data is collected on sign both inside and out (O) but for simplicity the graph only represents the latter. Since the initial decline in sign, catch rates as well as sign along the transects have remained constant with several spikes being observed in both. These spikes appear to be associated with both the winter-spring breeding season and the Kuaokalā Game Management Area (Unit A) Mokulē‘ia Public Hunting Area (Unit E) hunting season with dogs, which begins in August. There were no breaches in the fence this year.

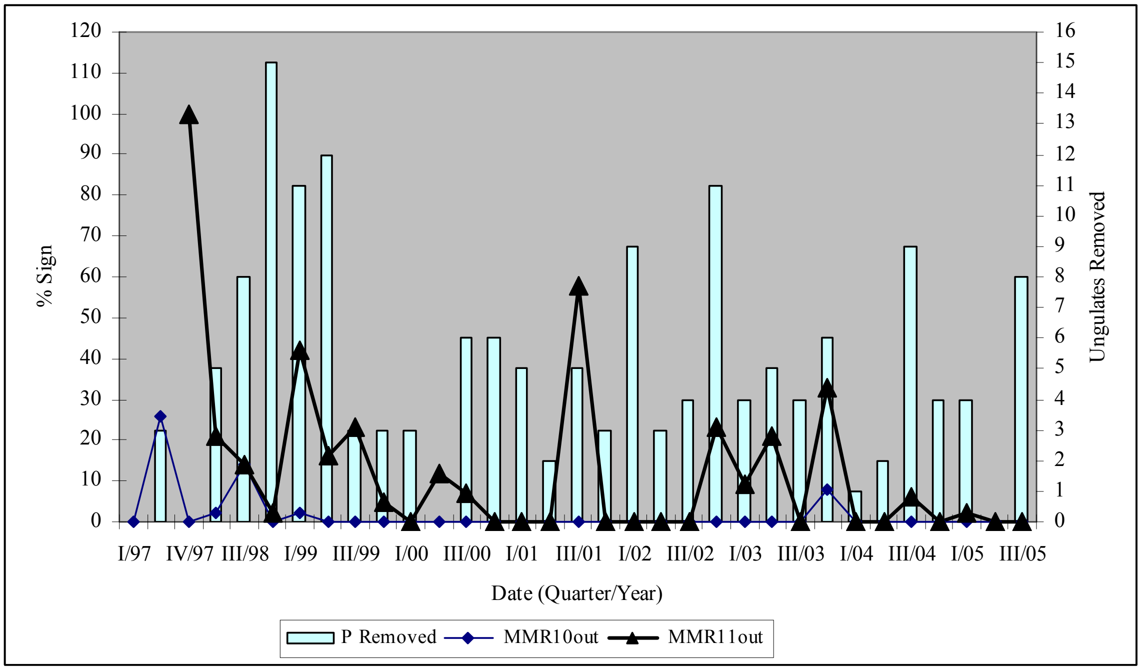


Figure 1.2 Kahanahāiki Ungulate Management Record

Kaluakauila

A 110 acre pig free exclosure was completed June 2002 protecting the priority Kaluakauila MU. Monitoring for ungulate activity takes place quarterly along two permanent ungulate transect (MMR 2 and MMR 12) which run alongside the fence (Figure 1-4). For MMR 2, data is collected on sign both inside and out and is denoted as in (I) and out (O) respectively. There does not appear to be any correlation between pig activity and removal. It appears that there is always seems to be a constant influx of animals to the MU probably because it is the wettest area in that part of the island. There also appear to be spikes in activity in quarters II and II which are probably associated with the fruiting season of *P. cattleianum*.

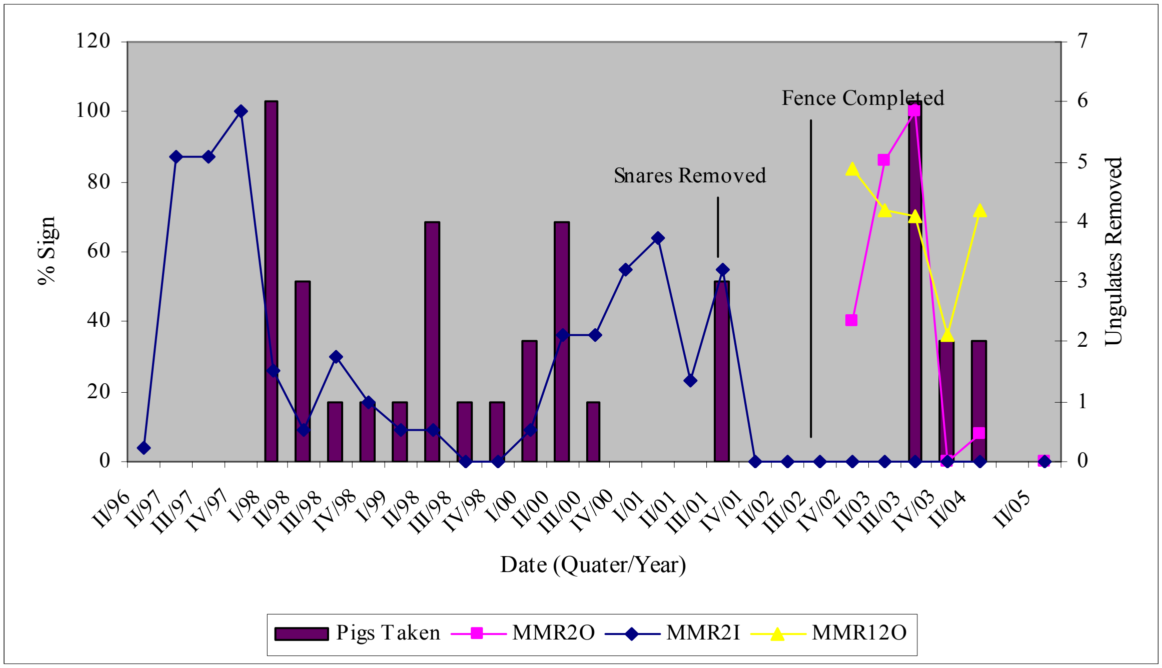


Figure 1.3 Kaluakauila Ungulate Management Record

In March 2005, about 50m of fence was severely damaged by a large landslide that allowed pigs to breach the exclosure. The fence was subsequently repaired. Due to the numerous rock slides that occur here, NRS constructed a deflective shielding fence above a 20m portion of the existing fence. NRS used stock panels for the repairs and shield. They are more solidly constructed and a lot stronger than the current hog wire fencing material and NRS believe this will greatly reduce the potential for rockslides to damage the existing fence. Pig sign has not been observed in the fence since repairs were completed. Once repairs were made snares were set just in case and no catches were made.

<u>Lower ‘Ōhikilolo</u>

A strategic fence protecting an endangered population of *Melanthera tenuifolia* was erected in June 2002. NRS later found that the goats were still able to get around the fence by jumping across a crevasse. Once the fence was extended further the goats were unable to make the jump. No breaches were observed over the past year but malicious fires originating along Farrington Highway burned close, which seems to be an annual occurrence. A prescribed burn in 2003 that was intended to clear about 900 acres of alien dominated grasslands within the firebreak roads jumped the firebreak and ended up burning approximately 2100 acres. Fortunately, alien grasses and other introduced weedy species dominated a very large portion of the area burned. Unfortunately, the fire compromised the galvanized coating on the perimeter fence in this MU, which makes the fence more susceptible to corrosion.

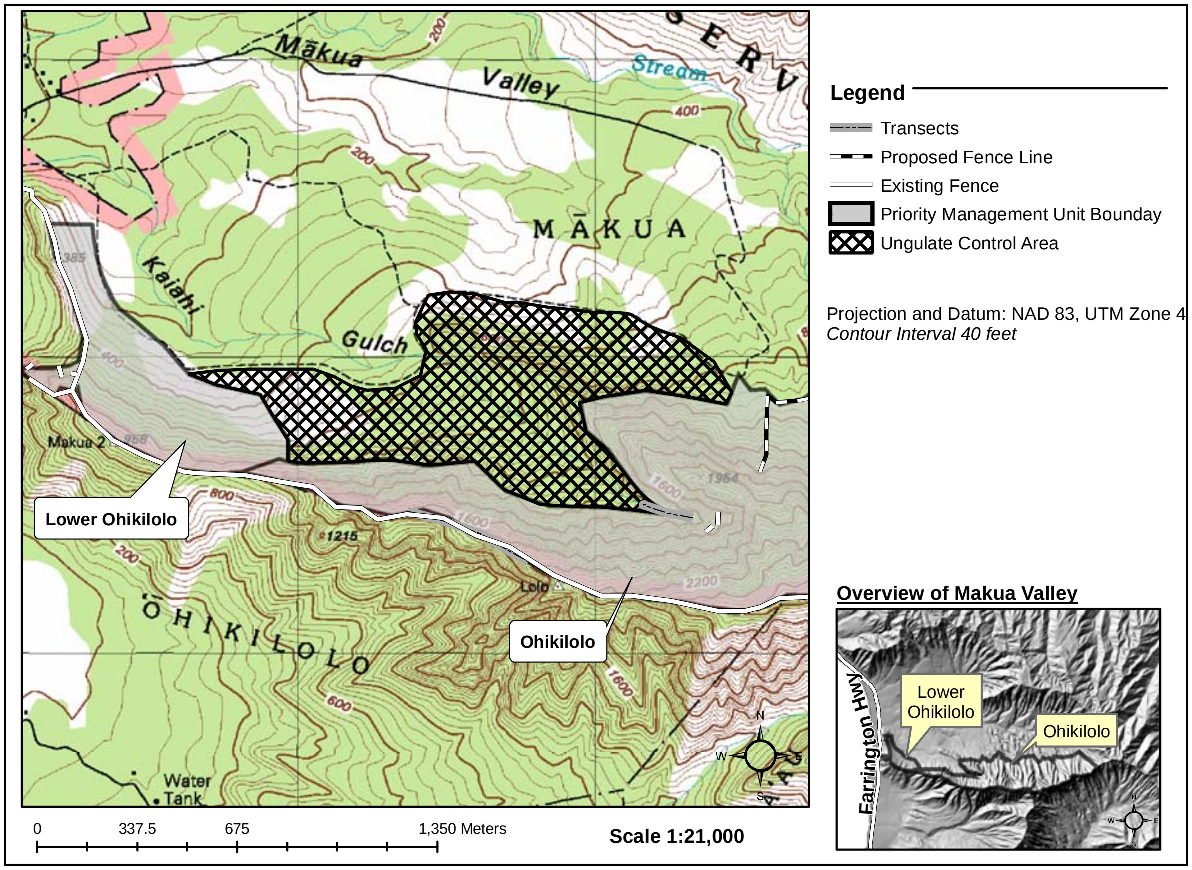


Figure 1.4 Western half of ʻŌhikilolo MU

<u>ʻŌhikilolo</u>

There is a perimeter fence that was completed in 2000 that separates the MU from the adjoining ʻŌhikilolo Ranch and Keaʻau Game Management Area to the south, which have large populations of feral goats. Presently, there are also three PU exclosures within the MU; one strategic, built in 2003, that protects a population of *Neraudia angulata*, one built in 2004 that encompasses a population of *Pritchardia kaalae*, and in 2005 two strategics were built in the very back of Koʻiahi gulch that protect two populations of *N. angulata*. All these exclosures have remained ungulate free and are checked quarterly. A fourth PU exclosure is slated for construction for 2006. This new PU fence will encompass a reintroduced population of *P. kaalae*. NRS also constructed a small enclosure that encompasses about two acres of high quality intact native forest and *Achatinella mustelina* habitat in 1999. In order to better graphically represent the MU, NRS split the area into eastern and western halves (Figures 1.4 and 1.5).

NRS have employed several different control methods over the years to eradicate goats from this MU and the adjoining ungulate control areas (UCA) to the east and west. These control methods include aerial hunting, hunting, radio-tracking, and snaring. Since control began in 1995, a total of 659 goats and 40 pigs have been removed from this MU. The two UCAs have had 396 goats and 52 pigs removed. To date, NRS believe that feral goats have been eradicated from this MU. This consistent with the lack of incidental observations, lack of sign on any of the transects, and the fact that NRS have spent several days scoping different areas of the MU and the adjoining UCAs. Due to this, NRS have opted to remove all of the snare groups except for a couple in the more remote regions of the western half of the MU. Once access restrictions are eased NRS will focus more attention on the ground in these areas to install more snare groups if deemed necessary. NRS will also contract WS to conduct at least one aerial hunt this year to better survey the inaccessible areas.

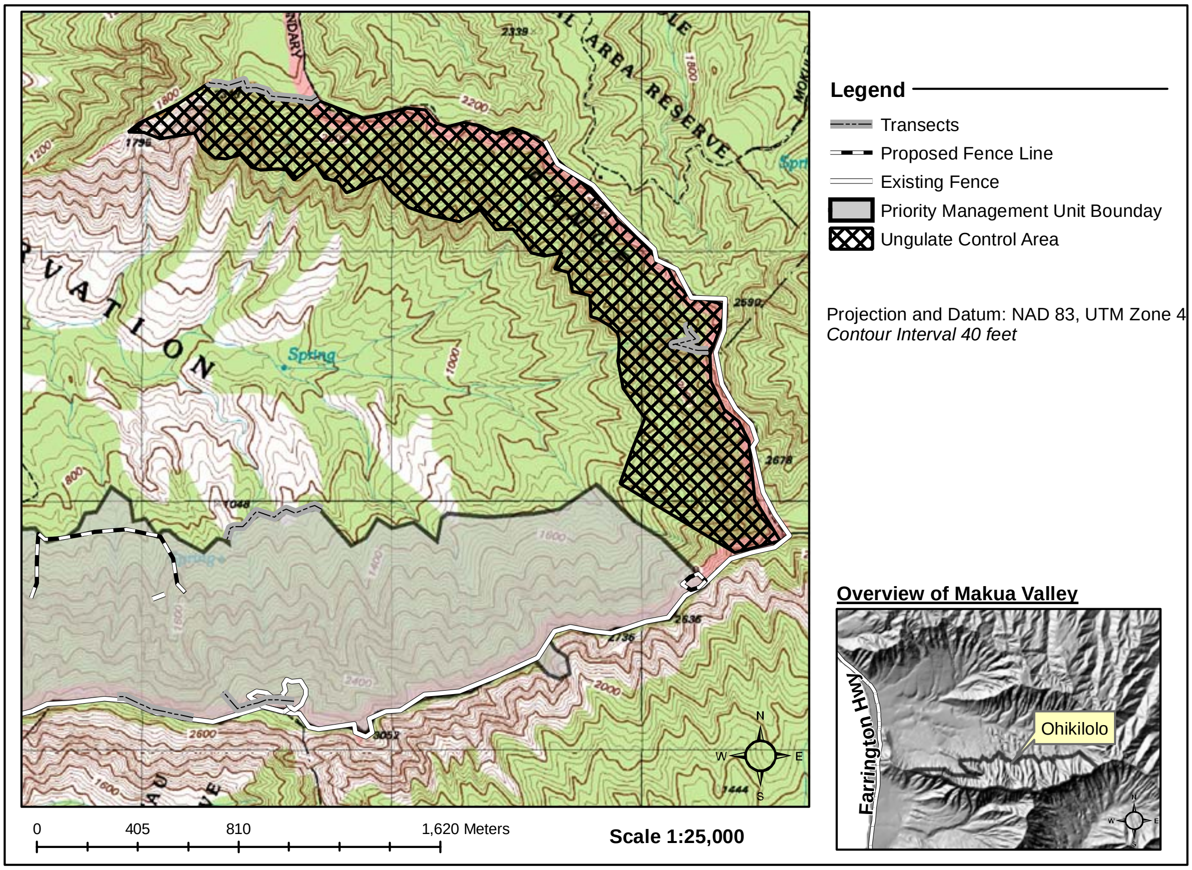


Figure 1.5 Eastern half of ‘Ōhikilolo MU

Monitoring of ungulate activity in ‘Ōhikilolo MU occurs quarterly along three permanent ungulate transects (MMR01, MMR08, and MMR09). Data is collected on percent sign both inside and out of the forest patch fence for MMR01 and of the perimeter fence for MMR 08 and MMR09. Transect data (Figure 1.3) indicates a steady downward trend in goat activity. There have been a couple of breaches in the fence since completion in 2000, once in 2003 and again in March 2005. NRS were able to repair the breaches and the goats were eliminated. No goat sign had been detected along the perimeter fence before this since quarter III of 2004.

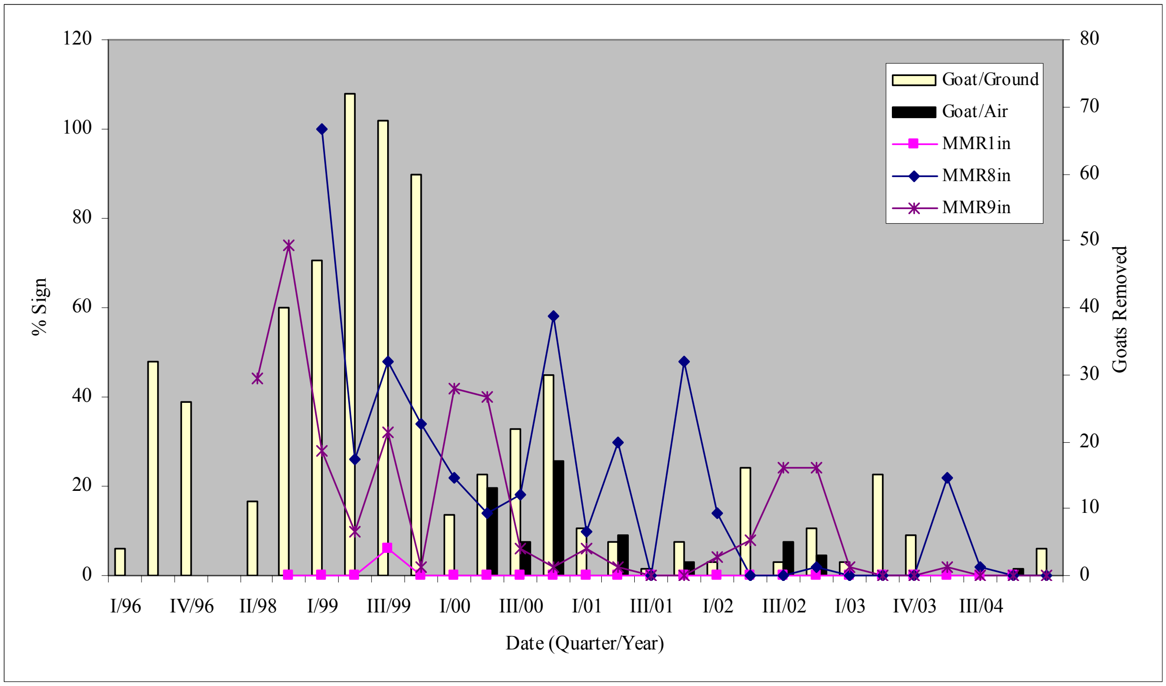


Figure 1.6 ʻŌhikilolo Ungulate Management Record

Kawailoa Training Area

Lower ʻŌpaeʻula
A 1,240 m MU fence is proposed to protect a population of *Cyrtandra dentata* and will include several OIP species in the mid-elevation Koʻolau Mountains (Figure 1.7). An EA has not been submitted for the fence as of yet but a portion of the money needed for construction has been earmarked by the Koʻolau Mountains Watershed Partnership (KMWP). KMWP have created a position for a hunter liaison to escort hunters into selected areas to help control feral pig populations. At the moment KMWP is working with the Army to gain access into the portion of Kawailoa Training Area (KTA) above Waimea Falls Park, which is owned by The Audubon Society. In the future both NRS and KMWP staff feel that this hunting program would be very beneficial to other areas within KTA that are owned by Kamehameha Schools. This could be a win-win situation for all concerned parties involved. The land owners and leasers will get the benefit of pig control at a minimal cost while the hunters will be able to access hunting areas that have been closed off for several years.

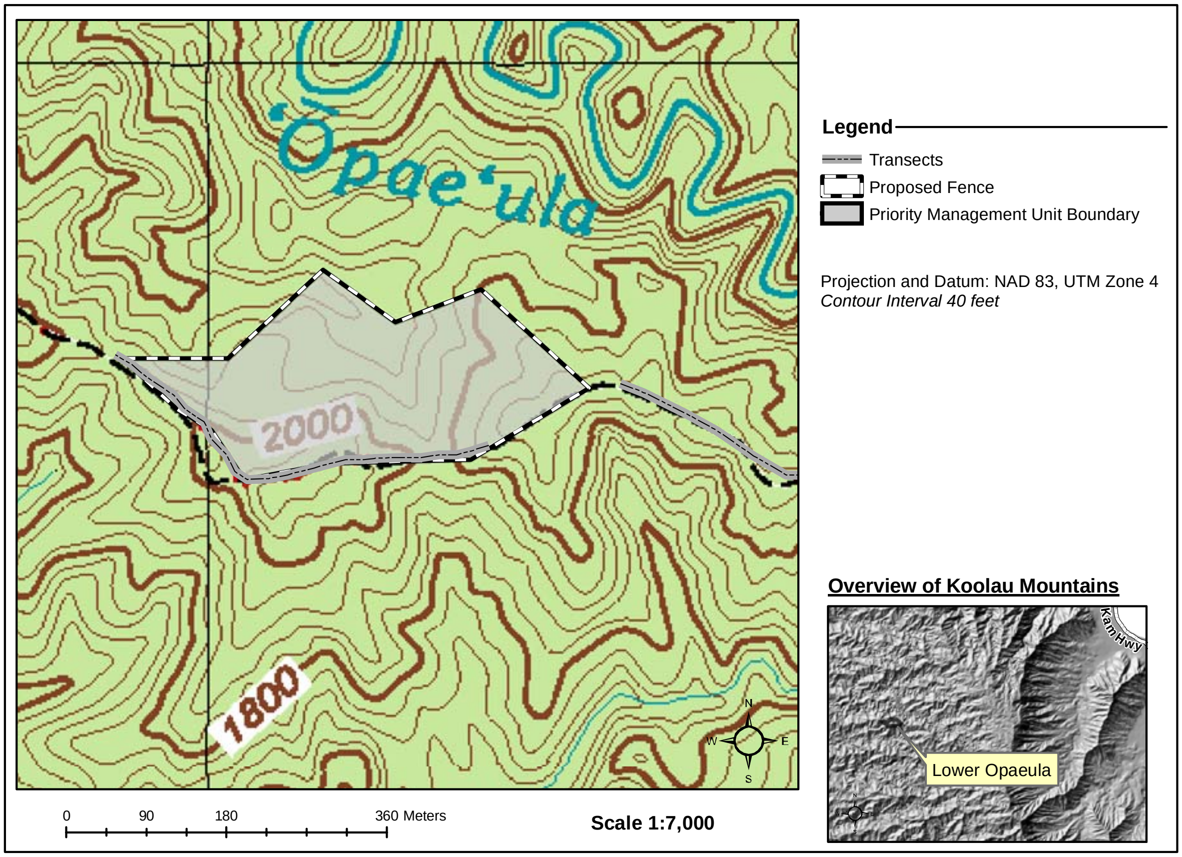


Figure 1.7 Lower ʻŌpaeʻula MU

Offsite Management Units

State of Hawaiʻi Department of Land and Natural Resources

NRS believe that the goat populations in the Mokulēʻia Forest Reserve originated from two goat ranches located in the Waiʻanae Mountains. According to sources familiar with the Waiʻanae Mountains, in the past, goats were either non-existent or present in very small numbers outside these "source" areas. Only recently have they become more established in Schofield Barracks West Range (SBW), Lower Kaʻala NAR (LKN), Makaleha, and Mākaha. Since 1995, NRS have observed an increase in the goat population within all of these areas and of late an increased amount of pressure on Pahole NAR. Due to this NRS has worked with NARS staff to implement control measures within the Mokulēʻia Forest Reserve. Immediate concern was focused on the population within the LKN as it was the largest and seemed to be the core. With the steep decline in goat numbers in LKN, NRS and NARS staff have now begun to focus a little more attention to the populations within Makaleha. NRS hope that this control work can continue in the future when the Memorandum of Agreement is signed.

East Makaleha

A 230 acre MU fence is slated for construction in Year 4 of the MIP (Figure 1.8). An EA and approval from DLNR must first be secured. In the meantime, to lessen the impacts of feral ungulates on the target species of the MU, limited hunting is underway in Central and East Makaleha and Lower Kaʻala NAR and a snare line is maintained along the border with SBW. All hunting efforts are directed by NARS staff. To date, a total of 240 animals have been removed from the Lower Kaʻala NAR since the hunts and snaring first started in 2000. Unfortunately, control work is just beginning in Central and East Makaleha. Since October 2004, only nine animals have been removed from these areas. NRS and NARS staff have been focusing more effort on scoping for ungulates in these areas to get an idea of the movements and composition of the herds. These areas are going to pose a major challenge for control work as the herds are quite small and discreet. These groups also have a tendency to spend more time down in the forest, as opposed to the ridge tops, which is more typical behavior. NRS would appreciate the chance to discuss alternative methods of control (snaring, aerial hunting, and radio collars) with the Wildlife and Forestry staff since this area comes under their jurisdiction.

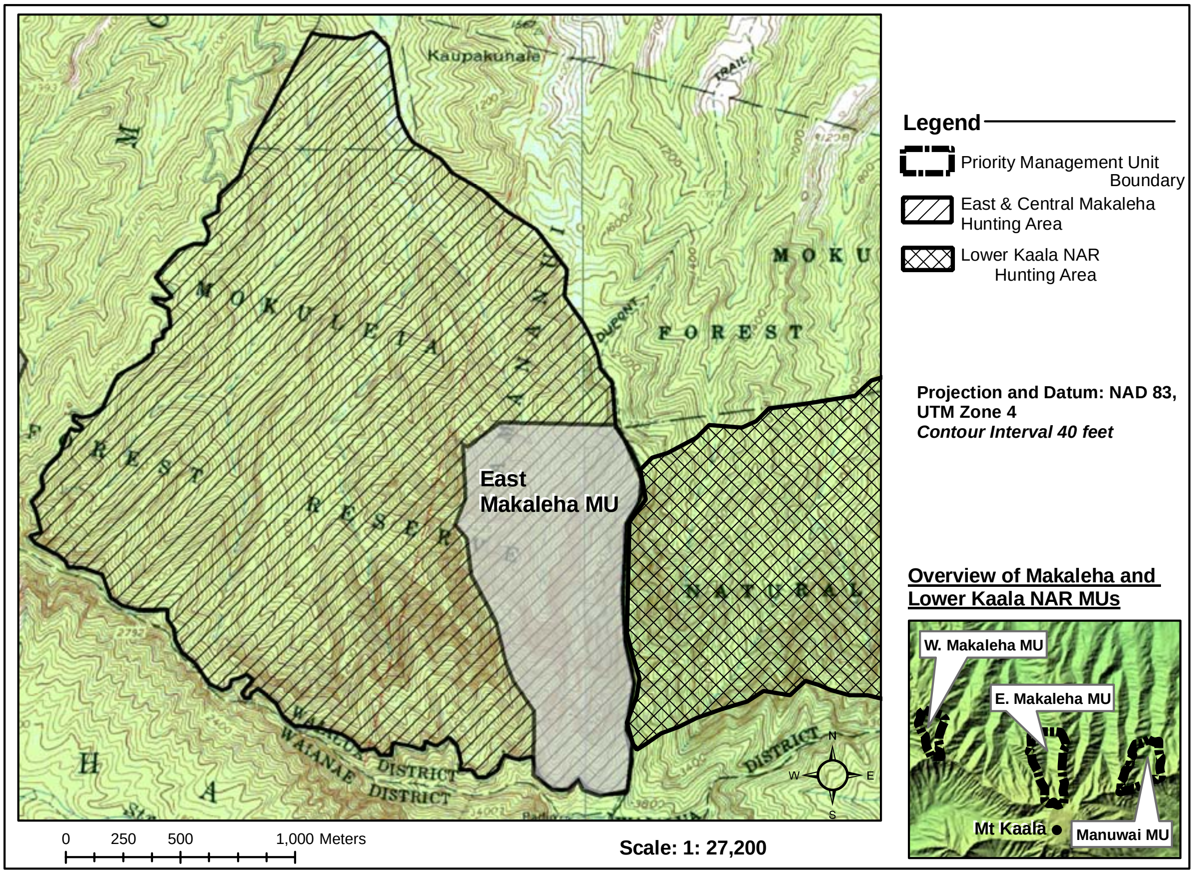


Figure 1.8 East Makaleha MU

Kamaileʻunu

Two small-scale fences have been proposed to protect *Sanicula mariversa*. One fence is near Puʻu Kawiwi and the other near Puʻu Kēpauʻula. The two fences are 176 m² and 2025 m² respectively. These fences will be constructed concurrently with the larger exclosure in Mākaha in late 2005-early 2006.

Keaʻau and Mākaha
A proposed PU fence is slated for construction in year 5 of the MIP. It will protect a population of *Sanicula mariversa* inside the Keaʻau Game Management Area.

Manuwai
A MU fence is slated for construction in Year 8 of the MIP. In the meantime, to lessen the impacts of feral ungulates on the target species of the MU, limited hunting is underway in LKN and a snare line is maintained along the border with SBW. All hunting efforts are directed by NARS staff. To date, a total of 240 animals have been removed from the Lower Kaʻala NAR since control efforts first started in 2000.
In August 2003, NRS wrote a letter to DOFAW for permission to fence a small population of *Neraudia angulata* within this MU. Of the 12 plants first seen in March 2003, only two were still extant in June 2004 because of impacts from feral goats. To date, NRS have yet to receive any word on the status of this fencing project. The fence will only encompass about 400 m² of forest in the MU.

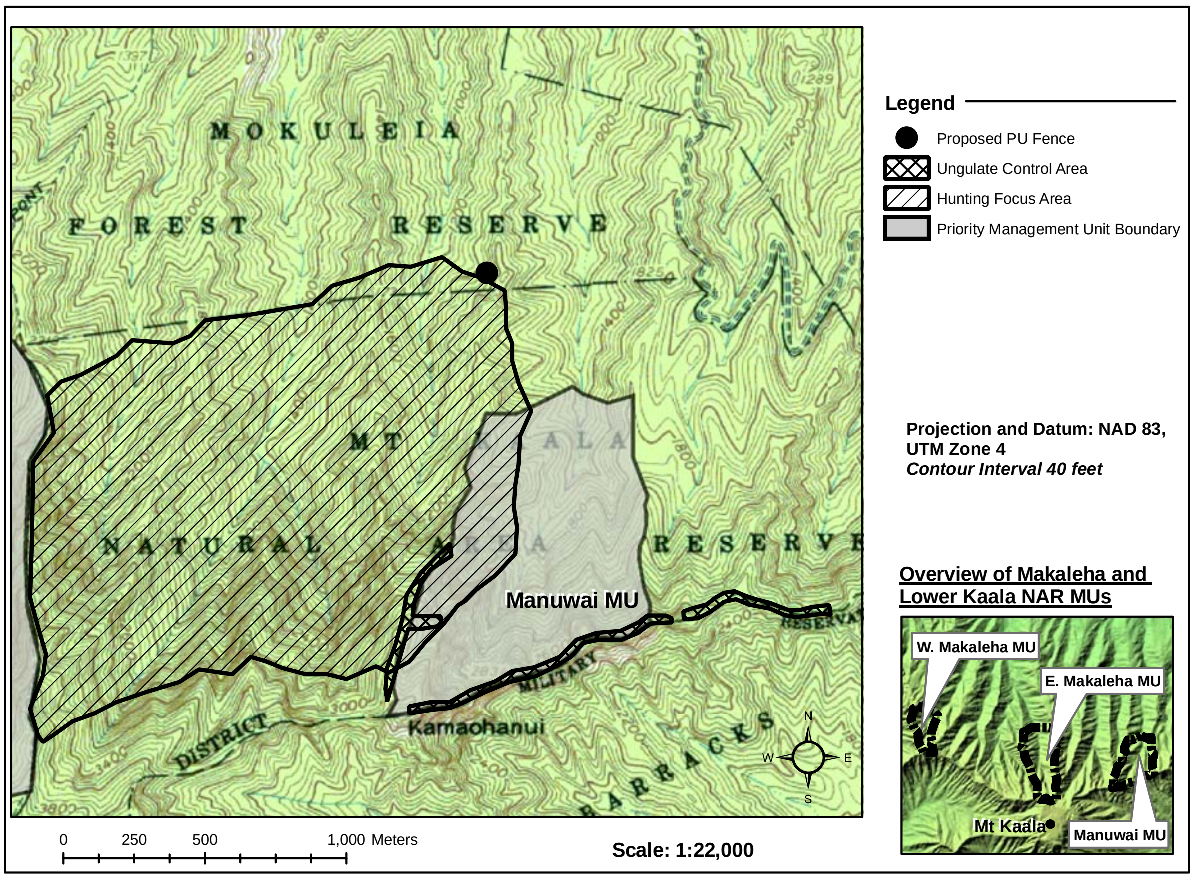


Figure 1.9 Manuwai MU

Pahole
In December 1996, the MU perimeter fence was completed, effectively protecting 15 endangered species from feral ungulates. This MU has been ungulate free since 1998.

Upper Kapuna
Originally the Kapuna MU was planned to be built as two subunits. Due to budgetary constraints, NARS staff opted to alter the proposed subunits into four subunits. These will be built over several years to offset costs. Subunit I is slated for construction in 2005. In February 2004, two PU fences were built to protect reintroduced individuals of *Phyllostegia kaalaensis* in Keawapilau gulch.

In March 2005, a small herd of goats was found in the southwest corner of the PU by a NARS employee. This discovery was quite significant as it was the first time that goats had been observed in the area and the Upper Kapuna perimeter fence is proposed to be only 38" tall. The planned fence height is inadequate for obstruct goats. This group is believed to have split from the herd located in West Makaleha. A team of NRS and NARS staff went out and removed the Alpha Billy. It then appeared that the rest of the herd moved out of the area. On a scoping trip a week later, NRS observed the goats with the West Makaleha herd.

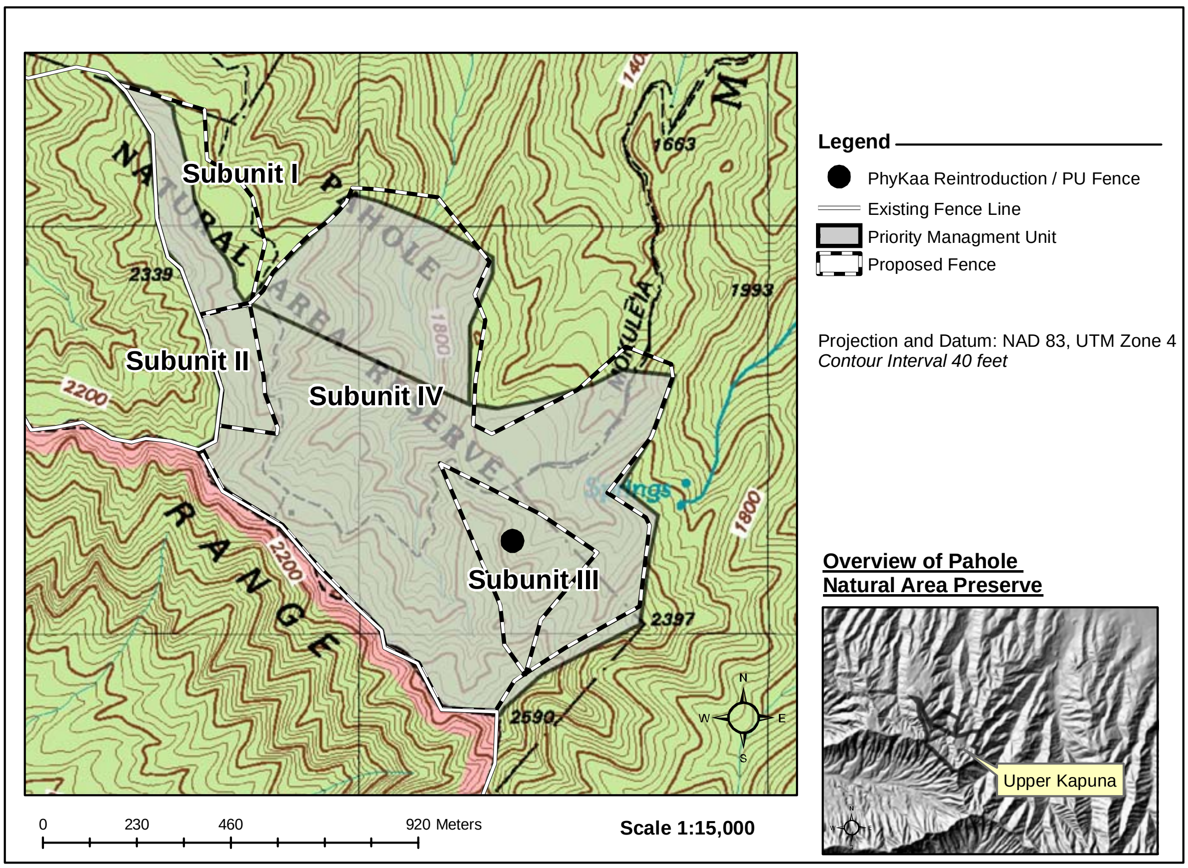


Figure 1.10 Upper Kapuna MU

West Makaleha
Two small PU fences were constructed to protect populations of *Cyanea grimesiana* subsp. *obatae* and *Schiedea obovatum* prior to the construction of the MU fence. Completion of the MU perimeter fence is slated for Year 2 of the MIP. In the meantime, NRS and NARS staff also try to control ungulate damage around the MU by reducing population numbers. From October 2004 – July 2005 NRS worked closely with NARS staff to remove a resident herd of feral goats from the boundary ridge of the Pahole NAR by hunting. To date a total of 16 animals have been removed and the remaining eight animals are believed to have moved onto a neighboring ranch. NRS would appreciate the chance to discuss alternative methods of control (snaring, aerial hunting, and radio collars) with the Wildlife and Forestry staff since this area comes under their jurisdiction. Close monitoring of this area will continue due to the fact that the goats have been known to travel back and forth from the ranch to state lands. This goat population is critical to eliminate as it poses a serious threat to Pahole NAR. Currently, the NAR fence is only 38" which is not tall enough to deter goats from jumping over.

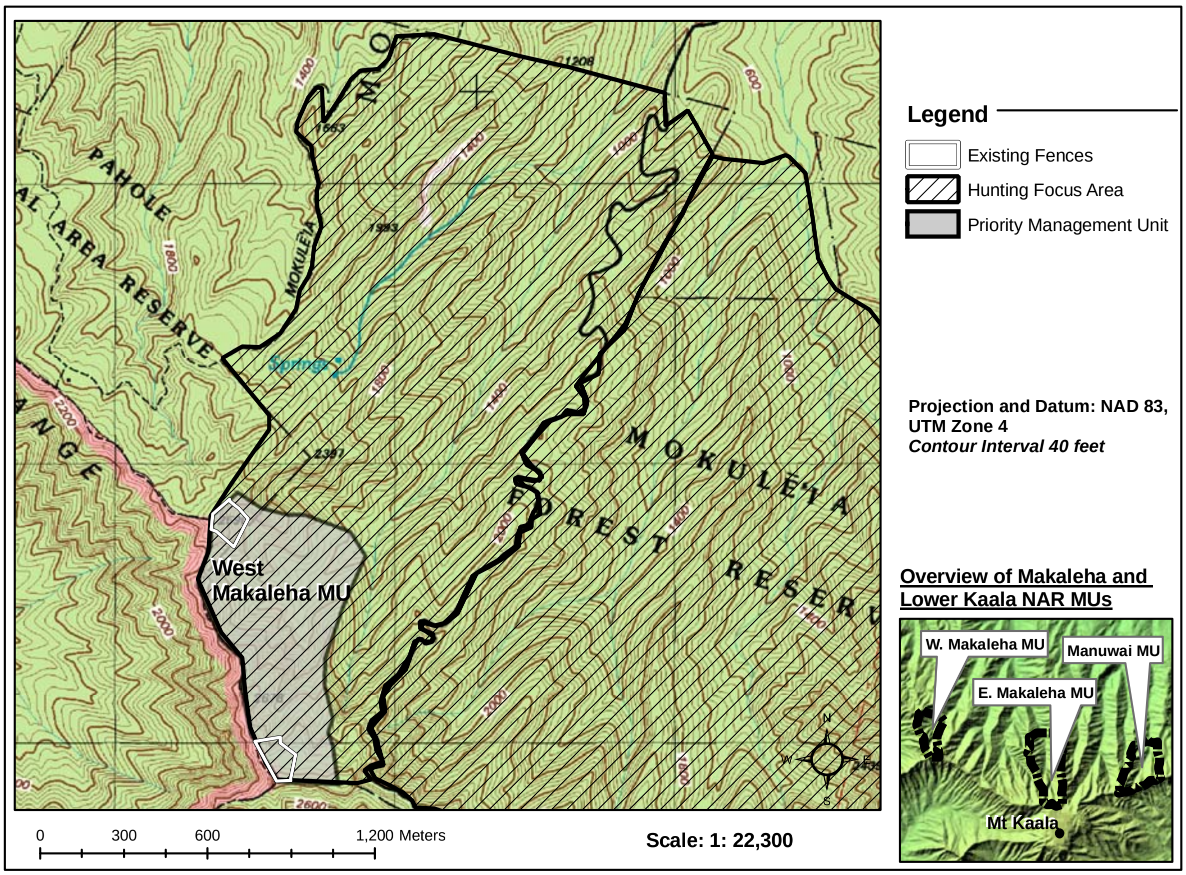


Figure 1.11 West Makaleha MU

Wai'anae Kai
Four fences are proposed for construction in different areas of the Wai'anae Kai Forest Reserve. The first is a small MU fence which will protect a population of *N. angulata*, *Tetramolopium filiforme*, and *Nototrichium humile* (see Figure 1.12). The second and third are strategic type PU

fences which will protect two other separate populations of *N. angulata*. The fourth PU fence will protect a population of *Hesperomannia arbuscula*. In August 2003, NRS wrote a letter to DOFAW for permission to fence these small populations of *N. angulata* and the *H. arbuscula*. To date, NRS have yet to receive any word on the status of the *N. angulata* fencing projects.

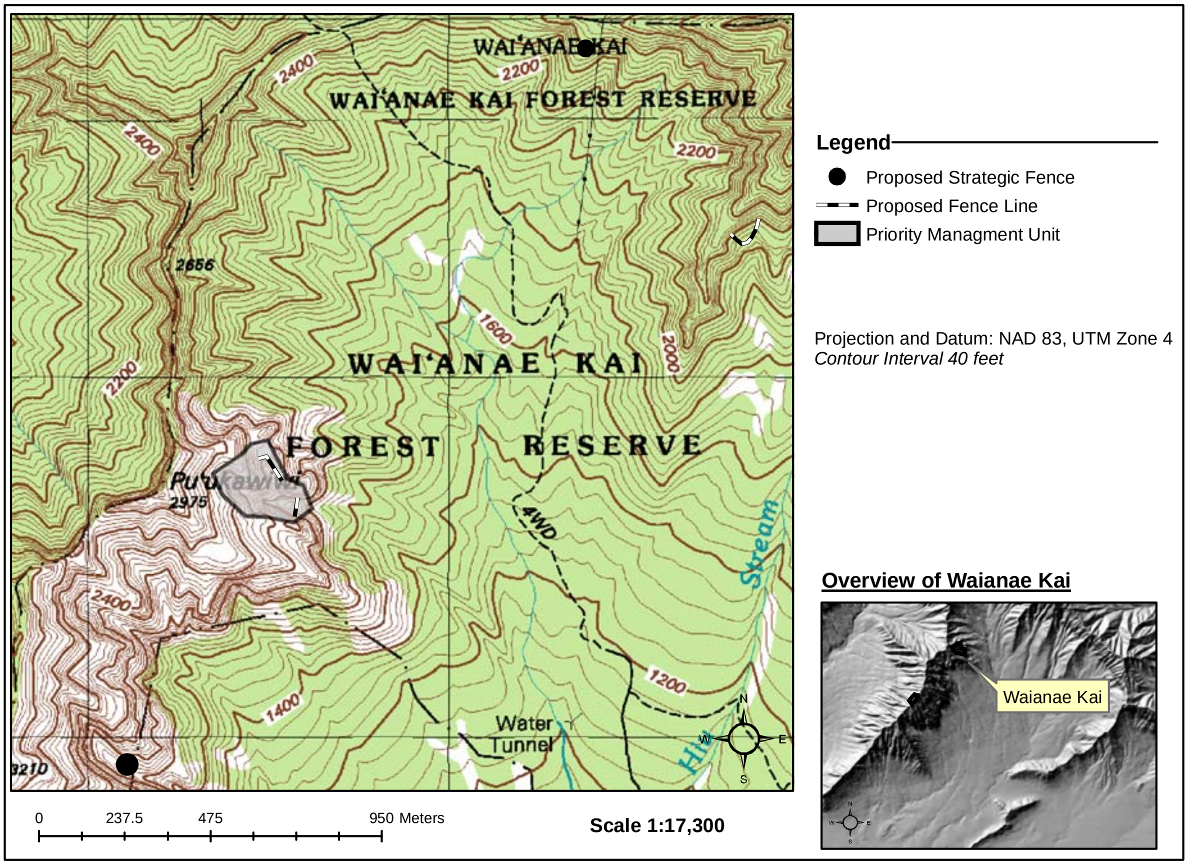


Figure 1.12 Wai'anae Kai MU

The Nature Conservancy of Hawaii Honouliuli Preserve

<u>'Ēkahanui</u>

The Nature Conservancy of Hawaii (TNC) completed the Subunit I fence in 2001. This perimeter fence encompasses about 44 acres. The EA is complete for Subunit II which is slated for construction in Year 3 of the MIP. This perimeter fence will encompass about 159 acres. In the meantime, four PU fences have been constructed to protect two target taxa, *Schiedea kaalae* and *Delissea subcordata* (see Figure 1.13). NRS and TNC staff conduct fence maintenance. There is some public hunting that occurs outside the fenced subunit but it is unknown how effective this is at reducing feral pig impacts on other target taxa. There is still a very real threat from goats invading from Lualualei Naval Magazine as they are still known from the Pu'u Kaua area.

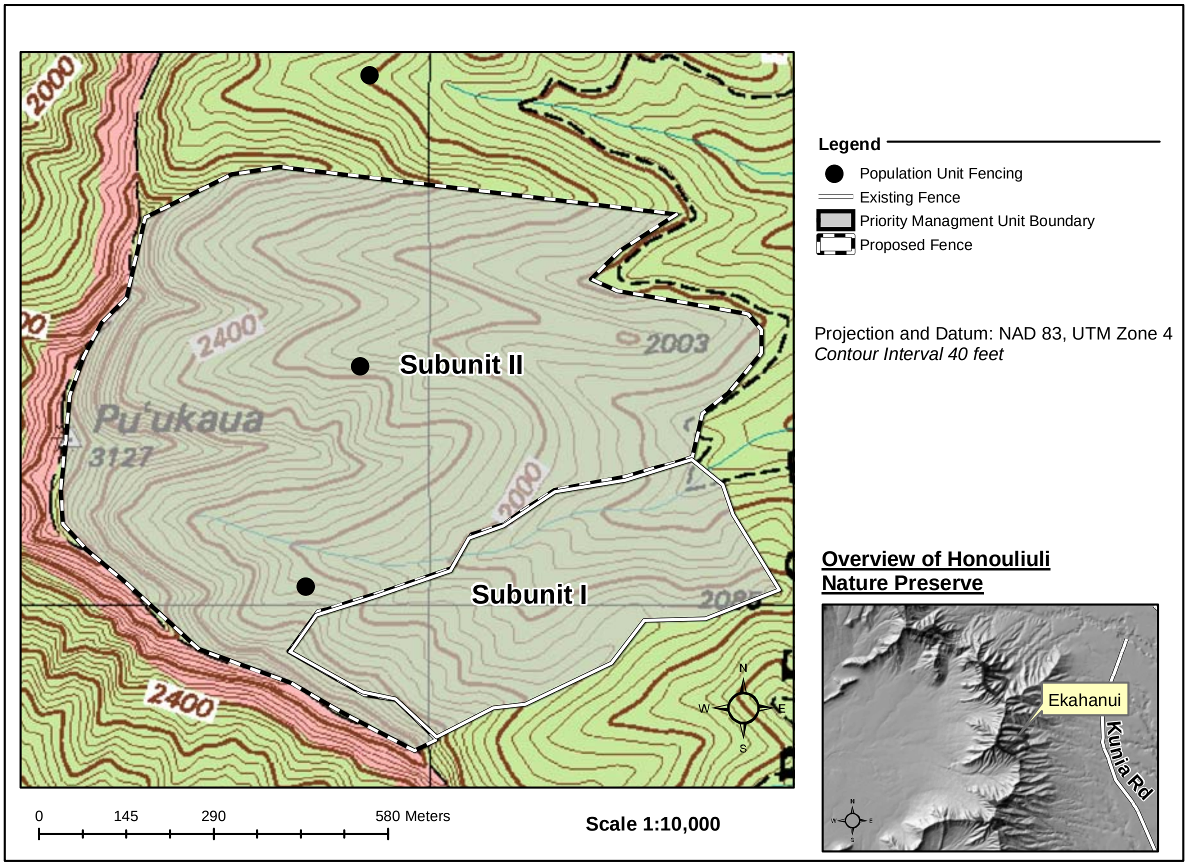


Figure 1.13 ‘Ēkahanui MU

Kalua‘a and Waieli

Subunit III was completely fenced by TNC in 1999 and is ungulate free. In May 2004, a small PU fence was constructed around a single *Cyanea grimesiana* subsp. *obatae* along the stream bank of South Kalua‘a gulch. A major portion of Subunit II A and C is slated to be completed by December 2005. The line has been cleared and construction has just begun. TNC staff do ungulate control in the area to lessen impacts from feral pigs. Subunit II B is slated for construction in Year 10 (see Figure 1.14).

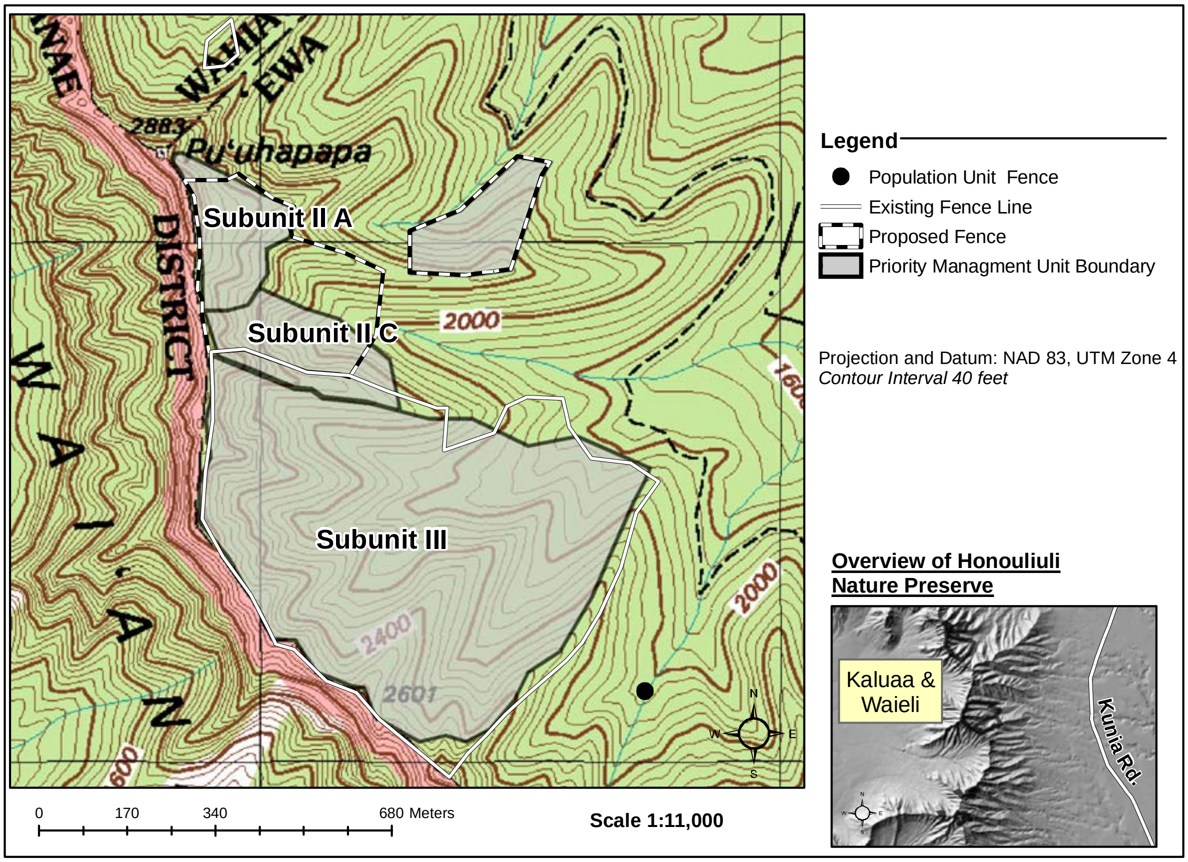


Figure 1.14 Kalua‘a and Waieli MU

Palikea

A small PU fence has been completed around a population *Cyanea grimesiana* subsp. *obatae* by TNC in Subunit I A. Several PU fences were built in Palawai gulch during 2003 and 2004. In November 2003, three of the fences were erected around populations of *Delissea subcordata*, *Hesperomannia arbuscula*, and *Schiedea kaalae*. Of these only, the *H. arbuscula* fence is within a proposed priority MU fence (Subunit I B). In January 2004, another PU fence was constructed around a population of *D. subcordata*, outside any proposed priority MU fence. All of the PU fences that are located outside of the priority MUs are protecting populations of plants that are manage for genetic collections (see Figure 1.15).

Both Subunits I A and I B are slated for construction in Year 5. In the meantime, TNC staff control pig populations until fences can be built.

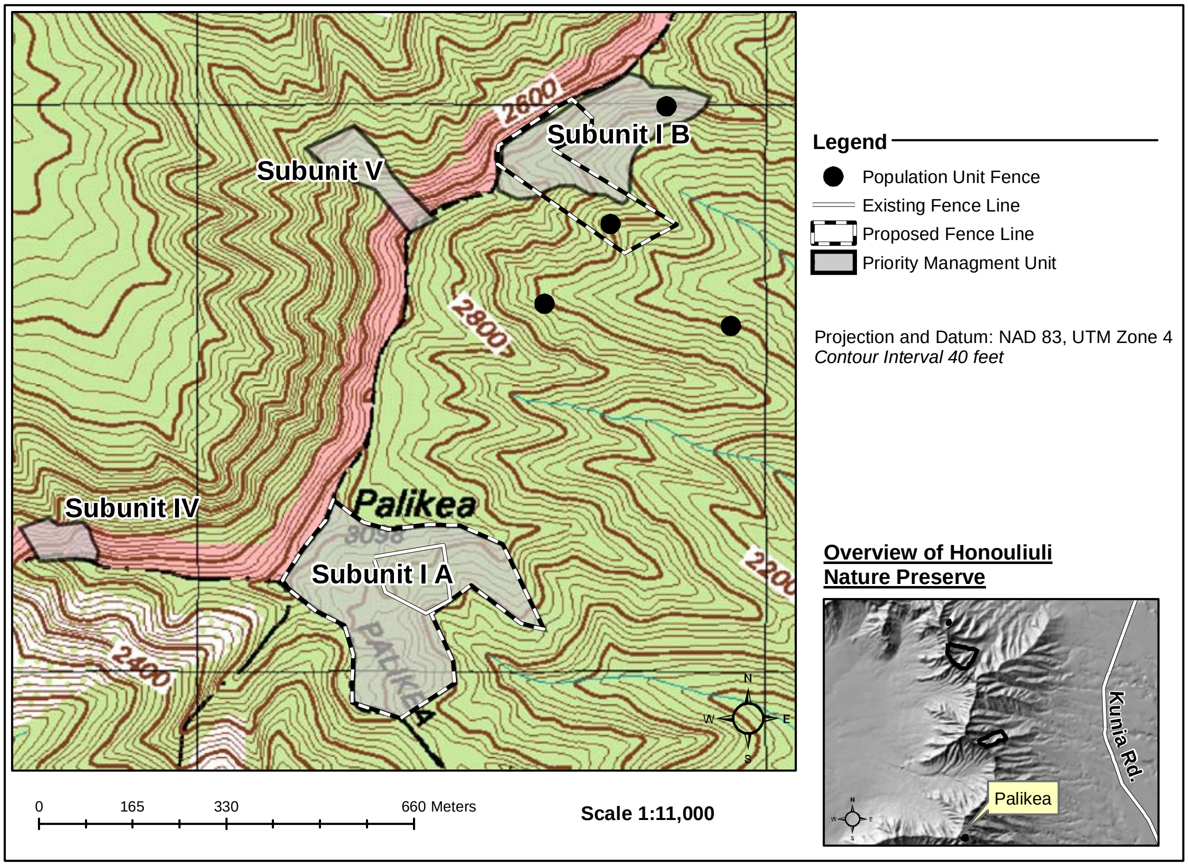


Figure 1.15 Palikea MU

The Honolulu Board of Water Supply

Mākaha

In an effort to protect a large portion of the 21 threatened and endangered species in Mākaha Valley, Subunit I of the MU is slated for construction 2005-2006. To date, the proposed fenceline has been scoped and surveyed for cultural resources. The EA has been approved and the CDUA is being processed. NRS expect construction to begin in late 2005. Subunits II and III are slated for construction in Year 5 of the MIP (see Figure 1.16).

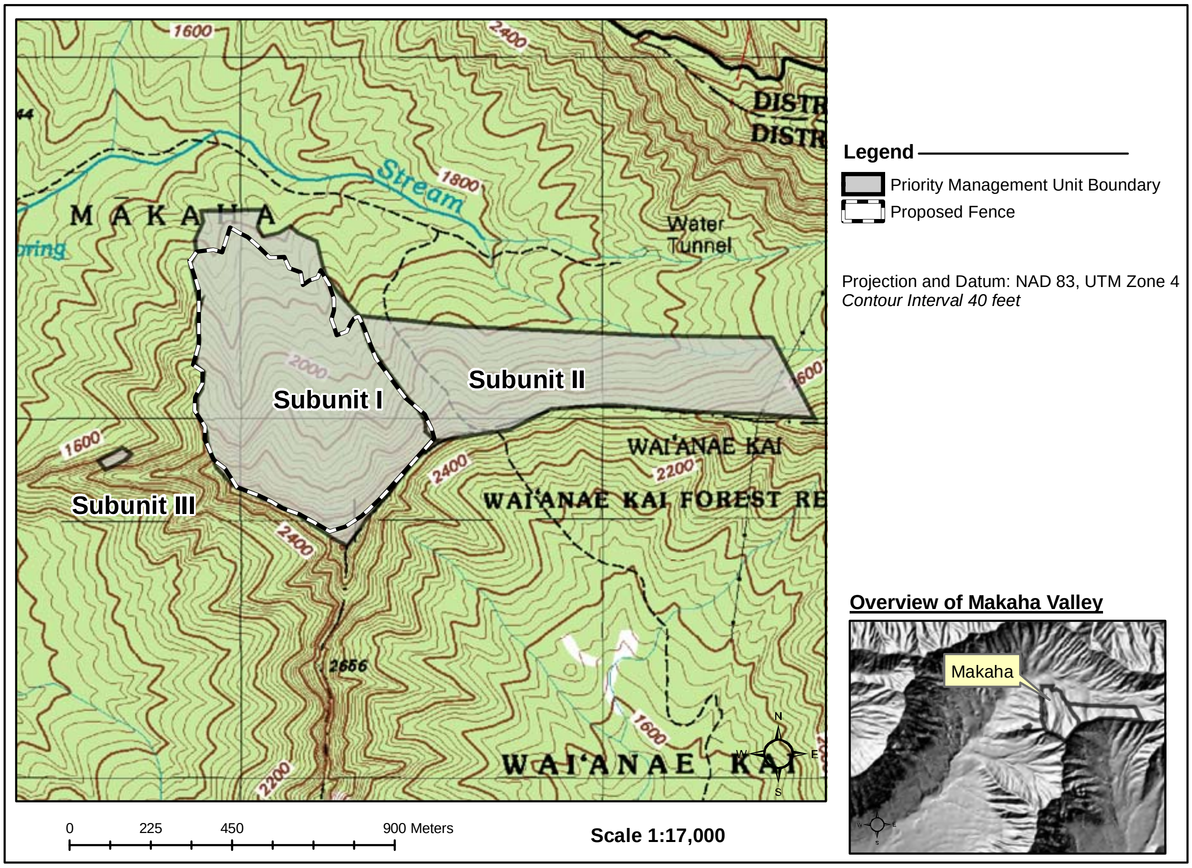


Figure 1.16 Mākaha MU

Dole Food Company

<u>Kaimuhole</u>
A 100 acre fence is proposed for construction in year 6 of the MIP. Permission must be obtained from Dole Food Company, Inc. This fence will protect a population of *Hibiscus brackenridgei* subsp. *mokuleianus* and *Nototrichium humile* from being damaged by feral ungulates. The exclosure would also serve as the center of *Hibiscus brackenridgei* subsp. *mokuleianus* management throughout the LKN. No ungulate control is currently being conducted around *H. brackenridgei* because NRS do not have a formal agreement with Dole to conduct management work on their lands, even hunting.

Kamehameha Schools, DLNR, and Hiram Fong Trust

<u>Waiawā</u>
An MU perimeter fence is slated for construction in Year 9of the MIP. Permission must be obtained from Kamehameha Schools, DLNR, and Hiram Fong Trust. This proposed MU perimeter fence will also encompass several OIP species so may be built earlier.

Chapter 2: Weed Management

Introduced plant species (weeds) threaten endangered species and native ecosystems by altering habitat and disrupting community structure. Weedy species out-compete natives for light, space and nutrients. Left unchecked, weedy species will replace the native forest and therefore are one of the primary focuses of all natural resource programs in Hawaiʻi. NRS have been conducting weed control on Army land for nine years, and this weed control has increased dramatically over the years, especially with the execution of the MIP. The overall goal is to minimize, remove, and prevent weed species from impacting native forest, thus preserving both the natural communities and the individual species that are unique to Hawaiʻi.

Mākua Section 7 Weed Management Overview

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

1. Prevention of Weed Spread

One of the two main threats from military training at Mākua as outlined in the Army's BA was the introduction of weed species. This threat was not only related to inadvertent weed transport between Hawaiian Islands but also from locations beyond Hawaiʻi. The BA emphasized troop education as an important tool in reducing the number of introductions each year. NRS have prepared educational brochures and have briefed troops upon request regarding this issue, but need to do more. NRS have made great strides in educating support staff working for the Garrison, such as the Range Division road crews and Integrated Training Area Management (ITAM) crew, in order to minimize weed spread due to road construction and maintenance. In the next year NRS will seek out other educational avenues for troops.

Mākua related section 7 documents also emphasized gear cleaning infrastructure and procedures for military personnel. This is a weak area for our program and needs improvement. NRS have identified a number of weed species at Army training areas on Oʻahu which may have originated at Pohakuloa Training Area (PTA) on Hawaiʻi 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 should be mandated for use prior to shipping vehicles back to Oʻahu. There is a Standard Operating Procedure dictating sanitation protocols that the troops are required to follow. This year, the PTA Colonel reissued this SOP by NRS request.

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 and volunteers are encouraged to think 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 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 including *Pennisetum setaceum, Melochia umbellata*, and *Acacia mangium*. Another is observation point *Halo* in Schofield Barracks, South Range where there is *Senecio madagascariensis*, an agricultural threat that's considered an ecosystem threat by PTA environmental workers. All these mentioned species are Oʻahu Invasive Species Committee targets.
- *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, is 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 based on the LZ weed list, and have identified LZs with weeds of concern. They are ʻŌhikilolo (*Triumfetta semitriloba, Cirsium vulgare*) and Ka`ala (*Rubus argutus*). After use at either of 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. NRS have discontinued the use of Eaton's rat bait as there are whole seeds in the formulation.
- *Personal gear.* NRS frequently wash backpacks, and other personal gear vectors to prevent spreading weeds.

2. Surveys to detect new weeds before they become established

Regular surveys along potential military introduction corridors were identified as important in all Mākua Section 7 related documents. One of the greatest potentials for weed spread by the military is via vehicles along roads. The large vehicles and machinery used for training, and training support, such as road maintenance, are vectors for weed dispersal within and between ranges. NRS survey roads used most frequently by the military and also by NRS, to track 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.

This year, NRS greatly improved communication with ITAM. Meetings are held quarterly to discuss concerns about weed spread between and within training areas. This year NRS met with range maintenance staff (including heavy machine operators) about natural resources and threats to these resources. NRS printed out a list of single target weed species that may be impacted by heavy machine operation. ITAM used this list to create a booklet of incipient weeds and pertinent information, which was then distributed throughout ITAM. NRS have also received a copy of ITAM's road condition survey and will assess road use and the need for any new road surveys on military training ranges using this resource.

NRS have been conducting road surveys on Army installations for more than five years, and occasionally add new roads. Offsite roads near management units are also surveyed. These roads may be used primarily by NRS or by other users, including agricultural lessees.

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

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

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

Some plants found during surveys are unidentifiable by NRS staff. These taxa are sent to Bishop Museum for identification. Upon identification, survey lists are updated to include these plants, and NRS research the significance of the presence and or spread of this weed. If the weed is incipient, or considered problematic, NRS will work to control it in the same manner as all incipient weeds occurring in Management Units (MU). Otherwise, weeds that are new to the survey and are not considered problematic are added to the list, thus tracking the spread of common weeds into new areas.

3. Prioritization of weed control areas and projects
All the Mākua documents reviewed simply emphasize that weed control projects should be prioritized in order to ensure that the projects with the most conservation value begin first. NRS prioritize control of incipient and management-unit level weed control projects.

<u>Incipient or Zero-tolerance weeds</u>
Priorities for incipient weeds are determined based on the extent of the weed, severity of the weed's potential impact if established, and control possibilities in terms of staff time required and control techniques. The MIP goal for incipient weed control is "total removal". NRS reviewed the Appendix 3.1 *Priority Weeds for Selected Management Units* from the Final MIP dated May 2003. In this table, a number of weeds were ranked to express the extent of their distribution by MU. This table was developed by Joel Lau and other field managers as a preliminary weed assessment. Since this time, NRS have spent many hours in the field adding to weed distribution data and in some cases identifying weeds that had not previously been listed in MUs. This year NRS reviewed each weed believed to be incipient and targeted for eradication (assigned a number "one" in the table). For a number of weed taxa, additional information has led to a change in status. For some taxa, the weed management code as referenced in 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 MU priorities.

A summary of the weeds still believed to be high threats can be found below (Table 2.1). The specific sites and or distributions of many of the weeds in Table 1 are still largely unknown. This is mostly the case on offsite areas, where NRS have not seen the species because they have not yet been into the areas where they occur. Where current locations are unknown, NRS aim to work with land managers to determine the locations of all of these weeds, to assess their threat levels, and begin control of the species if further determined incipient.

Although NRS still strive to achieve a better understanding of the list of weeds in Table 2.1, NRS already target several incipient weed species, mostly on Army controlled land. The tables in each Land Owner based discussion titled *Single Species Target Weeds*, outline the status of incipient weeds that NRS currently target by MU. The discussion also covers weeds for which status may change given new occurrences of those species.

Table 2.1 Summary of Incipient Taxa in Management Units from Appendix 3.1 Final MIP

Management Unit	Incipient Taxa	Comments
ʻĒkahanui	*Chrysophyllum oliviforme*	Locations unknown. Will map all locations & target if necessary.
	Dicliptera chinensis	Locations unknown. Will map all locations & target if necessary.
	Ficus macrophylla	Locations unknown. Will map all locations & target if necessary.
	Heliocarpus popayanensis	Locations unknown. Will map all locations & target if necessary.
	Melaleuca quinquenervia	Locations unknown. Will map all locations & target if necessary.
	Pimenta dioica	Locations unknown. Will map all locations & target if necessary.
	Schefflera actinophylla	Locations unknown. Will map all locations & target if necessary.
	Sphaeropteris cooperi	Locations unknown. Will map all locations & target if necessary.
Haili to Keālia	*Schefflera actinophylla*	Locations unknown. Will map all locations & target if necessary.
Kaʻena	*Agave sisalana*	Currently target within MU boundary.
Kaluakauila	*Casuarina glauca*	Currently targeted -See Section 1.2
ʻŌhikilolo	*Aracauria columnaris*	Currently targeted -See Section 1.2
	Axonopus fissifolius	Greater distribution unknown. Will monitor known sites.
	Morella faya	Treated in the past. Will monitor known sites.
Upper Kapuna	*Ehrharta stipoides*	Locations unknown. To be targeted.
	Rubus argutus	Few locations known -See Section 2.2
	Setaria palmifolia	Locations unknown. Work with State to determine level of control
	Sphaeropteris cooperi	Locations unknown. Work with State to determine level of control
	Toona cilliata	Locations unknown. Work with State to determine level of control
Kahanahāiki	*Acacia mearnsii*	Currently targeted –See Section 1.2
	Axonopus compressus	Location known. Treated in the past. Will work towards eradication this year.
	Casuarina glauca	Currently targeted –See Section 1.2
	Ehrharta stipoides	Currently targeted –See Section 1.2
	Pennisetum clandestinum	Location known (State land). Reproducing vegetatively. Work with State to determine level of control.
	Rubus argutus	Currently targeted –See Section 1.2
	Sphaeropteris cooperi	Currently targeted when seen. No matures seen for years.
	Triumfetta semitriloba	Currently targeted –See Section 1.2
Palikea	*Acacia mearnsii*	Locations unknown. Work with TNC to determine level of control
	Ficus macrophylla	Locations unknown. Work with TNC to determine level of control
	Juniperus bermudiana	Locations unknown. Work with TNC to determine level of control
	Montanoa hibiscifolia	Locations unknown. Work with TNC to determine level of control
	Schefflera actinophylla	Locations unknown. Work with TNC to determine level of control
	Sphaeropteris cooperi	Locations unknown. Work with TNC to determine level of control
	Toona ciliata	Locations unknown. Work with TNC to determine level of control

West Makaleha	*Sphaeropteris cooperi*	Locations unknown. Work with State to determine level of control
Wai‘anae Kai	*Chrysophyllum oliviforme*	Locations unknown. Will target if deemed necessary
	Coffea arabica	Locations unknown. Will target if deemed necessary
	Fraxinum uhdei	Locations unknown. Will target if deemed necessary
	Pimenta dioica	Locations unknown. Will target if deemed necessary
	Rivina humilis	Locations unknown. Will target if deemed necessary
	Rubus argutus	Locations unknown. Will target if deemed necessary
	Syzygium cumini	Locations unknown. Will target if deemed necessary
Kaluaa and Waieli	*Angiopteris evecta*	Locations unknown. Work with TNC to determine level of control
	Ardisia elliptica	Locations unknown. Work with TNC to determine level of control
	Mallotus philippensis	Found in Gulch 3 site C. Will map and control as deemed appropriate.
	Glycine wightii	Locations unknown. Work with TNC to determine level of control
	Schefflera actinophylla	Locations unknown. Work with TNC to determine level of control
Pahole	*Acacia mearnsii*	Currently targeted –See Section 1.2
	Angiopteris evecta	Locations unknown. Work with State to determine level of control
	Axonopus compressus	Same site as Kahanahāiki location
	Ehrharta stipoides	Targeted at known sites –See Section 1.2
	Glycine wightii	Locations unknown. Work with State to determine level of control
	Passiflora suberosa	Locations unknown. Work with State to determine level of control
	Rubus argutus	Locations unknown. Work with State to determine level of control
	Setaria palmifolia	Locations unknown. Will target if deemed necessary
	Sphaeropteris cooperi	Targeted by Kay Lynch of O‘ahu Trail and Mountain club
	Toona ciliata	Locations unknown. Work with State to determine level of control

Management Unit Level Weed Control

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

In addition to these broad-scale prioritization processes detailed above, NRS have broken up the MIP MUs into smaller units called Weed Control Areas (WCAs), where weed control has conducted in the past or in areas that are a high priority for weed control in the future. These areas in general, focus on ecosystem level weed control in addition to weed control conducted around MIP taxa. WCAs in most cases contain managed Population Units (PUs) and the native habitat surrounding those PUs. Weed control is easier to track over time within WCAs, as weed control issues are generally similar across a particular WCA. In the sections to follow, MU level weed control is organized and discussed by WCA because it is easier to report to the MIT using WCAs as they are more geographically specific than MUs. Additionally, NRS report on weed control conducted specifically around MIP taxa populations. Weed control in these areas is not likely to be expanded as is the goal for WCAs because often the areas are so terribly degraded. Weed control is therefore only conducted directly around plants to minimize direct impacts by weeds (See ‘Ōhikilolo, W. Makaleha, and ‘Ēkahanui PU weed control discussions). All weed control summary tables report weed control conducted from September 1, 2004 through August

31st, 2005. To save paper, and simplify tables, Weed Control Summary Tables reported below use six letter abbreviations for most weed and rare plant species. These abbreviations are made using the first three letters of a plant's genus and species. A list of these codes in their unabbreviated form can be found in the appendices.

Weed control efforts on land not controlled by the Army are only made possible by the support of the various offsite land owners. NRS are given guidance by the State and Board of Water Supply biologists on their respective lands, regarding locations of weed control areas as well as types of weed control projects. Similarly, NRS work closely with the Nature Conservancy Staff to supplement weed control efforts they already conduct throughout the Honouliuli preserve. Hours spent weeding, and area weeded by TNC staff is not reported in this document, however both are very valuable to help achieve MIP goals and should be considered as such.

Table 2.2 summarizes the MIP management units. Due to limitations on personnel and funding, NRS has not been able to conduct weed control in all MUs and fully implement the MIP weed control as planned. NRS has chosen to begin intense MU level weed control where there are fenced exclosures or where ungulates are not considered a threat. Less weed control has been initiated outside exclosures. Weed control is conducted at all seven of the MUs with ecosystem scale fences and at five sites without fences. Two of these five un-fenced sites will be fenced within the next year or two. An additional consideration is landowner permission. It is essential that NRS acquire formal permission to conduct MIP management actions in order to solidify plans. Formal permission has not been granted for a number of sites which therefore are not weeded regularly.

Table 2.2 Makua IP Priority Management Units

Land Owner/Manager	Management Unit	MU Acreage	Total Hours of Weeding Per MU	Acreage of Weed Control Areas within MU
U.S. Army	Kahanahāiki	94	804	48.12
	Lower ʻŌhikilolo	70	396.5	7.99
	Puʻu Kumakaliʻi	28		No weed control conducted
	ʻŌhikilolo	200	372.5	7.43
	Kaluakauila	104	195	11.92
	Lower Opaeula	17		No weed control conducted
	Haili to Keālia	30	46	3.3
State of Hawaiʻi	East Makaleha	231		No weed control conducted
	Kaʻena	52	71	3.01
	Manuwai	166		No weed control conducted
	Pahole	215	254.25	32.4
	Upper Kapuna	182	155.5	6.33
	West Makaleha	93	255	3.3
	Waiʻanae Kai	9		No weed control conducted
	Keaau and Mākaha	5		No weed control conducted
Kualoa Ranch	Lower Kahana	3		No weed control conducted

Land Owner/Manager	Management Unit	MU Acreage	Total Hours of Weeding Per MU	Acreage of Weed Control Areas within MU
B.P. Bishop Estate Trustees	Waiawa	124		No weed control conducted
Campbell Estate (Leased to The Nature Conservancy)	‘Ēkahanui	203	75.6	9.8
	Kaluaa and Waieli	127	56	2.9
	Palikea	45	98.5	4.61
Dole Food Company, Inc.	Kaimuhole	100		No weed control conducted
Board of Water Supply	Mākaha	162	228.5	22.38
	Kamaileunu	5		No weed control conducted

4. Monitoring of MIP related weed control

Monitoring of any weed control conducted is a priority in all documents related to the Mākua consultation and has special emphasis in the MIP. This currently is the area most in need of expansion and development by NRS. In the next year, NRS hope to greatly improve this aspect of the program. A Monitoring Manager has been hired to oversee all monitoring related to the MIP. This person will begin work in October 2005 and will help to address many questions regarding weed control. Thus far, weed monitoring has mainly been focused on weed control efficacy but not long-term impacts of our weed control on native habitat and rare species restoration. Photopoints have been used as an informal means of monitoring trends. The monitoring program will incorporate tracking of weed control within the 50 meter buffer around population units, along with weed control conducted across the rest of the MU outside of this area. The following is a list of high-priority weed monitoring issues.

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

In addition to using monitoring data to shape future weed management goals, organizational goals should also be emphasized. In the coming year NRS will standardize weed control data for future analysis using a database. The database will be expanded to track weed control areas, effort and pesticide use, and information gathered by the monitoring program. Improving monitoring and tracking of weed control efforts will help NRS to ensure efficiency and to direct future weed control actions.

5. Research

There are a few research issues related to weed management. In order to address these and other management-related research topics NRS created a new position, a ‘Research Specialist’. This person will conduct needed research, coordinate with researchers conducting work related to MIP management, and seek out more interest in these research topics. The following is a short list of research projects related to MIP weed management.

- Determine the longevity of seed banks for incipient species being controlled to guide management plans.

- Establish lines of communication with other agencies (especially on neighbor islands) so that findings can be shared between organizations.

MIP MANAGEMENT UNIT WEED CONTROL

Army Controlled Land

Weed control conducted on Army lands occurs in the northern Wai‘anae Mountain Range in the following Management Units: Kahanahāiki, Kaluakauila,‘Ōhikilolo, Lower ‘Ōhikilolo, and at Dillingham Military Reservation in the Haili to Keālia Management Unit. Figure 2.1 is a map of locations of landing zone, weed and road surveys, MUs, and existing fenced areas where weed control is conducted. While NRS have conducted weed control at Kawailoa Training Area, it is not included in the map, and further discussion of this issue can be found in the Lower ‘Opae‘ula section below and in Chapter 6: OIP status update.

Surveys

NRS conducted 5 weed transect surveys, 3 landing zone surveys, and 2 road surveys on Army controlled land (Figure 2.1). Weed surveys are conducted quarterly, landing zone surveys are conducted when used, and road surveys are conducted yearly. No new weeds of concern were found during these surveys. Problematic taxa known from previous observations during surveys are discussed in the single species target control section.

Single Species Target Control

The weeds listed in Table 2.3 are considered zero-tolerance within Army training areas or within single subunits. Most taxa listed are found at specific sites within the same small area worthy of monitoring or control. Therefore, area treated/surveyed is not relevant; note is made where ranges are in fact expanding. Locations of these species can be seen in Figure 2.2 (map of all Army land incipient species). The effort column in Table 2.3 indicates the total hours of management spent over the last year. In total NRS has spent 108.25 person hours controlling single target species.

Triumfetta semitriloba

The variety of single species targets in MMR draws attention to the number of considerations NRS must take into account when making weed management decisions. For example, *T. semitriloba* is common in other MUs in MMR such as ‘Ōhikilolo. There, *T. semitriloba* is controlled as part of regular weed sweeps in the native areas. Special attention is only given to the weed where it occurs along trails, to prevent its further movement into forested areas. In Kahanahāiki however, only two small populations were known from the MU. This species is present in greater numbers in adjacent gulches, but NRS have hopes of preventing the spread, if not eradicating, *T. semitriloba* from Kahanahāiki Management Unit. This type of control can only be done if all new colonizers can be detected before individual plants or small populations become well established. However, game birds may also be acting as vectors for this weed. This year alone, NRS found 4 previously unknown occurrences of the weed in the Kahanahāiki MU. One site was found during a large scale weed sweep, and three others were found doing other tasks. The three new sites with mature plants will now require regular control and monitoring, in addition to the two existing sites. While NRS aim to keep this taxon out of Kahanahāiki its high rate of fruit production, and its ability to mature quickly, may enable it to colonize new sites faster than NRS can detect them. If this is the case, this taxon may be considered established, and will not receive special attention, but rather be treated during general weed sweeps in high priority areas. Until that time though, NRS continue to aggressively control *T. semitriloba* by visiting each of these new sites quarterly, and by experimenting with herbicides that can kill emerging seedlings and seeds in the seedbank.

Table 2.3 Single Species Target Weeds

Species	Location	Effort (person hours)	Comments
Ehrharta stipoides	Pahole/ Kahanahāiki fenceline	6.5	Core population in State Snail exclosure. Four new populations monitored and controlled quarterly along boundary fence. Aim for complete eradication from all sites pending State access.
Achyranthes aspera	Kahanahāiki exclosure	4.5	Sites within known area in gulch bottom checked quarterly. Mature plants found 6/05; previously none seen since 9/03. See discussion.
Triumfetta semitriloba	Kahanahāiki exclosure	3.25	Controlled twice a quarter at 2 sites (one on a weed survey transect). 4 new sites found and controlled this year. See discussion below.
Acacia mearnsii	Kahanahāiki exclosure	See table 2.6 for summary	Controlled quarterly at one infestation site. Took GPS point at closest trees on Kuaokalā Rd, 850 meters from Kahanahāiki. See table 2.6 and WCA discussion for further discussion.
Rubus argutus	Black Wattle site in Kahanahāiki	9	Controlled quarterly. Grass sprayed at site to facilitate detection (hrs included in Black Wattle grass spray reporting). See discussion below for control issues. Observed plant fruiting after a lapse in regular monitoring due to army restriction of access to area.
	ʻŌhikilolo	5	Controlled quarterly. No mature plants seen for over two years.
	East Mākua Rim	0.5	Visited previously treated, lone, immature plant. Believed to be eradicated.
	Kahanahāiki exclosure	N/A	Have not seen any plants in over a year, check site when in area, but believed to be eradicated.
	Kuaokalā Road	2.5	Plants discovered during road survey last year. Controlled quarterly. NRS carefully surveyed area and will continue to survey where road improvements are made. Additional plants found in dirt pile 10 m away from founder site.
Cirsium vulgare	ʻŌhikilolo	4	Controlled quarterly. Numbers consistent. Extent not noticeably expanding, but mature plants still being found. Need to treat before plants reach maturity to exhaust seed bank and to save NRS from collecting tiny seeds off surrounding vegetation.
Desmodium intortum	East Mākua Rim	6	Controlled quarterly. Found significant numbers along Peacock Flats Rd to Mokulēʻia Trail. See discussion.
Araucaria columnaris	ʻŌhikilolo	N/A	Mature tree killed. Seed/saplings controlled when seen. Population will be eradicated when seed bank exhausted if all trees killed before maturing.
Casuarina glauca	Kahanahāiki	31	Controlled all mature within Kahanahāiki exclosure. See discussion.

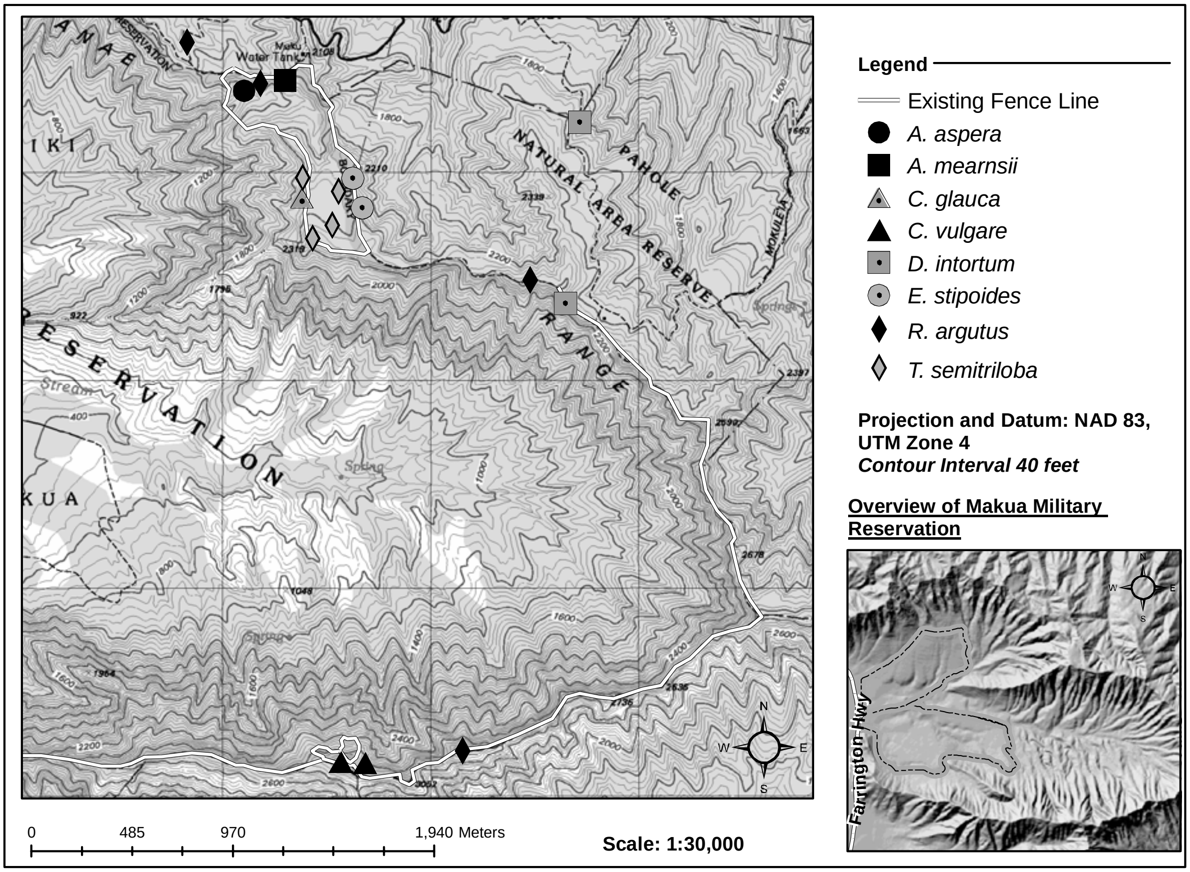


Figure 2.1 Locations of single species targets on Army Controlled Land

<u>*Desmodium intortum*</u>

Like *T. semitriloba,* NRS would like to keep *D. intortum* out of Kahanahāiki, although it occurs nearby in great numbers. The species has been treated at several sites within 500 meters of the MU, along the Mākua Rim fenceline to prevent spread along the corridor of the fenceline. However, a nearby sizeable population along the dirt road leading to the Mokulēʻia Trail trailhead, and along the trail itself went unnoticed by NRS until last year. NRS will continue to aim for eradication along the Mākua Rim, but will work with NARS staff to evaluate the distribution of the species and determine where control should be targeted to prevent further spread of this weed along trail and road corridors.

<u>*Rubus argutus*</u>

Rubus argutus, otherwise known as Blackberry, is a very undesirable weed. There is a very large seed source at Kaʻala, and NRS fear that birds continually disperse the weed from there. A single or small outlier group of plants may be eradicated with one treatment, if it can be controlled before fruiting, as done at East Mākua Rim. Follow-up is necessary to ensure that all seeds are exhausted from the seedbank. However, even small populations may be very difficult to eradicate. The Kahanahāiki exclosure site took over five years to eradicate. At three sites, it seems that a 20% dilution rate of Garlon 4 in Forestry Crop Oil is not completely killing the plant. At these sites, NRS often observe resprouting canes from cut portions of plants, as seedling type sprouts which are actually root suckers attached to greater plants persisting underground. NRS will experiment with a more aggressive approach for this taxon. Possibilities are to investigate other herbicides, higher concentrations of Garlon 4, and a combination of manual and chemical techniques. NRS will contact biologists at Hawaiʻi Volcanoes National Park that also work in *R. argutus* control. NRS continue to strive for eradication of the remaining *R. argutus* sites.

Casuarina glauca
The sizeable, isolated population of *C. glauca* off the edge of the Kahanahāiki exclosure is targeted for eradication because it poses a fire threat, makes habitat inhospitable to native plants, and is slowly spreading and growing. The population is located on a steep slope which makes treatment of the stand difficult; ropes and rappelling gear are necessary in some areas. In addition, this taxon reproduces vegetatively, and the infestation may be a clonal stand. Therefore, it should be treated all at once to prevent root suckers from sprouting from any trees left alive. However, at the end of this year, NRS were able to control nearly the entire stand during two work trips. Follow-up will be necessary to control any missed trees and root suckers that sprout.

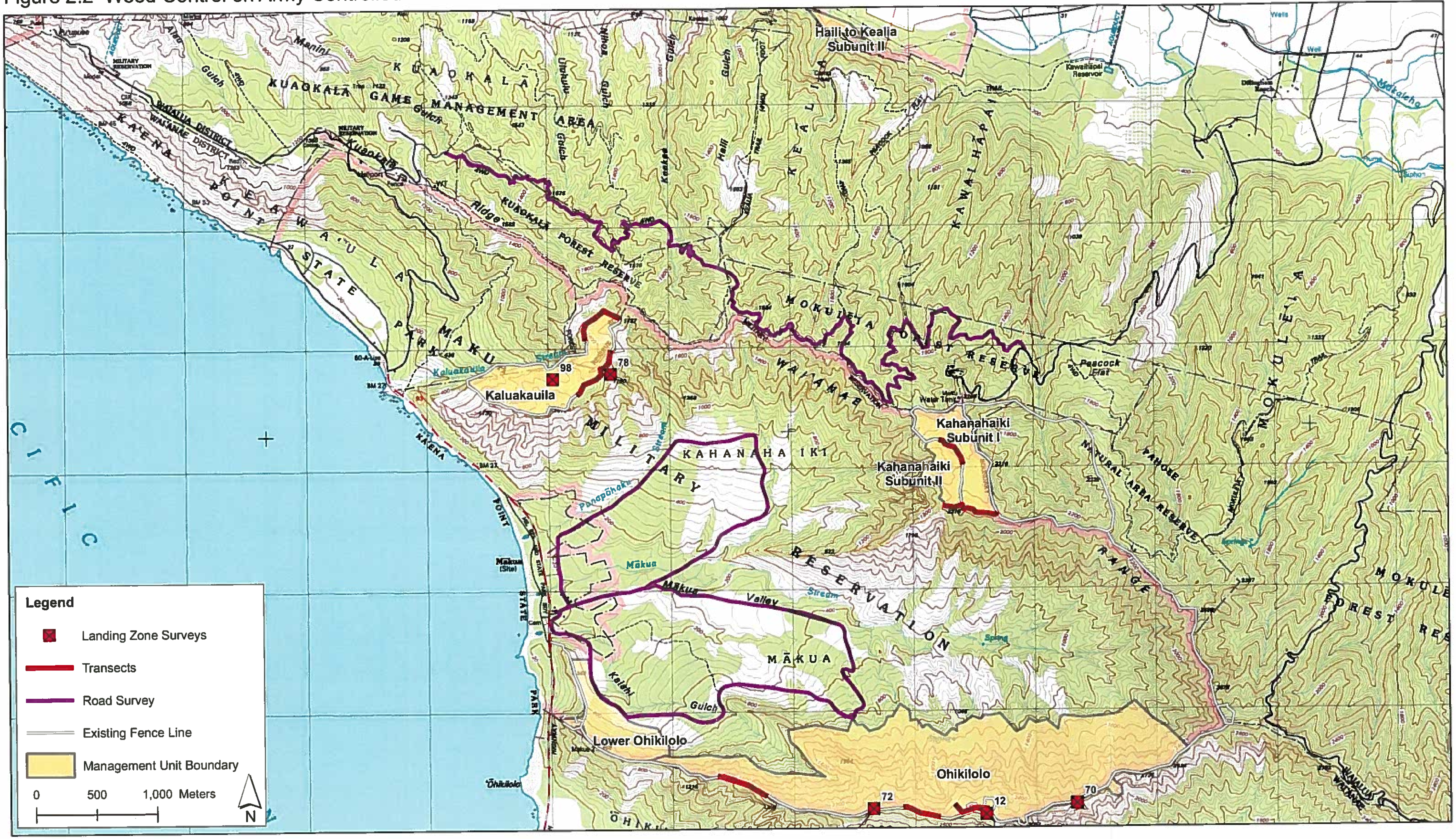
Achyranthes aspera
NRS were surprised to find one mature and approximately 80 immature *A. aspera* at the known infestation site in the early summer of 2005. This site has been monitored regularly and 3 months earlier not even seedlings were found. NRS visited the known sites one month later and found several immature plants and many more seedlings. It appears that some environmental or climatic requirement initiated germination at the time the cohort of seedlings was found. NRS will continue to visit these sites twice a quarter until the germination season appears finished. NRS will visit more frequently during the early summer in the coming years. *A. aspera* was also observed in August 2005 in great numbers in the greater Kahanahāiki Gulch below the NRS fenced unit. As with other weeds mentioned above, if such sources of *A. aspera* exist, control of the species must be limited to the MU, and the species may be taken off the single species target list if it becomes too well established in the MU. Understanding the overall extent of this weed and many of the others described above will aid NRS in their ability to control and prioritize single species weed control on Army land.

Ehrharta stipoides
The State snail exclosure is a small area with the incipient invasive *Ehrharta stipiodies*. This invasive grass is widespread at the snail exclosure and is also known from four sites along the boundary fence between Pahole and Kahanahāiki. NRS had almost completely eradicated this population when access to the area was lost. NRS fear that the *E. stipiodies* has rebounded to pre treatment levels as there has been a three month lapse in treatment.

Management Unit Weed Control

Kahanahāiki
Figure 2.3 shows the entire Kahanahāiki MU, and highlights the following Weed Control Areas (WCAs) where MU level weed control is conducted: Maile Flats, Kahanahāʻki Gulch, and the Black Wattle site. Weed control is not conducted throughout the entire fenced area as much of

Figure 2.2 Weed Control on Army Controlled Land



the south-facing fenceline is very weedy in both 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. Weed taxa controlled, effort and total area controlled in the last year within these areas are shown in Tables 2.4, thru 2.6 below.

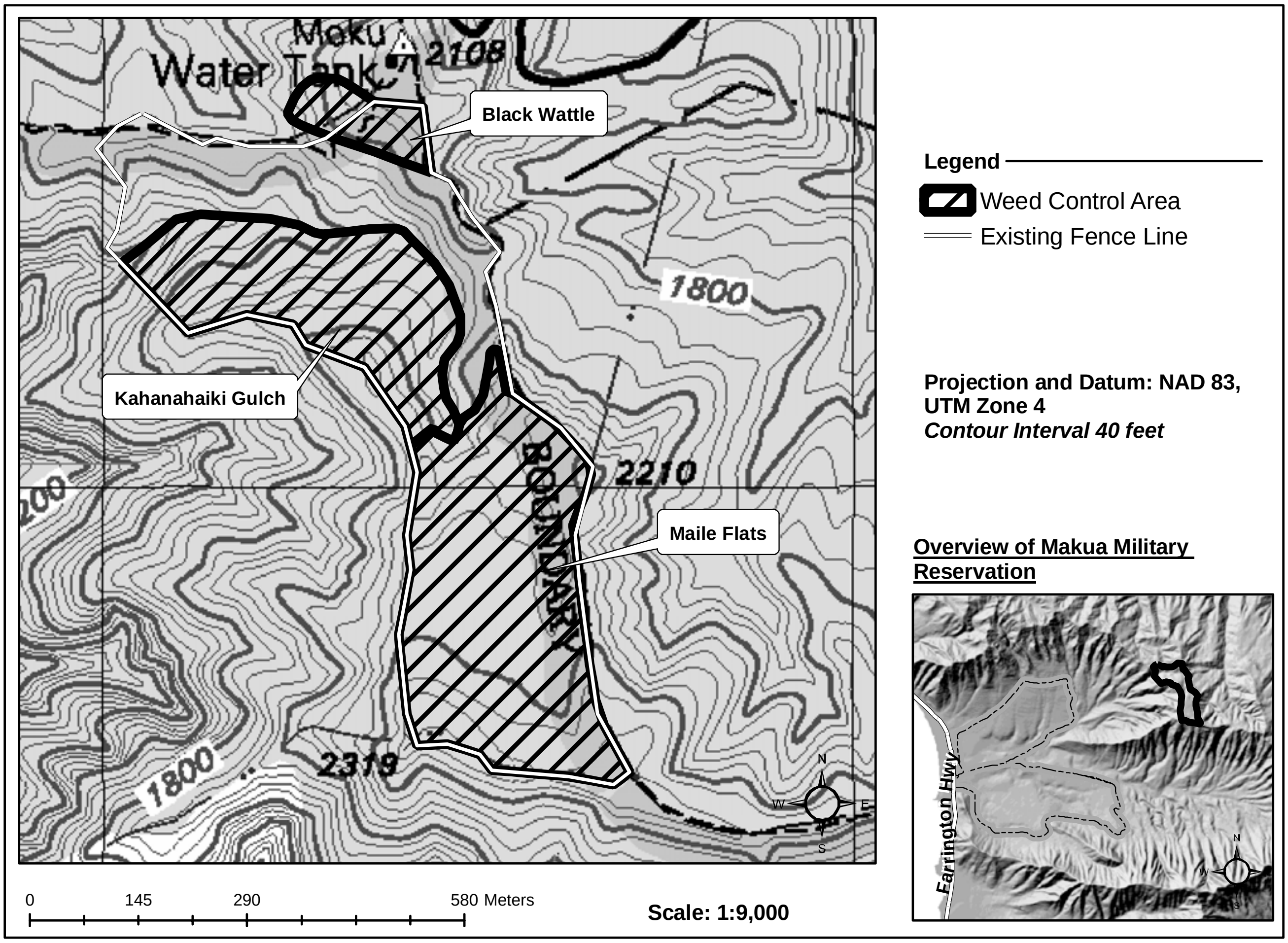


Figure 2.3 Kahanahāiki Weed Control Areas

Maile Flats WCA

This year emphasis was placed on re-sweeping the subunits that have not been treated for several years. NRS revisited the entire SE and SW quadrants (Figure 2.4). Volunteer support and a camping trip at Kahanahāiki was necessary for weed control on this level. NRS also spent time targeting large *Rubus rosifolius* and weedy fencelines before these sweeps, to ensure that groups of people could sweep together across an area without being held up on one weed patch. In the SW quadrant, levels of native canopy cover are so high that every single weed could be killed without affecting light levels in the area. NRS did however notice that sweeping this entire quadrant took longer than when it was treated three years prior. NRS believe that three years was too long to wait for re-visitation. In addition, more canopy weed removal took place years ago, resulting in more understory weeds on this treatment. However, NRS believe that with the effort made this year and a greater frequency of visitation (full sweep at least every two years), large areas of native ecosystem in the Kahanahāiki MU can be maintained.

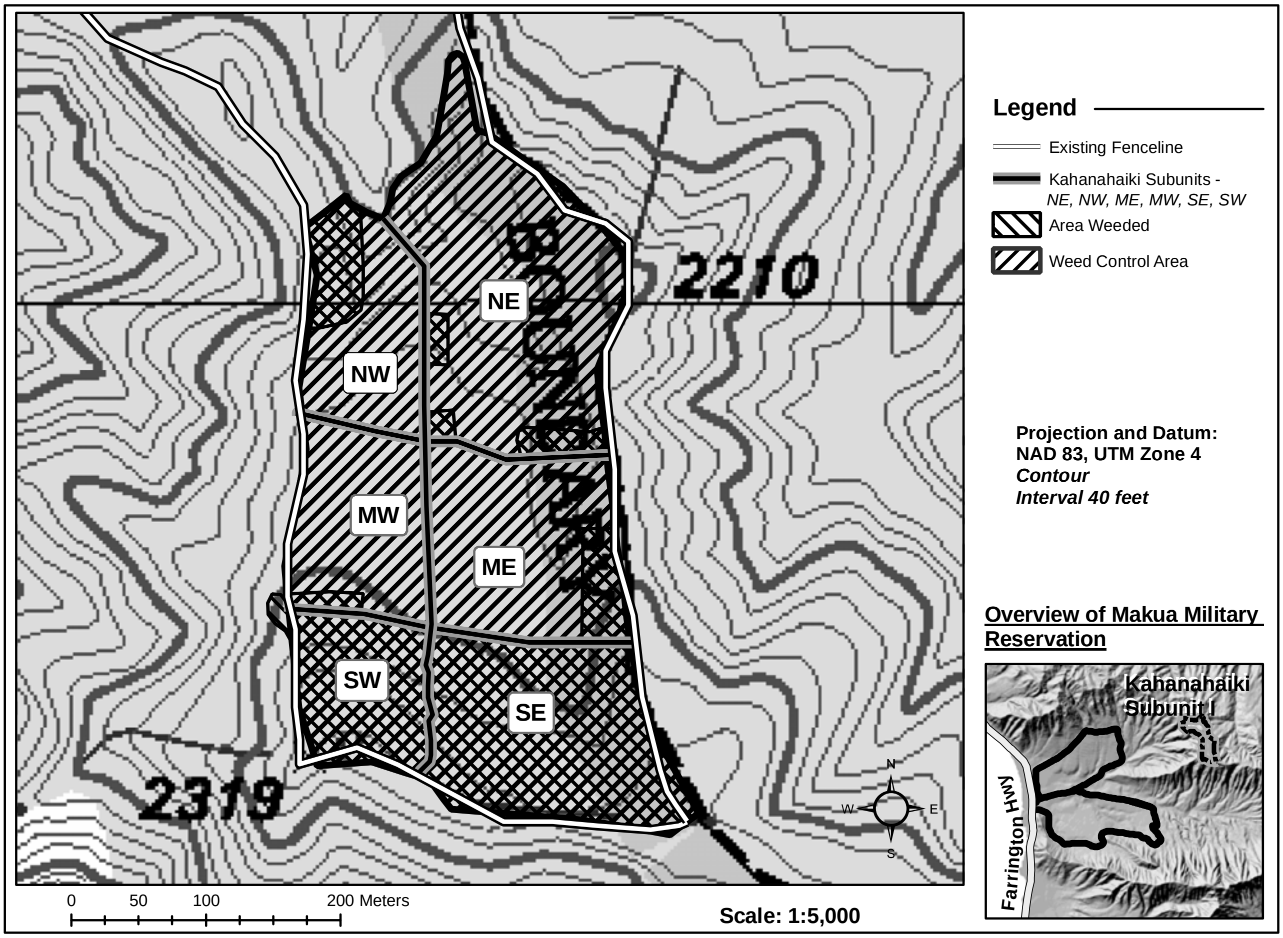


Figure 2.4 Maile Flats Weed Control Area Subunits *Area weeded does not include grass sprayed

Monotypic stands of *Psidium cattleianum* are interspersed throughout all but the southwestern quadrant and pose many challenges to NRS. NRS have conducted many informal *P. cattleianum* treatment trials that have definitely helped improve treatment techniques. However, it is still unclear which techniques were most effective on a particular stand, and how each stand is going to respond to treatment. This year, NRS weeded the edges of the monotypic stands (entire stands were removed if small) during sweeps, and mapped them for continual gradual removal. *P. cattleianum* treatment plots will be established this year by Tamara Ticktin (UH Professor in Botany) at Mākaha Valley to answer the uncertainties discussed above. In addition, long term monitoring of *P. cattleianum* control will surely be a focus for the new monitoring coordinator.

Table 2.4 Summary of Maile Flats Weed Control Area

Species controlled within Maile Flats	Subunit	Effort (People Hours)	% of Area Covered	MIP Rare Taxa Present	Comments
Ageade, Agerip,Budasi, Casgla, Clihir, Conbon, Cracre, Destor, Helpop, Lancam, Monhib, Pasedu, Psicat Psigua, Grerob, Rubros, Schter, Stajam, Syzcum, Trisem	SE Quad	263.5	100%	Achmus	Where weed management does not take place throughout entire subunit, weed control is prioritized by high percentages of native cover, around rare taxa, and potential augmentation sites.
	SW Quad	109.5	100%	Cenagragr Achmus	
	MW Quad	31	20%	Cenagragr Achmus	
	ME Quad	6.5	20%	Achmus	
	NW Quad	20	15%	Cenagragr Achmus	
	NE Quad	46.25	20%	Cenagragr Achmus	
Grass control: *Melmin, Pascon, Rhyrep, Oplhir, Andvir*	N/A. See discussion	31	N/A	Same as above	Always map grass hot-spots when seen. Treated all quads where grass known from this year. Determined several small patches to control next time. Should aim for large scale grass control throughout entire Maile Flats once a year.

NRS were pleased with the amount of area covered in the Maile Flats area this year (see Figure 2.4), especially since it had been nearly three years since thorough treatment of the southern quadrants. NRS would like to continue this type of effort, where possible across the other subunits in the coming year. NRS are also hopeful that the new monitoring coordinator will be able to gather data from weed control efforts and recommend desirable frequencies and type of weed control within the subunits in Maile Flats.

Grass in the Maile Flats area is treated throughout the entire unit, without regard to subunit boundaries. NRS mostly target the dominant grass *Melinis minutiflora* in Maile Flats, but also treat all other non-native grass species when present. These grasses are usually treated during large-scale sprays; however NRS occasionally target specific sensitive or infested areas if needed. NRS are also careful about grass control in the vicinity of both wild and outplanted *Cenchrus agrimoniodies.* Hand-pulling is the preferred control method of choice in those areas.

In addition to weed control in the Maile Flats area, NRS also weeded 300 m along the southern fenceline for four hours to facilitate easier access and to prevent a source of weeds from becoming established along this corridor (data not included in Table 2.4).

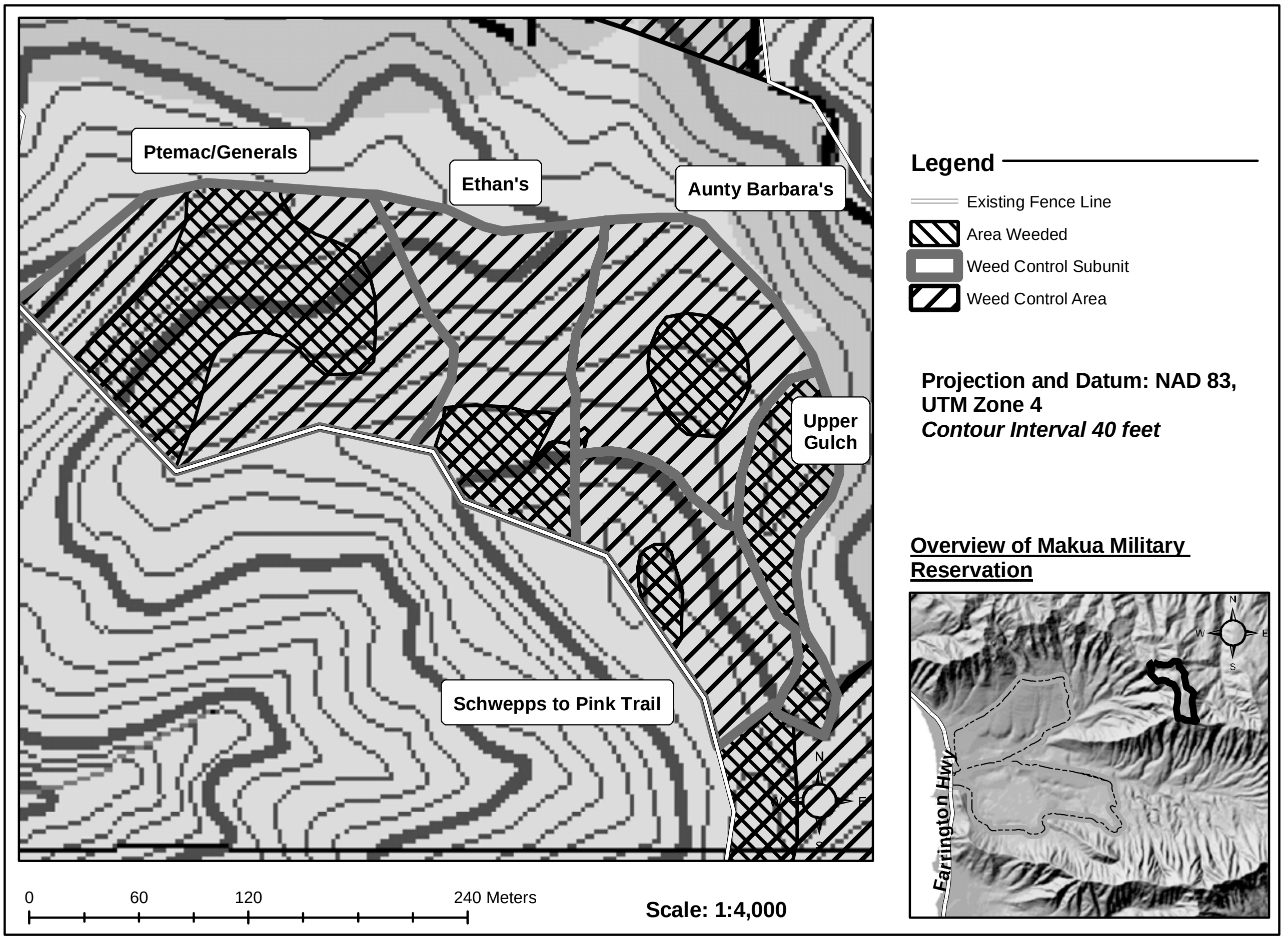


Figure 2.5 Kahanahāiki Gulch Weed Control Subunits *Area weeded does not include grass sprayed

Kahanahāiki Gulch WCA

This year, NRS defined subunits within Kahanahāiki Gulch to facilitate reporting and management efforts, as was previously done in Maile Flats. Subunit boundaries are loosely mapped in Figure 2.5, but a GPS point will be taken for accuracy this year. Subunits were defined by landmarks such as established trails, and also by topography and vegetation types. No subunit is as topographically simple or 'straightforward' as in Maile Flats, where entire units can be swept for weeds. Although smaller than Maile Flats subunits, the Kahanahāiki Gulch subunits are interspersed with very weedy areas, and more difficult topography. For the most part, the south facing slope of the gulch is very weedy; therefore subunits were not created on this slope. NRS have conducted vegetation surveys throughout the gulch area, and already have a sense of the priority weeding areas within each subunit. The new boundaries will help to track weeding efforts. NRS do however foresee problems reporting Kahanahaiki gulch weed control using maps, as is done in Maile Flats because it is extremely difficult to get accurate GPS points in the Gulch. NRS use very detailed sketch maps to track weed progress throughout this part of the MU.

Table 2.5 Summary of Kahanahāiki Gulch Weed Control Area

Species controlled within WCA	Subunit	Effort (People Hours)	% Area Covered	MIP Rare Taxa Present	Comments
Ageade, Agerip,Budasi, Casgla, Clihir, Conbon, Cracre, Destor, Helpop, Lancam, Monhib, Pasedu, Psicat,, Psigua, Grerob, Rubros, Schter, Stajam, Syzcum, Trisem, **Grass control:** Mostly target shade tolerant *Oplhir* in Gulch areas. Also target: *Melmin, Rhyrep, Pascon*	Auntie Barbs **Grass Control:**	58.5 4	30% 25%	*Cyasupsup, Delsub, Schobo, Achmus*	NRS weed control focused in small, nice areas. Two trips were made this year. Aim to expand through more of WCA this year. Grass sprayed twice in same area.
	Upper Gulch	62	100%	*Cyrden, Cyasupsup, Schobo, Achmus*	Focused on open area created by *Pisonia umbellifera* dieback where consequential influx of weeds occured (swept 3 times). Swept nearly entire WCA 1 time. No grass control conducted.
	Ptemac Gulch **Grass Control:**	15 2.5	50% 50%	*Alemac, Fluneo, Cyasupsup Delsub*	Mostly native areas require minimal weeding. Targeted 2 times this year. Grass spray targets *Oplhir*, the largest understory weed threat.
	Ethans' Gulch **Grass Control:**	86.5 4	35% 15%	*Cyasupsup Cenagragr*	Follow-up weed control in two previously treated monotypic guava stands where observed recruitment and increased vigor of native plants. Additionally conducted outplanting of common natives. Sprayed and handpulled *Melmin* getting thick around *Cenagragr*.
	Schwepps to Pink Trail	1	5%	*Cenagragr, Schnut*	Targeted north/northeast facing slope near crest with mostly native vegetation. Also selectively removed weeds around rare plant populations in relatively thick weeds (Cenagragr in *P. cattleianum* stand).

Oplismenus hirtellus is a target weed across most of the gulch subunits as it is one of the most prevalent and prolific understory weeds. Overall, the Kahanahāiki Gulch WCA is weedier than Maile Flats; overstory weed control can result in dramatic alteration of light regimes, ultimately favoring the establishment of weed species. *O. hirtellus* can get thick and grow over native seed/saplings. NRS treated *O. hirtellus* around outplantings of *Alectryon macrococcus* var. *macrocaccus, Cyanea superba* subsp. *superba, Delissea subcordata, Flueggea neowawraea, Pteralyxia. macrocarpa,* and *Schidea obovata.*

NRS also conducted follow-up weed control around two previously treated monotypic guava stands in the Chipper and Ethan's subunits (see Table 2.5). Due to the lack of understory present at the Ethan's site, NRS planted several overstory and understory common native plants. The following species were planted this past winter: *Bobea elatior, Carex wahuensis, Pouteria sandwicensis,* and *Rauvolfia sandwicensis*.

Black Wattle WCA

Most recent *A. mearnsii* control efforts at the Black Wattle site (Figure 2.2) involve large sweeps for seedlings. It is believed that only one mature tree remains close by on State land in Pahole Gulch and will be targeted pending access from the State. NRS mapped the closest source population about 1 mile away along the Kuaokalā Rd. If NRS can target remaining mature trees in the immediate vicinity, control of this species in the MU is achievable. This year, NRS will investigate seed viability to determine the time needed to exhaust the established seedbank.

Weed taxa controlled, effort, and total area controlled in the last year within the Black Wattle WCA are shown in Table 2.6. Due to the open nature of the site which was created by *A. mearnsii* removal, NRS conduct this level of weed control in the area to prevent the colonization of sun-loving weeds. This year less time was spent spraying grass and controlling common weeds than in previous years likely because outplanted common canopy and understory species are already closing large light-gaps at the site (see PCSU 2004 for history of area). As an overstory is established and as these weeds become less problematic, time and frequency spent in the area will continue to reduce.

NRS often pairs grass control along the Kahanahāiki access trail with grass control at the Black WattleWCA, due to the two sites proximity to each other. This year, 1 hour was spent treating 200 m² along the trail from the Nike Site to the Kahanahāiki fence.

Table 2.6 Summary of Black Wattle Weed Control Area

Species controlled within Black Wattle Area	Effort (People Hours)	% Area Covered	Comments
Acamea, Psicat, Clihir, Grerob, Schter, Lancam	36	100% (seedling sweep) 50%(weed control)	Swept area for *A. mearnsii* seedlings quarterly. Many immature plants still found each visit. New mature outliers identified and removed this year.
Grass control: *Melmin, Pascon, Rhyrep,*	12.5	100%	Known grass areas sprayed 2 times. Control only conducted within and immediately around fence; outside is weedy and has lots of grass. Although grass sprayed outside of fence around *Rubarg* site to facilitate detection.

<u>Kaluakauila</u>

The 2003 Mākua fire reinforced the significance of the fire threat to Kaluakauila. NRS have paid a great deal of attention to grass control in the MU, focusing on the WCAs. NRS have designated the 'Upper Patch' and 'Lower Patch' as priority weeding areas shown in Figure 2.6. Weed taxa controlled, effort, and total area controlled in the last year within the WCAs are shown in Table 2.7.

Fuel-break maintenance along the crestline was halted last year due to their ineffectiveness in the 2003 fire. NRS are still working with MMR Range Fire-Chief and staff to come up with a useful fire prevention and management plan. Until this issue is resolved, NRS will not spend effort creating possibly useless firebreaks. NRS will work with newly hired Army fire crews to implement other pre-suppression actions they feel are warranted.

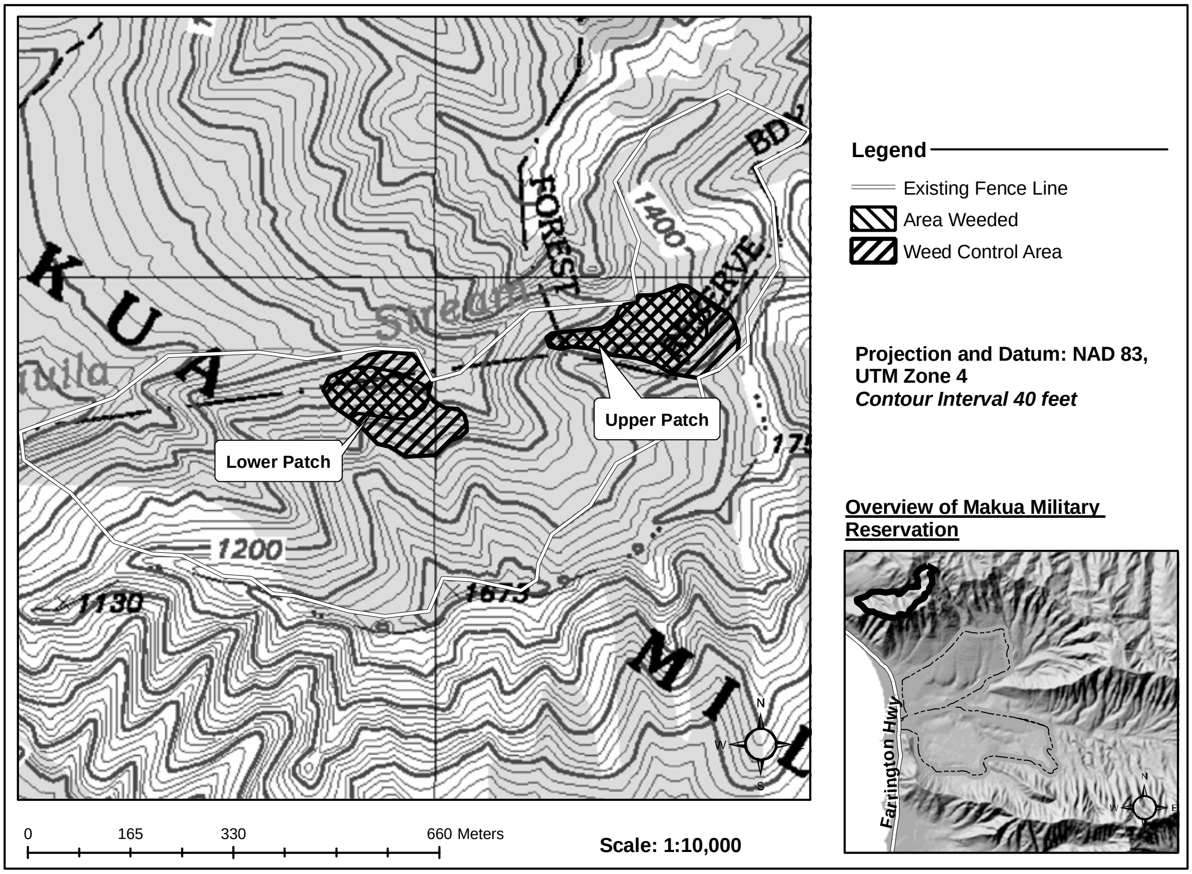


Figure 2.6 Kaluakauila Weed Control Areas *Area weeded does not include grass sprayed

NRS conducted extensive *Panicum maximum* control throughout and on the boundaries of both WCAs, lowering amounts of fuel around rare and endangered plants, as well as within critical habitat designated for those species. As mapped, the WCAs encompass all areas where grass was sprayed, and NRS will expand the WCAs next year as grass control efforts increase.

These sprays were a success in part because of the improvements in water availability in the patches. Two water catchments and a network of hoses and 'filling stations' throughout the patches decreased total spray time as well as decreased amount of backbreaking, tiring, physical labor. In addition, NRS bypassed hours spent weedwhacking grass in past years by applying lessons learned from the Lower 'Ōhikilolo MU. Round-up Pro mixed at a 1% concentration kills mature stands of grass, but has little impact on other native broadleaf species. After a trial spray, NRS found little impact on native seed/saplings. Furthermore, NRS conducted searches for seedlings of rare species, such as *Euphorbia haeleeleana,* and flagged them before sprays to ensure they would not be impacted by the herbicide. A patch of *Schiedea hookerii* however, were accidently sprayed, and further measures will be taken next year to prevent any harm to this rare plant. A second spray was done in both WCAs to retreat previously missed clumps and to further expand the boundaries of the patches. NRS anticipate that amounts of time spent spraying will dramatically decrease in the future due to the major effort made this year.

Once the grass sprays were finished, NRS focused on *Laucaena leucocephala* and other common woody weed removal throughout both WCAs. NRS anticipate that such sweeps around wild *Melanthera tenuifolia* and *Nototrichium humile* and outplanted *Hibiscus brackenridgei* subps. *mokuleianus* and, *Neraudia angulata* will resume as a regular quarterly activity in Kaluakauila MU. Weed control efforts will continue to evolve as fire considerations and plans are developed and priority weeds are reduced.

Table 2.7 Summary of Kaluakauila Weed Control Areas

Species controlled within Kaluakauila MU	Weed Control Area	Effort (People Hours)	% Area Covered	MIP Rare Taxa Present	Comments
Leuleu, Psicat, Psigua, Rivhum, Lancam, Agerip, Agecon, Hyppec **Grass control:** *Panmax, Melmin, Rhyrep, Pascon*	Lower Patch **Grass Control:**	101 53	65% 100%	*Nothum*	Weeding prioritized along rat baiting trails and areas with high levels of native vegetation. NRS mostly target *L. leucocephala* (found in highest abundance and highly habitat altering) as well as others listed. Major grass control of Panmax took place this year just within the boundaries of the entire WCA twice.
	Upper Patch **Grass Control:**	30 11	75% 100%	*Melten, Nothum, Hibramol, Nerang*	NRS targeted patches of *Leuleu* remaining in areas with highest levels of native canopy. Weeding prioritized around these areas as well as around rare taxa (conducted large scale sweep on upper slope this year). Panmax targeted just within the boundaries of the WCA twice.

‘Ōhikilolo

Figure 2.1 (Army Controlled Land) shows that the ‘Ōhikilolo MU is one of the largest, yet it has the least amount of weed control area (Figure 2.7). NRS has not been able to access the portion of this MU in the bottom of Mākua Valley due to UXO related access restrictions. This is also due to the very steep cliffs in the MU. These cliff areas are home to several MIP rare taxa, yet are extremely difficult to manage. The plants on the cliffs are mostly stable and do not have as many weed problems compared to the forest exclosure. The habitat above and around the rare plant populations on the cliffs is more weedy than the actual cliffs where the plants are, so control should be conducted in these areas. To date, weed control has been mostly focused around the unique forest patches along the ridge; however NRS aim to expand control onto the rest of the ridge to benefit the MIP species nearby. NRS conducted weed control at four WCAs and around two rare plant populations in ‘Ōhikilolo MU this year.

A large amount of weed control in ‘Ōhikilolo MU is ecosystem level focused, targeting weeds in forest patches that occur on the north-facing slopes of the ridge. Other weed control is conducted around population units of rare species. Tables 2.8 and 2.9 summarize the weeding in the forest patches and around rare taxa population units.

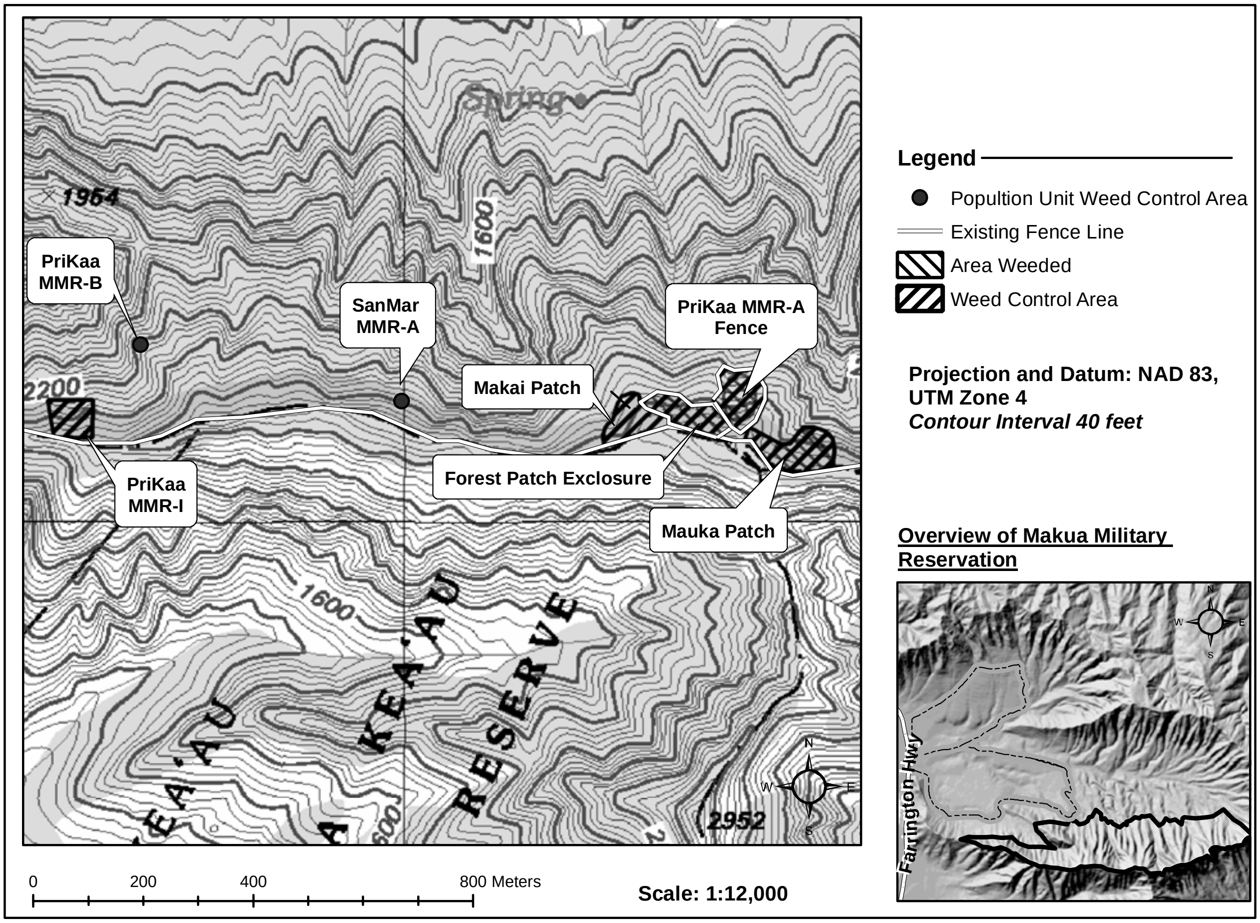


Figure 2.7 ʻŌhikilolo Weed Control Areas

Table 2.8 Summary of ʻŌhikilolo Weed Control Areas

Species controlled within WCA	Weed Control Area	Effort (People Hours)	% Area Covered	MIP Species Present	Comments
Ageade, Agerip, Lancam, Rubros, Schter, Stadic, Verlit	Forest Patch Exclosure **Grass Spray**	92.5 5.5	100% 90%	*Prikaa Achmus*	Swept and sprayed grass throughout nearly entire area this year. Many areas are so thick with native vegetation it is hard to find a weed.
Grasses controlled: *Melmin, Andvir, Vulbro, Setgra, Pascon*	Mauka Patch **Grass Spray:**	217 7	80% 75%	*Prikaa Achmus*	Lapse in weed control resulted in need for major effort camping trip. Swept twice thereafter. See discussion. Will expand weed management area once weeds under control
	Makai Patch	12	N/A	*Alemac Achmus*	Aim to expand weed management into this subunit. See discussion below.
Agerip, Lancam, Schter, Bleapp, Stadic	*Prikaa* MMR-A exclosure	28	75%	*Prikaa*	Regular sweeps limited to approximately once a year due to sensitive nature of site.
Lancam, Schter, Stadic	*Prikaa* MMR-I	0	0	*Prikaa*	Weed control also conducted for Achmus also present in area. No weed control conducted this year. Scheduled for this coming year.

Mauka and Forest Exclosure WCAs

Two water catchments were constructed this year to facilitate outplanting and grass spraying efforts in the Mauka and Forest Exclosure WCAs. The catchments, network of hoses and water 'filling stations' should save significant time and effort, allowing NRS to work elsewhere along the ridgeline MU.

Weed control in the subunits is conducted for *Achatinella mustelina* management, and *Pritchardia kaalae* reintroduction maintenance, and general native forest improvement. Outplantings of *Myrsine lessertiana*, believed to provide favorable habitat for the snails were conducted several years ago to create canopy over weedy light gaps, as well as to replace the many trees of this species observed dying in past years. These trees are well on their way to maturing, and *A. mustelina* have been seen on them. Additionally, NRS have been planting *Acacia koa* along upper slopes of the forest patches for several years. This year, more were planted in the Mauka WCA.

During a large group camping trip this year, NRS were able to sweep the entire forest patch exclosure for weeds. Grass throughout the subunit was also treated thus creating a nearly entirely native forest patch. Re-treatment of the subunit will not be due for another year and NRS try to minimize time spent walking through the thick and fern-choked native understory.

Due to a lapse in regular weed control in the Mauka WCA, NRS were displeased to see nearly every vacant bit of understory occupied by *R. rosifolius*. NRS spent much of a camping trip with a large group of people treating this mauka forest patch. Weed control in the WCA during the two subsequent camping trips was greatly reduced, and NRS were able to begin reclaiming an adjacent, weedier gulch that experienced the same influx of *R. rosifolius*. This experience emphasizes the need for NRS to have continued access to all weeding sites.

With significant progress made in the first two subunits, NRS aim to expand forest patch weed control into a third subunit makai. This subunit is mapped loosely, and still needs to be officially defined after further scoping of the area. It stretches from the exclosure, across several gulches to the west. While this subunit boasts just as many native resources as the other patches, it has more challenging topography and lacks historical weed control efforts due to limited staff time. Nonetheless, when possible, NRS will begin to make the area more accessible and safe for weed control. NRS already spent some time bucking up dead logs and snags in the area. Hopefully, in the next year, weed control will begin in this subunit.

Prikaa MMR-A and MMR-I WCAs

Both the Prikaa MMR-A and MMR-I WCAs are relatively small and include a wild and reintroduced population of *P. kaalae* respectively. Prikaa MMR-A contains a rather non-native forest composition. NRS have been weeding yearly at this site, however, now that *Schinus terebinthifolius* overstory has been eliminated, NRS will increase the frequency of understory weed control to establish good habitat for *P. kaalae* and native seedlings to establish and reclaim the area. This year *M. minutiflora* was sprayed and a sweep for other weed species was conducted in the Prikaa A WCA. The Prikaa MMR-I WCA contains about 50% native forest canopy, and also contains several *A. mustelina*. The site was not weeded this year, but in the past weeding was focused around slow removal of small *S. terebinthifolius.*

SanMar and Prikaa MMR-B

As mentioned above, there are limited areas where weed control can be conducted around the rare plants that occur on the steep cliffs of ‘Ōhikilolo Ridge. Table 2.9 describes weed control efforts possible around one population of *Sanicula mariversa* and one population of *P. kaalae*.

Table 2.9 Summary of Rare Taxa Population Units

Species controlled within Population Units	Population Unit Weed Control Area	Effort (People Hours)	% Area Covered	Comments
Grasses controlled: *Andvir, Melmin, Rhyrep, Setgra*	Sanmar MMR-A	7	100%	Aim to keep large *M. minutiflora* patches out of immediate area. Control other habitat altering grasses throughout population. Sprayed area 3 times this year.
Grasses controlled: *Andvir, Melmin, Rhyrep, Setgra*	Prikaa MMR-B	3.5	100%	Grass control focused around potential seedling beds below three wild trees. Controlled when necessary. Sprayed 3 times this year.

The tasks at these two sites are rather specific and straightforward. For example, weed control to improve habitat at the Prikaa MMR-B site is not necessary. The three trees in this population are located meters from the edge of a cliff, surrounded by *S. terebinthifolius,* and there is little weed control that will greatly improve habitat for these trees. However, NRS can assist in promoting the regeneration of the seedlings from these trees by controlling grasses around the seed ‘catchments’ that keep seeds from falling off the cliff to inhabitable sites.

In contrast, grass control at the *S. mariversa* site is thought to be helpful in promoting quality habitat for the rare taxa, and restoring a dry, cliff, ecotype. In addition, NRS will begin removing *S. terebinthifolius* at this site. In both the Prikaa-B and Sanmar-A sites, total area is less than 900 meters squared (30m by 30m). Weed control tasks there are simple and need only be done approximately 2 times a year.

<u>Lower ‘Ōhikilolo</u>

Management in the Lower ‘Ōhikilolo MU is unique among the many weed control projects performed by NRS because it is focused primarily on fuel-break construction and maintenance, and secondarily on native habitat management. There are three endangered species, *Chamaesyce celastroides* var. *kaenana, H. brackenridgei* subsp. *mokuleianus,* and *Spermolepis hawaiiensis* in the MU. Management is focused around the two *C. celastroides* patches and one *H. brackenridgei* population. Each rare plant population serves as its own weed control area (Figure 2.8). NRS efforts in these areas are concentrated on controlling *P. maximum* and *L. leucocephala* in order reduce fuel to fires that threaten the area every summer. Since weed control began in the winter of 2001, NRS has seen this site transform from a grass dominated waste land to a native shrubland with broadleaf weeds mixed in. There are now large populations of *Dodonaea viscosa*, *Sida fallax*, *Waltheria indica*, and *Abutilon incanum* present in the patches.

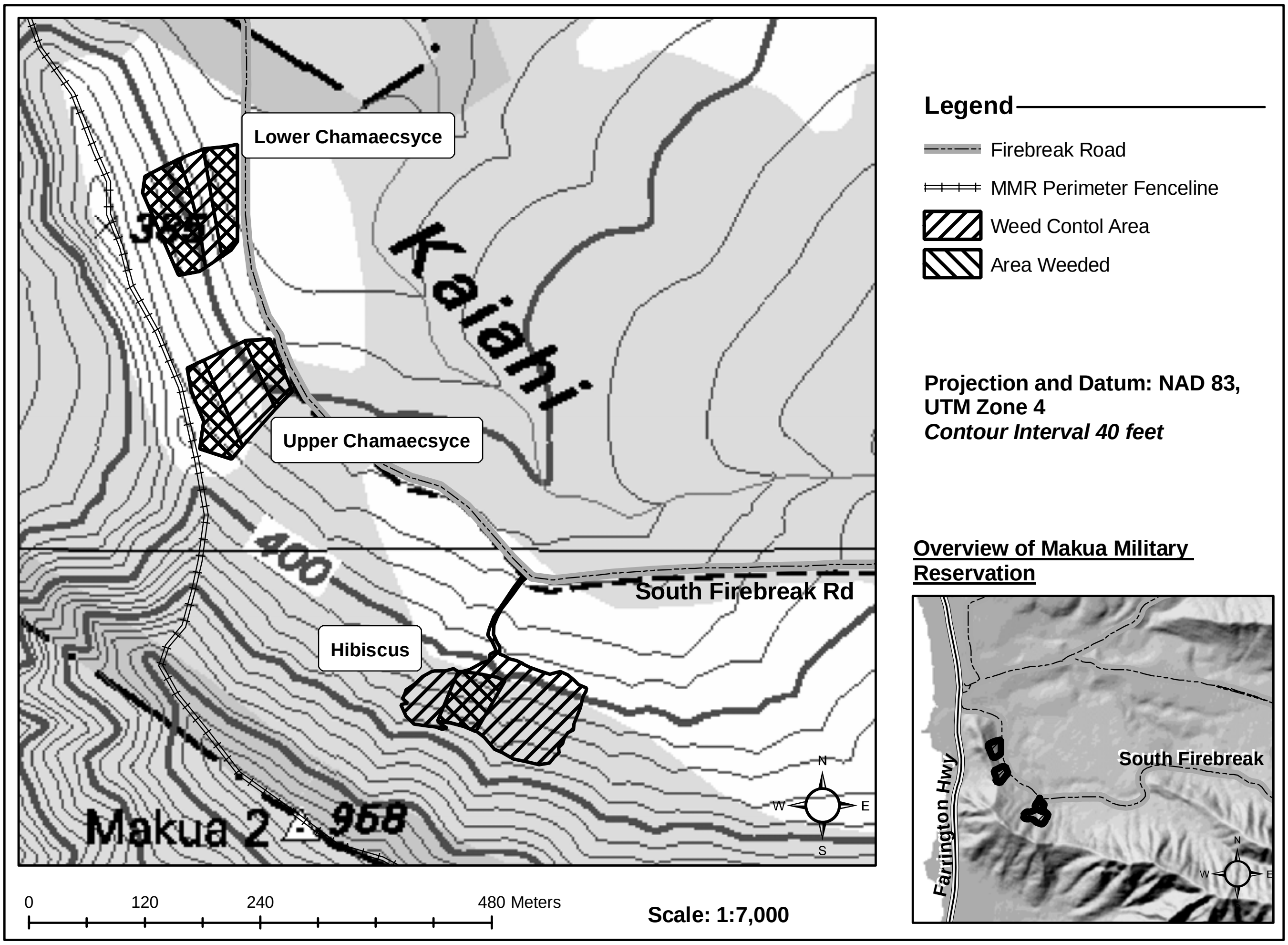


Figure 2.8 Lower ʻŌhikilolo Weed Control Areas *Area weeded does not include grass sprayed

Weed control at Lower ʻŌhikilolo is going well. Unlike the summer of 2004, in the summer of 2005, Mākua Valley dried out and no grass spraying was needed during the summer months. The frequency of spray during the non-summer months is a question that NRS is interested in investigating with the monitoring coordinator. Presently, NRS take an aggressive approach by spraying at the first sign of new growth. It is unclear if this is the best approach. NRS cleared both *Chamaesyce* patches to the fire break road this year to further reduce fire threats to the patch. In July of 2003 a fire burned into the Lower *Chamaesyce* patch, this happened again in August of 2005. Both times the fire burned in from the Range Control side of the patch after jumping the fire break road in an un-maintained section at the base of ʻŌhikilolo ridge. NRS believe that clearance of fuel in this section is high priority. (See the *C. celastroides* var. *kaenana* section for more discussion and a map). Woody species control is ongoing at the *Hibiscus* patch and the Upper *Chamaesyce* patch. NRS completed removal of all weedy mature plants from the lower patch this year. In the next year NRS should be able to complete this for the other two patches. A couple efforts not recorded in the totals above include spraying the trail to the *Hibiscus* patch as well as spraying the road margins below the *Hibiscus* patch to widen the fuel-break.

Effort calculated in number of hours spent controlling grass and woody weed species varies from season to season based on rainfall (Figure 2.9). This year's effort as compared to previous most closely reflects what is anticipated to be the new average as dictated by the low number of mature woody weed species left in the patches, and observed amount of yearly rainfall (Table 2.10). With the removal of grass from these patches, there has been a marked increase of herbaceous weeds such as *Leonotis nepetifolia* and *Ageratum conyzoides*. NRS have conducted weed trials on *L. nepetifolia* to determine if control of herbaceous species would be a productive management activity. These trials produced negative results with dense seedling recruitment even during the driest period of the season. Currently, control of these species has not been deemed a productive use of time, nor a significant source of fuel for fire.

Table 2.10 Summary of Lower ʻŌhikilolo Weed Control Areas

Species controlled within Lower ʻŌhikilolo MU	Weed Control Area	Effort (People Hours)	% Area Covered	Comments
Leuleu, Acafar	Lower *Chacelkae* Patch	95	75%	NRS conducted weed control on three trips this year. Patch has been cleared of all mature plants.
Grass control: *Panmax, Chlbar, Rhyrep*	**Grass Control**	44	100%	NRS performed grass spraying on five trips this year. This is a reduction in effort from last year.
	Upper *Chacelkae* Patch	89.5	50%	In four trips NRS finished clearing both lower and upper boundaries of patch. These areas were infested with weeds. This is the first year NRS worked in these areas.
	Grass Control	41.5	100%	Panmax was most densely accumulated in lower boundary of patch extension from previous year.
	Hibramok Patch	89.5	25%	NRS worked on two trips in areas in patch that still had mature plants. There is still more ground to cover.
	Grass Control	37	100%	The amount of staff needed to cover these areas varied depending on the density of grass. Area sprayed three times this year.

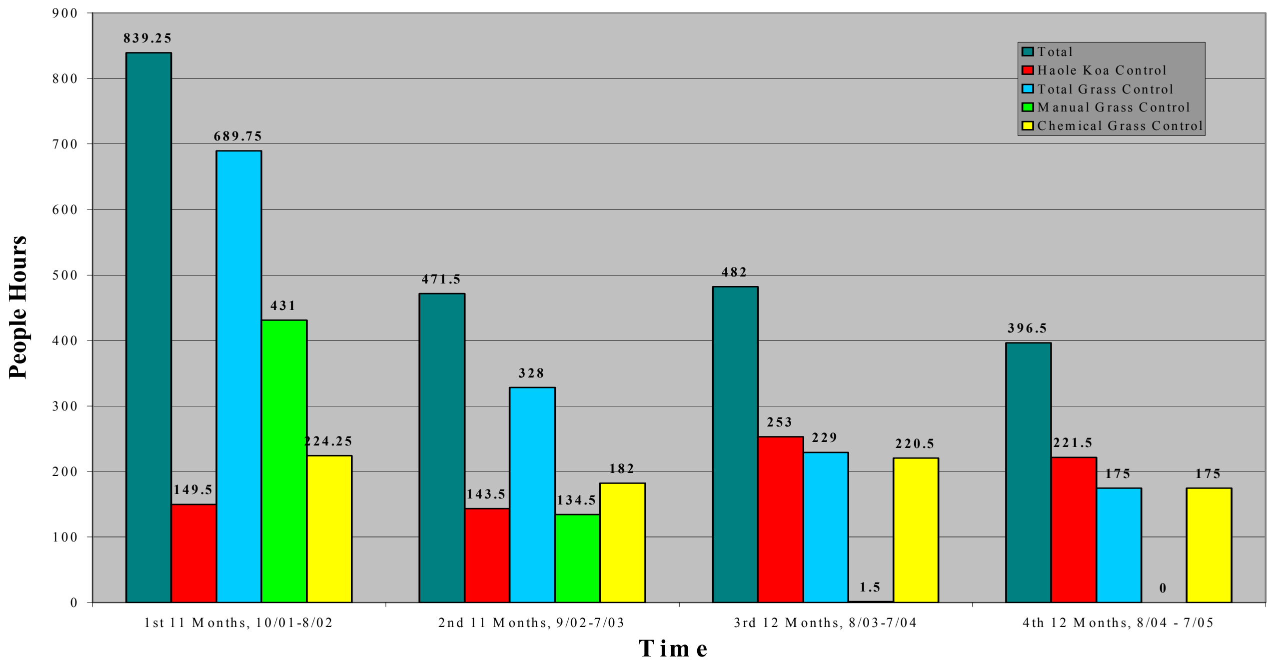


Figure 2.9 Lower ʻŌhikilolo: Change in Effort Over Time 2003-2005

<u>Haili to Keālia</u>

Weed control in this management unit takes place on Army land at Dillingham Military Reservation (DMR) (Figure 2.10 and 2.11). Much of DMR is made up of highly degraded habitat, but the rocky talus slopes on the Mākua end of the reservation host patches of native dry forest. The long-term objective of weed management in DMR is to focus on these talus slopes and expand the native forest patches. The weedy lower flats of DMR are not a management concern.

The only significant change to this management unit was the addition of a catchment which will be used in a *H. brackenridgei* outplanting area. NRS spent time prepping this area by controlling grass and *L. leucocephala.* Some additional weed controlefforts were conducted in this WCA (Table 2.11).

Table 2.11 Summary of Keālia Weed Control Areas

Species controlled within Keālia WCA	Weed Control Area	Effort (People Hours)	% of weedy area covered	Comments
Acafar, Cocgra, Lancam, Leuleu, Momcha, Pasedu, Plusym, Riccom, Schter	Keālia	46	10%	Swept in *Sapindus oahuensis* forest off of transect trail in three trips.

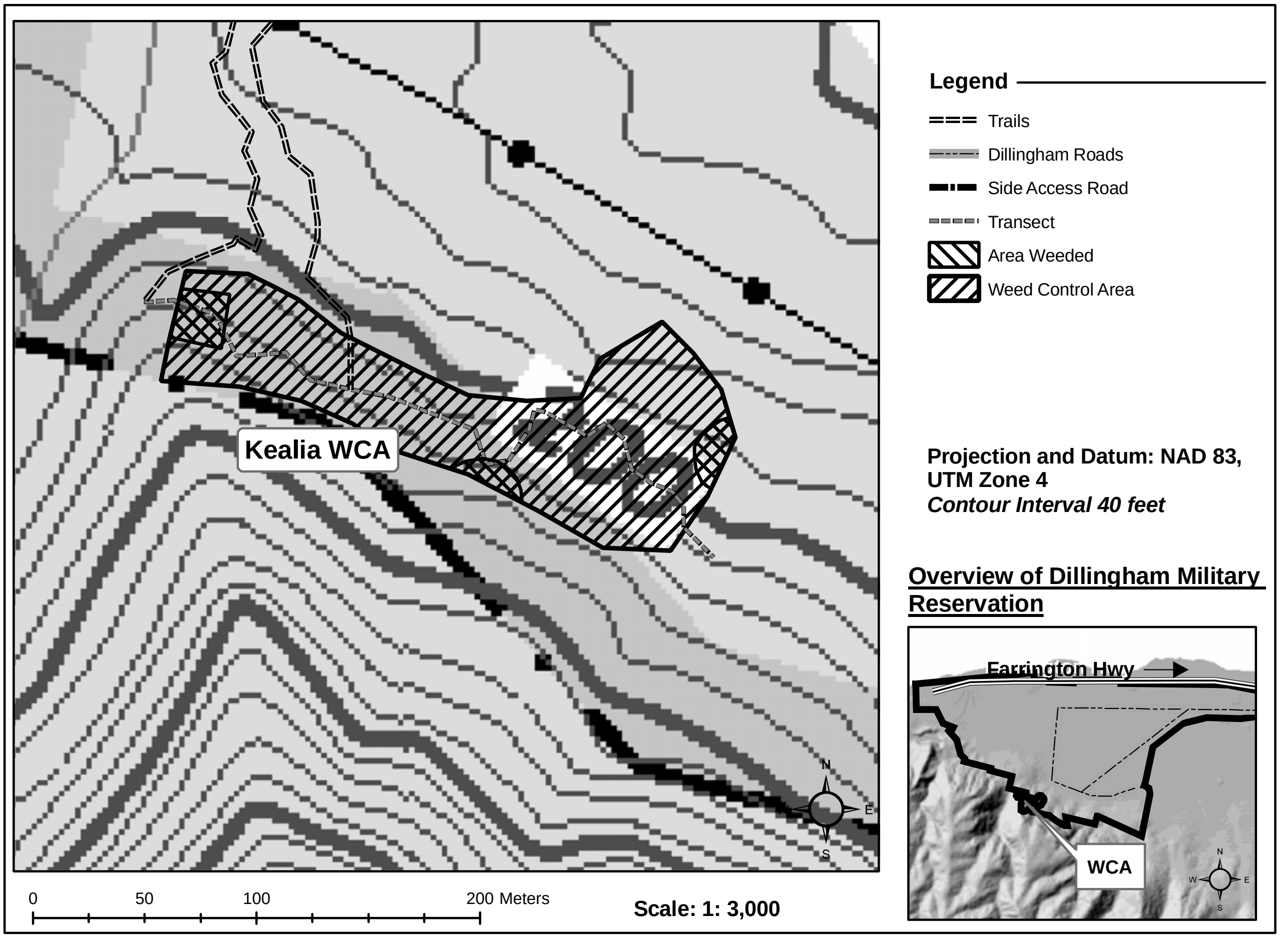


Figure 2.10 Keālia Weed Control Areas

Lower ʻŌpaeʻula

Not present on the Army Controlled Land map (Figure 2.1) due to lack of weed control in the area for over two years, the Lower ʻŌpaeʻula weed control area is worth mentioning. The area is home to diverse forest and several rare MIP taxa, and historically has seen significant levels of weed control. NRS stopped weeding in this area due to the great presence of pigs in the area. Such a high level of pigs impact makes weeding potentially damaging to the native resources. For example, NRS spent many hours weeding *Clidemia hirta* around native plants, only to find that opening the understory attracted and directed pigs to those weeded areas. 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 ʻŌpaeʻula. Once the fence is completed NRS will resume weed control.

State of Hawai‘i Land

Weed control takes place in the four following MUs on State land: Pahole, Upper Kapuna, Ka‘ena Point and West Makaleha (Figure 2.11). NRS initiated more weed control on State land this year than in years past. However, due to access issues, NRS were unable to carry out weed control between July and Spetember, 2005. The following data represents work done up to July.

Surveys

NRS conducted one road survey on State Land this year along the Peacock Flats road to the Nike Site (Figure 2.11). Given the high volume of use this road receives by NRS, State, and other agencies, as well as its proximity to the Pahole NAR and Kahanahāiki MU, it was a high priority to monitor. During the Road survey, it was clear to NRS that in fact some weeds were being spread to higher elevations much faster than they would have been without the road. NRS believe that the lack of road maintenance also played a role in this spread, but have initiated intense road maintenance along with the State to better manage weed spread. NRS plan to expand the number of both road and LZ surveys in the State MUs next year.

Single Species Target Control

There are few weed species that NRS target for complete removal from State land. Much of this is due to the fact that NRS do not yet have a sense of weed abundance for any incipient invasives on State land. NRS expects that these targets will be developed with the State using the species list from Table 2.1. Given that State land borders several Army MUs such as Kahanahāiki, controlling any Kahanahāiki single species targets that occur across adjacent State land seems prudent in order to create buffers for invasive weeds across State and Army land.
NRS currently target two species for control (Figure 2.11). NRS are aware of one *R. argutus* population in Keawapilau (Upper Kapuna MU) but the population has not yet been targeted. NRS have also assisted the NARS Specialist in targeting a large stand of the ornamental, *Tecomaria capensis,* along the East Mākua Rim. NRS have observed that the treated stand is growing back and will continue treatment at this site if permitted.

Management Unit Weed Control

Pahole

Weed actions conducted in the Natural Area Reserve are based on objectives established through discussion between NRS and the NARS Specialist. Within the Pahole NAR weed control areas and subunits have been established based on populations of existing rare plant taxa and areas with intact native habitat (Figure 2.12).

As this year was the first year we have begun coordinated management within the NAR, all WCAs are newly established. The NARS Specialist helps determine and facilitates what actions are taken. Some of the larger scale projects include ridding the gulches within Pahole of *Montonoa hibiscifolia* and conducting trials on *Grevillia robusta* to determine the most effective method of killing the weed. *M. hibiscifolia* is an easy weed to locate during its flowering season, and eradication thus far has yielded good results with few re-sprouts. The *G. robusta* trials consist of three different control techniques. Results of these trials will be discussed after data from these trials have been collected. The NARS specialist indicated that data collection would occur in the summer of 2005.

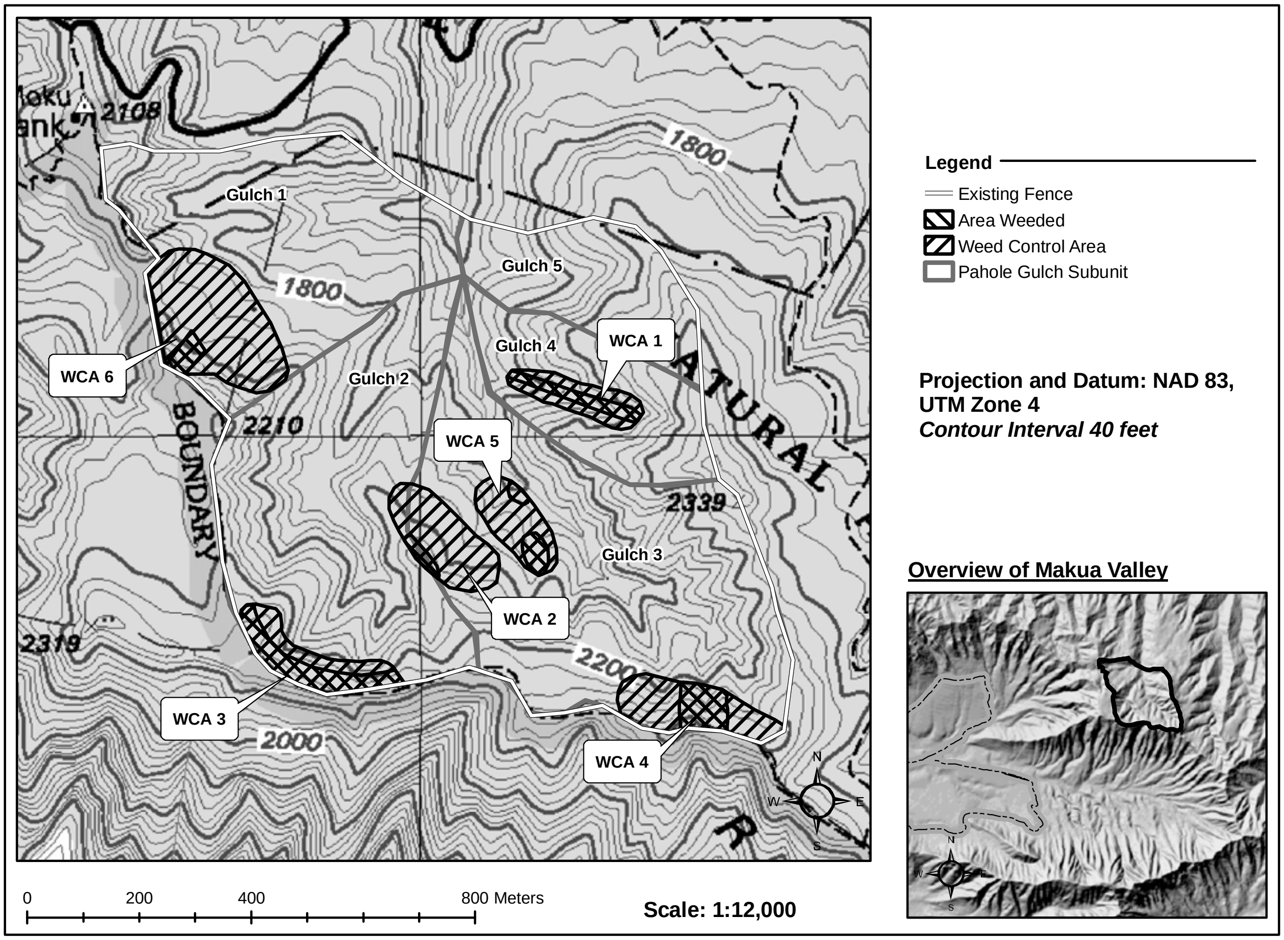


Figure 2.12 Pahole Weed Control Areas *Area weeded does not include grass sprayed

The largest collaborated weeding activity in Pahole was a ecosystem scale weed project conducted in WCA #1 (Figure 2.12 and Table 2.12). This effort was focused on improving the lower gulch habitat by removing weeds at the back of the gulch where the last remaining population of *Phyllostegia kaalaensis* once existed. These actions also paved the way for the reintroduction of *P. kaalaensis* into the gulch (for more information on this reintroduction see rare plant section). NARS staff had not recently weeded in this area and it was labor intensive to eliminate the established weedy patches. However, since the gulch was cleared, it is now relatively easy for NRS to maintain and to expand this effort with quarterly trips.

In the *C. agrimonioides* WCA #2, weed control has only just begun. NRS began clearing *M. minutifolia* around the wild plants. Unfortunately, NRS was unable to return in a timely manor due to access restriction and now expect that the grass has returned to pre-treatment levels. If access to the area resumes, NRS will return to the site and begin grass control again. In addition, NRS would like to expand weed control efforts to begin habitat scale weed control in the area.

Table 2.12 Summary of Pahole Weed Control Areas

Species controlled within Pahole MU	Weed Control Area	Effort (People Hours)	% Area Covered	MIP Rare Taxa Present	Comments
Ageade, Agerip,Budasi, Casgla, Clihir, Conbon, Cracre, Destor, Helpop, Lancam, Monhib, Pasedu, Psicat,, Psigua, Grerob, Rubros, Schter, Stajam, Syzcum, Trisem, **Grass control:** Mostly target shade tolerant *Oplhir* in Gulch areas. Also target: *Melmin, Rhyrep, Pascon* and, *Ehrsti*.	WCA #1	98	50%	*Phykaa*	NRS got good coverage in this gulch around *Phykaa* reintros. Swept for understory weeds, prepped for outplantings and installed trail over 6 trips.
	WCA #2 **Grass Control:**	2	5%	*Cenagragr*	Cut *Melmin* away from *Cenagr* and later treated with grass specific herbicide. Larger scale weed control has not begun.
	WCA #3	58	75%	*Cenagragr*	Got good coverage in area. Swept twice this year. Area is relatively intact.
	WCA #4	60.5	25%	*Schnut Cyalon*	Weeded along rim off trail and in vicinity of *Cyalon* and *Schnut* over four trips.
	WCA #5	32	25%	*Cyasupsup Chaher Cyagri*	Concentrate on eradicating all *Monhib* in gulch. Conducted baseline survey of overstory and understory weeds. Large scale weed control need has not begun.
	WCA #6	3.75	5%	*Schnut*	Weed control occurred only around outplantings. No weed control occurred in forest patch below.

In contrast, weed control at the *C. agrimonioides* var. *agriminioides* reintroduction site in WCA#3 is going well. This area is along the western side of the Pahole rim. The habitat in this area is relatively intact. In the last year NRS conducted weed control across much of WCA #3. Around the reintroduction site, NRS are able to carry out quarterly maintenance trips because the majority of the weeds have been removed in previous years. NRS swept new areas below the rim and found the habitat well intact and could easily remove the few weeds present. In the next year NRS will work to expand weed control in this area. *Hedyotis degnerii* var. *degnerii* populations also benefit from weed control in this area.

Another extremely native area in Pahole is the eastern rim WCA #4 around the *Cyanea longiflora* and *Schiedea nuttallii* populations. NRS has weeded about a quarter of the proposed WCA #4 this year and plan to expand weeding efforts next year.

In WCA #5, NRS focused on removal of *M. hibiscifolia* patches. This WCA spans wild populations of *Cyanea grimesiana* subsp. *obatae* and *Chamaesyce herbstii* as well as a large reintroduction of *Cyanea superba* subsp. *superba*. This is intensive work and NRS did not cover very much area. NRS look forward to large scale habitat weed control in the next year. NRS also cleared management trails this year to facilitate management of this area. The time spent on this action is not recorded in the table as it fell outside of the WCA.

The switchback site at WCA #6 contains a new reintroduction of *S. nutallii* NRS weeded the area around the outplantings this year. Below these outplantings there is a large stretch of beautiful native forest. NRS requested permission to weed this area and expand the boundaries of WCA #6, however were denied. NRS will seek permission to weed this area in the coming year.

Upper Kapuna

NRS conduct weed control in three areas, all in Subunit 1 of the Kapuna MU (Figure 2.13 and Table 2.13). Two of these are smaller WCAs in Keawapilau Gulch, and are based around rare plants there. The larger WCA in Kapuna Gulch also includes rare species, however also encompasses a patch of high quality native forest too. The WCA has had extensive, regular weeding since NRS were permitted to begin weed control in the area two years ago. NRS made initial weed control decisions in the MU based on its proposal for fencing by the State. NRS strongly support a fence in this Management Unit and given permission by the State would consider expanding weeding efforts within the fenced area.

WCA Discussion

The NARS Specialist suggested the Kapuna WCA as a priority weeding area. NRS are excited about the weeding conducted in Kapuna because the area is very native, and it is easy to see the benefits of regular weed control. For example, the native fern understory appears to have expanded. NRS are careful to leave large canopy weeds such as *P. cattleianum* standing in order to maintain light regimes. This year, NRS expanded the area weeded to include the lowest known *C. herbstii* all the way up the gulch to the Mokuleiʻa Trail. It is believed that the regular frequency of weed control, and the gradual, careful weeding conducted in the area has improved the habitat for rare species present, as well as helped maintain the integrity of a large portion of native forest in Kapuna MU. NRS fear that without access into these areas, weeds will begin to reestablish themselves throughout the WCA.

The Schnut and Phykaa WCA 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 plants and the steep terrain of the site. NRS only weed in these immediate areas to maintain their existing microclimates. In the rest of the WCAs, there are patches of mostly native forest where more intense, understory weed control is conducted. Next year, NRS would like to continue maintenance in areas already weeded, as well as to bridge the gap between these two WCAs. NRS believe that species such as *C. longiflora* would benefit from creating more continual habitat through the population.

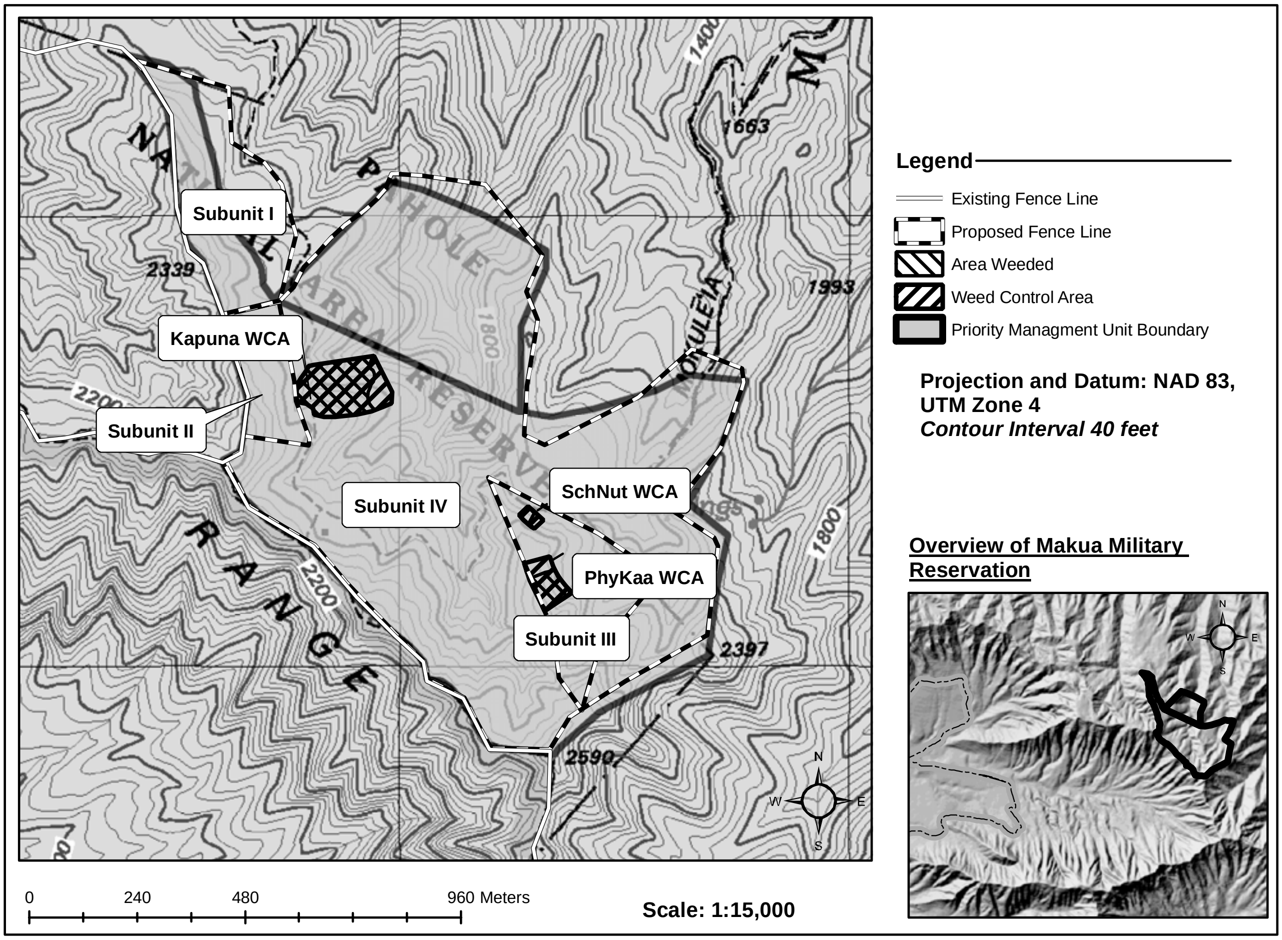


Figure 2.13 Upper Kapuna Weed Control Areas *Area weeded does not include grass sprayed

Table 2.13 Sumary of Kapuna Weed Control Areas

Species controlled within Kapuna MU	Weed Control Area	Effort (People Hours)	% Area Covered	MIP Rare Taxa Present	Comments
Agerip, Ageade Psicat, Lancam, Clihir, Grerob, Stadic, Spacam, Schter, Psigua, Trisem, Desint, Rubros, Budasi, Chrden,Chrpet	Kapuna	86.5	80%	*Chaher, Hesarb, Cyrden*	Weeded once quarterly, sometimes more often. Focus on removal of all non-native understory, leaving some canopy weeds for gradual removal. Entire core weed area weeded twice.
	Schnut	22	50%	*Schnut, Cyalon*	Minimal, careful weeding around the two rare plant species present. Weeding conducted through partial WCA twice.
	Phykaa	47	75%	*Phykaa, Cyalon*	Weeded critically around rare plants, and heavier in mostly native areas. Expanded weeded area this year. Focused on weedy understory through partial WCA three times.

Ka'ena

Ka'ena MU consists of one WCA and one PU located approximately 1300m apart, around two populations of *C. celastroides* var. *kaenana*. The populations known as KAE-A and B are located east of Alau Gulch and within Kaʻena NAR respectively. One WCA is defined in each of these management unit areas (Figure 2.14).

Weed control was last conducted at KAE-A in 2004 in a very small area immediately around the *C. celastroides* var. *kaenana*. On returning to monitor the plants this year, it was noted that weeds had not yet begun to impact the rare plants again. The site is unique in that the *C. celastroides* var. *kaenana* plants nearly encircle a small, relatively weed-free talus slope. NRS have cleared non-native vegetation in the past, and this year observed plants expanding growth into these areas, as well as observed seedlings within the talus area. NRS will return to the site this year to continue to clear weeds around the plants, and to maintain the talus slope as potential habitat for *C. celastroides* var *kaenana*.

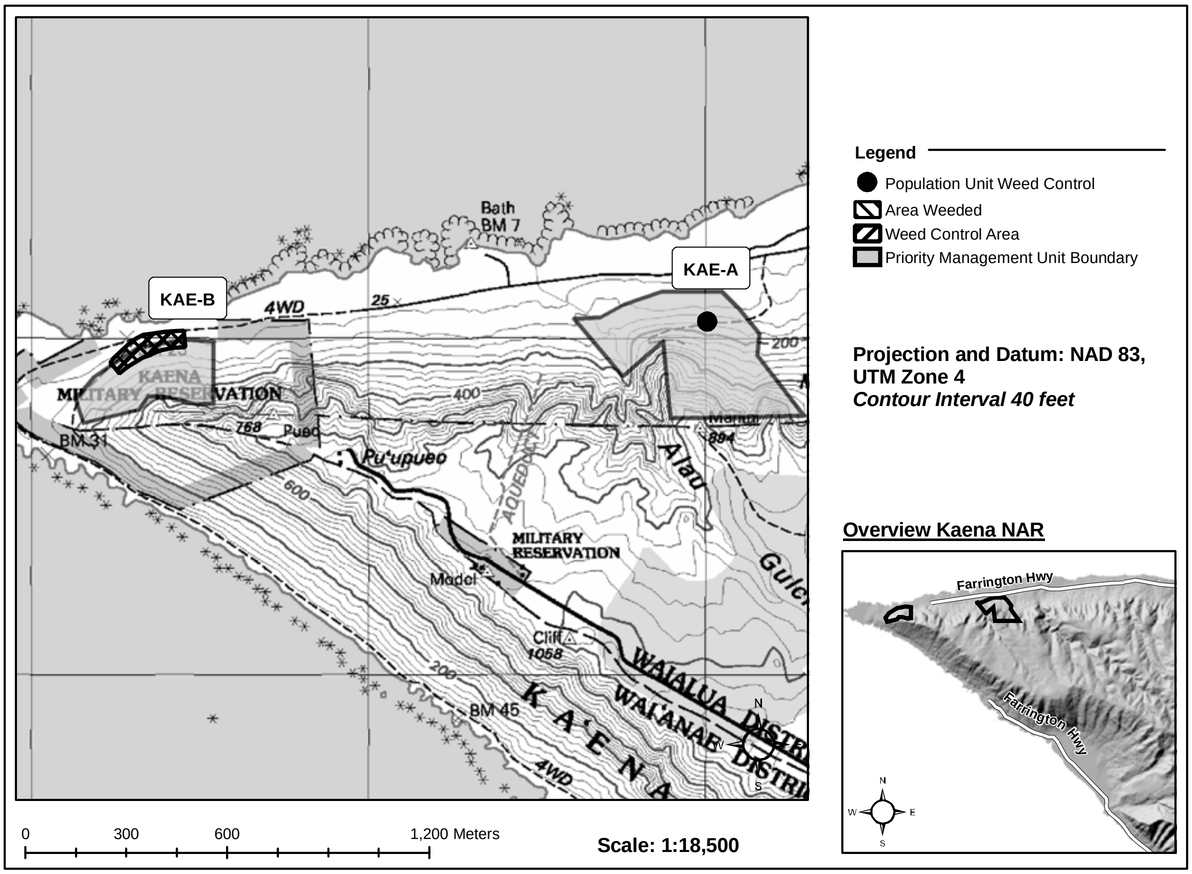


Figure 2.14 Kaʻena Weed Control Areas *Area weeded does not include grass sprayed

Table 2.14 Summary of Ka'ena Weed Control Areas

Species controlled within (Ka'ena MU)	Weed Control Area/PU Weed Control Area	Effort (People Hours)	% of area covered	MIP Rare Taxa Present	Comments
Leuleu, Lancam, Acafar, Atrsem, Achasp,	KAE-A (Population Unit Weed Control)	0	0	*Chacelkae*	Site monitored, minimal weeding necessary. See discussion. Scheduled for weed control this year.
Grasses controled: *Panmax, Chlbar, Setgra, Cencil, Digins*	KAE-B **Grass Control:**	38.5 32.5	100% 75%	*Chacelkae*	Swept entire patch for *Achasp*, *Leuleu*, or *Atrsem* at least once. See discussion. Targeted *Chlbar* and *Digins* throughout patch.

NRS has made great weed control progress in the KAE-B WCA over the years. For one, the amount of *L. leucocephala* has been dramatically reduced; nearly no mature trees exist in the core weeding area. Due to the fact that the main target weeds require different weeding techniques, NRS usually sweep for one of these species at a time, thus clearing large portions of the weed control area of one particular weed. Due to the success of removing many of the woody and herbaceous shrubs and groundcovers, NRS noticed an influx of grasses. NRS therefore spent nearly an equal amount of time this year treating grasses as well as other weed species. Currently, NRS try to time spraying so weedy grasses are beginning to flush, while native grasses have not yet emerged. NRS are still identifying ideal times for these grass sprays where native grasses are less susceptible, and non-native grass kill will be effective. NRS will continue to balance grass spraying and other weed removal efforts this coming year and expect to see more native vegetation colonization of these weed free areas. While there is no conclusive evidence, other than photo points and NRS observations, NRS believe that both the number of *Chamaesyce* plants, and the area in which the population occurs, has increased. NRS also think that the amount of native vegetation, such as *Sida fallax, Eragrostis variabilis, Panicum fauriei,* and *Myoporum sandwicense* has also increased due to weed control efforts over the years.

West Makaleha

The Mokulē'ia Forest Reserve borders MMR and is home to two exclosures containing rare plant populations, *Cyanea grimesiana* subsp. *obatae* and *Schiedea obovata* (Figure 2.15). Objectives for the Three Points WCA are focused first around managing the population of *C. grimesiana* subsp. *obatae*, and second on overall site restoration and management around outplanted populations of *D. subcordata*, *C. longiflora,* and *P. kaalae*. Goals for the smaller *S. obovata* LEH-B WCA revolve around maintaining the habitat for the population of *S. obovata*.

Work in the upper open portion of the Three Points WCA was centered around continuing habit restoration efforts and expanding outplanting sites (Table 2.15). NRS successfully controlled grass species dominating the upper portion of the exclosure. However, once accomplished the previously patchy spots of *R. argutus* took advantage of the new lack of competition and have now replaced the grass as the dominate weed species in this spot. Management in this large light gap is a continuing challenge that can only be resolved with the creation of an overstory and shade. *A. koa* has been outplanted in this area to provide the needed overstory and future weed control of *R. argutus* will resume to buffer these plants.

NRS have taken a more aggressive approach to killing the monotypic *P. cattleianum* stands that exist in the middle portion of the exclosure. Where these monotypic seedling and sapling patches can be sprayed with a 10% foliar solution of Garlon 3A without risk to native plants, NRS have successfully reduced their numbers. This treatment in combination with hand weeding has facilitated taking pressure off the more native areas and was also instrumental in an area that has been outplanted with *C. longiflora*.

The highest priority weed control in this area is concentrated around the population of *C. grimesiana* subsp. *obatae*. As this species habitat occupies the steep northern section of the exclosure and working in this high angle environment could potentially threaten the plants, NRS built trails reinforced with dead *P.cattelianum.* These trails provide safe access to and around the plants and should help reduce further substrate degradation. Work at removing weeds in this area has been continuous throughout most of this year due to increased rainfall.

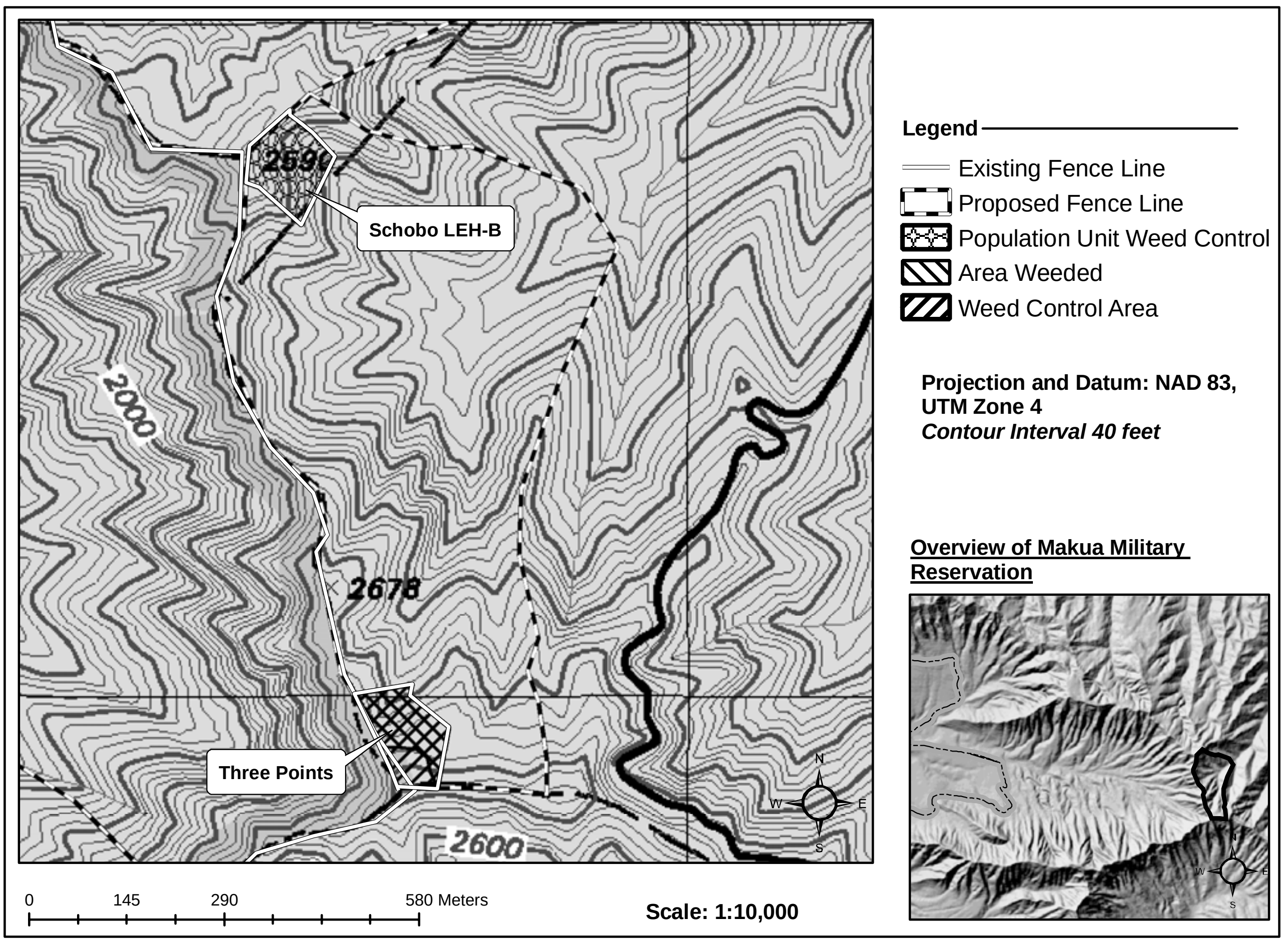


Figure 2.15 West Makaleha Weed Control Areas *Area weeded does not include grass sprayed

Work in the *S. obovata* WCA is scheduled with routine monitoring and collection visits (Table 2.16). Shortly after the exclosure was erected it was sprayed with Fusilade II, a grass specific herbicide and has remained almost entirely free of grass since that spraying. Because the plants grow on a steep slope, and the immediate habitat is not highly threatened by weeds, NRS have intentionally minimized their presence and impact in the area.

Table 2.15 Summary of West Makaleha Weed Control Areas

Species controlled within West Makaleha WCA	Weed Control Area	Effort (People Hours)	% of Weedy Area Covered	MIP Rare Plant Taxa	Comments
Ageade, Agerip,Budasi, Clihir, Erikar, Grerob, Lancam, Monhib, Pasedu, Psicat Psigua Rubarg,, Rubros Schter, Spacam, Stadic, Stajam, Youjap **Grasses controlled:** *Melmin, Pascon*	Three Points **Grass Control:**	227.5 14.5	 100%	*Cyagri, Delsub, Cyalon, Prikaa, S. obovata*	Upper open portion of exclosure was sprayed to control grass and *Rubarg*. Lower northern section was swept to control other weeds around outplantings and *Cyagri*. Area's immediately surrounding rare plant taxa may have been visited multiple occasions.

Table 2.16 Summary of West Makaleha Population Unit Weed Control

Species controlled within Population Unit	Population Unit Weed Control Area	Effort (People Hours)	% Area Covered	Comments
Ageade, Agerep, Lancam, Psicat, Schter **Grasses Controlled:** *Melmin, Pascon*	Alsobo LEH-B **Grass Control:**	6 7	10% 30%	Aim to keep large *M. minutiflora and P. conjugatum* patches out of exclosure. Control other habitat altering weeds directly around plants without creating too much disturbance in the process.

The Nature Conservancy Land

NRS continue to collaborate with The Nature Conservancy to preserve and protect rare endangered plant taxa of mutual concern. Weeding activities are focused around wild endangered plant populations and reintroduction sites in the following Management Units in Honouliuli preserve: ʻĒkahanui, Kaluaʻā, and Palikea (Figure 2.16). Weed control along crestlines, the Contour road, the Contour trail, and various LZ's throughout the preserve is conducted to reduce fuel loads in fire prone areas and to prevent the spread of weeds along transportation corridors to other parts of the preserve.

Surveys

Currently, no surveys are made on Nature Conservancy Land. This year NRS will make efforts to conduct LZ surveys and will add surveys on access roads. NRS will focus incipient weed mapping efforts on species listed in Table 2.1 with advice from TNC staff.

Single Species Target Control
Currently NRS are not targeting any single species on TNC land. The locations of incipient taxa listed on TNC land in Table 2.1 are currently unknown. However, it is anticipated that as NRS become more familiar with these areas single species threats will be targeted.

Management Unit Weed Control

Kalua'ā
NRS began weed control in Kalua'ā this year (figure 2.17). Overall the MU is a very challenging to perform weed control within. The Nature Conservancy staff has identified much of the nicest remaining habitat. Unfortunately, these areas typically have a native canopy but understory that is overrun with invasive plants including *C. hirta*, *Passiflora suberosa*, *Lantana camera* and others. It is extremely intensive work to push these weeds out of the area (Table 2.17). However, with regular maintenance the effort is much reduced. The majority of the effort this year was spent creating a new management area around a *C. grimseana* subsp. *obovatae* and *Schiedea kaalae* outplanting. In recent trips NRS has swept through the established area and has begun to expand into adjacent weed infested areas. It will take a few years before NRS clear the majority of this WCA for the first time. Presently, the boundaries are roughly drawn to include all the outplanting sites in the area. However, there is area presently within the WCA that needs to be scoped to determine whether it is fit for inclusion. NRS will expand the areas weeded around the reintroduction sites as well as clarify the boundaries of this WCA in the next year.

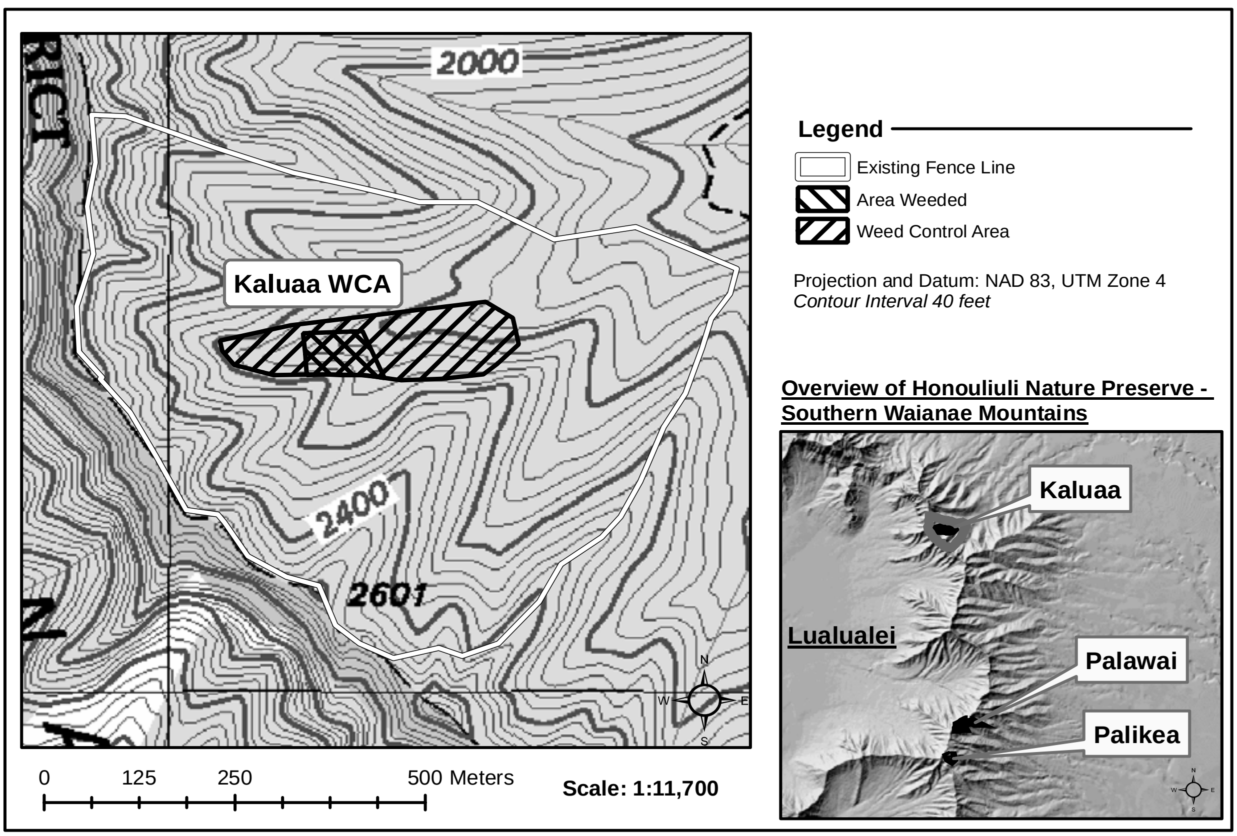
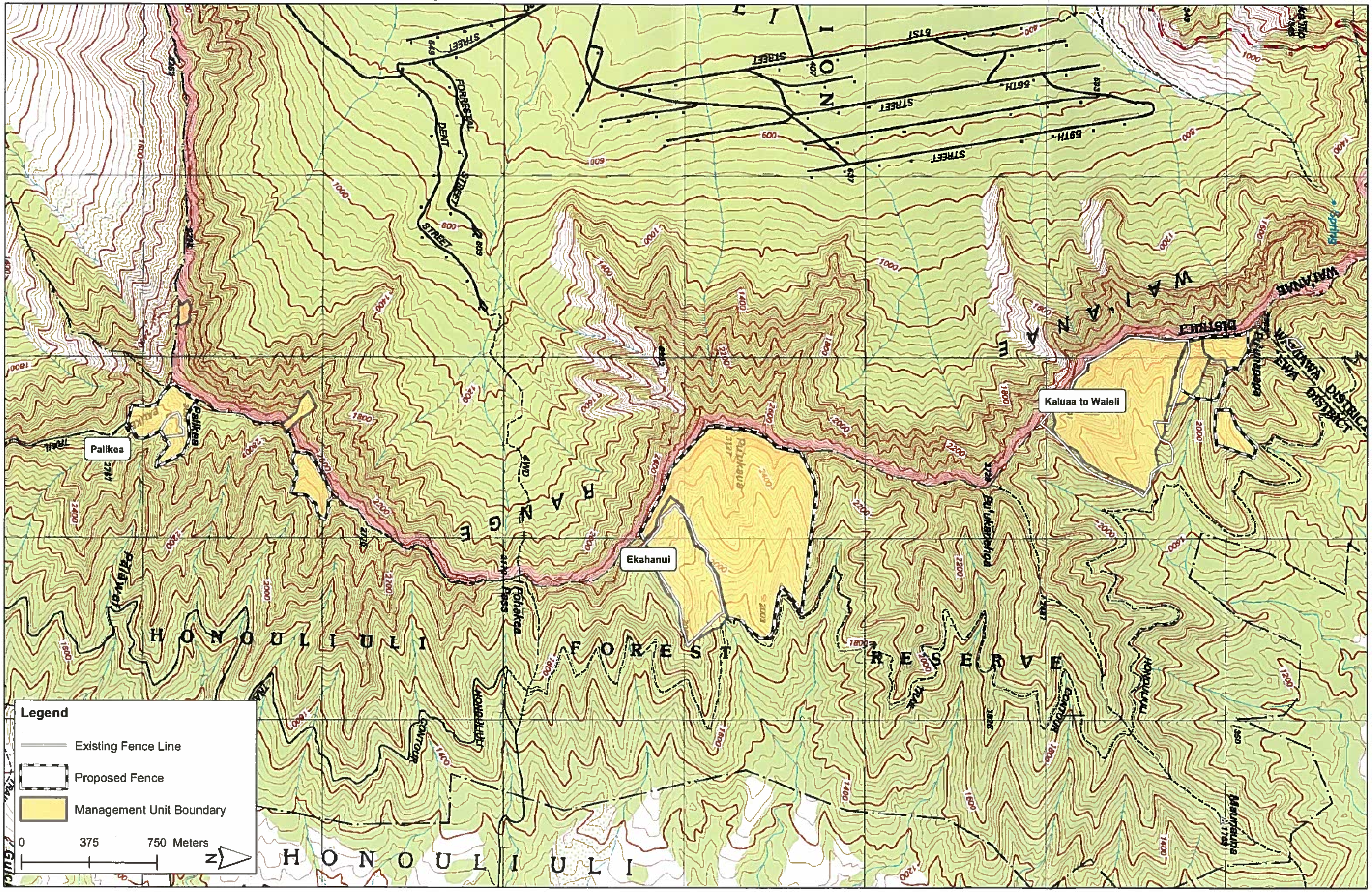


Figure 2.16 Kalua'ā Weed Control Areas *Area weeded does not include grass sprayed

Figure 2.17 Weed Control on Nature Conservancy Land



Additional weed control efforts outside of the WCA include weed control around rare species and trail maintenance. TNC staff spent additional hours weeding trails that access those sites. TNC staff also sprayed *M. minutiflora* along the crest line to reduce fuel loads in case of fire. NRS initiated weed control around the *Stenogyne kanehoana*. Unfortunately, the population disappeared over the summer perhaps due to a combination of water stress and arthropod impacts. Since that time NRS has terminated these efforts.

Table 2.17 Summary of Kalua'ā Weed Control Areas

Species controlled within Kalua'a MU	Weed Control Area	Effort (People Hours)	% Area Covered	MIP Rare Taxa Present	Comments
Budasi, Clihir, Lancam, Psicat, Passub,Pastub, Psigua, Rubros, Schter, Stajam, Toocil	Central Kaluaa	56	25%	*C.grimesiana, S.kaalae*	Controlled weeds around both TNC and Army outplantings over four trips. Initial weed control is intensive as *P.suberosa* and *C.hirta* are thick. Areas require diligent follow-up.

<u>Palikea</u>

Weeding efforts by NRS and TNC staff in Pālāwai are focused around wild populations of *Hesperomannia arbuscula* and *D. subcordata* (Figure 2.18 and Table 2.18). Unfortunately, much of the lower reaches of Pālāwai is dominated by invasive weeds. The *H. arbuscula* WCA is at higher elevations and still has nice habitat. NRS and TNC constructed a small fence around the *H. arbuscula* in this area. NRS have cleared the small fence of *P. suberosa* and *C. hirta*. In addition, the *M. minutifolia* has been pushed out of the fence and a buffer is maintained. NRS swept the exclosure this year and grass control was not needed. NRS found two mature *Cyathea cooperi* near the exclosure this year and destroyed them. No others have been seen but NRS will be watchful. This year NRS approximated a larger WCA around the small fence. This area will be fenced in the next few years and weed control will follow fencing. This area will be used as an augmentation site for *H. arbuscula*. The boundaries are only approximate and need to be refined.

In past years, NRS has been involved in managing a *Plantago princeps* var. *princeps* population for genetic storage in Pālāwai. TNC staff report that some control of *Erigeron karvinskianus* around *P. princeps* var. *princeps* would benefit the remaining plants there and could help foster more reproduction for genetic storage in that population. NRS will revisit the site next year and conduct the recommended control.

TNC and NRS continue to coordinate weeding efforts around the five acre fence protecting the *C. grimesiana* subsp. *obatae* wild and augmented population near Pu'u Palikea, in South Pālāwai gulch. TNC has also outplanted *Cyanea superba* subsp. *superba* at this site. NRS made four trips this year to the exclosure for weed control. On each trip, about ten percent of the exclosure was covered with the endangered plant area as priority. NRS also began to work on the upper more weed-infested areas of the fence. TNC staff conducted a spray operation where all of the exclosure was covered. NRS and TNC cooperated this year to scope a larger exclosure that will provide more habitat for restoration and reintroduction. TNC started weeding this area in anticipation of the proposed fence. In addition, TNC sprays *Ehrharta stipoides* along the fence, trails, and TNC's "meadow" restoration site, but eradication is highly unlikely due to the extent of the infestation. NRS will work with TNC in the next year to set priorities for the control of *Ehrharta stipoides*.

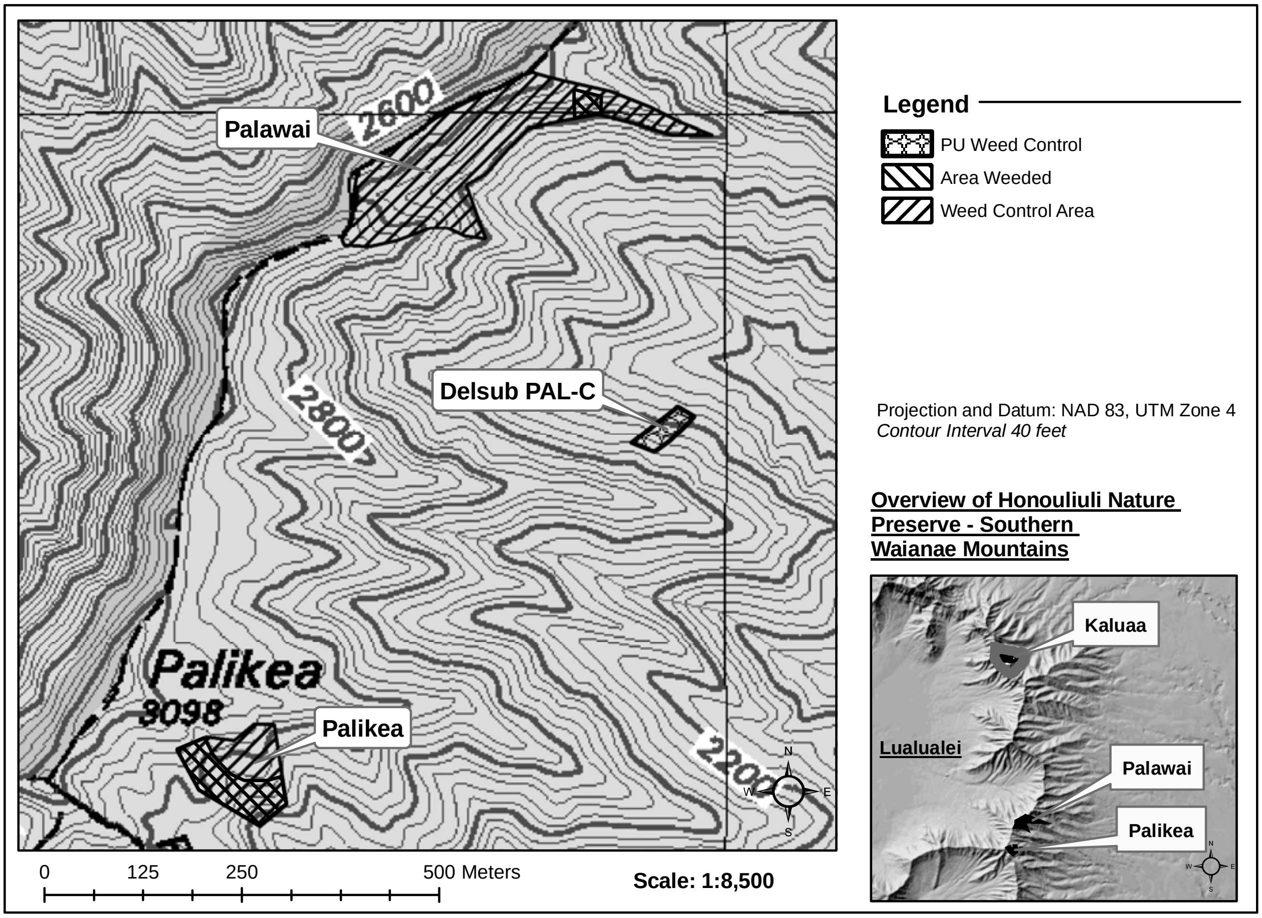


Figure 2.18 Palikea Weed Control Areas *Area weeded does not include grass sprayed

The Palawai Delsub PAL-C WCA is lower in elevation and is a priority site because it is one of the few areas that remain mostly native. The TNC biologist found three immature *D. subcordata* in this patch and NRS and TNC cooperated to construct a fence around the site. The area is very small and NRS had thoroughly weeded the site (Table 2.19). Maintenance trips are scheduled to stop reinvasion.

Table 2.18 Summary of Weed Control in Palikea

Species controlled within Palikea	Weed Control Area	% of WCA Covered	Effort (People Hours)	MIP Rare Taxa Present	Comments
Ageade, Agerep, Budasi, Clihir, Lancam, Psicat, Passub,Pastub, Psigua, Rubros, Schter, Stajam, Toocil	**Palwai Hesarb site**	20%	8	Hesarb	Controlled *Passub* and other weeds within *Hesarb* exclosure.
	Palikea	75%	84	Cyagrioba Cyasup	Controlled weeds within *Cyagrioba* exclosure.

Table 2.19 Summary of Population Unit Weed Control in Pālāwai

Species controlled within Population Unit	Population Unit Weed Control Area	Effort (People Hours)	% Area Covered	Comments
Ageade, Agerep, Budasi, Clihir, Lancam, Psicat, Passub,Pastub, Psigua, Rubros, Schter, Stajam, Toocil	Pālāwai Delsub PAL-C	6.5	100%	Controlled *Passub* and other weeds within *Delsub* exclosure. Swept entire area twice.

<u>‘Ēkahanui</u>

NRS only began intensive weed control in ‘Ēkahanui in the last few years (Table 2.20). The WCAs defined below are loosely based on areas where weed control has been conducted in the past (Figure 2.19). Additional weed control areas are likely to be added in the future as weed control goals are finalized for ‘Ēkahanui. A small amount of PU level weed control takes place around two populations of *D. subcordata* fenced with very small fences, and one population of *C. agriminioides* var. *agriminioides*.

Weed control in the Upper ‘Ēkahanui WCA largely involves grass spraying. NRS work with TNC staff to spray the crestline of the ridge to reduce fuels, and also to reduce the amount of grass in *P. princeps* var. *princeps* habitat. This year, grass was sprayed directly around all *P. princeps* var. *princeps* plants and across a band of cliffs where three ‘populations’ of *P. princeps* var. *princeps* occur using a grass specific herbicide. NRS would like to conduct herbaceous and woody plant weed control in areas with high levels of native canopy and around rare plants within this WCA.

The Reintroduction WCA is important because it is home to many *A. mustelina,* has many nice patches of native forest, and is home to outplantings of MIP taxa and several other TNC taxa of concern. Three MIP species have been planted in to this area, and weed control efforts have focused largely around these plants. Grass control is conducted when observed necessary. With the two agencies maintaining the Reintroduction WCA, weed control is beginning to become more continuous throughout the entire area. An example of this is the absence of *P. suberosa,* a prominent weed in all of ‘Ēkahanui. Since *P. suberosa* is such a physical nuisance, clovers native vegetation, and is present nearly everywhere in ‘Ēkahanui, its absence is greatly noticed and serves as a sort of indicator of where weed control has taken place, and where more is needed. NRS aim to continue controlling weedy understory in previously weeded areas, as well as connecting these areas with newly created native canopies free of *P. suberosa*.

At the wild *C. agriminioides* var. *agriminioides* site, minimal weed control is conducted in coordination with annual monitoring of the population. The habitat where these plants occur, lacks continuous native components, and would require intense, active restoration to greatly improve the site. As the population of *C. agriminioides* var. *agriminioides* appears to be doing okay, NRS justify small levels of weed control immediately around individual plants in order to increase plant vigor and thus seed set. This year NRS were careful to maintain canopy, weedy or not, and focused on expanding potential understory habitat around high concentrations of plants.

Table 2.20 Summary of Weed Control in ‘Ēkahanui MU

Species controlled within Upper ‘Ēkahanui **and Reintroduction WCAs**	**Weed Control Area**	**Effort (People Hours)**	**% Area Covered**	**MIP Rare Plants Present**	**Comments**
Passub, Psicat, Schter, Clihir, Chrpar, Bleape, Rubros, Agerip Grass Control: *Melmin, Rhyrep*	Upper ‘Ēkahanui **Grass Control:**	4	15%	*Plapripri Achmus*	Major grass spray conducted this year along *Plapripri* cliff habitat across populations. Also sprayed crestline as fuelbreak.
	Reintroduction	64.5	50%	*Cenagragr Delsub, Schkaa,*	Swept through reintroductions, focusing on understory weeds. Maintained reintroductions and opened areas for new reintrodctions. Made four large sweeps this year.
Species controlled within Population Units	**Population Unit Weed Control Areas**	**Effort (People Hours)**	**% Area Covered**	**MIP Rare Plants Present**	**Comments**
Clihir, Rubros, Lancam, Passub	Delsub EKA-A	1	100%	*Delsub*	Handpulled *Pascon* around *Delsub* and treated other weeds listed.
	Delsub EKA-B	1	100%	*Delsub*	Sprayed *Oplhir* within fence and treated few, spindly *Schter*. Handpulled *Pascon* around *Delsub.*
	Cenagragr EKA-A	5	50%	*Cenagragr*	Weed control minimal and ‘non-invasive’, although around all plants. See discussion

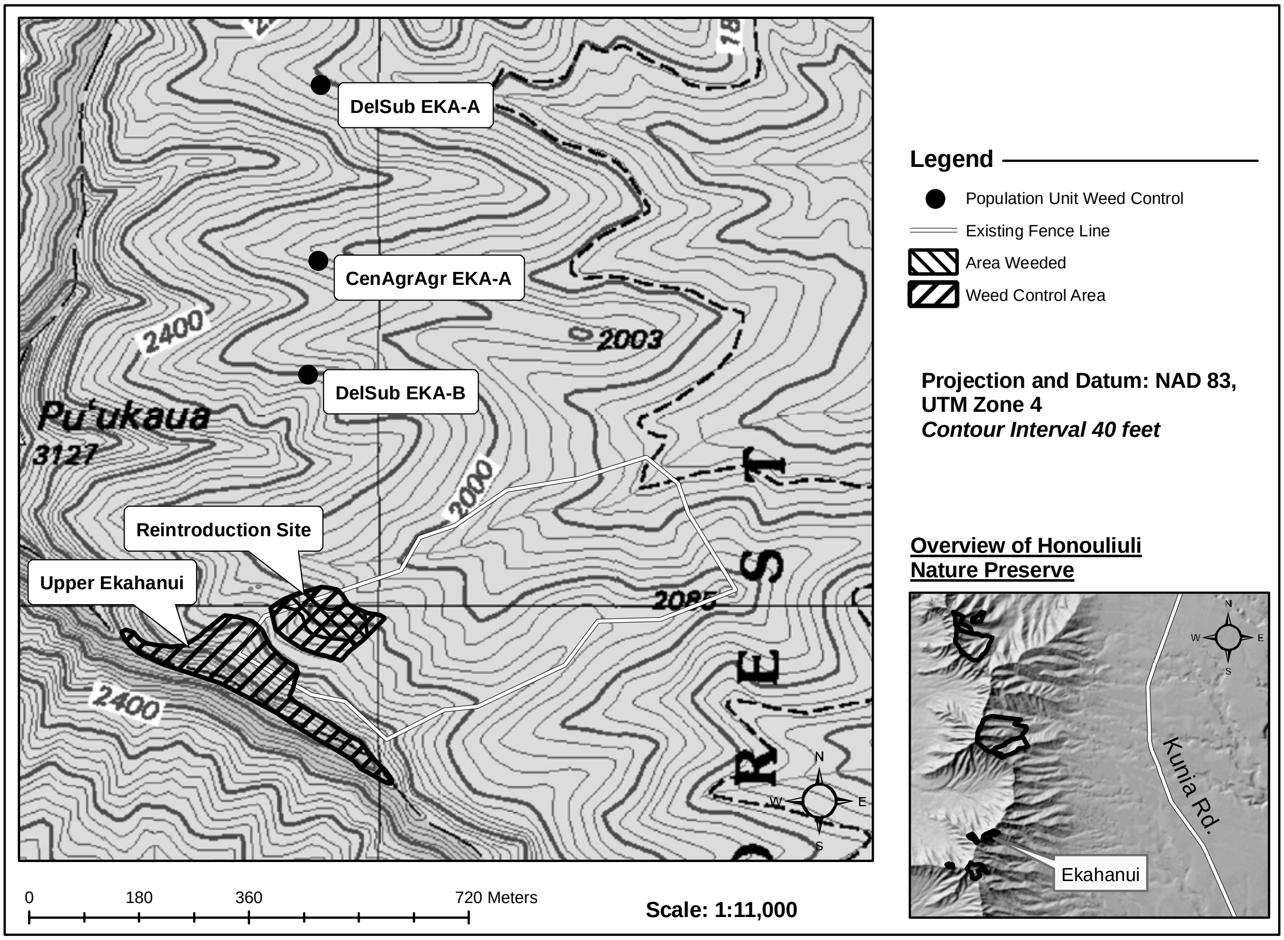


Figure 2.19 'Ēkahanui Weed Control Areas *Area weeded does not include grass sprayed

Board of Water Supply Land

NRS received permission for the use of herbicides in Mākaha valley by the Board of Water Supply (BWS) in June of 2005. Many areas in Mākaha are in exceptional condition with very few weeds. Weed Control Areas have started to become established with the help of the BWS Watershed Planner, and are focused around rare or endangered plant populations and habitat with high conservation value. As Mākaha Valley is surveyed in greater detail, more WCAs may be established. Current weeding activities are occurring prior to the construction of a proposed fence, with the knowledge that their impact will only be accelerated with the removal of ungulates.

WCA Discussion

The Makai Ridge Gulch WCA #1 is an exceptionally native dry-mesic forest with *A. macroccocus* and *F. neowawraea*. NRS have weeded this area on four occasions and in most of the WCA completely removed all weeds. Approximately, 75% of the WCA has been weeded. NRS believe that this type of area will require treatment only every few years. A large stand of *Toona ciliata* in the back of the gulch threatens to continually seed this area and NRS are contemplating removing the stand.

The *A. macroccocus* Heartland WCA #2 contains the highest density of *A. macroccocus* NRS has recorded. The area is similar to the Makai Gulch WCA, it is a dry-mesic forest with very few weeds. NRS has taken two trips to the area and weeded approximately forty percent of the area. The gulch bottoms are problematic in this area. These areas contain loose substrates and substantially more light gaps than the surrounding slopes. NRS came upon patches of *Ricinus communis* in these areas and needs to develop a strategy for control. In contrast, the gulch slopes are impressively native and will require infrequent management.

The Flag city WCA #3 is named for the impressive amount of flagging UH researchers have used in the area. This area contains two *F. neowawraea* and intact forest. Unfortunately, there are also some weedy areas especially in the gulches and some monotypic stands of *C. arabica*. This is the most accessible WCA in Mākaha and NRS plan to use volunteer labor in this area. Only one volunteer trip has been conducted so far.

NRS have also identified another potential WCA #4 (Figure 2.20). Weeding within this proposed WCA will commence sometime after more detailed surveys of the area have been conducted. Presently the boundaries of this WCA are approximated.

The Cyalon WCA #5 is below the Kumaipo saddle outside the area of the large proposed fence. This area will be fenced within the next year by a smaller exclosure to protect the *Cyanea longiflora*. NRS have spent one day weeding this area and covered approximately 25% of the WCA. Much of the WCA is wet-mesic forest. The habitat around the *C. longiflora* is in good shape. However, just down the slope the *P. cattlelinum* is monotypic.

Table 2.21 Summary of Weed Control in Mākaha

Species controlled within Mākaha.	Weed Control Areas	Effort (People Hours)	% Area Covered	MIP Rare Plants Present	Comments
Ageade, Agerep, Budasi, Cafara, Clihir, Grerob, Lancam, Pascon, Paslig Psicat, Psigua, Rubarg, Rubros, Schter, Stajam, Syzcum, Toocil, Trisem	**Makai Ridge/Gulch WCA #1**	126	75%	*Fluneo Alemac*	Controlled weeds in high value habitat around *Fluneo* during four trips.
	Alemac heartland WCA #2	64	30%	*Alemac*	Controlled weeds in high value habitat around *Alemac*, and *Ptemac*.
	Flag city WCA #3	19	10%	*Fluneo*	Controlled weeds in high value habitat around *Fluneo*.
	Cyalon Area to Burn Site WCA #5	19.5	25%	*Cyalon*	Controlled weeds in high value habitat around *Cyalon*.

T. semitriloba is a weed found throughout Mākaha valley. In order to prevent continued spread of this weed it is being considered as a target for removal along trails and access points. Once the distribution of *T. semitriloba* within the proposed exclosure is known, NRS will determine whether this weed should become a candidate for eradication within the fenced area.

In order to have a better understanding of the effects of weeding monotypic stands of *P. cattleianum* in Mākaha and other MUs, NRS are working with a University of Hawaiʻi Botany

Professor. This professor has generously given her time at no cost to NRS. NRS also hired a graduate Research Assistant to facilitate implementation of field monitoring. This Research Assistant and NRS will be setting up twelve plots for three different guava control treatments. These three trials will consist of Selective Girdle, Total Girdle, and Clear Cut plots. All three of these methods have been tested previously in Kahanahaiki (see RCUH Report 2003-2004). It was clear from the Kahanahāiki trials that both the Clear Cut and Total Girdle methods promoted regeneration of *A. koa* and limited guava recruitment as affected by a change in light regime. The less light altering Selective Girdle trial may prove beneficial to areas with shade tolerant native flora and areas threatened by more sun loving understory weeds. The purpose of these trials is to more rigorously test conclusions derived from the Kahanahāiki trials, as well as to test their effectiveness in similar habitats such as those found in Mākaha.

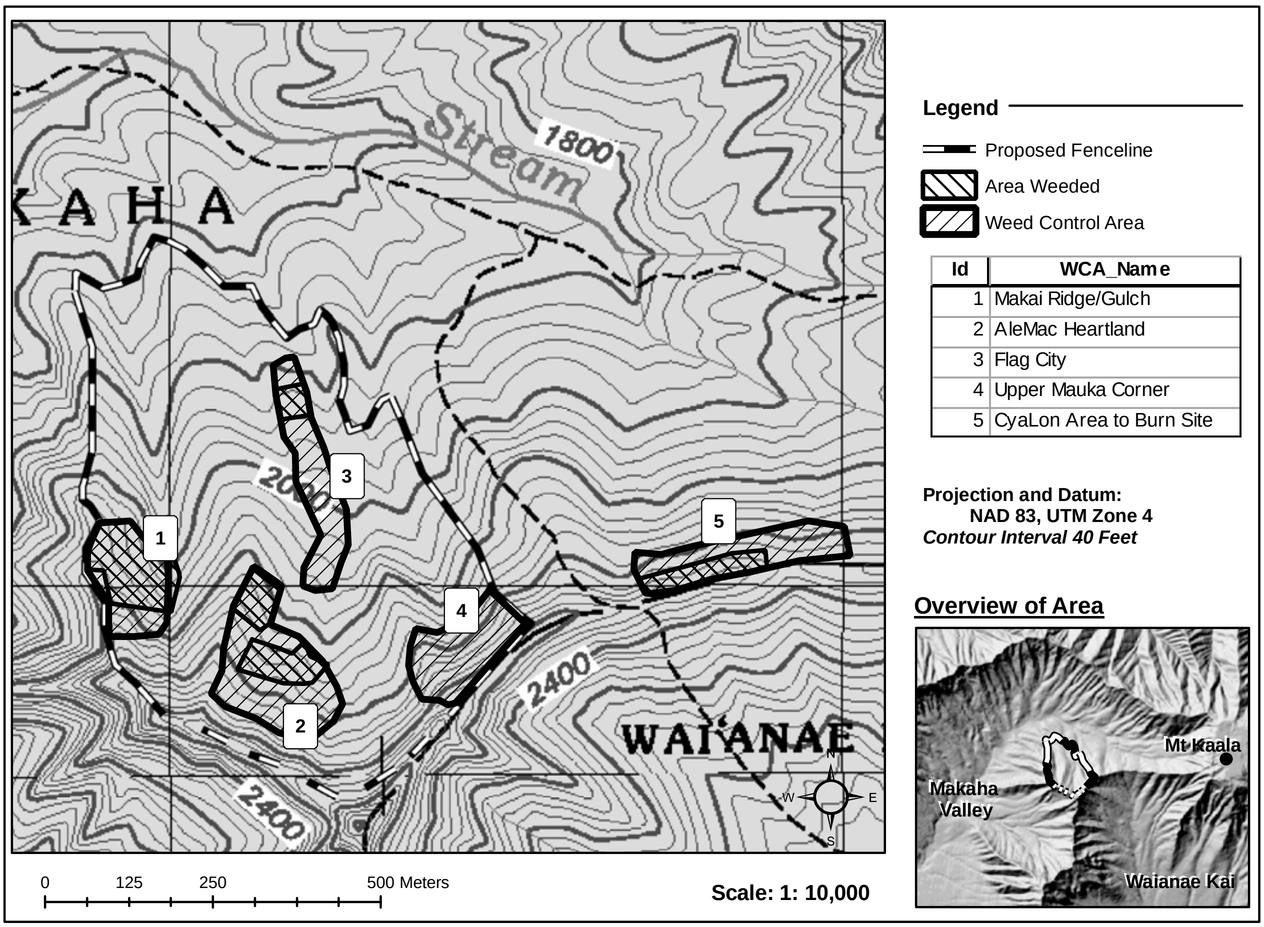
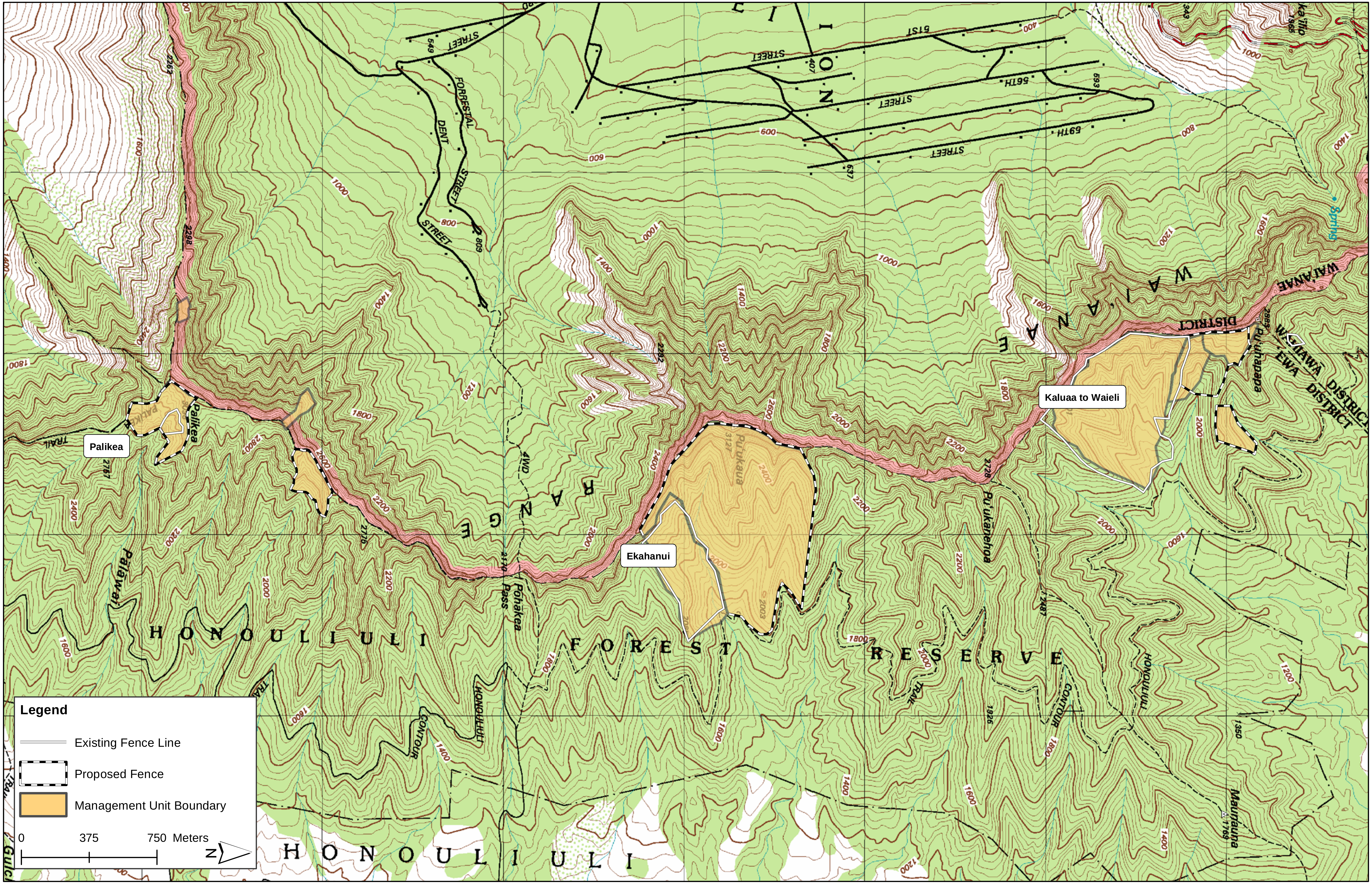


Figure 2.20 Mākaha Weed Control Areas *Area weeded does not include grass sprayed

Figure 2.2 Weed Control on Army Controlled Land

Figure 2.11 Weed Control on State of Hawaii Land

Figure 2.17 Weed Control on Nature Conservancy Land



Chapter 3: RARE PLANT STABILIZATION PLAN STATUS

General Rare Plant Issues

In preparation of this section, NRS attempted to touch on all of the parts of the MIP stabilization plan outlined for plants. This includes a discussion on taxon status, genetic storage, outplanting and threats. The minimum requirement for each rare plant taxa covered under the MIP is to implement Population Unit (PU) management and associated ecosystem level management to achieve stable population numbers at all ‘manage for stability’ PUs. The most current list of selected PUs to be managed to stability are outlined in the MIP Addendum 2004. A number of over-arching rare plant related actions are discussed up front in the beginning of this chapter followed by 27 Species Status Summaries, one for each of the MIP rare plant taxa requiring stabilization.

Propagation infrastructure

An urgent action from 2002 was to construct additional greenhouse space for propagation of plants related to the MIP. NRS have reached capacity in the current space. The nursery space was planned for the Pahole Mid-Elevation Nursery owned by the State of Hawai‘i. The Army and the State have been working to overcome a number of planning, permitting, budgetary, staffing changes and logistical issues in order to begin construction. Ground-work for the new greenhouse is set to begin shortly. Construction of this facility in the short term is critical to achieving MIP reintroduction and genetic storage goals. In addition to the basic need for space, the mid-elevation location is critical in propagating certain MIP taxa. The NRS Horticulturist has documented significant performance differences for many species between the lower elevation greenhouse and the higher elevation Pahole Nursery. Of special note are *Viola chammisoniana* and *Dubautia herbstobatae,* which will not flower at lower elevations, but do so prolifically at the Pahole Nursery. Flowering for these two taxa is important in securing seed collections for genetic storage. Living collections require significant amounts of growing space and as a result nursery space, even after the Pahole Nursery comes on line, will be limited. In addition, O‘ahu Implementation Plan needs will place more demands on existing facilities. NRS will investigate other options for additional expansion at sites within the Kahuku Training Area and Schofield Barracks, East Range.

NRS have set up two growth chambers at the Army Natural Resources Center. The temperature, humidity and day length within these chambers can be adjusted, allowing NRS to more closely control the growing environment and mimic conditions for a particular elevation. The growth chambers are used for seed germination and initial seedling growth. Germination rates can be more closely tracked as seeds are germinated in Petri dishes. This propagation technique has increased germination rates and seedling survivorship, thus reducing the number of seeds withdrawn from the Seed Conservation Lab. The growth chambers also allow seedlings from different populations to grow in the same controlled environment, similar to a common garden experiment. As a result, NRS has observed differences in leaf morphology between seedlings of the same species from different populations.

Research

A number of research issues arise repeatedly in the following species status summaries. In order to address these research topics, we have created a new position, a ‘Research Specialist’. This person was hired to conduct management-related research, coordinate with researchers conducting work related to MIP management and to seek out more interest in MIP-related research topics. Much of this person's work will focus on rare plant management, in particular developing control techniques for slugs, black twig borer and other limiting factors. The following is a list of research projects related to MIP rare plants.

- Determine if slug baiting can be done safely in native habitat with special attention to the effect on recruitment of MIP species and slug bait efficacy.
- Coordinate with the Hawaii Agricultural Research Center (HARC) in testing pheromone attractants to control black twig borer in native habitats.
- Conduct greenhouse trials to determine the relative impacts of mechanical damage from the twig borer versus the damage incurred from the fungus.
- Test pesticides *ex situ* for use in controlling black twig borer and pursue an experimental use permit for forest use. Determine the effectiveness in the field of any new products.
- Coordinate with researchers studying control techniques for the *Erythrina* gall wasp. Monitor populations of *Erythrina sandwichensis* critical to MIP taxa stabilization.
- Coordinate with seed conservation specialist to determine the best germination and storage techniques for MIP rare plant taxa.

Monitoring
An obstacle to clear and meaningful reporting on population trends and management efficacy has been a lack of monitoring techniques and infrastructure. This year a Mākua Monitoring Program Manager was hired to increase monitoring efforts and guide adaptive management. There are a number of questions that can be asked related to MIP management. The following is a short list of high priority rare plant related monitoring questions. NRS will need to prioritize monitoring needs.

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

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

<u>Requirements for Stability:</u>

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

- 3 Population Units (PUs)
- [25-100] reproducing individuals in each PU (justification for number of individuals; life span, life form, other factors)
- Threats controlled

- Complete genetic representation of all PUs in storage

Taxon-Level Discussion

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

1) Justification is given for which sites were chosen as 'manage for stability'. If more than one of the 'manage for stability' PUs is in the Action Area (AA), this is also justified. Any new populations found in the last year are recognized and implications for management are discussed. Any PU management designation changes are justified and presented for discussion.
2) Taxon threats are introduced.
3) The prognosis for reaching stability and the challenges to reaching stability are discussed. PUs with stable numbers of plants are recognized. Challenges include taxon threats, propagation hurdles, and unique species issues.
4) Any proposed changes to the stabilization approach or goals since the January 2005 MIT meeting are also presented in this section.

Example 'Taxon Status' Table

Action Area: In

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Makua Population UnitName	Management Designation	Num Mature in Final Makua IP	Num Imm in Final Makua IP	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to Pahole	Manage for stability	0	0	0	0	0	58	34	149	**58**	**34**	**149**
Keawapilau to West Makaleha	Manage for stability	21	12	42	1	33	0	0	0	**42**	**1**	**33**
	Total for Taxon:	21	12	42	1	33	58	34	149	**100**	**35**	**182**

Action Area: Out

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Makua Population UnitName	Management Designation	Num Mature in Final Makua IP	Num Imm in Final Makua IP	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Manage reintroduction for stability	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**

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

<u>Makua Population Unit Name</u>: PUs were modified based on changes agreed upon by the MIT at the January 2005 meeting. Where PUs were merged, the names of the former PUs were combined, i.e. the separate population units 'Kahanāhaiki' and 'Pahole' are now 'Kahanāhaiki' and Pahole'. None of the original PUs were divided. Only PUs designated for management are

shown in the table. Some reintroductions which have not yet begun are shown in the table with zeros for population numbers.

Management Designation: Management status is based on changes agreed upon by the IT at the January 2005 meeting, and thus may be different from the final IP, 2004 MIP Status Report and the MIP Addendum. Most population units are either ‘manage for stability’, ‘manage reintroduction for stability’ or ‘genetic storage’. In addition, *Neraudia angulata* at Kaluakauila carries the designation, ‘manage reintroduction for storage’ to clarify that wild plants no longer exist at the site but the reintroduced plants are valuable as stock representing the Kapuna PU. The ‘manage as a propagule source’ category has been eliminated.

NRS Mature, Immature 2004: The number of mature NRS monitored plants, as reported in the MIP Status Report 2004 in the *Taxon Status* Table. For populations discovered since the 2004 Status Report, this column is blank. If a PU was split, thus creating a new population division, a zero is used in this column in order to distinguish it from entirely new PUs. If the number was previously presented as a range, for example 70-120, formatting problems required that we use the average so the number is 95. These formatting problems will be corrected for the next MIP Status report. The number of immature plants NRS monitored, as reported in the MIP Status Report 2004 in the *Taxon Status* Table. For populations discovered since the 2004 Status report, this column is blank.

Current Mature, Immature, Seedling: These three columns reflect the most up to date individual plant numbers for each PU of the wild plants. In most cases these numbers are generated from Army monitoring data, but data from the O‘ahu Genetic Safety Net (GSN), the Nature Conservancy (TNC) and the State of Hawai‘i are used for some PUs. This is the case for those PUs where other agencies have a management mandate and are conducting sufficient management to meet MIP needs. Numbers reported have only changed since last year if new monitoring data was acquired since the last reporting period. If no additional monitoring was conducted in the last year, last year’s number is used. A discussion of number changes since last year’s MIP status report is included in the ‘Population Unit Level Discussion’ for each PU.

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

Total Mature, Immature, Seedling: The sum of the updated numbers of *in situ* plants and the number of augmented individuals. This number shows how close each PU is to reaching the stability number of individuals. The numbers also indicate whether recruitment is occurring within PUs.

Genetic storage

The status of seed storage testing and an overview of seed storage collections are discussed here. Living storage collection techniques are also discussed, including micropropagation, greenhouse and garden collections. The relative success rates of the different techniques and general recommendations for future genetic storage efforts are given.

Example 'Genetic Storage Summary' Table

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Lipochaeta tenuifolia							
Kahanahaiki	54	23	4	11	0	40	6
Kaluakauila	64	20	0	8	0	15	2
Kamaileunu and Waianae Kai	831	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	13
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				35	0	73	21

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

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

Partial Storage Status: According to the plant stabilization plans, for taxa where seed storage is the preferred genetic storage method, up to 50 seeds should be collected from each of up to 50 plants per population. Since the MIP is in the early stages of implementation, NRS felt it was important to show how many plants were partially to 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. Where large numbers of seeds have been collected, more information is included in the text. The goal for vegetative collections is a minimum of three clones per plant. Plants with greater than or equal to one plant in either micropropagation 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.

Propagation/Germination Techniques

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

Unique Species Observations

Any unique features of a taxon's morphology, phenology, ecology, or pollination biology observed by NRS are discussed here. Post-fire observations for relevant species are also discussed in this section.

Outplanting Issues

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

Example 'Founders Represented in Outplanting' Table

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

Total Num Plants based upon Plants that have been numbered

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

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

Research Issues

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

Surveys

Any significant finds or lack thereof in the last year are discussed in this section. In addition, a brief summary of future survey plans is 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 status of the population units are discussed. This section is split into two parts.

<u>‘Manage for Stability’ PUs</u>
In the first part, each ‘manage for stability’ PU is discussed. Any large changes in numbers of individuals from the Makua IP Addendum are explained. Management efforts at the PU are discussed, including any collections, augmentations, fencing, rat control or weeding in the vicinity of the PU.

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

Example 'Population Unit Threat Control Summary' Table

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus

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

Action Area: Out

TaxonName: Alectryon macrococcus var. macrococcus

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

This table shows the status of NRS's threat control efforts at all PUs. The 'Population Unit' and 'Management Designation' columns are the same as in the 'Taxon Status' table above. Naturally, more extensive threat control programs are in place at 'Manage for Stability' PUs and little if any threat control is in place at 'Genetic Storage' PUs. 'Partial' designations are explained within the PU discussions. For 'Manage reintroduction for stability' PUs, threat control conducted during site preparation as well as reintroduction site threat control maintenance is reported. This approach is a temporary way of demonstrating in general where effort is being spent. NRS anticipate that monitoring data will replace much of this information and improve this aspect of our reporting. Also, the database threat table does not indicate in any way if the threat is actually a concern for the taxon or PU. For example, many rare plant taxa are not threatened by rats. For next year's report, NRS will work to display applicable threats via shading similar to the *Achatinella* chapter threat tables.

<u>Protected from Ungulates</u>: 'Yes' is entered into the column if all of the individuals in the PU are fenced or otherwise protected from ungulates by natural barriers. If some of the individuals are at risk from ungulates, it is recorded as 'partial'.

<u>Weeds managed</u>: In most areas, NRS conduct weed management on a PU scale. 'Yes' is entered into this column if weed management has been conducted specifically for this taxon around the entire PU. 'Partial' is entered into the column if weed control has been conducted around a portion of the PU, or habitat-level weed management has been conducted in the vicinity of the PU. An explanation is included in the PU discussions. 'No' indicates that NRS are not currently controlling weeds at the PU. An explanation for this lack of management is included in the text within PU discussions for 'manage for stability' PUs.

<u>Rats controlled</u>: 'Yes' is entered into this column if a rat-baiting and snap trap grid is set up around the entire PU. 'Partial' means rat control is in place for a portion of the PU, or is in place for another species in the vicinity of the PU. For taxa receiving rat control, a table summarizing

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

3.1 *Alectryon macrococcus* var. *macrococcus*

Requirements for stability:

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

Taxon-Level Discussion

Alectryon macrococcus var. *macrococcus* is widely distributed throughout the Waiʻanae Mountains. The MIT chose the largest populations in the best habitats to manage for stability. The Kahanahāiki to West Makaleha PU covers one large contiguous area, and is within the Action Area (AA). The Mākaha and Central Kaluaʻā to Central Waiʻeli Pus are outside of the AA. Presently, the Mākaha and Central Kaluaʻā to Central Waiʻeli PUs exceed the required stabilization target number of individuals. Unfortunately, many of the trees observed are in poor condition, due primarily to the damaging effects of the black twig borer (*Xylosandrus compactus*). Interestingly, in many PUs there is a subset of trees that appear to be healthy and appear to have escaped twig borer impacts. These trees are worth further examination and NRS will pursue this as a research topic. Other threats to the taxon include rats, invertebrates, weeds, and ungulates. NRS has also observed very little fruit production and recruitment of this species in the wild, which may in part be due to rat predation. Vegetative propagation can be done by air-layering, but this method is labor intensive and only about 10% of the air-layers are successful. This taxon will be a very challenging species to stabilize, let alone save, if twig borer control techniques are not developed.

Taxon Status

Action Area: In

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

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to West Makaleha	Manage for stability	43	4	42	4	0	0	6	0	42	10	0
Makua	Genetic Storage	17	0	20	0	0	0	0	0	20	0	0
South Mohiakea	Genetic Storage	15	1	6	0	0	0	0	0	6	0	0
	Total for Taxon:	75	5	68	4	0	0	6	0	68	10	0

Action Area: Out

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

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Central Kaluaa (to Central Waieli)	Manage for stability	50	1	56	1	1	0	8	0	56	9	1
Makaha	Manage for stability	35	0	62	5	2	0	0	0	62	5	2
Waianae Kai	Genetic Storage	16	0	5	0	0	0	0	0	5	0	0
	Total for Taxon:	101	1	123	6	3	0	8	0	123	14	3

Genetic Storage

All methods of genetic storage are being attempted. Seed collection is very difficult for this species as very few trees produce viable seeds, and seeds do not mature at the same time. In addition, seeds are vulnerable to rat and invertebrate predation. Seventy-two seeds were collected from one prolifically fruiting tree in Mākaha in July 2004. These seeds were taken to the Seed Conservation Lab for seed storage testing. Unfortunately, most seeds appeared to have been eaten by the larvae of an unidentified insect. The seeds showed signs of predation and most floated in water, which suggests they are not viable. Despite the low possibility of germination, they are stored at 4˚C and 20% relative humidity. Fourteen seeds from this same tree were collected in August 2005. Three healthy, ripe fruit were sent to the Micropropagation Lab for propagation, and then to be planted at Waimea Botanical Garden. The remaining 11 seeds went to the Seed Conservation
Lab, where 8 were rotten, two of which had a grub inside. The remaining three are being stored in two different conditions known to be successful for other species of *Alectryon* that also have recalcitrant/intermediate seed characteristics. This taxon probably does not have high storage potential and if an ideal storage treatment can be determined its collection schedule would probably have to be frequent. Due to uncertainty of storage potential, NRS is propagating most collected seed and has been experimenting with other methods of propagation for storage of this taxon, including air-layers and living collections. Micropropagation is not a good storage method for this taxon because it is not possible to subculture plants, and because plants quickly become too large to store in vials.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	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)	56	1	0	0	0	0	0
Kahanahaiki to West Makaleha	42	4	0	0	0	0	0
Makaha	62	5	0	1	0	0	1
Makua	20	0	0	0	0	0	0
South Mohiakea	6	0	0	0	0	1	0
Waianae Kai	5	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	0	1	1

Propagation/Germination Techniques

Although micropropagation is not a preferred storage method, seeds have been successfully germinated in the lab, and have been grown out in the greenhouse. Three of these trees have been successfully established at Waimea Botanical Garden, see photo below. These plants are monitored and treated with an insecticide quarterly to address the black twig borer threat.

Successful vegetative propagation of this taxon has been limited to air-layers. Extensive graft and cutting trials have so far been unsuccessful.

Unique Taxon Observations

Some trees of this taxon are small fruited (1 cm diameter) and some are large fruited (5 cm diameter). The Mākua populations are small-fruited and more closely resemble the Kaua‘i trees. The Kalua‘ā and Wai‘eli trees have very large fruit. In general, this taxon does not produce many fruit. In the Mākua and Mākaha populations, it appears that a few trees will fruit prolifically, while others have not been observed to fruit at all. In the Kalua‘ā population, a scattered number of trees produce small quantities of fruit, but again, most of the trees have not been observed to fruit at all. NRS observed many dead trees in the last couple years, suggesting a recent large-scale decline. It is important to get genetic representation from all of the PUs as soon as possible because this taxon is in rapid decline.

Outplanting Issues

Since there is low recruitment, augmentation will be considered as a tool to achieve stability once black twig borer controls are in place. One augmentation has been established in the Kahanahāiki to West Makaleha PU. As black twig borers pose a continual threat, NRS are conferring with the Department of Agriculture (DOA) on possible experimental control techniques. Thus far, experimental techniques have had limited success. As of July 2005, six of nine plants are alive, though few are healthy.

Living collection, *A. macrococcus* at Waimea Botanical Garden

Research Issues

In order for this species to become stable *in situ*, a sustainable method for controlling black twig borer will need to be found. NRS submitted a research application with United States Geological Survey (USGS) to fund black twig borer research projects. NRS is also working with the University of Hawai'i and the State of Hawai'i Department of Agriculture to solicit expertise on this project and to support funding for research. The Hawai'i Agricultural Research Center (HARC) received funding from the Hawai'i Invasive Species Council (HISC) to study the potential of behavioral chemicals on the black twig borer, which also affect commercially valuable species like *A. koa*. Scolytid beetles are susceptible to behavioral chemicals because these chemicals play a large part in their life cycle. HARC hopes to identify potential attractants, repellents, and effective trap designs. NRS will support HARC's work on this important project. In addition, the prolifically fruiting trees in Mākaha and Mākua should be studied to determine what factors lead to their high productivity and good health. Research should also be conducted on seed storage potential. Fifteen seeds were sent to the National Seed Storage Laboratory (NSSL) in 2001 for storage testing. Most seeds were not viable, but 2 of 5 seeds stored imbibed at 4°C germinated after 5 months of storage. The Seed Conservation Lab will test the longevity of this storage condition on a few seeds collected this year. This year's seed collection showed heavy insect predation. Research should be conducted on pollinators, and whether the plants are cross-pollinating or self pollinating. *Inter-situ* sites such as botanical gardens should be considered as potential sites for conducting research.

Surveys

Incidental observations of this taxon were made by the HINHP contract botanist while on surveys for other species. In addition, this year NRS resurveyed areas in Kalua'ā and Wai'eli for *A. macrococcus*, but did not find any new trees. In Mākaha, a thorough count is underway to better discern the numbers of individuals within the MU.

Taxon Threats

The most serious threat to *A. macrococcus* is the black twig borer. All trees of this taxon are being affected by the black twig borer to some degree. NRS has unsuccessfully attempted to control the black twig borer on *in situ* trees by using experimental treatments. Rats and invertebrates prey on the seeds of this taxon and reduce seed viability and germination. NRS has rat bait stations around trees in Mākaha and Central Kalua'ā in conjunction with 'elepaio management. *A. macrococcus* is susceptible to ungulate browse, and ungulates and weeds pose ecosystem-level threats for this species.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus

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

Manage for Stability PUs:

Kahanahāiki to West Makaleha: Many areas in this PU were monitored in the last year, but not all trees were revisited. The status table reflects the number from the most current count, which is not a complete assessment of the PU. Very few of the trees have ever been observed flowering and fewer still have been observed with mature fruit. Most of the trees show a significant amount of black twig borer damage. In this PU, 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: NRS conducted status surveys in Wai‘eli and the Central and South branches of Kalua‘ā during the last year. Locations reported by TNC staff were revisited and new areas surveyed. The status table reflects the number from the most current count, which is not a complete assessment of the PU. Very few of the trees have ever been observed flowering and fewer have been observed with mature fruit. Most of the trees show a significant amount of damage from the black twig borer. There are additional areas to search and NRS believes that more individuals will be discovered. Some of these trees exist within the Central Kalua‘ā fence and are in areas where weed control is ongoing. There is no management ongoing for trees in Wai‘eli.

Mākaha: Mākaha is by far the richest of all *A. macrococcus* sites. NRS recently started to thoroughly count this population to better assess the number of plants within the proposed MU fence. The status table reflects the number from the most current count, which is not a complete assessment of the PU. NRS is also familiar with other areas outside the proposed fence that contain this taxon; these areas will be surveyed in the coming year. The final count will almost certainly contain more than the originally estimated 75 mature trees. NRS began conducting weed control in some of the densest *A. macrococcus* areas in Mākaha this year. The habitat in this area is extremely intact. Some trees occur in the vicinity of rat control grids set up to protect ‘Elepaio and may benefit from this action.

Other PUs:

Mākua: Seven airlayers were set up on two different trees in February 2005. As of June, only one of the airlayers exhibited any sign of callusing. The others appeared to be alive, but the growing tips were dying. NRS has initiated some weeding operations around the *A. macrococcus* trees at the ‘Ōhikilolo site. The ‘Ōhikilolo plants are protected from ungulates, and rats are controlled in the vicinity of some trees in conjunction with snail and *Pritchardia kaalae* baiting efforts.

***Alectryon macrococcus* Air-layer**

South Mohiākea: A thorough count of this population has not been done recently, but one tree was observed dead last year. Of the known trees, NRS have observed a significant decline. 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. Air-layers have been done with some success and are established at the Army Nursery, see photo above.

Wai‘anae Kai: The status table reflects the number from the most current count, which is not a complete assessment of the PU. Monitoring in this PU is incomplete but NRS will endeavor to make a complete assessment of the remaining plants. Any fruits collected will be stored and air-layers will be attempted with the permission of Department of Land and Natural Resources (DLNR) staff.

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

3.2 *Cenchrus agrimonioides* var. *agrimonioides*

Requirements for Stability

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

Taxon-Level Discussion

The largest populations in the best habitat were chosen for management. Huliwai was not included as ‘manage for stability,’ even though it has more individuals than the Mākaha and Wai‘anae Kai PU because the habitat is much degraded. Only the Kahanahāiki and Pahole PU is in the Action Area (AA). This PU has stable numbers of wild plants, and has been augmented with over two hundred out-planted individuals. All size classes are present in both the wild and augmented sites. The Mākaha and Wai‘anae Kai PU is along the dividing ridge, near the Kūmaipō trail. Most of the plants are within the Wai‘anae Kai Public Hunting Area. Stock from these Wai‘anae Kai plants will be reintroduced into the fenced unit in Mākaha when the fence is complete. Stock from the Central ‘Ēkahanui PU is being reintroduced into managed areas within and just outside the fence in South ‘Ēkahanui. Ungulates and weeds are the major threats that impact this species. Management of this taxon is going well and there is a good prognosis for stability. It is relatively easy to grow plants from seed, cuttings and divisions, and managed populations recruit well. Augmentations have been successful in producing mature F1 plants.

Taxon Status

Action Area: In

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

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki and Pahole	Manage for stability	66	23	71	26	49	202	41	1	273	67	50
	Total for Taxon:	66	23	71	26	49	202	41	1	273	67	50

Action Area: Out

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

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Central Ekahanui	Manage for stability	30	3	30	3	16	6	27	0	36	30	16
Makaha and Waianae Kai	Manage for stability	9	2	13	1	3	0	0	0	13	1	3
South Huliwai	Genetic Storage	18	0	21	0	0	0	0	0	21	0	0
	Total for Taxon:	57	5	64	4	19	6	27	0	70	31	19

Genetic Storage

Cuttings have been taken from all PUs and established in the Army Nursery to collect seed for storage. This simultaneously allows NRS to collect stock from wild founders and encourages natural recruitment in the PUs. Seed collections for the seedbank are still ongoing and seed storage tests will be more extensive once seed is collected from greenhouse plants. Seed was collected this year from two reintroduction sites and is currently being tested. Previous seed storage testing was done at the Seed Conservation Lab on a small seed lot, and the preliminary recommended storage condition is 24°C at 20% relative humidity. There are currently 6,034 seeds collected from reintroductions, and 2,610 seeds from wild plants from three of the four PUs.

Genetic Storage Summary

Makua 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
Cenchrus agrimonioides var. agrimonioides							
Central Ekahanui	30	3	0	11	0	14	4
Kahanahaiki and Pahole	66	25	15	45	0	38	31
Makaha and Waianae Kai	13	1	0	0	0	13	7
South Huliwai	21	0	0	10	0	7	5
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				66	0	72	47

Propagation/Germination Techniques

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

Unique Species Observations

There are no unique observations for this taxon.

Outplanting Issues

Reintroductions and augmentations have been conducted in all PUs except for Mākaha and Wai‘anae Kai. The Stock from this PU is kept as a living collection in the Army Nursery for now until the Mākaha fence is complete. Stock from Kahanahāiki Gulch was outplanted into three sites in Kahanahāiki and Pahole Gulches, beginning in 1999. One additional outplanting of Pahole Gulch stock will be planted into Pahole in the coming year (permission pending). On TNC lands, a reintroduction was established in the South ‘Ēkahanui fence with stock from the Central ‘Ēkahanui and Huliwai PUs. All augmentations will be supplemented until the founding stock is balanced. At two of the planting sites in the Kahanahāiki and Pahole PU, many seedlings have been observed; up to 90 in Kahanahāiki and 190 in Pahole. Although most do not persist through the summer, juvenile and mature F1 plants have become established at both sites. NRS expect that given time, the other reintroductions will also produce mature F1 plants and become established.

Founders Represented in Outplantings

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

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central Ekahanui	Manage for stability	33	6
Kahanahaiki and Pahole	Manage for stability	106	36
Makaha and Waianae Kai	Manage for stability	14	0
South Huliwai	Genetic Storage	21	14
	Total for Taxon:	174	56

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

Research Issues

The primary need for research is to determine the best monitoring technique to follow population trends that will not require a complete census of all individuals.

Surveys

NRS tried to relocate a historical site this year in Mākaha, but found no plants. No surveys for this taxon were conducted as part of Urgent Actions. However, new plants have been found in known populations, and NRS continue to survey around known PUs for more plants.

Taxon Threats

The major threats to *C. agrimonioides* var. *agrimonioides* are ungulates and weeds. During drought conditions in 2001, rats ate stems of this taxon but did not kill any of the plants. Presumably, the rats were searching for water, as it was a very dry year and other species that are not usually eaten by rats were also predated. This year in Wai‘anae Kai, NRS observed all plants chewed by either rats or goats. However, no plants were killed. This taxon grows in areas where alien grasses are prevalent. This makes it difficult to spray grass specific herbicides like Fucilade II® because the herbicide will kill *Cenchrus* as well as the target grasses.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki and Pahole	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides

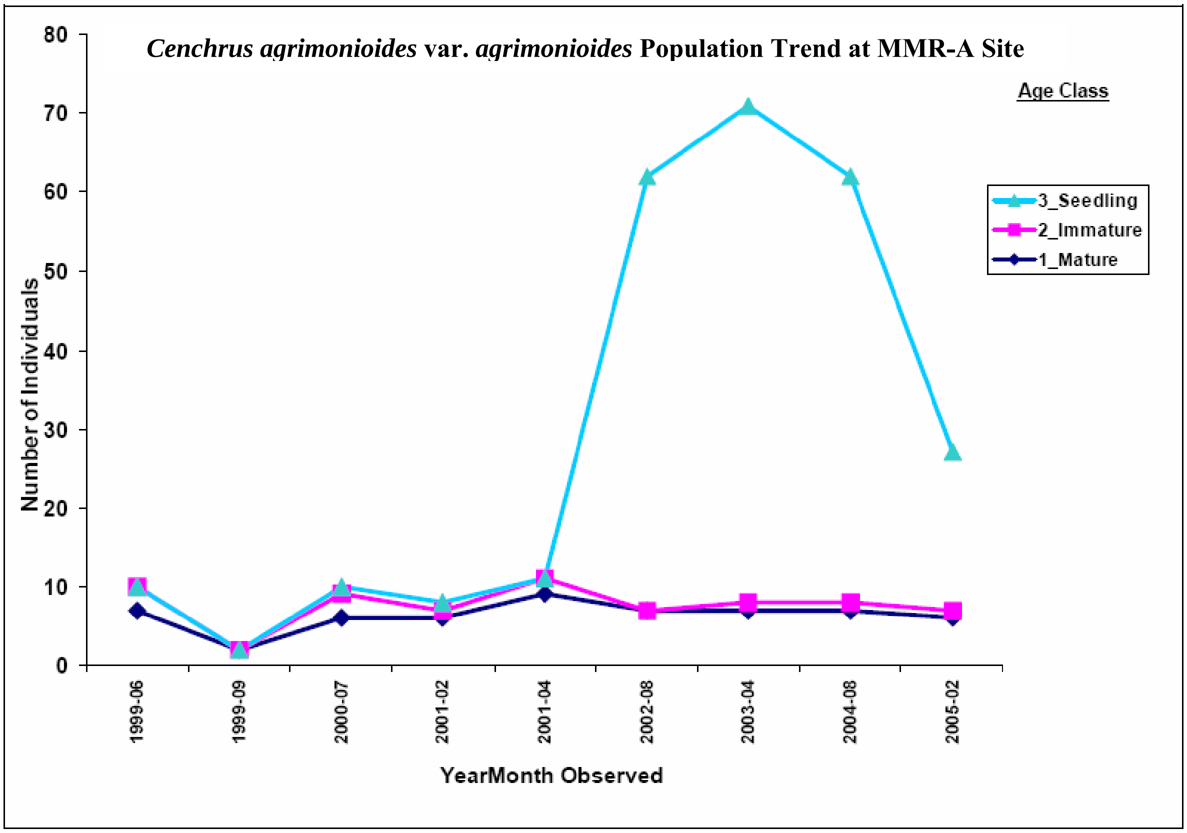
MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Ekahanui	Manage for stability	No	Yes	No
Makaha and Waianae Kai	Manage for stability	No	Partial	No
South Huliwai	Genetic Storage	No	Yes	No

Manage for Stability PUs:

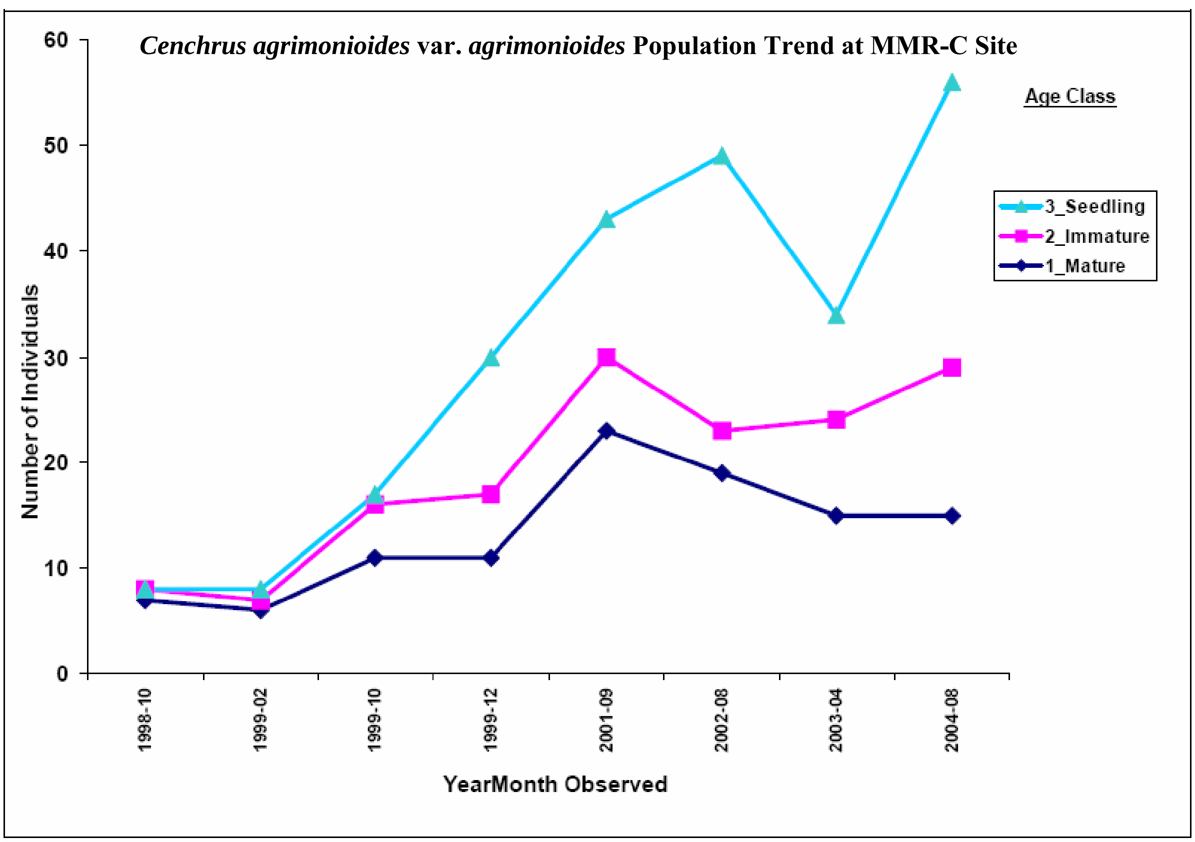
Kahanahāiki and Pahole: This is a large PU covering at least seven wild sites and two large augmentation sites in two gulches. Three of the Kahanahāiki sites are located inside the Kahanahāiki fence; the fourth has one mature, two immature and one seedling, and is outside the fence. All of the Pahole locations are within the exclosure. Approximately 100 meters separate the subgroups within the exclosures. This PU has more than fifty reproducing individuals and all threats have been controlled. The number of plants has increased in this PU since the MIP was initiated and NRS expects this trend to continue.

The first population trend figure below illustrates the trend seen at the wild MMR-A site in Kahanahāiki. Numbers are stable although seedlings have come and gone. Overall NRS believe that this site has not shown a larger increase because the available habitat is saturated with plants. Weed control would likely create more habitat for this population.

The second population trend figure below illustrates the population trend at the wild MMR-C site in Kahanahāiki. Unlike the MMR-A site, there is additional appropriate habitat in proximity to the known plants. New plants have germinated on site and NRS has discovered additional plants while searching nearby areas. NRS expect this trend will continue until the site is saturated.



Cenchrus agrimonioides var. *agrimonioides* Population Trend at MMR-A Site
Age Class
3_Seedling
2_Immature
1_Mature
Number of Individuals
0
10
20
30
40
50
60
70
80
1999-06
1999-09
2000-07
2001-02
2001-04
2002-08
2003-04
2004-08
2005-02
YearMonth Observed



Cenchrus agrimonioides var. *agrimonioides* Population Trend at MMR-C Site
Age Class
3_Seedling
2_Immature
1_Mature
Number of Individuals
0
10
20
30
40
50
60
1998-10
1999-02
1999-10
1999-12
2001-09
2002-08
2003-04
2004-08
YearMonth Observed

Pahole: In August, 2004 NRS counted 25 mature plants, two immature plants and one seedling at one of the wild Pahole populations. NRS and the NARS Specialist collected seeds and conducted weed control this year. There are significant weed threats at this site, including encroaching *Melinus minutiflora* and *Psidium cattleianum*. NRS discussed these weed issues with the NARS Specialist and have developed a plan to implement weed control for the area. Unfortunately, due to a lapse in visitation, NRS fear that the progress made, in particular on *M. minutiflora* has been lost. NRS coordinated with the NARS Specialist to visit the second *in situ* site in Pahole, but have not yet visited the site. Seed collected from the two Pahole *in situ* sites will be propagated and outplanted into a new reintroduction site in Pahole next year, pending state permission.

NRS outplanted 60 *C. agrimonioides* from Kahanahāiki stock into Pahole in December 2000. This reintroduction has flourished. Fifty-one F1 generation plants on-site are now either immature, or have already matured. NRS will balance founders for the last time at this site in the winter. NRS conducts monitoring and weed control twice a year.

Mākaha and Wai‘anae Kai: The Wai‘anae Kai portion of this PU is along a hiking trail in a public hunting area. These plants are not proposed for fencing. The Mākaha portion of this PU will be fenced in the second Mākaha subunit, proposed for construction in year five of the MIP. A few more plants were found in October 2004, when NRS counted 13 mature plants, one juvenile and three seedlings. Plants are being grown from all the founders; these will be used to produce seed in the Army Nursery for storage and to produce stock for reintroduction into a fenced unit in Mākaha when it is complete. NRS will continue to monitor this population and collect from of any additional founders. As mentioned earlier, while no plants were killed, the plants were browsed heavily. NRS will work to determine whether goats or rats were the cause of this damage, and will discuss further actions to address this threat.

Central ‘Ēkahanui: Due to recent plant discoveries, there has been an increase in the total number of plants at this site. There is no fence; however, ungulates have not been noted as a threat. More than a dozen seedlings were observed here in the past and they are likely still present. Cuttings or seeds have been collected from nearly all plants; they will be grown to supplement a reintroduction in South ‘Ēkahanui in the coming year.

Other PUs:

South Huliwai: Although there are many plants at this site, this PU is not designated for manage for stability. The habitat is marginal compared to other PUs and NRS believe it is not viable in the long-term. Cuttings have been taken from nearly all of the founders and will be grown in the Army Nursery for seed production and reintroduction into the South ‘Ēkahanui fence.

3.3 *Chamaesyce celastroides* var. *kaenana*

Requirements for Stability from MIP:

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

Taxon-Level Discussion

Chamaesyce celastroides var. *kaenana* has stable numbers at six PUs. The three populations designated as 'Manage for Stability' are Ka'ena to Keawa'ula (Ka'ena), Ka'ena (East of Alau) and Mākua. Only the Mākua PU is located within the action area. All three of these PUs are located in manageable terrain where threats can be addressed. Other PUs with stable numbers are located on cliffs or in very degraded habitat. Complete genetic storage for these PUs is a priority as this is also a stability goal due to fire threats. Four populations, not three, were designated as 'manage for stability' at the MIT meeting in April 2004 because it was determined that the Wai'anae Kai PU could be monitored, but not managed. All of the plants in this PU are found on the inaccessible cliffs of the Kamaileunu ridge. NRS will continue to monitor this population annually for threats and to confirm its stability. This site is considered a 'manage for stability' back up site. Although this taxon faces invasive species challenges and is significantly threatened by fire, in the areas where NRS have implemented management there has been strong recruitment. NRS believe that there is no need for reintroduction/augmentation to reach stability numbers. In addition, NRS has made great strides in collection goals by both bagging immature fruit for later collection as well as collecting available mature fruit for storage. With threats controlled, fire being the most challenging, NRS feel this species has a good prognosis for stability.

Taxon Status

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana — **TaxonCode: Chacelkae**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kaluakauila	Genetic Storage	12	7	12	7	0	0	0	0	**12**	**7**	**0**
Makua	Manage for stability	57	55	89	45	20	0	0	0	**89**	**45**	**20**
North Kahanahaiki	Genetic Storage	177	0	177	0	0	0	0	0	**177**	**0**	**0**
Puaakanoa	Genetic Storage	145	10	145	10	0	0	0	0	**145**	**10**	**0**
	Total for Taxon:	391	72	423	62	20	0	0	0	**423**	**62**	**20**

Action Area: Out

TaxonName: Chamaesyce celastroides var. kaenana — **TaxonCode: Chacelkae**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
East Kahanahaiki	Genetic Storage	2	0	2	0	0	0	0	0	**2**	**0**	**0**
Kaena (East of Alau)	Genetic Storage	21	4	21	4	20	0	0	0	**21**	**4**	**20**
Kaena and Keawaula (Kaena)	Manage for stability	300	0	300	0	0	0	0	0	**300**	**0**	**0**
Kaena and Keawaula (Keawaula)	Genetic Storage	24	1	24	1	0	0	0	0	**24**	**1**	**0**
Waianae Kai	Manage for stability	33	0	33	0	0	0	0	0	**33**	**0**	**0**
	Total for Taxon:	380	5	380	5	20	0	0	0	**380**	**5**	**20**

Genetic Storage

Since 2001, NRS have been developing collection methods at the Mākua PU. *Chamaesyce celastroides* seeds violently dehisce upon maturity. Therefore, NRS crafted lightweight organza bags that cover the small branches. The light material is important because the branches of *C. celastroides* are very fragile. The fabric allows for aeration if it rains so the seeds do not rot or begin to germinate. The bags are placed over immature fruit in mid-summer and seeds are collected in late summer or early fall. Due to lack of success in the past of cuttings and immature fruit in the Micropropagation Lab, as well as with cuttings from the Army Nursery, seed is currently the only method of genetic storage for this taxon.

Since the bagging technique was developed, NRS has acquired three substantial collections from the Mākua PU. NRS are approaching bagging slowly so as to allow for additional on-site recruitment. NRS, however, has been unable to make a bulk collection for storage testing. Instead, 25 seeds from three plants collected in 2003 with over 250 seeds banked for each will be sown for viability testing. This will give immediate and valuable information for the longevity of the stored collections until bulk collections can be made for testing. Assuming seeds store well, NRS will continue to collect seeds from the populations within MMR that are threatened by fire, focusing on individuals with less than 50 seeds in the seedbank. NRS will also begin to collect from all populations which are designated 'manage for stability'. NRS will approach the State for permission to collect from offsite populations on their land once preferred seed storage methods are determined. At east Kahanahāiki, only one plant had fruit this year and it was bagged. At north Kahanahāiki, bags were placed on nine accessible plants and seed was collected.

This summer, in addition to bagging inflorescences, fruit that appeared close to dehiscing were picked and kept in paper envelopes, where most of the fruit matured and dehisced within one week. Collected fruit were red, many starting to dry and brown, and fissures along the capsules were more pronounced than in immature fruit. Though this technique initially takes less time, the number of seeds collected from bagged inflorescences is greater than the number of seeds collected via the picking technique. Multiple collections within the fruiting season would be necessary to achieve significant numbers of seed for storage. However, since both methods yield mature seed, NRS will continue to use both techniques.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	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	0	0	0	0
Kaena (East of Alau)	21	4	0	0	0	0	0
Kaena and Keawaula (Kaena)	300	0	0	0	0	0	0
Kaena and Keawaula (Keawaula)	24	1	0	5	0	0	3
Kaluakauila	12	7	0	0	0	0	0
Makua	89	45	2	39	0	0	19
North Kahanahaiki	177	0	1	4	0	0	2
Puaakanoa	145	10	0	0	0	0	0
Waianae Kai	33	0	0	0	0	0	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				48	0	0	24

Propagation/Germination Techniques

Chamaesyce celastroides continues to be unsuccessful with vegetative propagation trials. Recent tests at the Micropropagation Lab suggest soaking cuttings prior to potting may help to leach out a majority of the latex. NRS will try this technique. Currently, the preferred propagation technique for this taxon is seed germination. Initial germination rates range from 30-75% for seeds sown on agar at the Seed Conservation Lab.

Unique Taxon Observations

There is some morphological variation amongst populations of *C. celastroides* that may be due to environmental rather than genetic variation. Plants from the Ka'ena to Keawa'ula (Ka'ena) PU are very prostrate, which may result from the wind exposure at that site. The other PUs, located on cliffs or in areas out of the wind, have erect plants.

The east and north Kahanahāiki populations were negatively impacted by the fire that occurred in July 2003. Mature plants were killed by the fires and others are still recovering and have not yet begun to flower and fruit to the same degree as prior to fire impacts. The mature plants that remain in these fire prone areas are growing on rocky outcroppings where past fires have not been intense. NRS have found many new seedlings present in areas with deeper soils and heavier fuels indicating that this is appropriate habitat and that plants have been destroyed by past fires. In addition, this indicates that the seeds have survived past fires.

Outplanting Issues

Germination and progression through age classes to maturity is occurring naturally at the PUs that NRS are managing. Therefore, there is currently no need to outplant into these populations. Vigorous plants grown from Mākua PU stock are planted at the Mākua Range Control Building where they are protected from fires. This planting is used in part for educational purposes as well as an experimental ex-situ site. NRS will continue to maintain this planting and supplement it with new founders from the wild population.

Research Issues

No research needs have been identified by NRS at this time.

Surveys

No additional surveys have been conducted for this taxon in the past year. NRS found no new occurrences of this species this year.

Taxon Threats

Fire is the primary threat common to most of the extant populations. This taxon grows in very dry and rocky lowland environments and cliffs, which are now dominated by alien grasses and easily accessible to arsonists. *Panicum maximum* is the most significant grass affecting *C. celastroides* habitat. This invasive grass not only competes with *C. celastroides* for resources it also produces dense fuel that greatly increases the threat and impact of fire. Additional weed species that threaten *C. celastroides* habitat include *Leucaena leucocephala* and *Acacia farnesiana*. Goats are a threat to a few of the plants in the Wai‘anae Kai PU and are not controlled at this time. Pigs are not a threat to this taxon.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaluakauila	Genetic Storage	Yes	No	No
Makua	Manage for stability	Yes	Yes	No
North Kahanahaiki	Genetic Storage	Yes	No	No
Puaakanoa	Genetic Storage	Yes	No	No

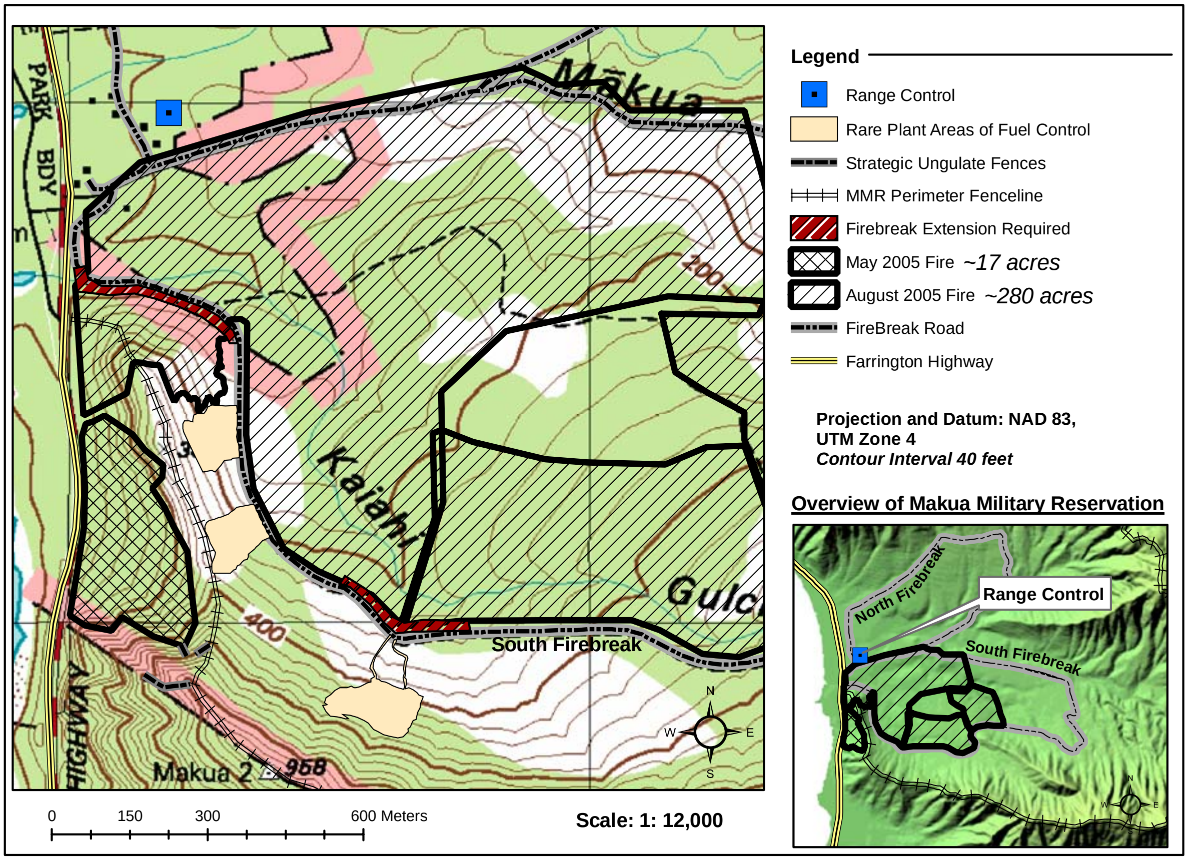
Action Area: Out

TaxonName: Chamaesyce celastroides var. kaenana

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
East Kahanahaiki	Genetic Storage	Yes	No	No
Kaena (East of Alau)	Genetic Storage	Yes	Yes	No
Kaena and Keawaula (Kaena)	Manage for stability	Yes	Yes	No
Kaena and Keawaula (Keawaula)	Genetic Storage	Yes	No	No
Waianae Kai	Manage for stability	Yes	No	No

Manage for Stability PUs:

Mākua: NRS has done extensive fuel and weed management around this PU and the population is doing extremely well. Numbers have grown significantly from the numbers in the final IP. The number of immature plants has grown exponentially and at each new monitoring NRS tag new mature plants. Seedlings continue to come and go with the seasons. Although NRS has been effective at removing alien grasses and greatly reducing fuels the threat of fire is ever present. Many broad leaf weeds as well as native grasses and shrubs have moved into the area. NRS began to investigate ways to control broad-leaf weeds without success (see weed chapter for discussion). In the summer of 2005, two fires burned in the vicinity of this PU. One fire burned from the road up to the crest of ‘Ōhikilolo ridge. This area has burned every summer in the recent past and typically stops on the ridge crest. The second fire started inside of the south Fire Break Road and jumped the road at the base of ‘Ōhikilolo ridge, burning up the ridge and into the firebreak along its western edge. The fire burned within ten meters of an outlier in the lower patch. This is of great concern to NRS and we are working with Range Control to prevent this from happening in the future. The strongest recommendation that NRS has made is that the firebreak be extended out thirty meters at the base of ‘Ōhikilolo ridge. At present, the edges of the firebreak are not maintained and are dominated by large *L. leucocephala* and thick *P. maximum*. A fire also jumped the road in this area in the summer of 2004. The area inside of the fire break just below the patches is well maintained to thirty meters. Although this burned, the fire did not jump the firebreak here. See the map below for an illustration of these issues.



Lower ‘Ōhikilolo Management Areas and Fire Recommendations

Ka’ena and Keawa’ula (Ka’ena): This 0.9-acre population of 300+ mature plants, protected within the Ka’ena Natural Area Reserve, is located in a predominantly native coastal habitat. There is substantial on-site recruitment; with many juvenile and seedling plants. The size and density of this PU makes monitoring the population structure each year an overwhelming and potentially damaging task. To avoid damaging plants, NRS have not and will not conduct a census of this population each year as the number is well over the target number of 25 mature individuals. NRS will work with NARS staff to determine the best monitoring and collection approach for this PU. NRS have not yet collected seeds for genetic storage from this PU because there is such a substantial wild population and threats are low compared to other populations. NRS does extensive weed control on this site and attribute much of the increase in numbers to this management. Fortunately, fire is not as large a threat as at the other PUs due the wind-swept strand vegetation in the PU.

Ka'ena (East of Alau): This population was visited once in the last year and there was no change in population size or vigor. There is no grass in the area immediately surrounding this PU and the plants are protected by large rock talus. Unfortunately, encroachment by fire prone grasses is occurring nearby. A fire in 2003 burned a nearby area but did not impact the PU. In the coming years, NRS will visit this site twice a year to conduct weed control. This site should be monitored with some sampling technique in the future to avoid trampling.

Other PUs:

Wai'anae Kai: In the past the Wai'anae Kai PU was considered for a "Manage for Stability" PU. There are stable numbers of mature plants, but reproduction is impossible to detect from aerial surveys. The plants are located in very open portions of cliffs where weeds and goats are not a direct threat. Genetic storage collections from this PU will be very difficult if not impossible to acquire. Over 30 plants were counted during surveys by NRS and HINHP in Wai'anae Kai in 2002 and no change in numbers was detected when the site was monitored in June 2005. NRS will monitor this PU annually to confirm its stability and survey for new threats.

Kaluakauila: The estimated number of individuals in the MIP was based on a single observation with binoculars. Since that time, the plants have been monitored and their maturity level has been assessed more accurately. No weed control has been conducted at this PU because it occurs on a cliff. NRS have not collected seeds. The upper edges of this PU are choked with alien grass and are at risk from fire. Lower portions are on open cliff habitat and are not at risk. NRS will work to secure seed collections from this site in the coming years.

North Kahanahāiki: The number of individuals reported in the final MIP was based on an estimate of individuals by the HINHP Botanist. The plants in North Kahanahāiki are found mainly on cliffs, necessitating helicopter surveys. Some of these plants have since been identified as hybrids of *C. celastroides* var. *kaenana* and *C. celastroides* var. *amplectans*. A portion of this PU was burned in 2003 and plants were killed. Other plants are still recovering from the impacts of the fire. At the time, some plants were bagged for seed collection. These bags were destroyed in the fire and reset in July 2004. Due to access restrictions NRS was not allowed to revisit this area after the bags were set in 2004 and no collections were made. In 2005 NRS monitored, bagged and collected fruit as a priority. Significant collections were made from most plants. Next year NRS will direct collections based on this years results. Fire is still a major threat in the area and NRS expects devastating impacts from any future fires. NRS are not performing weed control at this site as NRS feel it is not viable in the long term due to the fire threat and degraded habitat.

East Kahanahāiki: There are two plants growing on a vertical cliff in East Kahanahāiki (C-Ridge). The lower plant was heavily impacted by the fire of July 2003 and has still not recovered. This individual was reproductive prior to the fire but has not flowered since it was burned. The other was higher on a cliff, further from alien grass fuel and was not impacted by fire. NRS bagged the upper plant and expects to collect in the early fall of 2005. There are no significant weed threats to these plants as they occur on a barren cliff.

Pua‘akanoa: Plants were monitored in 2002 but NRS have not revisited the site. The fire of 2003 did not affect this PU because most of the plants are located on sparsely vegetated cliffs. Once collections from the more fire-prone PUs are completed, NRS will shift its collection and monitoring focus to this PU. NRS believe that this is a valuable PU because there are many plants and the habitat is in good condition.

Ka’ena and Keawa’ula (Keawa’ula)*:* The number of individuals in the final MIP was a tally of observations from this area between 1991 and 2001 by the HINHP Botanist. The number in this report represents the number of individuals monitored by NRS at two sites in Keawa’ula. A thorough count has not been done by NRS. Collections were acquired from this PU in the summer of 2003 and will be again in the coming years based on the outcome of seed longevity trials. Fire is a threat at this PU and the site has very poor habitat quality with significant weed threats.

3.4 *Chamaesyce herbstii*

Requirements for Stability:

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

Taxon Level Discussion

Historically, this taxon was found in both the north and south ends of the Waiʻanae range. Currently, there are no extant individuals in the southern Waiʻanaes. The only remaining extant PU, Kapuna to Pahole, occurs in the northern Waiʻanaes. This PU falls within the Action Area (AA), and will be managed for stability. This PU has severely declined since the MIP was finalized. NRS believe there is a combination of factors including weed impacts, ungulate impacts and low on-site germination which have led to this decline. Reintroductions using the northern stock will take place in West Makaleha and Mākaha MUs once fences are constructed. The Mākaha fence will be constructed in the next year and the West Makaleha fence is slated for year two of the MIP. NRS have just begun to work intensively with this taxon. This year seeds were collected and germinated, wild plants were monitored, new juvenile plants were found in multiple sites, and weeds were controlled. It is too early to predict, but NRS hope that with reintroduction/augmentation and ungulate and weed control this species may reach stability.

Taxon Status

Action Area: In

TaxonName: Chamaesyce herbstii **TaxonCode: Chaher**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kapuna to Pahole	Manage for stability	52	3	40	5	0	0	0	0	40	5	0
	Total for Taxon:	52	3	40	5	0	0	0	0	40	5	0

Action Area: Out

TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0
West Makaleha	Manage reintroduction for stability	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

Genetic Storage

Storage testing for this taxon has recently been initiated. Seeds of *C. herbstii* dehisce violently. NRS worked with the NARS Specialist to bag fruits for seed collection this year. Seeds were collected from 16 plants in the Kapuna to Pahole PU and are being propagated and stored. Plants will be reintroduced in the next year or two, depending on when the stock is ready and pending State permission. The reintroduced plants will serve as a source for seed collection for storage and storage testing. No collections have been tested for storage potential. Despite a small degree of storage testing for two other species of *Chamaesyce*, seeds of this taxon appear morphologically different; particularly, they are much larger in size. Storage results are for the other small-seeded *Chamaesyce* species, and therefore, can not be projected for this taxon. Tissue culture techniques for seed, both mature and immature, brought to the Micropropagation Lab, have not been successful.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	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	40	5	0	5	0	8	4
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				5	0	8	4

Propagation/Germination Techniques

NARS staff grew plants from seeds for an outplanting in Kapuna. NARS staff also collected seeds from several of the Pahole plants in the mid-1990’s. This stock grew in the Pahole Mid-elevation Nursery for several years. The plants were very healthy, and flowered more than once. The plants were outplanted below the Pahole nursery in approximately 2003. Seeds collected in Kapuna and Pahole this year had high variation in germination rates (0-100%) between plants. Seeds were germinated on 1% water agar and were easily transferred to pots. These plants are now growing well in the Army Nursery. Seeds that did not germinate within two months became rotten during this time, suggesting that seeds would not form a soil seedbank. Though cuttings brought to the Micropropagation Lab in the past for this and other species of *Chamaesyce* have not been very successful, recent techniques of initially soaking cuttings to leach out a majority of the latex have worked for other species and will be attempted for this species.

Unique Species Observations

This species has gone through a major decline in numbers in the last five years (T. Takahama, pers. comm. 2005). One of the gulches monitored in Pahole this year had 25 mature plants and 20 dead plants. It has been difficult to collect fruit at the right stage as ripe fruit dehisce. Consequently, bagging immature fruit has worked well.

Outplanting Issues

NRS have just started working extensively with this species, therefore, no outplantings have been attempted yet. The State successfully outplanted into a small exclosure in Kapuna around 1995. These plants are growing vigorously and are reproductive. Plants were over one meter tall when outplanted. An outplanting done at an *inter situ* site off of the Pahole road in 2003 was not successful.

Research Issues

Research on seed storage needs to be conducted.

Surveys

The Nature Conservancy staff monitors the site of the former ‘Ēkahanui population annually, but have never found any new seedlings. This coming year the HINHP Botanist will spend four days surveying Makaleha and Mt. Ka‘ala NAR for possible new populations. NRS did not find any new populations of *C. herbstii* this year but will continue to look for additional plants in existing PUs.

Taxon Threats

Weeds such as *Ageratina adenophora, Rubus rosifolius, Buddleia asiatica, Schinus terebinthifolius, Psidium guajava, Clidemia hirta,* and *Psidium cattleianum* have dramatically altered the mesic habitat in which this taxon grows. Plants produce many flowers and immature fruits each year, but not many fruit are left on the plants at maturity (T. Takahama pers. comm. 2005). The mature fruit are red, and it is possible birds eat them before they reach maturity. Feral ungulates negatively impact the gulch bottom habitat where this species grows in Kapuna, which is not yet protected by a fence.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Chamaesyce herbstii

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna to Pahole	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Chamaesyce herbstii

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No
West Makaleha	Manage reintroduction for stability	No	No	No

Manage for Stability PUs:

Kapuna to Pahole: The number of individuals in the final MIP was based on counts by the NARS specialist between 1991 and 1999. Based on extensive monitoring in Pahole last year and discussions with the NARS Specialist, it is clear that this species has declined greatly in numbers in the last five years. NRS worked with the NARS Specialist to bag fruits and collect seeds this year. This stock will be used to augment sites in Pahole. NRS focused efforts on the Pahole portion of this PU this year, where extensive weeding was conducted. In conducting weed control, NRS discovered additional juvenile plants. All of the known Pahole plants occur within the fenced Pahole NAR.

In the next year, NRS plan to expand their focus to include the Kapuna portion of the PU. Over the past year two mature and three immature plants were monitored and fruit was collected from one individual at one site in Kapuna. It is not known how the other sites are doing in Kapuna or how many more there may be. NRS hope to get the locations from NARS staff in the coming year and begin monitoring and threat control. The fence proposed for this coming year will not protect the site NRS has been monitoring. However, additional fencing is planned for Kapuna in year two of the MIP. Completing the Upper Kapuna MU fence will be the highest priority for the fence crew once hired.

Mākaha: Kapuna to Pahole founders will be used to introduce plants to Mākaha, pending approval from the State. A fence will be constructed in Mākaha in the next year and an appropriate site will be identified. In the next year, NRS will work with NARS to secure seed from Pahole and Kapuna for augmentation into Pahole and introduction at Mākaha.

West Makaleha: Kapuna to Pahole founders will be used to reintroduce plants to West Makaleha, pending approval from the State. A fence will be constructed in West Mākaleha in year two of the MIP.

3.5 *Cyanea grimesiana* subsp. *obatae*

Requirements for Stability:

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

Taxon Level Discussion

The healthiest extant populations with mature plants will be managed. Pahole to West Makaleha is the only PU in the AA. The other two PUs, Central Kalua‘ā and ‘Ēkahanui, are both on TNC land in Honouliuli. The *ex-situ* site at ‘Ēkahanui has been extirpated since PUs were chosen, but the stock is represented in an outplanting installed by TNC. Reintroductions have occurred in all three ‘manage for stability’ PUs. While this taxon is easy to propagate and reintroduce, reaching stability will be challenging. Though plants produce viable seed, there is a limited genetic base due to the low number of founders. Rats and slugs attack plants of all size classes. Because of these predators, there is limited *in situ* recruitment. NRS has only recorded regeneration at two sites, West Makaleha and Palikea. These are the only wild sites with more than one mature plant.

Taxon Status

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: Cyagrioba**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Pahole to West Makaleha	Manage for stability	7	3	8	2	0	15	15	0	23	17	0
	Total for Taxon:	7	3	8	2	0	15	15	0	23	17	0

Action Area: Out

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: Cyagrioba**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Central Kaluaa	Manage for stability	0	0	1	0	0	0	70	0	1	70	0
Makaha	Genetic Storage			1	0	0	0	0	0	1	0	0
North branch of South Ekahanui	Genetic Storage	0	0	0	0	0	4	6	0	4	6	0
Palikea (South Palawai)	Manage for stability	8	7	10	12	18	0	12	0	10	24	18
Palikea Gulch	Genetic Storage	0	1	0	1	0	0	0	0	0	1	0
South Kaluaa	Genetic Storage	1	0	1	0	0	0	14	0	1	14	0
	Total for Taxon:	9	8	13	13	18	4	102	0	17	115	18

Genetic Storage

Both seed storage and tissue culture are successful methods of genetic storage. Seeds withdrawn this year from storage for propagation indicate that seeds can be successfully stored at 4˚C and 20% relative humidity. Seeds have been stored for over two years with little to no decrease in germination. Germination from older collections, however, is significantly lower. These collections were stored at -18˚C from one to three years. There has only been one small two-year storage test for this species with inconclusive results, but more extensive storage testing for many other species of *Cyanea* have indicated that seeds of this genus cannot be stored frozen. Therefore, seeds from older collections may have low germination not because of low storage potential, but rather due to the species' inability to be stored at -18˚C. Further storage testing is necessary. A collection schedule is uncertain due to lack of long-term storage data, but collections can be made less frequent than every two years. Plants can also be stored in micropropagation. They are easily subcultured, so it is possible to store many clones from one plant.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cyanea grimesiana subsp. obatae							
Central Kaluaa	1	0	0	1	0	1	1
Makaha	0	0	0	0	0	0	0
North branch of South Ekahanui	0	0	1	0	1	1	1
Pahole to West Makaleha	8	2	1	7	1	6	8
Palikea (South Palawai)	10	12	2	12	5	7	12
Palikea Gulch	0	1	0	0	0	0	0
South Kaluaa	1	0	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**
				21	8	15	23

Propagation/Germination Techniques

Germination rates can vary between collections of the same plant as well as between different plants. Seeds are easily germinated within the first month on 1% water agar with 80-100% germination. Plants can be grown from cuttings, but since most plants have only one terminal branch this method cannot be widely used and is only attempted if there is an emergency threat to the site.

NRS currently germinate all seeds and grow seedlings in a growth chamber at the Natural Resource Center. The growth chamber is regulated for monthly average temperatures and day lengths at 2,000 ft elevation. This tool allows for greater environmental stability and higher success in germination and seedling establishment. Even in the growth chamber, seedlings grow very slowly.

Unique Species Observations

There is significant variation among the various PUs in flower morphology, leaf morphology, recruitment, and fruiting seasonality. The ‘Ēkahanui plants produce pure white flowers, while all other populations have purple and white striped flowers. Seedlings grown from stored seed from plants in West Makaleha and Palikea for next year’s reintroductions display variation in leaf morphology after a couple months. Leaves of seedlings from West Makaleha are more deeply lobed, and lobes appear more numerous and much thinner than leaves on seedlings from Palikea. The Palikea (South Pālāwai) site demonstrated remarkable regeneration this year with eighteen seedlings counted. This is the largest amount of regeneration seen by NRS for this taxon. Unlike most species, not all populations flower at the same time of year. The plant in Central Kalua‘ā is extremely prolific, and produces lots of flower and fruit over several months in the summer and fall; it is reproductive almost all year round. The South Kalua‘ā plants flower in late summer/fall. The North Branch of South ‘Ēkahanui plants flower from late summer to winter. The Pahole to West Makaleha and Palikea (South Pālāwai) PUs flower in winter.

Outplanting Issues

C. grimesiana has been augmented or reintroduced at five separate locations, four on TNC land and one on State land. In the last three years TNC reintroduced this species to Palikea (South Pālāwai), ‘Ēkahanui and Central Kalua‘ā, and NARS reintroduced it into Pahole with assistance from NRS. NRS performed two augmentations this past year, one each in Central Kalua‘ā and Palikea (South Pālāwai). Founder stock for each outplanting is summarized in the tables below.

PU	Reintroduction Site	Founder Stock of Pre-existing Reintroductions	Founder Stock of 2004 -2005 Reintroductions	Founder Stock of Future Reintroductions
Pahole to West Makaleha	Pahole	Pahole	none	Pahole
Pahole to West Makaleha	Kapuna/Keawapilau	N/A	N/A	Pahole, West Makaleha
Pahole to West Makaleha	West Makaleha	N/A	N/A	West Makaleha
North Branch of South ‘Ēkahanui	‘Ēkahanui	‘Ēkahanui, Kalua‘ā	none	‘Ēkahanui (2006)
Central Kalua‘ā	Central Kalua‘ā	South Kalua‘ā	Central Kalua‘ā	Central Kalua‘ā
Central Kalua‘ā	Central Kalua‘ā	N/A	N/A	South Kalua‘ā
South Kalua‘ā	South Kalua‘ā	South Kalua‘ā	none	none
Palikea (South Pālāwai)	Palikea	Palikea	Palikea	Palikea

Using data collected from previous outplantings of this genus, NRS grew *C. grimesiana* in the greenhouse until it was of substantial size before outplanting, averaging about 50cm. This is thought to minimize the impact of slug predation on the plants. NRS also experimented with outplanting onto steep terrain and cliffs; very big or very small plants were found to be most appropriate for these reintroductions. Planting efforts this year will focus on increasing and equalizing the number of founders represented at reintroduction sites. NRS started germinating stock from the West Makaleha, Pahole, Palikea (South Pālāwai), South Kalua‘ā and ‘Ēkahanui populations. The seedlings are growing slowly and may not be ready to plant during the 2006-2007 reintroduction season.

Founders Represented in Outplantings

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: Cyagrioba**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central Kaluaa	Manage for stability	1	1
Makaha	Genetic Storage	1	0
North branch of South Ekahanui	Genetic Storage	1	1
Pahole to West Makaleha	Manage for stability	11	3
Palikea (South Palawai)	Manage for stability	24	3
Palikea Gulch	Genetic Storage	1	0
South Kaluaa	Genetic Storage	1	1
	Total for Taxon:	**40**	**9**

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

Research Issues

Slugs likely attack all members of this genus. Federal biologists consider slugs to be an “immediate and significant threat” to *C. grimesiana* though their conclusions are based on anecdotal observations. Formal investigation involving a related species, *C. superba*, suggests slugs reduce *C. grimesiana* survival as well (see Research Issues *C. superba* subsp. *superba*). NRS recently hired a Research Specialist to investigate slug control options for this species.

Surveys

While surveying for *Hesperomania arbuscula* in Mākaha, NRS discovered an individual of *C. grimesiana*. The plant was mapped and photographed. NRS has been back to the site to monitor and the plant has flowered and is expected to have fruit in the early fall. NRS plans to collect propagules from this individual and are considering additional outplantings in Mākaha. This new population is a new consideration for the IT when considering MIP plans for this taxon.

Taxon Threats

Threats to *C. grimesiana* include slugs, rats, weeds, and ungulates. Slugs prey on plants of all size classes of this species. The Invertebrate Research Specialist will be further investigating slug impacts and control options. In May 2002, NRS discovered major rat damage to the five mature plants in West Makaleha. Predator control is currently ongoing, at least during the fruiting season at all of the PUs except Pahole and Palikea Gulch, which consists of just one juvenile plant in a small exclosure. Weeds are a threat at all PUs. *Morella faya* is a problem weed at the Palikea (South Pālāwai) PU, and *Rubus argutus* is a threat to the West Makaleha PU.

All of the PUs except Mākaha and ‘Ēkahanui are protected by exclosures. The ‘Ēkahanui reintroduction is within the MU fence, but the wild site, now extirpated, is not. The Mākaha plant will not be protected by the fence being constructed this year, but it will be protected by another MU fence planned for year 4 of the MIP.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central Kaluaa	Manage for stability	Yes	Yes	Partial
Makaha	Genetic Storage	No	No	Yes
North branch of South Ekahanui	Genetic Storage	Partial	Partial	Partial
Palikea (South Palawai)	Manage for stability	Yes	Yes	Partial
Palikea Gulch	Genetic Storage	Yes	No	No
South Kaluaa	Genetic Storage	Yes	Yes	Yes

Manage for Stability PUs:

Pahole to West Makaleha: NRS believes there are two extant plants within the large exclosure in Pahole NAR. The NARS specialist has been monitoring and collecting from these plants. NARS staff are working to develop a management plan for these plants and will enlist the help of NRS if necessary. NARS reported that predator control has not been necessary in the past for fruit collection. NRS assisted the State with reintroducing 45 plants of Pahole stock into the Pahole exclosure in 2003. The NARS Specialist selected a site on the Pahole rim just below the State snail enclosure. At the last monitoring in August of 2005, fifteen mature and fourteen immature plants were observed. All plants were healthy. NRS is closely tracking the vigor and reproductive status of a couple plants in the reintroduction because they are the progeny of extirpated wild plants for which there is no other stock available. Presently, seeds are being germinated for the augmentation of this site. Outplanting will likely occur in the winter of 2006-2007, when plants reach acceptable size. No regeneration has yet occurred at the reintroduction site, but NRS feel that with greater fruit production, germination may occur, as germination may outpace slug predation and the plants are thriving. *Schiedea obovatum*, which is greatly impacted by slugs, has shown remarkable regeneration at the site. NRS has conducted weed control at this site and plan to do two trips a year for maintenance.

At the West Makaleha site, mature fruit was collected from four plants in October and November of 2004. NRS expect to collect additional fruit this year. Presently, seeds are being germinated for augmentation of this site. Outplanting will likely occur in the winter of 2006-2007, when plants reach acceptable size. NRS perform quarterly weed control in the area. An ungulate exclosure was constructed around the West Makaleha plants in 2001 and NRS established a rat grid in the area soon after. NRS discovered goat browse and scat within the exclosure in late May of 2005. In response NRS quickly reported the sign to NARS staff and made improvements to the fence in early July. Luckily there was no damage to the *C. grimesiana;* however, some outplanted A. *koa* were browsed. NRS believe that with the fence improvements, goats will no longer be able to enter. The fence remains pig-free.

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
2002	8	292	120	41%	25	15
2002-2003	8	696	463	67%	26	16
2003-2004	8	1008	693	69%	42	16
2004-2005	8	1001	322	32%	43	16

In May 2002, NRS discovered major rat damage to the five mature plants in West Makaleha. In response to the damage, NRS increased the number of bait stations from six to eight, and now monitor them twice a quarter, instead of once a quarter. NRS have not seen rat impacts since rat control efforts were expanded. Access to the West Makaleha reintroduction site has been suspended by the State DLNR. With this suspension, restocking of bait stations and snap traps has not occurred since 07 July 2005. This site is usually visited on a monthly basis to insure adequate protection of these plants. NRS feels this site is of great importance and is in the process of obtaining a special use permit from DLNR to reinstate baiting efforts.

Palikea (South Pālāwai*):* Located within a two-acre fence, these plants are monitored regularly by TNC and NRS staff. This PU has the largest number of wild plants. TNC staff augmented the population with stock from the same area in 2002 and 2003 with 35 individuals, in 2004 with 16 individuals, and in 2005 with 14 individuals. NRS augmented the same site with 12 plants in November 2004. These plants are healthy as of the last monitoring, June 2005. Presently, seeds are being germinated for future augmentations. Out-planting will likely occur in the winter of 2006-2007, when plants reach an acceptable size. The current fence needs to be expanded to increase the area for future outplantings. NRS has been working with TNC to scope possible fence lines and have a proposed route. Construction is pending until funds are available or the NRS fence crew is hired. NRS and TNC staff bait the site for rats twice a quarter. Feral pigs are controlled outside the fence with snares. NRS perform weed control in the area on a quarterly schedule. The area is predominantly native, except for planted Sugi pines. The large pines produce an environment that supports a native fern understory and are not targeted for removal at the present time. The wild population at this site is very robust, with vigorous plants in all age classes. In November 2004, NRS recorded eighteen seedlings. This is the greatest regeneration seen by NRS for this species. Overall, the site is thriving and NRS feel there is a good chance for the population to reach stability with additional outplantings.

Central Kaluaʻā: In 2003 a new wild plant was discovered in a dense thicket of *Clidemia hirta* within about a hundred feet of an intensively managed and outplanted area. This plant is remarkably vigorous; it fruits and flowers almost year around. Both TNC and NRS have collected seed for propagation and storage. South Kaluaʻā stock was reintroduced into the fenced unit at Central Kaluaʻā in 2003, before the wild plant was found. The population is for the most part healthy; 13 plants remain as of the last monitoring in June of 2004. This represents approximately 70% of the original outplanting. In addition, many of these plants are now mature. NRS and TNC conduct weed control around the site. Part of the PU is protected by rat bait grids set up for ʻelepaio predator control.

In the winter of 2004-2005, TNC gave NRS more than a hundred seedlings from the wild plant. Using these seedlings, 97 plants were outplanted in December of 2004. NRS took an aggressive approach at this site, reintroducing plants that were relatively small. The benefits of this approach included a shorter growing time for plants in the nursery, logistical ease in moving the plants, and increased outplanting options; because of their small size, the plants could be placed in precariously steep spots where wild plants are known to occur. However, as NRS feared, there was higher mortality with the small out-plants than with larger out-plants. At the last monitoring in March of 2005, 43 of the original 97 plants were healthy. NRS felt justified in taking chances with outplanting this stock because of the large amounts of seed available from the founder.

Other PUs:

South Kaluaʻā: This population is significant as it is the location of the holotype for the species. NRS constructed a small fence around the single remaining plant in May 2004. Fruit were successfully collected from this plant in the summer of 2004 and plants are now being grown from the seeds. Unfortunately, the plant appears to have taken a turn for the worse this summer (2005) and only a single fruit was collected this year. The plant had many buds earlier in the summer but they aborted. Presently, the plant only has a single large leaf, but it does have some small shoots that look healthy. This summer was very dry and this may have been the cause of decline. NRS will consider watering the plant. NRS will continue to monitor this individual and hope it will rebound this winter.

In the next year or two NRS will install a reintroduction site with pure South Kaluaʻā stock in a isolated location in Central Kaluaʻā. NRS germinated stock for this reintroduction in the summer of 2005. However, the seedlings are growing slowly and are not expected to be ready for the winter season of 2005-2006. This stock is severely limited and NRS will take a more conservative approach and grow plants to a larger size before reintroduction.

North Branch of South ʻĒkahanui: The last remaining wild plants at this site died in 2002. A reintroduction of mixed ʻĒkahanui and Kaluaʻā stock was planted in the ʻĒkahanui fence in 2003. 14 plants were outplanted, but slugs damaged many of the plants and only seven are left. Some of the remaining plants sustained slug damage and are in poor condition. Limited *ex situ* stock from this site is available; therefore all fruit from the outplanted individuals will be collected and put into propagation. The ʻĒkahanui stock are mature, but the Kaluaʻā stock are only beginning to mature. If the Kalua‘ā plants at this site produce flowers, they will be removed to prevent crossing with the ‘Ēkahanui stock. Seed collected from these plants will be used to establish a new reintroduction that only has ‘Ēkahanui stock. Limited weed control has been conducted in the area in the last year. TNC staff and NRS are working together to treat a patch of *P. maximum* which is the nearest fuel source above the outplanting. Staff hope to reduce the fuel load and thus the fire threat to this area. NRS and TNC will continue weed control in the area next year. There is a small rat grid set up around the outplanting; no rat damage has been seen, but due to the importance of the stock, NRS and TNC are eager to minimize all threats.

Palikea Gulch: This immature plant is growing in a small scale fence. A large koa tree fell over the plant, just missed crushing it, and is now inhibiting its growth. This plant was last monitored in May 2005 and was of moderate health. The subspecies identity of this plant has not been confirmed since it has yet to flower. This site was weeded in 2003 and again this year. This past year, a bomb was found near the plant. The State was informed of this discovery. In the coming year, NRS will escort EOD to the site, and hopefully EOD will remove the UXO.

3.6 *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

Taxon Level Discussion

Cyanea longiflora is only known from select locations in the Wai‘anae Mountains, none of which are on Army lands. Thus, all management is contingent upon cooperation with the Board of Water Supply (BWS) and State of Hawai‘i. All extant populations will be managed. The Kapuna to West Makaleha and Pahole PUs are both in the Action Area (AA). These two sites include the majority of the individuals of this taxon. The Mākaha side of the Mākaha and Waianae Kai population will be managed, and will be augmented with Waianae Kai stock. This decision was made because the Wai‘anae Kai population is located in a high use hunting area, eliminating the possibility of a large-scale fence to protect against ungulate damage. A fence is already planned for Mākaha. Full genetic storage collections for this species are underway. *C. longiflora* faces threats from fire, pigs, weeds, and slugs. In general, known populations are located in manageable habitat and many of the threats are controllable. The prognosis for stability is good, although none of the PUs are currently close to attaining stability. The table below shows fewer (29 as opposed to 40) plants counted in 2005 compared to the previous year. This should not be interpreted as a decline because not all of the known locations were monitored in 2005.

Taxon Status

Action Area: In

TaxonName: Cyanea longiflora **TaxonCode: Cyalon**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kapuna to West Makaleha	Manage for stability	40	0	23	6	0	0	21	0	23	27	0
Pahole	Manage for stability	50	0	30	52	13	0	0	0	30	52	13
	Total for Taxon:	90	0	53	58	13	0	21	0	53	79	13

Action Area: Out

TaxonName: Cyanea longiflora **TaxonCode: Cyalon**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha and Waianae Kai	Manage for stability	3	8	3	8	2	0	0	0	3	8	2
	Total for Taxon:	3	8	3	8	2	0	0	0	3	8	2

Genetic Storage

Over 105,700 seeds have been banked in the Seed Conservation Lab. Seeds were collected in October 2004 and August 2005 for storage testing and will be tested for the first time in October 2005. Collections prior to October 2004 were too valuable to be used for testing. Until results indicate otherwise, banked seeds are stored refrigerated at 20% relative humidity as this condition was determined most successful for all other tested species of *Cyanea*.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cyanea longiflora							
Kapuna to West Makaleha	23	6	0	7	1	2	6
Makaha and Waianae Kai	3	8	1	4	0	0	3
Pahole	30	52	1	22	0	3	22
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				33	1	5	31

Propagation/Germination Techniques

For good germination, fruit must be collected when seeds are mature. The best germination has come from seed that was dark brown. The fruit, however, can be at various stages of ripeness and contain dark brown seed. At seed maturity, the inside and outside flesh of the fruit should be orange, however, the inside flesh may still be green (outside orange) and contain dark brown seeds. Fruit that are dark purple and typically small are also green on the inside but have never been observed to have mature seed and should not be collected for seed storage. Seeds germinate on 1% water agar. Initial viability varies between plants and it ranges from 80-100%. For a few plants initial germination remains low, between 20-40%.

Unique Species Observations

This species is not fire-resistant. There are currently about three mature plants left on the Kumaipo Ridge, which separates Wai‘anae Kai and Mākaha. An illegal campfire that got out of control in early September 2003 killed at least one plant, see photo below. Other undiscovered individuals may also have burned.

Outplanting Issues

In February 2005, NRS experimented with outplanting 23 immature *C. longiflora* into a small pre-existing exclosure which lies with in the Kapuna to West Makaleha PU. Two nearby wild plants were used as founders. The reintroduction was done because of a contamination at the Micropropation Lab. The stock was taken out of tissue culture and grown out in the Army Nursery, until the plants averaged about 25cm. NRS treated the reintroduction as a trial. During monitoring in July 2005, sixteen plants were healthy, five were moderate, and two were dead. This size may have been a little smaller than ideal and in the future larger plants will be out-planted. Although slug predation has been observed to contribute to the decline of larger plants, for the purpose of out planting larger plants have demonstrated better survivorship. Prior to beginning more outplanting efforts, NRS will work to address the slug threat.

Founders Represented in Outplantings

TaxonName: Cyanea longiflora **TaxonCode: Cyalon**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kapuna to West Makaleha	Manage for stability	29	2
Makaha and Waianae Kai	Manage for stability	12	0
Pahole	Manage for stability	83	0
	Total for Taxon:	**124**	**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

Slugs likely threaten all members of this genus. Federal Biologists consider slugs to be an "immediate and significant threat" to *C. longiflora* (U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices) though their conclusions are based on anecdotal observations. Formal investigation involving a related species, *Cyanea superba*, suggests slugs are decreasing *C. longiflora* survival as well (see Research Issues *C. superba* subsp. *superba*). We have recently hired an Invertebrate Research Specialist to investigate slug control options for this species.

Surveys

No surveys were conducted for this species in the last year. NRS will continue to search around existing populations for additional plants. No other surveys are planned but NRS will need the cooperation of the State to help with plant locations.

Burned *Cyanea longiflora*

Taxon Threats

Fire, weeds, pigs, and slugs are all threats to this taxon. While few of the populations are located in areas with a high risk of fire, at least one plant burned in the 2003 fire in Wai‘anae Kai. Pigs drastically alter the species' habitat, and may affect delicate seedlings and juveniles. Weeds such as *Psidium cattleianum* and *Coffea arabica* are major habitat modifiers. Slugs may prey on seedlings. NRS have not observed rat predation on this species, but will monitor for it because other taxa in this family have been impacted by rats.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyanea longiflora

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha and Waianae Kai	Manage for stability	No	No	No

Manage for Stability PUs:

Pahole: This PU includes all of Pahole NAR. This year NRS monitored and counted 22 mature plants, 41 immature plants and 19 seedlings. Based on NRS monitoring observations and conversations with the NARS Specialist, it is estimated there are approximately 50 mature plants in Pahole. This population appears healthy, with plants of all size classes present. However, the

NARS Specialist reports that there has been a dramatic decrease in the number of individuals in this area in the last six years. The population is fenced, so ungulates are not causing the decline. NRS will work with the NARS Specialist to try to determine the cause of the decline. The habitat is dominated by native species, and requires minimal weed control. Weed control at this site is ongoing, and NRS will continue to visit the area biannually. NRS plan to work with the NARS Specialist to collect fruit from all of the remaining plants next year. So far, over 50,000 seeds were collected from 14 individuals in Pahole.

Kapuna to West Makaleha: This PU encompasses three gulches: Kapuna, Keawapilau and West Makaleha, and includes 23 mature and 27 immature plants. In the last year NRS have monitored only a portion of this PU, and also asked the NARS Specialist for his latest population estimates of other areas. None of the wild plants in this PU are currently fenced, but the reintroduced plants in West Makaleha are within an exclosure. The State is planning to build a small fence in Kapuna and Keawapilau. This area is threatened by pigs. Construction has begun on subunit 1 of this fence, however, this subunit will not include any *C. longiflora*. The West Makaleha plants are growing on a cliff and not at risk from pigs, but the habitat around these plants is scheduled to be fenced in Year 2 of the MIP.

NRS have not monitored any of the plants in Kapuna Gulch since 1999. In the next year, NRS hope to get the locations and status of the remaining plants from NARS staff. No collections have been made from these plants and the threats have not been assessed by NRS. The State fence which is being built this year will not protect either of the known sites.

There are at least two known sites in Keawapilau Gulch, spread out over several small gulches. NRS monitored these plants while conducting weed control in the area and will continue this in the coming year. There are plants of all size classes in these sites. Collections were made from a few of the plants this past year. In the coming year, NRS will seek to get collections of mature seed from all individuals into storage. NRS hope to receive additional population locations and data from NARS staff in the coming year. NRS began a program of regular weeding this year, visiting the area twice a quarter. The primary weed threats include *Clidemia hirta*, *P. cattleianum*, and *Rubus argutus*. Fire is not a threat at this site.

There are three mature wild plants located in West Makaleha but the plants are difficult to monitor. The area surrounding the cliff has nice native forest with Uluhe lau nui (*Diploterygium pinntatum*) understory. Trampling through this type of vegetation to rappel to the plants disturbs the forest and invites weeds as well as ungulates into the area. In the coming years, NRS will alternate rappelling to the plants with binocular monitoring from a nearby ledge. This past year, NRS didn't collect any fruit, since the Seed Conservation Lab has over 2,000 seeds in stock from two of the plants. NRS are hopeful that by not collecting and allowing seeds to be dispersed naturally, they will germinate on their own. In the coming year, NRS will monitor this site and look for seedlings. No seedlings have been observed thus far, but they may be difficult to detect due to the thick understory. The third plant has never flowered while NRS have surveyed. If the third plant does flower in the future, genetic stock from the unrepresented individual will be collected. The plants are not within a fence, but are protected from pigs by the vertical cliff where they are growing. No weed control has taken place directly around the wild plants.

However, weed control has taken place around the reintroduction in West Makaleha. Much of the focus in the reintroduction site has been on *R. argutus* and *P. cattleianu.*

Mākaha and Wai‘anae Kai: This population is centered around the Kumaipo Ridge, which separates Mākaha and Wai‘anae Kai valleys. Some of the plants are on State land in Waianae Kai, and some are on BWS land in Mākaha. NRS, together with the BWS Watershed Planner, regularly monitor the site. There are three mature, eight immature, and two seedlings. NRS monitored the plants this past year and collected from the reproductive individuals. Many seed collections have been made from this site the last several years. NRS will work with the NARS Specialist to conduct more surveys along the Wai‘anae Kai side of this PU, as this area is under-surveyed. The one mature Wai‘anae Kai plant fruits more prolifically than any of the other plants of this species observed by NRS. NRS will coordinate with the NARS Specialist to collect seeds from this plant for storage testing.

NRS are currently finishing a permit application to build a small fence around the Mākaha portion of this population. This site will be augmented with stored stock taken from the Wai‘anae Kai portion of the PU. NRS will not conduct ungulate control around the Wai‘anae Kai plants. In September 2003 a fire burned one of the mature plants in Mākaha. While this area continues to see high use from hikers and hunters, University of Hawai‘i researchers are monitoring the area regularly to study fire recovery. NRS hope that increased official presence will help reduce the chance of further fires. As part of their study, the UH researchers have performed some weed control in the burned area. In addition, NRS recently received permission to perform weed control in Mākaha, and have are begun control of *C. arabica* and *P. cattleianum*, the major weed threats at this site.

3.7 *Cyanea superba* subsp. *superba*

Requirements for Stability:

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

Taxon Level Discussion

The last wild *Cyanea superba* died in 2002. There are four augmentation sites within the Kahanahāiki PU and three reintroduction sites within the Pahole to Kapuna PU. All of these augmentation/reintroduction sites are in the Action Area (AA). The MIP Addendum stabilization summary for this taxon proposes two off-site reintroductions. This deviation from a total of three managed PUs is justified by *C. superba*'s recent extinction at wild sites and the critical nature of management. They will be in the Mākaha and the Central and East Makaleha PUs. These off-site reintroductions will be initiated once Management Unit (MU) level threat control is in place. Based on genetic studies done at the University of Hawai'i, the genetic diversity of this taxon is extremely low. Despite this limited genetic variability, the taxon does not show signs of inbreeding depression as plants grow vigorously and produce viable seed. Plants flower and produce seed, but there has been no evidence of recruitment in the wild. This is largely attributed to very high slug predation levels on the small size classes of *C. superba*. Other threats include ungulates, rats and weeds. The prognosis for reaching stability for *C. superba* depends on addressing threats to the seedling stage.

Taxon Status

Action Area: In

TaxonName: Cyanea superba subsp. superba **TaxonCode: Cyasupsup**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki	Manage for stability	0	0	0	0	0	78	62	0	**78**	**62**	**0**
	Total for Taxon:	0	0	0	0	0	78	62	0	78	62	0

Action Area: Out

TaxonName: Cyanea superba subsp. superba **TaxonCode: Cyasupsup**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Central and East Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Pahole to Kapuna	Manage reintroduction for stability	0	0	0	0	0	29	148	0	**29**	**148**	**0**
	Total for Taxon:	0	0	0	0	0	29	148	0	29	148	0

Genetic Storage

NRS attempted to propagate this species via cuttings in the Army Nursery as well as at the Micropropagation Lab but without success. Therefore, seed storage is the preferred genetic storage method. There are over 50,000 seeds in storage that have been collected from outplanted plants. Three different temperatures at two moisture levels each have been tested. Seed viability appears to drastically drop after one year of storage and seeds do not tolerate freezing. Storage potential appears to be very low, but more storage treatments can be tested before long-term seed storage is ruled out. Until better storage conditions are determined, seeds from outplanted individuals should be collected every other year in order to keep viable seed in the seedbank.

Thousands of *C. superba* fruit are available from reintroduction sites each year, but a limited number of founders and the lack of lineage data complicate collections. Since 1995, seed was collected from 3 wild plants in Mākua (MMR-A-2, MMR-A-3 and MMR-A-4). Of the 375 plants able to be grown from these wild collections, only one plant was grown from MMR-A-2, 44 were grown from MMR-A-3 and the rest from MMR-A-4. Lineage data is not available for stock NARS staff used to establish two Kapuna reintroductions. Since genetic results indicate that stock collected from the Kahanahāiki PU is practically identical to stock from the Kapuna reintroductions, NRS will include the Kapuna reintroduced stock into the Kahanahāiki PU founders and count them all as one additional founder for a total of four founders.

Plants not needed for reintroductions where planted at Lyon Arboretum, Waimea Botanical Garden and the National Tropical Botanical Garden, see image below. Five plants were planted in February of 2003 in the Hawaiian section at Lyon Arboretum. However, the plants were not thriving, and NRS believe they have since died. Since 2004, the Waimea botanical Garden received eleven plants. Six are doing well, two are fair and three died. These plants were from seed from the Kapuna reintroductions. In addition, plants were sent to the National Tropical Botanical Gardens in April 2003.

C. superba **living collection at Waimea Botanical Garden**

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Cyanea superba subsp. superba							
Kahanahaiki	0	0	6	1	2	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**
				1	2	2	1

Propagation/Germination Techniques

Fresh germination is highly variable between plants, ranging from 0% - 95% on agar. Due to lack of lineage data and uncertainty of seed maturity at time of collection, it is unknown as to why there is such variation in initial viability. It is also possible to germinate seeds in vermiculite and perlite. NRS have attempted vegetative propagation, but cuttings in the greenhouse or in micropropagation do not grow.

Unique Species Observations

Mark Gardener, a University of Hawaiʻi at Mānoa post-doctoral associate, did a study on the pollinators of *C. superba* subsp. *superba.* Native bees, tentatively identified as *Hylaeus connectans*, visited the flowers and appeared to pollinate them. The introduced Japanese White-eye (*Zosterops japonicus*), was observed nectar-robbing, but also occasionally contacting the stigma and carrying pollen between flowers. Rats were also observed on plants but were not seeing causing any damage.

Outplanting Issues

NRS has outplanted significant numbers of *C. superba* since 1999. Plants establish themselves faster and survivorship is higher if the plants are about two years old and close to one meter tall or taller when outplanted. The survivorship of this taxon is also tied closely to micro-site characteristics. Outplantings conducted in main gulch bottoms are most vigorous and have the highest survivorship. As stated above, stock from three wild plants was acquired and progeny have been reintroduced. In addition, most reintroductions were done with progeny from a single founder plant. All reintroductions are not balanced with stock from the other founders, which are now dead. Last winter NRS planted the only A-2 plant into the reintroduction site which had the best survivorship and vigor. The decision was made to reintroduce this valuable stock as the plant was performing poorly in the Army Nursery and it was not possible to take a vegetative clone of the individual. In addition, NRS has never seen this species flower in the Army Nursery and believe that outplanting is imperative for fruit production. These plants were all healthy as of August 2005. NRS will continue to supplement these plantings to balance the founders when seed is available from the progeny of the missing founders. Also NRS will balance reintroductions with progeny from the Kapuna reintroductions as this stock will now be treated as one additional founder. In addition to the Army's efforts with this taxon, the State of Hawaiʻi has reintroduced this taxon with success into the Pahole NAR over the last ten years and The

Nature Conservancy (TNC) has also conducted reintroductions. These are discussed in the PU sections below.

Founders Represented in Outplantings

TaxonName: Cyanea superba subsp. superba **TaxonCode: Cyasupsup**

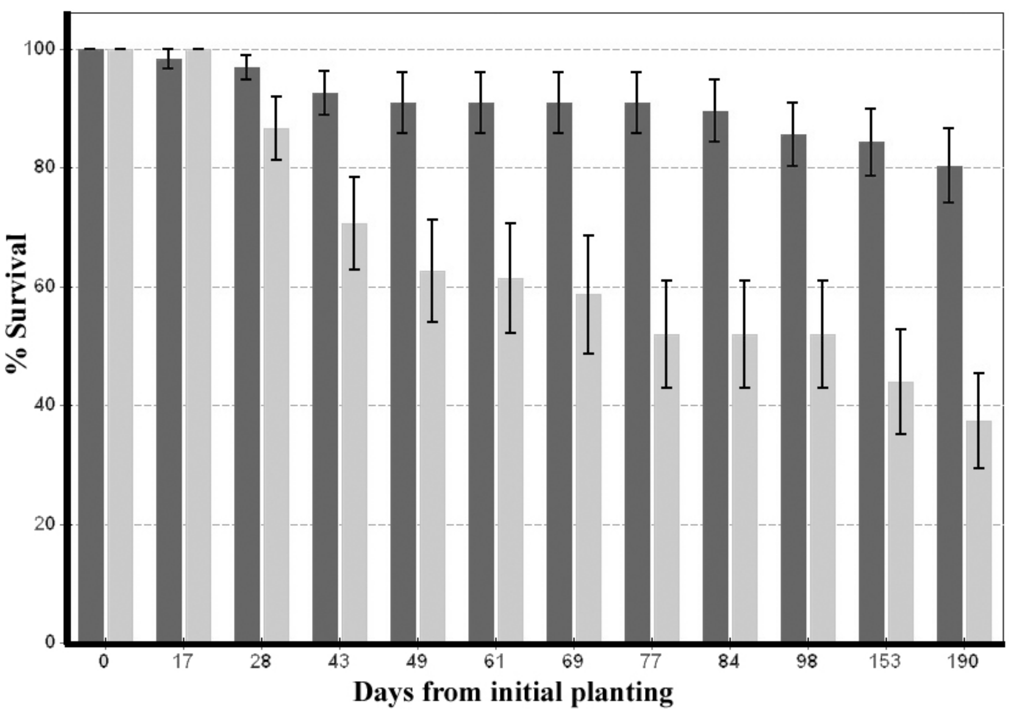
Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Central and East Makaleha	Manage reintroduction for stability	0	0
Kahanahaiki	Manage for stability	6	4
Makaha	Manage reintroduction for stability	0	0
Pahole to Kapuna	Manage reintroduction for stability	0	0
	Total for Taxon:	6	4

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

Research Issues

Slugs are believed to threaten almost all members of this genus. Two field trials at Lyon Arboretum by A. Yoshinaga and C. Daehler demonstrated slugs could reduce the survival of *Cyanea angustifolia* seedlings by as much as 80%. With NRS support, a UH graduate student, Stephanie Joe, researched slug impacts on *C. superba* and found similar levels of mortality (approximately 70%), see figure, below.



This figure illustrates the fate of 150 C. superba seedlings over 190 days.

Seedlings were either exposed to slug herbivory (dark grey bars) or protected from slugs (light grey bars). Slugs were prevented from attacking seedlings in the latter group using a combination of molluscacide and copper mesh. Intervals shown in black are one standard error from the mean.

Seedlings were reared in the Army Nursery and transplanted into Kahanahāiki MU after attaining a height of 3 cm, at which time most individuals had 4 leaves. Seedling survival more than doubled when slugs were prevented from grazing plants. After 190 days, plant survival between treatments (slug-exposed vs. slug-protected) was compared using nonparametric statistical procedures and found to differ significantly (P>0.05).

These results illustrate the need to control slugs in areas surrounding extant *C. superba* populations, see photo below. The UH graduate student has recently joined the NRS team as a Natural Resources Research Specialist and is currently investigating ways to protect *C. superba* from slug herbivory.

Slugs (Deroceras sp.) with remains of *C. superba* seedling (photo by S. Joe).

Surveys

No surveys were conducted in the last year and no new plants were found.

Taxon Threats

All reintroductions are within ungulate exclosures. Seedlings and young plants of this species are susceptible to slug predation (see Research Issues). Fruits are subject to rat predation, so it is necessary to bait for rats during the fruiting season in order to collect seeds. Weeds are a threat to habitat, especially *Rubus rosifolius*, *Clidemia hirta* and *Psidium. cattleianum*.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyanea superba subsp. superba

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Manage for stability	Yes	Yes	Partial

Action Area: Out

TaxonName: Cyanea superba subsp. superba

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central and East Makaleha	Manage reintroduction for stability	No	No	No
Makaha	Manage reintroduction for stability	No	No	No
Pahole to Kapuna	Manage reintroduction for stability	Yes	Partial	No

Manage for Stability PUs:

Kahanahāiki: The last wild Kahanahāiki plant died in 2002. Beginning in 1999, NRS augmented the PU with 251 plants grown from the wild founders. Survivorship has varied at the different sites, from 35% at the marginal sites, to 80% at the best. When monitored in August 2005, 78 plants were mature and beginning to flower. The prime sites for planting have been determined and future reintroductions will be planned for areas matching the characteristics of the successful sites. Additionally, NRS will continue to monitor reintroduced A-2 and A-3 lineage plants for fruit availability in order to secure this stock in genetic storage. The rat control that is conducted for ‘Elepaio in Kahanhāiki benefit the reintroduction in this area. Baits are maintained from January to June. See chapter 5 for details on the bait grid. The reintroduction areas are weeded multiple time a year to maintain habitat quality.

Pahole to Kapuna: Since 2001, 120 plants grown from Kahanahāiki stock were planted at one site in Pahole gulch. Survivorship is just over 60% and there are now at least 12 mature plants. There are likely more mature plants at this site but NRS has not been able to visit due to access restrictions.

There are two sites with a total of 45 reintroduced *Cyanea superba* ssp. *superba* in Kapuna Gulch. At least 19 of these plants were mature last year and even more may be this year. NARS staff originally outplanted into these sites in 1997 and 1998. NRS supplemented the sites in 2001 with stock from more recent Kahanahāiki collections. NRS monitors these sites periodically when conducting other management. In the past, NRS assisted the NARS Staff in controlling rats around these plants and collecting fruits for seed storage at the Seed Conservation Lab. In the next year, NRS will reconsider these two reintroductions sites for active management as part of the Pahole to Kapuna PU. The first Upper Kapuna subunit fence will be constructed in the next year enclosing the ‘one acre’ reintroduction site and surrounding habitat. This will open up more habitat management possibilities in the area. As stated in the collections section above, the NARS staff planted *C. superba* at these reintroduction sites. This site will now be considered a unique founder from the Kahahāiki PU and collections will be made according to this new treatment. NRS has conducted some weed control around the two Kapuna reintroductions and regularly weed around the Pahole site.

Other PUs:

Honouliuli: Thirty-nine individuals of mixed stock were planted into the Palikea fence in North Pālāwai in spring 2004 by TNC. Another 97 individuals of mixed stock were planted within the Kalua‘ā fence in spring 2004. TNC with some assistance from NRS, continue to monitor their growth and manage the rat populations with bait stations.

Mākaha: No reintroductions will begin until the management unit fence is built.

Central and East Makaleha: No reintroductions will begin until the management unit fence is built.

3.8 *Cyrtandra dentata*

<u>Requirements for Stability:</u>

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

Taxon Level Discussion

The Kahanahāiki and Pahole to West Makaleha PUs are found growing in several gulches over this widespread area and have stable numbers of individuals. These PUs are also the center of abundance for this species, so even though they are both found in the action area (AA), they are both designated 'Manage for Stability'. The plants in these two PUs are spread over a large area, and it is unlikely that one catastrophic event could wipe out all of the plants. The two PUs found outside of the AA are both in the Koʻolau Mountains and overlap with the Oahu AA. The ʻŌpaeʻula PU will be managed rather than Kawaiʻiki because ʻŌpaeʻula has more manageable terrain, and there are many other rare species in the ʻŌpaeʻula proposed MU. ʻŌpaeʻula is undersurveyed, and it is likely there are more individuals in this PU. Despite the fact that pigs significantly impact the habitat of *C. dentata,* all of the populations have good recruitment. When ungulates are controlled, this species does well *in situ.* Weeds also impact this taxon as its gulch bottom habitat is often dominated by *Clidemia hirta*.

Taxon Status

Action Area: In

TaxonName: Cyrtandra dentata — **TaxonCode: Cyrden**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki	Manage for stability	156	6	156	57	27	0	0	0	156	57	27
Pahole to Kapuna to West Makaleha	Manage for stability	478	470	488	470	174	0	0	0	488	470	174
	Total for Taxon:	634	476	644	527	201	0	0	0	644	527	201

Action Area: Out

TaxonName: Cyrtandra dentata — **TaxonCode: Cyrden**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kawaiiki (Koolaus)	Genetic Storage	21	33	19	35	43	0	0	0	19	35	43
Opaeula (Koolaus)	Manage for stability	22	12	16	12	0	0	0	0	16	12	0
	Total for Taxon:	43	45	35	47	43	0	0	0	35	47	43

Genetic Storage

Seeds were collected and taken to the Seed Conservation Lab for seed storage testing this year. After one year of storage, refrigerated and frozen seeds showed no decrease in viability, with germination at 90-100%. Enough large collections have been made for sufficient testing so that future results will determine appropriate storage methods. Additional collections have been made, and seeds from three plants from the Kahanahāiki PU and one plant from the Pahole to Kapuna to West Makaleha PU are in storage. No collection schedule has been determined, but collections will probably last for at least five years or more. Due to the magnitude of collections required to meet storage goals for this taxon, NRS waited to see some positive preliminary seed storage results before attempting full collections. Now that it seems promising that this taxon will store well, NRS will more actively pursue seed collection. Since this taxon overall is fairly stable and full funding has not been achieved for the MIP, collections will start slowly as resources become available.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cyrtandra dentata							
Kahanahaiki	156	57	0	3	0	0	3
Kawaiiki (Koolaus)	19	35	0	0	0	0	0
Opaeula (Koolaus)	16	12	0	0	0	0	0
Pahole to Kapuna to West Makaleha	488	470	0	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**
				4	0	0	4

Propagation/Germination Techniques

Seeds germinate best when the fruit is browning and cracked open. This allows the seeds to absorb the sugars from the fruit, which increases germination (Dr. Jim Smith, Boise State University, pers. comm. 2004). Fresh germination on agar was 100%. Seedlings are easily transferred from agar to grated moss or germinated on grated moss. Seedlings have not been successfully transferred from agar to sand, vermiculite, or a mix of perlite and vermiculite. Due to the probable success in seed storage, no attempts have yet been made to grow plants from cuttings.

Unique Species Observations

The leaf shape and sepal width varies between populations.

Outplanting Issues

NRS have not outplanted this species.

Research Issues

Federal biologists consider slugs to be an "immediate and significant threat" to *C. dentata* survival (U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.), though these conclusions are based on anecdotal observations. Research is needed on the effect of slug predation on this species. Since numbers are relatively high and recruitment is very high at wild sites of *C. dentata*, quantifying the effect of slugs is not a high priority research project as compared to others. This research question will be prioritized alongside other projects and may increase in priority as others are completed.

Surveys

No surveys have been conducted specifically for this taxon. The Koʻolau populations were discovered while surveying for *Stenogyne kaalae* var. *sherfii*.

Taxon Threats

Slugs impact this species but research is needed to determine the extent of their impact. This species grows in wet gulches, which are heavily impacted by feral pigs. The major weed threats to this species include *Ageratina adenophora, Buddleia asiatica, Rubus rosifolius, C. hirta, Aleurites moluccana, Psidium Cattleianum,* and *Christella parasitica.* Rat damage has not been observed, but NRS will continue monitoring for leaf or stem chewing or seed predation.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Cyrtandra dentata

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kawaiiki (Koolaus)	Genetic Storage	No	No	No
Opaeula (Koolaus)	Manage for stability	No	No	No

Manage for Stability PUs:

Kahanahāiki: All of the plants in this PU are fenced. NRS have not thoroughly monitored this PU in the last year because of the increasing effort involved in counting hundreds of plants. NRS will work with the NRS Monitoring Program Manager to determine the best monitoring approach for this taxon. The number shown in the table is from last years count. NRS have observed an increase in population numbers in Kahanahāiki since the fence was constructed in

1996. Seeds were collected in the last year from this PU for storage testing. The rat control that is conducted for a nesting ‘Elepaio pair may benefit this PU. Baits are maintained from January to June (see the ‘Elepaio section for details on the bait grid). Weed control is conducted in the gulch once a quarter.

Pahole to Kapuna to West Makaleha: The Pahole portion of this PU is fenced. The Kapuna portion of this PU is scheduled to be fenced in year 1 of the MIP but due to certain restrictions such as funding and contracting problems, it is unclear when the fence will be completed. This area was partially monitored this year and large numbers of individuals of all size classes were counted. Future surveys would likely reveal even more plants. Plants in this PU appeared healthy and were recruiting well. In July 2004, seeds were collected from this PU for storage testing. Some weed control occurred around plants in the gulch bottom and the removal of *Montenoa hibiscifolia* from Pahole helps this species.

‘Ōpaeula: NRS surveyed this area with the HINHP Botanist in 1999. These sites have not been monitored since that time. A new site with one mature and seven immature plants was found by NRS in 2003 and it’s likely that more will be found. In the next year NRS will collect a voucher from the Ko‘olau populations to compare with the Wai‘anae specimens. A fence was scoped in this area and will benefit this taxon. NRS and the Ko‘olau Mountain Watershed Partnership is working together on the construction of this fence.

Other PUs:

Kawai‘iki: In January 2005, NRS accurately monitored this PU. Although the area surrounding the plants is thick with alien dominated vegetation, such as *C. hirta,* recruitment is good and all size classes are present.

3.9 *Delissea subcordata*

Requirements for Stability:

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

Taxon Level Discussion

Two of the 'Manage for Stability' PUs are out of the action area (AA) and one is in the AA. This species is very rare and continues to decline in numbers. NRS have been successful in capturing most PUs with extant founders in genetic storage. Plants can be propagated easily from seeds. This taxon does show recruitment at wild sites and occasionally new plants are found in sites away from known populations, suggesting they may be dispersed by birds. It is also possible this species has a persistent seedbank. All three 'Manage for Stability' PUs have been augmented and outplanting has been successful. The largest threats to *Delissea subcordata* are pigs and goats. In addition, slugs are a threat to this taxon. Although declining, this taxon seems to survive in fairly weedy forest dominated by *Schinus terebinthifolius* and *Psidium cattleianum*. Because NRS has been successful in propagation and reintroduction and has seen regeneration in the wild, *D. subcordata* has a positive prognosis for stability.

Taxon Status

Action Area: In

TaxonName: Delissea subcordata **TaxonCode: Delsub**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to Keawapilau	Manage for stability	5	0	4	0	0	21	1	0	**25**	**1**	**0**
South Mohiakea	Genetic Storage	1	1	1	0	0	0	0	0	**1**	**0**	**0**
	Total for Taxon:	6	1	5	0	0	21	1	0	**26**	**1**	**0**

Action Area: Out

TaxonName: Delissea subcordata **TaxonCode: Delsub**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Ekahanui	Manage for stability	3	1	4	0	0	81	0	0	**85**	**0**	**0**
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Kaawa	Genetic Storage	0	0	0	0	0	0	0	0	**0**	**0**	**0**
Kaluaa	Manage for stability	1	1	1	1	0	34	0	0	**35**	**1**	**0**
Kealia	Genetic Storage	7	0	2	0	0	0	0	0	**2**	**0**	**0**
Palawai	Genetic Storage	2	3	2	3	0	0	0	0	**2**	**3**	**0**
Palikea Gulch	Genetic Storage	2	0	1	0	0	0	0	0	**1**	**0**	**0**
	Total for Taxon:	15	5	10	4	0	115	0	0	**125**	**4**	**0**

Genetic storage

Due to the efficiency and success of collections and storage, seed storage is the preferred method of genetic storage. Three different temperatures at two different relative humidity (RH) levels each have been tested for five years. Results indicate 4°C (refrigeration) at around 20% RH yields the highest percent germination, while seeds that were frozen drastically lose viability after one year. Seeds can be stored for at least five years in refrigeration with little to no decrease in viability. Some of the older collections do not have high germination. All of these had been stored for some extended period of time (> one year) at -18°C. There are currently 26,972 seeds in storage from the Kahanahāiki to Keawapilau PU, 11,167 seeds from Haili PU, 5,017 seeds from the Pālāwai PU, 32,090 seeds from ʻĒkahanui PU, 19,654 seeds from Palikea Gulch PU, and 1,022 seeds from the South Mohiākea PU. According to test results collections for this taxon can be made every eight years. There are also over 10,000 seeds being stored from reintroduced plants. Immature fruit have been brought to the Micropropagation Lab and successfully established in culture.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Delissea subcordata							
Ekahanui	4	0	2	5	2	2	6
Huliwai	0	0	0	0	0	0	0
Kaawa	0	0	0	0	0	0	0
Kahanahaiki to Keawapilau	4	0	5	9	1	2	9
Kaluaa	2	0	0	0	0	0	0
Kealia	2	0	0	2	0	1	2
Palawai	2	3	1	3	1	0	3
Palikea Gulch	1	0	4	5	0	4	5
South Mohiakea	1	0	3	2	0	1	2
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				26	4	10	27

Propagation/Germination Techniques

Fruit should be collected when none of the outside flesh is green. Coloring of outside flesh of mature fruit varies among populations from tan with pink/purple lines or patches to entirely dark purple. The number of seeds per fruit also drastically varies, from zero to over 250 seeds. Seeds germinate well in flats on vermiculite and perlite. Initial germination rates on agar during the seed storage trials at the Seed Conservation Lab were around 90%. It is also possible to grow plants from cuttings; however, plants usually have only one growing point, so cuttings are not the preferred method of propagation unless the parent plant is multi-branched or needs to be salvaged.

Unique Species Observations

The HINHP botanist has observed germination of same-aged plants in the field in areas where there is no obvious parent plant, suggesting there may be a persistent seed bank. Seed storage testing has shown that seeds stored imbibed in the dark germinate well when exposed to light, also suggesting there is a good potential this species forms soil seed banks. Bird predation on fruit has been observed, and at two separate sites juvenile plants were found growing right next to fences, which make good perches. This could be because of bird dispersal, or possibly the result of soil disturbance through foot traffic enhancing seed germination.

Outplanting Issues

Currently, about 160 plants from four PUs have been reintroduced. Kapuna stock has been reintroduced into Kahanahāiki, South Mohiakea and ‘Ēkahanui stock has been reintroduced into Kalua‘ā by The Nature Conservancy (TNC), and Palikea Gulch stock has been reintroduced into West Makaleha. Details on the individual outplantings are discussed below in the ‘Population Unit Level Discussions’. All sites have been monitored by NRS and mature seed has been collected from many sites for storage and propagation. This taxon is tolerant of weedy areas, so it is not difficult to find sites for outplanting. All reintroductions have had at least 80% survival and at one site in Kahanahāiki, seedlings have been observed. Last winter, NRS planted 40 plants of ‘Ēkahanui stock into ‘Ēkahanui as an augmentation. In the coming year, NRS will use stock from two new PUs (Pahole and Ke‘ālia) to establish reintroductions and will augment others to balance the founders. Plants at the Kalua‘ā PU have not yet produced seed in the two seasons that NRS has been monitoring them. Once seed is collected it will be propagated for reintroduction.

Founders Represented in Outplanting

TaxonName: Delissea subcordata **TaxonCode: Delsub**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Ekahanui	Manage for stability	6	3
Huliwai	Genetic Storage	0	0
Kaawa	Genetic Storage	0	0
Kahanahaiki to Keawapilau	Manage for stability	10	3
Kaluaa	Manage for stability	2	0
Kealia	Genetic Storage	2	0
Palawai	Genetic Storage	6	0
Palikea Gulch	Genetic Storage	5	1
South Mohiakea	Genetic Storage	4	2
	Total for Taxon:	35	9

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

Research Issues

Slugs are a threat to seedlings of this species, and slug damage has been observed on plants of all size classes. Federal biologists consider slugs to be an “immediate and significant threat” to *D. subcordata* survival (U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.), though these conclusions are based on anecdotal observations. We have recently hired a Natural Resources Research Specialist to investigate slug control options for this species.

Surveys

No surveys were conducted for this taxon in the past year, however, new plants were discovered in both the Kahanahāiki to Keawapilau (Kapuna gulch) and the Palikea gulch MUs this year. An additional plant was found by the NARS Specialist at the Kapuna PU. NRS will continue to look for new plants in the course of ongoing management.

Taxon Threats

Slugs eat seedlings and fruit of this species, and slugs appear to have eaten into the stem of immature and mature plants in the West Makaleha reintroduction. Birds and rats are known to prey upon the fruit of this species, but it is not known if the seeds survive. A grid of rat bait stations and snap traps has been set up around the West Makaleha reintroduction, the only place where damage was observed. Access to the West Makaleha reintroduction site was restricted by the State. Due to this suspension, restocking of bait stations and snap traps has not occurred since 07 July 2005. This site is usually visited on a monthly basis to insure adequate protection of these plants. NRS feel this site is of great importance for these plants and is in the process of obtaining a special use permit from the State. If rat damage is observed in any other PU, stations and traps will be deployed. This species tends to be found in weedy habitat in mesic forests, and weeds such as *S. terebinthifolius* and *Passiflora suberosa* are major threats.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Delissea subcordata

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ekahanui	Manage for stability	Yes	Yes	No
Huliwai	Genetic Storage	No	No	No
Kaawa	Genetic Storage	No	No	No
Kaluaa	Manage for stability	Yes	Yes	No
Kealia	Genetic Storage	No	No	No
Palawai	Genetic Storage	Yes	Partial	Partial
Palikea Gulch	Genetic Storage	No	No	No

Manage for Stability PUs:

Kahanahāiki to Keawapilau: This PU covers four gulches on Army and State NAR lands. The sites are discussed separately below.

There is a single mature plant within the Kahanahāiki exclosure which is monitored regularly and has been collected from for seed storage. The origin of this single plant is still unclear. It may be an F1 plant from the nearby reintroduction, transported to the site by a bird or it may be a wild plant from a historic population. NRS collected leaf material from the plant for genetic analysis by Dr. Cliff Morden at the University of Hawaiʻi. Until the results are in, NRS will treat this individual plant as unique and significant. Collections have been made from this plant and the seeds are in storage at the Seed Conservation Lab. There are two reintroduction sites in Kahanahāiki Gulch, both established with plants from Kapuna Gulch. At the MMR-A site, the larger of the two, 20 of the 31 plants are alive and healthy and one immature F1 plant was observed in the past year. Mature seed has been collected from this site for storage as the parental stock has been extirpated from Kapuna stock. At MMR-B, six plants were planted but only one remains and is in healthy condition.

NARS staff reports that there are currently one mature plant alive in Pahole. Collections have been made and are in storage at Lyon and are also being germinated from these collections for reintroduction into Pahole this winter. A reintroduction site will be determined by NRS and NARS staff.

One plant is currently known from the historic site in Kapuna.   A new site with one mature plant was found near the historic location in 2004 and this year an additional plant was found nearby. In the last year, NRS and the NARS Specialist collected many mature fruits from all three of these plants for storage. The seeds will be used to grow plants for future reintroductions.

‘Ēkahanui: There are still four plants at two of the three historical sites. NRS and TNC staff built fences around these sites in 2004. Seed collections were made from all plants again this year. The sites are degraded and only minimal management is done to allow the plants to mature and produce seed for reintroduction into managed habitat. TNC has reintroduced over 85 plants into the ‘Ēkahanui exclosure and this site will be augmented in the coming year to balance the founders. Seeds have also been collected from the reintroductions for storage. NRS will continue to monitor the wild and reintroduced plants at these sites and collect seeds for storage and reintroduction.

Kalua‘ā: Two plants were discovered in 2003. NRS have attempted to collect fruit from these plants for the past two years but the buds aborted before flowering. NRS will continue to monitor and try to collect. There may be two *D. subcordata* seedlings on site but they have not yet been confirmed. When Kalua‘ā stock is collected it will be germinated with South Mohiākea stock and reintroduced together into the Kalua‘ā reintroduction sites. Weed control continues to be conducted at the reintroduction site in Kalua‘ā.

Other PUs:

South Mohiākea: Last year, one mature and one immature plant was documented at this PU. In January 2005, three seedlings appeared at the site. NRS monitored the PU again in August and none of the seedlings appear to have survived. The one immature plant was also dead. There is high mortality at this population but also relatively high recruitment levels. NRS conduct weed control within the small exclosure protecting this PU.

Huliwai: The HINHP Botanist monitored this site in 2004, and the plants were gone. The habitat has been severely degraded by weeds and ungulates. No stock from this PU remains.

Ka‘awa: NRS and the HINHP Botanist surveyed the historic location for this species in 2004 and no live plants were found. No stock from this PU remains. This site may be monitored in the future for new plants when conducting other management in the area, but will not be a target for management. The habitat at this site has been heavily impacted by feral ungulates.

Pālāwai: Fences are being maintained at two sites in Pālāwai. Collections have been secured from all mature plants. Weed control is being conducted at one site with remaining native components. The other site is dominated by *S. terebinthifolius* and is not worth weeding. TNC will be conducting reintroductions with this stock in the coming year.

Palikea Gulch: There is now only one remaining plant in this PU. There were two general locations known in this gulch and both were monitored in the last year. The NARS Specialist reported that the plants have been extirpated from one site, and NRS found only one plant at the other. Neither site was protected by a fence and pigs were a noted threat at both. Mature seed was collected for storage and germination by NARS and NRS from both sites in the past, and again this year. Stock from this location is also represented at the reintroduction in the West Makaleha exclosure.

Ke'ālia: The NARS Specialist found a new population of seven mature individuals on State land in 2004. NRS have not been to this site. NRS requested permission from the State to fence the site but were told to wait until the land changes from unencumbered land to Forest Reserve in the near future. NRS are concerned that this will not happen quickly enough to provide adequate protection for this population. The NARS Specialist has been monitoring this site and collecting mature seed for storage. Seed from this stock has been germinated for a reintroduction planned for Kaluakauila in winter 2005-2006.

West Makaleha*:* Twenty plants from Palikea gulch stock were planted inside the small West Makaleha exclosure in January 2003. Rat and slug predation has been a problem at this reintroduction site. Rat control was initiated in May 2003 (see table below). Palikea founders represented in this reintroduction are now extirpated so the seed from reintroduced plants is valuable for storage. Collections were made in the summer of 2005 and is scheduled again for next summer. This site will not be supplemented because the site is not in preferred *D. subcordata* habitat.

West Makaleha *Delissea subcordata* Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of rats trapped	# of snap traps
2003	5	80	30	38%	0	0
2003-2004	5	640	336	53%	12	10
2004-2005	5	660	228	35%	15	10

3.10 *Dubautia herbstobatae*

Requirements for Stability:

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

Taxon Level Discussion

The two largest populations at ‘Ōhikilolo will be managed because they represent the center of abundance for this taxon. Both of these PUs have stable numbers of individuals, and both of these PUs are in the Action Area (AA). However, because of their widespread distribution on ‘Ōhikilolo, it is very unlikely one catastrophic event could wipe out both PUs. The ‘Ōhikilolo Mauka PU has been split further to show the plants that exist on the Mākaha side of ‘Ōhikilolo as a separate PU (Mākaha/‘Ōhikilolo). These plants have a different threat status because of the high numbers of goats in Mākaha and have been designated as a ‘Manage for Genetic Storage’ PU. The current numbers listed in the taxon status table below are from actual counts, rather than estimates, and do not represent a real decline in individuals since the final MIP. In the coming years, NRS will continue to search for new plants and refine the counts; though, counts may never reach original estimates as many plants are on steep inaccessible cliffs. A new population was found in Mākaha in the last year and NRS were able to collect cuttings and seeds. NRS have proposed that this be considered the third ‘Manage for Stability’ PU to replace the proposed reintroduction in Mākaha. NRS were able to collect cuttings and fruit from the remote Wai‘anae Kai PU. The other remaining PUs will be managed for genetic storage. *Dubautia herbstobatae* tend to grow on steep cliffs where feral ungulates pose a low threat. However, goats do pose a threat to the surrounding habitat. Currently weeds are not a major problem. This species can be grown from seeds or cuttings, and storage and germination trials are underway. Seed collection for genetic storage has been difficult as seed is difficult to reach and is often not viable.

Taxon Status

Action Area: In

TaxonName: Dubautia herbstobatae **TaxonCode: Dubher**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Keaau	Genetic Storage	70	0	70	0	0	0	0	0	70	0	0
Makaha/Ohikilolo	Genetic Storage			350	0	0	0	0	0	350	0	0
Ohikilolo Makai	Manage for stability	357	0	357	0	0	0	0	0	357	0	0
Ohikilolo Mauka	Manage for stability	267	20	328	20	0	0	0	0	328	20	0
	Total for Taxon:	694	20	1105	20	0	0	0	0	1105	20	0

Action Area: Out

TaxonName: Dubautia herbstobatae **TaxonCode: Dubher**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kamaileunu	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0
Makaha	Manage for stability			36	1	0	0	0	0	36	1	0
Waianae Kai	Genetic Storage	5	0	10	4	0	0	0	0	10	4	0
	Total for Taxon:	5	0	46	5	0	0	0	0	46	5	0

Genetic Storage

All methods of genetic storage are being utilized. Collections are difficult to obtain from this species because all are located on big cliffs and do not produce fruit year round. Seed of this taxon has low viability, and most collections usually contain few to no viable seed. Seed collected in 1999 from the ‘Ōhikilolo Mauka PU had high enough viability to undergo storage testing. Three temperatures have been tested and seeds stored refrigerated and frozen show a 5% decrease in viability from initial germination after five years. Some one-year storage results yielded higher germination than initial tests, but this is probably due to testing small seed counts on a collection with low viability, rather than a new finding. This year seed was collected from Army Nursery stock for testing and storage

In the past year, NRS has collected cuttings from several plants and many have rooted and are growing in the Army Nursery. NRS will continue to collect cuttings to be grown *ex situ* for seed production. In addition, cuttings were taken to the Micropropagation Lab to determine the viability of tissue culture as an alternate storage option for this species.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Dubautia herbstobatae							
Kamaileunu	0	0	1	1	0	1	1
Keaau	70	0	0	0	0	0	0
Makaha	36	1	0	10	0	3	8
Makaha/Ohikilolo	350	0	0	1	0	0	0
Ohikilolo Makai	357	0	0	0	0	0	0
Ohikilolo Mauka	328	20	0	2	0	0	2
Waianae Kai	10	4	0	3	0	1	2
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				17	0	5	13

Propagation/Germination Techniques

Entire dried flower heads can be collected for seed collection efforts. Achenes are grey and should be loosely held within the head. Initial viability of seed collected from a 1999 ʻŌhikilolo Mauka collection was 23%. NRS have been able to propagate this species from cuttings. In order to propagate enough stock for outplanting, NRS will need to experiment further with different propagation techniques and will continue to grow plants at the Pahole Mid-Elevation Nursery.

Unique Species Observations

In the last year, NRS were able to visit several populations of this species within a few weeks time. Most plants were in some stage of reproduction, but were not on the same schedule. While the plants in Mākaha had immature and mature fruit, the plants on ʻŌhikilolo and in Waiʻanae Kai were mostly flowering. The plants in the Army Nursery did flower at about the same time as wild plants.

This year, for the first time, seed was collected from Army Nursery plants established from cuttings. All of the mature plants are cuttings from the one Kamaileʻunu plant. These plants flowered and produced seed, yet all seed investigated were lacking embryos and none germinated. Though this particular species of *Dubautia* has not been tested, it is highly probable that the species is at least partially self-incompatible and may be strongly self-incompatible (Gerald Carr pers. comm. 2005). The remaining greenhouse stock is still immature, but once genetically different plants flower NRS will try outcrossing in an attempt to increase seed set and determine the level of self-incompatibility. Wild collections have higher viability, but few have been tested due to small seed lots.

Outplanting Issues

No outplantings have been attempted with this species. It may be challenging to find locations for outplanting. Plants grow on very steep cliffs, so outplantings may have to take place on rappel. Prior to the discovery of an extant population within Mākaha, NRS planned a reintroduction there with Kamaileʻunu and Waiʻanae Kai stock. However, NRS are not proposing to do any reintroductions with this species at this time.

Research Issues

Due to the large numbers of individuals, a monitoring technique to determine population trends needs to be found. NRS are hoping to investigate the use of high resolution imagery as a possible monitoring method. The US Geological Survey- Biological Resources Division staff have developed techniques in this field that appear to be promising.

Surveys

No Urgent Actions surveys were conducted for this species. A new population was found by NRS in Mākaha while searching for other taxa. Additional plants were also discovered in the Waiʻanae Kai PU. NRS plan to survey the Kawiwi area in the next year.

Taxon Threats

Feral goats are the main threat to this species and are the only ungulate that impact its habitat. Currently weeds are not a threat in most of the steep, exposed habitat this species prefers, but weeds are present in nearby areas and could become a threat. NRS will continue to monitor *Melinis minutiflora, Rubus argutus, Ageratina riparia* and *Erigeron karvinskianus* in the area, and will begin control if any of these species become a threat.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Dubautia herbstobatae

MakuaPopulationUnitName	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

MakuaPopulationUnitName	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: The populations of this species on ‘Ōhikilolo Ridge are large and robust. The current number of individuals included in this report is based on recent counts of specific sites within the PU. The whole PU has not been monitored, or even fully searched, and there are certainly more individuals than have been counted. Immature and smaller plants have been noted in populations, but are often not included in estimates since it is often difficult to identify size classes through binoculars while on rappel. Since the MIP is not yet fully funded, NRS have focused on managing ecosystem threats to this species rather than conducting a census of the population. Since 1995, approximately 1,500 goats have been removed from MMR and currently no goat sign can be found. The ‘Ōhikilolo Mauka PU was split to show the numbers of plants that are on ‘Ōhikilolo, but on the Mākaha side of the fence. These plants are not protected from goats. A monitoring method must be developed for this species to demonstrate population trends without an annual census.

Mākaha: This new PU was discovered by NRS in the last year. It is located on a cliff on the south side of the valley and was monitored by NRS on rappel. Thirty-six plants were observed and cuttings and seeds were collected from many. This site has not been completely searched and NRS believe that there are about fifty plants on site. NRS will continue to monitor, collect and assess threats to this site in the coming year. Although seed collections were made, much of the fruit was not viable (see Genetic Storage section above).

Other PUs:

Kea‘au: This population has not been visited since the HINHP botanist monitored the plants in 2000. Feral goats have degraded the habitat at this site, and the invasive tree *Schinus terebinthifolius* surrounds the cliffs where *D. herbstobatae* is growing. Seed will be collected from this PU for storage once a method is developed.

Kamaile‘unu: Steve Perlman collected the only plant seen on this section of Kamaile‘unu in 2000. The approximate site was monitored by NRS and the HINHP Botanist, no plants were found. Cuttings were salvaged from the only collection and are now being grown at the Army Nursery. These plants are flowering and will be kept as a living collection and for outcrossing testing (once other *ex situ* plants flower), propagule production for research and storage. NRS plan to survey this area again in the next few years.

Wai‘anae Kai: These plants are on a very large cliff and are difficult to access. This area is protected from ungulates by the steep terrain. However, feral goats have heavily degraded the surrounding habitat. In the last year, NRS were able to collect cuttings from one individual near the bottom of the cliff and also were able to finally get to the plants at the top of the cliff with a helicopter and lots of rope. Cuttings and seeds were collected from many plants and will be maintained as a living collection and propagule source. This site is very difficult to access and will not be visited regularly.

3.11 *Flueggea neowawraea*

Requirements for Stability:

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial, dioecious, low to no reproduction, all senescent, major pest problems)
- Threats controlled
- Complete genetic representation of all PUs in storage

Taxon Level Discussion

Flueggea neowawraea is still found in many gulches of the northern Wai‘anae Mountains. The trees are most often found alone or in small groups, and typically are widely scattered across PUs. The largest populations in the best habitat were chosen for management. Both the Kahanahāiki to Kapuna PU and portions of the Mākaha PU are within the Action Area (AA). The Central and East Makaleha PU is out of the AA. The known trees are all mature and no juveniles or seedlings have ever been observed by NRS. The trees may not reproduce due to a combination of threats and reproductive challenges. This taxon is dioecious and usually found alone, far from plants of the opposite sex. Most trees are found in degraded unprotected habitat with ungulate and weed threats. Trees are typically in poor health because of damage from the black twig borer (*Xylosandrus compactus*) and the associated fungus (*Fusarium solani*) they carry. This appears to weaken many trees so that they are unable to produce flowers and fruit. NRS has monitored almost all known trees on O‘ahu, but have only collected viable mature fruit from two trees. Currently, NRS are continuing to focus on collection from known trees. Little habitat management has been done. Changes in population numbers are due to surveys identifying new plants. NRS has started experimental outplantings of this species with mixed success. When adequate stock is established and successful threat control and planting techniques are determined, populations will be augmented with available stock, and founders from across the northern Wai‘anae Mountains will be mixed into reintroductions. Due to the overwhelming threat posed by the black twig borer stabilizing this taxon will be challenging.

Taxon Status

Action Area: In

TaxonName: Flueggea neowawraea **TaxonCode: Fluneo**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to Kapuna	Manage for stability	8	0	7	0	0	0	42	0	7	42	0
Ohikilolo	Genetic Storage	2	0	2	0	0	0	0	0	2	0	0
West Makaleha	Genetic Storage	3	0	5	0	0	0	0	0	5	0	0
	Total for Taxon:	13	0	14	0	0	0	42	0	14	42	0

Action Area: Out

TaxonName: Flueggea neowawraea **TaxonCode: Fluneo**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Central and East Makaleha	Manage for stability	6	0	6	0	0	0	0	0	6	0	0
Halona	Genetic Storage	2	0	2	0	0	0	0	0	2	0	0
Kauhiuhi	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
Makaha	Manage for stability	8	0	9	0	0	0	0	0	9	0	0
Mikilua	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
Mt. Kaala NAR	Genetic Storage	4	0	4	0	0	0	0	0	4	0	0
Nanakuli, south branch	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
Waianae Kai	Genetic Storage	1	0	0	0	0	0	0	0	0	0	0
	Total for Taxon:	24	0	24	0	0	0	0	0	24	0	0

Genetic Storage

All possible methods of genetic storage have been attempted for this taxon. Few trees have been observed in flower and fewer still produce mature viable fruit. Viable fruit has been collected from two trees. This fruit has been grown in the Army Nursery and Seed Conservation and Micropropagation Labs. A small amount of fruit brought to the Seed Conservation Lab in January 2002 was tested. Two-year storage tests indicate seeds must be stored at -18°C, with no decrease in seed viability (88%). Storage trials on the frozen seeds are ongoing. Some plants are being grown *ex situ*, in the Army greenhouse and at botanical gardens. However, greenhouse space is limited, and the black twig borer still affects trees removed from a forest setting. Also, a large, easily accessible location is necessary to account for its large size and allow for frequent monitoring and treatment to protect from the black twig borer. NRS hope to collect fruit from *inter/ex situ* plants for storage and testing in the coming years, as plants mature. Tissue storage in the Micropropagation Lab has not been very successful; it is unlikely to be a good storage option for this taxon. There are currently 14 of the 36 founders represented in the Army Nursery, most of which are from seed, but a few from cuttings and air-layers.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Flueggea neowawraea							
Central and East Makaleha	6	0	0	0	0	1	0
Halona	2	0	0	0	0	2	0
Kahanahaiki to Kapuna	7	0	0	0	0	2	0
Kauhiuhi	1	0	0	0	0	0	0
Makaha	9	0	0	0	1	3	0
Mikilua	1	0	0	0	0	0	0
Mt. Kaala NAR	4	0	0	0	1	1	2
Nanakuli, south branch	1	0	0	0	0	0	0
Ohikilolo	2	0	0	0	0	1	1
Waianae Kai	0	0	0	0	0	0	0
West Makaleha	5	0	0	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	11	4

Propagation/Germination Techniques

Fruit was collected by NRS from six individuals, however, only two of these contained viable seed. PUs with fruiting trees include: ʻŌhikilolo, Mākaha, Kahanahāiki to Kapuna, West Makaleha, and Mt. Kaʻala NAR. In 2002, 14 fruits were collected from the ground below a tree in the Mt. Kaʻala NAR PU. These were brought to the Micropropagation Lab and only two germinated. Those two remained in tissue culture until July 2005, when they were planted in perlite/vermiculite and placed in the growth chamber at the Army Natural Resource Center. The plants had no roots when they came out of tissue culture and both died within one month. In 2003, immature fruit was collected from one tree in Mākaha and brought to the Micropropagation Lab but the seed was not viable. In 2001, one of the West Makaleha trees had hundreds of fruit. Over 600 fruit were collected at three different times over two months during a single season. These seeds were either grown in the Army Nursery or sent out for germination and storage testing at the Micropropagation and Seed Conservation Labs. Initial viability of this collection at the Seed Conservation Lab was 84% on 1% water agar. Seeds require no special germination treatments. Seedlings were easily transferred to pots.

NRS have been successful in propagating *F. neowawraea* from air-layers (See photos below), however, access limitations and black twig borer damage have restricted the success of this method. Air-layers can dry out during the months between visits to the remote and sometimes restricted areas. The material being air-layered is still vulnerable to the black twig borer while on the tree. Air-layers are performed and monitored by the NRS Horticulturist and trained staff. Typically, a wound is cut in the basal suckers or branches of mature trees, Rootone® is applied to the cut section, and wet sphagnum moss is wrapped around the cut. The moss is then covered with black plastic and sealed with wire and tape. The air-layers are left for at least a month and then re-wrapped if no roots have developed. One airlayer was successfully harvested over four months after being installed, while another had enough root development to harvest after about two months.

Air-layer on *Flueggea neowawraea*

Rooted Air-layer from *Flueggea neowawraea*

Typically, only one or two trees can be visited per day and air-layers may take several trips to maintain and monitor. In contrast, many cuttings can be collected on a single trip. NRS have observed an approximate 15% success rate with cuttings. Cuttings also take a long time to produce roots, and many fail. Despite the poor success rate, cuttings are proving to be more efficient to acquire. They are treated with Dip-n-Grow® and placed in a mixture of vermiculite and perlite in small pots on the mist bench at the Army Nursery. They can take weeks to months to produce roots. Once established, the cuttings are transferred to sterile media. All successful cuttings are currently thriving. Cuttings made from plants in the Army Nursery root better than wild cuttings. This species may store well as a living plant in this manner.

Unique Species Observations

This taxon is known to flower at a relatively young age (J. Lau pers. comm. 2004), but none of the three-year-old plants from the 2001-2002 collection have flowered yet in the Army greenhouse or at Waimea Audubon Center. Cuttings taken from plants grown in the greenhouse survive better than those taken from wild trees, perhaps because greenhouse plants are healthier than wild plants. This suggests that the few cuttings that are established from wild trees could be cloned and kept in the greenhouse as a living *ex-situ* collection. One of the reintroduction sites in Kahanahāiki also has a few individuals of *Alectryon macroccoccus*. The *F. neowawraea* planted here seem to be able to respond to attacks by the black twig borer with new growth better than the *A. macroccoccus*. This resilience may allow *F. neowawraea* to persist even in the presence of the black twig borer.

Outplanting Issues

Since there is little to no recruitment, augmentation must be used as a tool to achieve stability once black twig borer controls are in place. Two augmentations have been established in the Kahanahāiki to Kapuna PU. As black twig borers pose a continual threat, NRS are conferring with the Department of Agriculture (DOA) on possible experimental control techniques. Thus far, experimental techniques have had limited success. One augmentation site was established this year. At this site, NRS planted large trees. All were in two gallon tall pots, about two meters tall, and multi-branched. These plants were planted in the bottom of the gulch, in deep soils, in an environment where they will get lots of water. To prepare this site for planting, NRS cut down some large *Aleurites moluccana* to increase light levels and remove them as competitors. This approach was suggested by the HINHP Botanist and University of Hawaiʻi Researchers. It is suspected that in a very favorable environment, the trees may be able to out-pace the black twig borer and hand pruning of damaged branches may be all that is necessary for the trees to mature and flower.

Ten juvenile plants were given to the Kaʻala Learning Center (KLC) to be planted into a reintroduction site in Nānākuli. These plants are monitored by KLC staff. This summer, large wildfires in Nānākuli burned this reintroduction site. NRS have not yet received an update from KLC staff on the status of *F. neowawrae* post-fire. Five juvenile plants were given to Leeward Community College (LCC) to be planted in their Native Hawaiian garden. These plants are monitored by LCC staff. Fourteen juvenile plants were given to the Waimea Audubon Center (WAC). NRS and WAC staff planted the trees and NRS monitor the trees and apply systemic insecticide quarterly. Most recent monitoring data shows that *F. neowawrae* planted in the sun are more vigorous than those planted in the shade. Below are some photos of the living collection at WAC.

Living collection of *Flueggea neowawraea* at Waimea

Research Issues

In order for this species to become stable *in situ*, a sustainable method for controlling black twig borer will need to be found. NRS submitted a research application with US Geological Survey-Biological Resources Division (USGS-BRD) to fund black twig borer research projects. NRS are also working with the University of Hawaiʻi and the DOA to solicit expertise on this project and to support funding for research. The Hawaiʻi Agricultural Research Center (HARC) received funding from the Hawaiʻi Invasive Species Council (HISC) to study the potential of behavioral chemicals on the black twig borer, which also affect commercially valuable species like *Acacia koa*. Scolytid beetles are susceptible to behavioral chemicals because these chemicals play a large part in their life cycle. HARC hopes to identify potential attractants, repellents, and effective trap designs. NRS will to support HARC's work on this important project. The NRS Research Specialist will coordinate efforts with all who are currently involved in black twig borer research.

Surveys

No surveys specifically targeting *F. neowawraea* were conducted in the last year. However, in the course of surveys for other species, NRS discovered seven new locations this year: two in Mākaha, two in West Makaleha, two in the east fork of East Makaleka, and one in Palikea Gulch, Lower Kaʻala NAR. The HINHP Botanist also discovered an additional location in Mākaha. As NRS management expands into new areas, the expectation is that additional plants will be discovered.

Taxon Threats

In addition to the black twig borer discussed above, *F. neowawraea* is threatened by habitat degradation from ungulates and weeds. Goats have been known to browse the basal suckers that are found on many trees, and would undoubtedly browse seedling and juvenile trees. Pigs and cattle are known to degrade the habitat where this taxon is found but in general do not have a direct impact on mature trees only seedlings. Only five mature trees are protected from ungulates within an existing large-scale exclosure. Most known trees are located in degraded areas with major weed threats, including, *Psidium cattleianum, Aleurites moluccana* and *Schinus terebinthifolius.*

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Flueggea neowawraea

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

Action Area: Out

TaxonName: Flueggea neowawraea

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Central and East Makaleha	Manage for stability	No	No	No
Halona	Genetic Storage	No	No	No
Kauhiuhi	Genetic Storage	No	No	No
Makaha	Manage for stability	No	Partial	No
Mikilua	Genetic Storage	Yes	No	No
Mt. Kaala NAR	Genetic Storage	No	No	No
Nanakuli, south branch	Genetic Storage	No	No	No
Waianae Kai	Genetic Storage	No	No	No

Manage for Stability PUs:

Kahanahāiki to Kapuna: This PU includes seven trees found in Kahanahāiki, Pahole and Kapuna gulches, and two reintroductions, located in Kahanahāiki. Last year eight trees were reported from this PU because NRS thought there were four trees in Pahole. The NARS Specialist has since indicated that there are only three trees.

In Kahanahāiki Gulch there are three wild trees and two reintroduction sites. The two outplantings in this PU are discussed in the 'Outplanting Issues' section above. Some of the wild trees from this part of the PU are represented in the Army Nursery by cuttings or airlayers. While the reintroductions and some of the wild trees are protected by an exclosure, two of the trees are located outside the fence. NRS will construct small exclosures around these trees if ungulates become a threat. NRS has conducted weed control around the reintroductions and around some of the wild trees that occur in native habitat.

In Pahole Gulch, there are three mature trees. NRS collected cuttings from all of these trees, however not all have survived. NRS will work to collect from unrepresented trees in the next year. NRS conducted weed control around one of the sites in Pahole. These trees are within the larger Pahole fenced unit.

One tree is known from Kapuna Gulch. The tree is not currently fenced, but will be protected by the planned Kapuna fence. NRS recently began weed control in this area in the last year. Efforts will be expanded into the area directly around the plant next year. NRS visited and collected from this tree on multiple occasions and some cuttings survive in the Army Nursery.

Central and East Makaleha: Two trees are known from Central Makaleha. Cuttings from one tree have been successfully rooted in the Army Nursery. Both trees are in moderate condition and are not fenced. In the coming year, NRS will continue to monitor these trees and collect from the unrepresented tree. No other management has been done in the last year. NRS will consider small scale fencing if necessary.

In East Makaleha, four trees had been reported in the past. NRS visited all sites, discovered two new trees, and found that some previously known plants may have died. Presently, NRS knows of four trees, but it is not clear which of the four original trees this represents. There are large unsurveyed areas in the management unit, which very likely harbor additional trees. In the coming year, NRS will revisit these trees and collect for propagation, as well as continue to search for more trees. No other management has been conducted here for *F. neowawraea* in the last year. This area is scheduled to be fenced in year four of the MIP. Goat control has been conducted in this PU.

Mākaha: NRS currently know of nine *F. neowawraea* in Mākaha Valley. This includes the discovery of three new plants this year by NRS and the HINHP Botanist. NRS worked with the Board of Water Supply (BWS) Watershed Planner, Amy Tsuneyoshi, to successfully root airlayers from trees in Mākaha. NRS will continue to airlayer and collect cuttings from unrepresented trees. In late 2003, hundreds of fruit were seen on the ground around one mature tree. NRS collected approximately 50 fruits and had high hopes that some fruit might be viable, as there are other *F. neowawraea* in the area. However, the fruit appeared immature. The fruit that were collected were sent to the Micropropagation Lab, but no seeds germinated. Four of the trees are within the proposed Mākaha fence exclosure. There are likely more undiscovered trees in Mākaha. Weed control has been approved by BWS and weeding has begun in predominately native areas, including two sites with *F. neowawraea*.

Other PUs:

West Makaleha: NRS know of five *F. neowawraea* in West Makaleha, two of which were recently discovered by NRS and the HINHP Botanist. NRS attempted to establish air-layers on two of these trees in the last year. Two air-layers were destroyed by the black twig borer on one plant, however a single air-layer on a second individual was successful and is now growing in the Army Nursery. Cuttings from two of the trees were successfully rooted in the greenhouse. NRS will work to secure stock from the all unrepresented individuals in the next year. Over 600 mature fruit were collected from one of these trees in December 2001. Plants grown from these collections have been reintroduced and planted into four sites, as discussed above. This tree will be collected from in the future and may prove to be the most productive individual on O‘ahu. The other two trees growing adjacent to this tree at this site are thought to be male. This may explain why the West Makaleha female tree produces so many viable fruit; it is the only location where there are known male trees in close proximity. NRS believes there are more trees yet to be found in West Makaleha, and will conduct surveys in the future during regular management work.

‘Ōhikilolo: NRS has not visited this site this year due to range restrictions imposed by the Army Safety Office. One of these trees is within a small fence to keep goats from browsing the suckers, which could be used for cuttings and air-layers. Fruit has been collected from this site, however none have ever germinated. Cuttings have been established from this site, and are being grown in the Army Nursery. NRS has conducted weed control in this area in the past.

Hālona: NRS helped the Navy to collect cuttings from the two trees known in 2004. One tree was re-visited in the last year to collect cuttings. Cuttings were rooted from both the trees and are now being grown at the Army Nursery. They will be managed as a living collection and will be cloned. No other management has occurred at this site.

Kauhiuhi: This tree was monitored by NRS in 2002 and was in poor condition. In the last year, NRS worked with Navy staff to monitor the site and collect cuttings. The plant was still in poor condition and cuttings were taken to the Army Nursery. These cuttings did not take and NRS will monitor and collect from this tree again in the coming year.

Mikilua: The site has been protected by a fence constructed by the Navy for at least five years. The tree was monitored by Navy staff and N. Sugii of the Micropropagation Lab in the last year. Cuttings were collected and brought to the Micropropagation Lab (Julie Rivers pers. comm., 2005). This tree is in poor condition and NRS will work with the Navy in the coming year to secure collections.

Mt. Ka‘ala NAR: There are currently four living trees in this large PU. Two trees were originally reported from Manuwai; however both have died since their discovery. In the last year, NRS visited Palikea Gulch with the HNHP Botanist and a new tree was found. Others trees known to be alive in the past were found to have died. Three trees are known from Ka‘awa Gulch. NRS has collected from two of these trees and now have three plants from one of these trees in the Army Nursery. These three trees are close together in one gulch and one has been observed producing viable seed in the past. NRS will continue to monitor this site to collect mature fruit in the coming year. Propagules will be grown from nursery clones of wild plants. None of these sites are within a fence and NRS does not conduct weed control at any of these sites.

Nānākuli: This tree was last monitored in 2001 and was healthy. NRS has not revisited this site. NRS will monitor and collect cuttings from this tree in the coming year. NRS do not know if this tree was affected by the extensive fires in the last year.

3.12 *Hedyotis degeneri* var. *degeneri*

Requirements for Stability:

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

Taxon Level Discussion

One PU designated 'Manage for Stability' is located within the Action Area (AA). The two others are outside of the AA and occur on State land. This taxon as a whole has not been given high management priority. This is mainly due to the relatively high numbers of individuals of this taxon and the order in which Management Units were planned for construction. The East Makaleha MU fence is scheduled for construction in year four and the Manuwai MU fence in year eight of the MIP. The major threats to this taxon are feral goats and pigs. This species of *Hedyotis* occurs on ridge crests where there are major ungulate trails. Over the last year, NRS worked to control goat populations in Makaleha Forest Reserve and Mt. Ka'ala NAR with NARS staff. The largest portion of the Kahanahāiki to Pahole PU is located in near pristine habitat along the back wall of Pahole Gulch and has stable numbers. Numbers at this PU increased in the last year because it was the first time NRS was able to completely monitor the site. Additional genetic storage collections were made in the last year and no augmentations or reintroductions are planned until the East Makaleha MU fence is constructed. The Central Makaleha and west branch of East Makaleha PU is the only 'Manage for Stability' population without stable numbers. NRS hope to locate more plants via surveys and eliminate the need for reintroductions. This taxon exhibits good on site recruitment and NRS feel that with ungulate and weed control it will be possible to stabilize this taxon.

Taxon Status

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri TaxonCode: Heddegdeg

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to Pahole	Manage for stability	40	0	279	8	8	0	0	0	279	8	8
	Total for Taxon:	40	0	279	8	8	0	0	0	279	8	8

Action Area: Out

TaxonName: Hedyotis degeneri var. degeneri TaxonCode: Heddegdeg

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Alaiheihe and Manuwai	Manage for stability	60	0	61	0	2	0	0	0	61	0	2
Central Makaleha and West Branch of East Makaleha	Manage for stability	35	3	33	3	7	0	0	0	33	3	7
East branch of East Makaleha	Genetic Storage	10	0	13	7	2	0	0	0	13	7	2
	Total for Taxon:	105	3	107	10	11	0	0	0	107	10	11

Genetic storage

This taxon can be kept in all methods of genetic storage. However, this taxon does not have a predictable phenology, so it is very difficult to know when mature seed will be present. Despite this, there are 9,519 seeds from 11 plants from the Central Makaleha and West Branch of East Makaleha PU in storage, 1,581 seeds from three plants from the Kahanahāiki to Pahole PU, 310 seeds from three plants from East Branch of East Makaleha PU, and 676 seeds from six plants from Alaiheihe and Manuwai PU. However, no storage testing has been done, and all seeds are currently banked at 4C and 20% relative humidity. These conditions are based on storage preferences determined for other species of *Hedyotis*. Since some collections have been stored for two to three years, and certain plants have over 1,000 seeds in storage, 25 seeds from three plants will be pulled for viability testing. This will help determine; 1) whether seed storage is a feasible option, 2) the storage potential at the banked storage condition, 3) a collection schedule for maintaining adequate counts for storage goals, and 4) provide valuable information on seedling quality and propagation of stored seed. Plants also respond well to subculturing in micropropagation. This year, NRS collected cuttings for micropropagation to research the possibility of using micropropagation as an alternative storage method for large numbers of individuals. Cuttings have also be taken and rooted in the nursery.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis degeneri var. degeneri							
Alaiheihe and Manuwai	61	0	0	6	0	0	4
Central Makaleha and West Branch of East Makaleha	33	3	4	11	0	2	9
East branch of East Makaleha	13	7	0	3	0	0	2
Kahanahaiki to Pahole	279	8	3	3	0	1	3
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				23	0	3	18

Propagation/Germination Techniques

Germination trials have shown quite a bit of variability. Initial viability from two separate collection dates (October 2002 and January 2004) of seeds from Kahanahāiki had high germination, averaging 81%. Initial viability of seeds collected from the West Branch of East Makaleha in November 2003 was low, averaging 26%. NRS will investigate the reasons why this difference in initial germination occurs between PUs. The difference is not due to collection date and all seeds collected were mature. Also, the number of seeds collected to maintain enough viable seed in the seedbank will have to increase for populations with lower viability, so goals may need to be determined based on population rather than taxon.

Plants can be propagated from cuttings. Approximately 30% to 50% of cuttings collected in November 2003 rooted. Currently, there is one plant in the Army Nursery that was propagated from a cutting collected in the West Branch of East Makaleha in November 2003. Because plants have an unpredictable fruiting time, NRS will focus on collecting cuttings to be grown in the Army Nursery and used for seed production for storage.

Unique Species Observations

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

Outplanting Issues

NRS have not outplanted this species, nor have any other natural resource programs on O‘ahu. Reintroductions may be considered in the Central Makaleha and West Branch of East Makaleha PU once the MU fence is constructed.

Research Issues

There are no pressing research issues for this taxon.

Surveys

No surveys were conducted for this species in the last year. NRS will continue to survey the East Branch of East Makaleha for more individuals in order to get a better understanding of the extent of this population.

Taxon Threats

Feral pigs and goats are the greatest threat to this taxon. In Makaleha, goats are causing erosion which is limiting the available habitat for this taxon, and goat browsing has been observed on some of the plants. Weeds such as *Ageratina adenophora* and *Rubus argutus* also threaten this taxon’s habitat.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Pahole	Manage for stability	Partial	Partial	No

Action Area: Out

TaxonName: Hedyotis degeneri var. degeneri

MakuaPopulationUnitName	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: Most of the plants in this PU are found along the back wall of Pahole Gulch where the native habitat in this area is close to pristine. The number of individuals in Pahole in the final MIP was based on Ken Wood's 1996 estimate of 150 plants. This year NRS began working more frequently in Pahole Gulch and visited known populations of *H. degeneri* var. *degeneri* NRS approximated 36 mature plants at one site, and over 230 mature at another. Juveniles and seedlings were observed at the large population. This year, NRS will monitor these sites and attempt to collect for genetic storage. The Kahanahāiki portion of this PU is located outside the exclosure and only has six mature plants. This site is monitored regularly by NRS in order to secure collections. NRS have observed recruitment at this site in the past and have observed seedlings becoming juveniles and mature plants. NRS will continue to collect for genetic storage and will continue ungulate control in the area.

East Branch of East Makaleha: This site was monitored by NRS in the past year. There are currently 13 mature plants, 7 juveniles and 2 seedlings. Mature seed was collected and is being stored at the Seed Conservation Lab. This PU benefits from the goat hunts that NRS and the State of Hawaii have been conducting in the area. In the coming year, NRS will collect seed from unrepresented individuals and continue to search for more plants within this area. In addition, ungulate control will continue in order to prevent goats from further degrading the area. Small-scale fences may be considered for the short term if the need arises.

Alaiheihe and Manuwai: This is a large area covering two gulches and several sites with plants. Goats are present in this area and no fences currently exist. This area is scheduled to be fenced in year eight of the MIP. In the last year, NRS visited this area and monitored some of the plants. Seed collections have been made for storage at the Seed Conservation Lab. In the coming year, NRS will continue ungulate control, survey for more plants in this area, and collect for genetic storage. Temporary, small-scale fences will be considered if genetic collections can not be made from these declining populations.

Other PUs:

Central Makaleha and West Branch of East Makaleha: There are currently 33 mature plants in Central and East Makaleha at three different locations. Juvenile plants and seedlings have also been observed within the populations. Goats are a threat to these sites and hunting will continue in the coming year. Also in the coming year, NRS will continue genetic storage collections from this PU.

3.13 *Hedyotis parvula*

Requirements for Stability:

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

Taxon Level Discussion

There are two *in situ* populations and both will be managed for stability. One PU is inside the Action Area (AA) and one outside. Both of the extant populations have numbers of individuals greater than the goal for stability for this species. A reintroduction is planned outside the AA within the East Makaleha Management Unit (MU) fence once it is constructed. The name assigned to this PU was previously 'Central and East Makaleha' but since the MU fence will only be built around the Eastern Branch of East Makaleha, we have changed the reintroduction name to 'East Makaleha' to avoid any future confusion. This represents a change from all previous MIP related documents. Plants tend to grow on steep cliffs where feral ungulates are less of a threat, and currently weeds are not a major problem. Fire has increasingly become a threat as recent wild fires (2005) in Nānākuli and Lualualei did come close to the Hālona PU. In the coming year, NRS will reassess the threat of fire to this site. NRS acquired significant collections for this taxon in the last year. This species can be grown from seeds or cuttings, and while reintroductions have not been attempted, NRS believe they are possible. This taxon has a good prognosis for reaching stability.

Taxon Status

Action Area: In

TaxonName: Hedyotis parvula **TaxonCode: Hedpar**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Ohikilolo	Manage for stability	66	1	79	12	17	0	0	0	79	12	17
	Total for Taxon:	66	1	79	12	17	0	0	0	79	12	17

Action Area: Out

TaxonName: Hedyotis parvula **TaxonCode: Hedpar**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
East Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0
Halona	Manage for stability	64	0	87	28	19	0	0	0	87	28	19
	Total for Taxon:	64	0	87	28	19	0	0	0	87	28	19

Genetic Storage

Seeds are being stored at the Seed Conservation Lab. Cuttings were previously rooted in the Army Nursery but a large trial has not been tested to determine the optimal technique. NRS are currently collecting cuttings from the nursery stock to be tested in the Micropropagation Lab for the first time as a possible addition to seed storage. Seeds have been brought to the Micropropagation Lab and successfully established in tissue culture and later moved to the lab's greenhouse. No seed storage testing has been done and all seeds are banked at 4C and 20% relative humidity. These conditions are based on storage preferences determined for other species of *Hedyotis*. There are currently 50,422 seeds in storage from 58 plants in the ʻŌhikilolo PU (one plant has < 10 seeds and is therefore not in the table). As the MIP requires collection from 50 plants from each PU, storage requirements for the ʻŌhikilolo PU have been met. NRS focused on collecting seeds from the Hālona PU this year, and 6,069 seeds from 11 plants in the Hālona PU were collected and placed into storage. Since some of the 2001 / 2002 ʻŌhikilolo collections have close to or over 1000 seeds in storage, 25 seeds from 24 plants will be pulled for viability testing. This will help determine; 1) whether seed storage is a feasible option, 2) storage potential at the banked storage condition, 3) collection schedule for maintaining adequate counts for storage goals, 4) and provide valuable information on seedling quality and propagation of stored seed.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis parvula							
Halona	87	28	0	11	0	1	9
Ohikilolo	79	12	2	57	0	0	56
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				68	0	1	65

Propagation/Germination Techniques

Plants can be propagated from seeds or cuttings. For most germination tests, initial viability from multiple plants from multiple populations averaged 64%. A few collections tested had very low germination, 0-28%, but this appears to be due to maturity of seed at time of collection, and not due to the specific plant or population that was collected. Seeds from herbarium specimens from the National Tropical Botanical Garden were taken to the Seed Conservation Lab for germination testing, but none of the seeds were viable. NRS will continue to try cuttings in the Nursery and Micropropagation Lab.

Unique Species Observations

There are no unique observations for this taxon.

Outplanting Issues

No outplantings of this species have been done. It may be challenging to find locations for outplanting. Plants grow on very steep cliffs, so outplantings will have to take place on rappel. The East Makaleha PU will be established by reintroduction. The historical population has been extirpated. NRS plan to reintroduce along the tops of cliff edges in hopes that plants will drop seeds onto the cliffs below.

Research Issues

No research issues have been identified for this species.

Surveys

NRS conducted surveys for this species at the Hālona PU in the last year and acquired a more accurate assessment of the population numbers and distribution at this site. NRS will continue to survey for plants around known sites.

Taxon Threats

Hedyotis parvula grows on very steep cliffs, and goats impact its habitat. No goat browsing has been observed on plants of this species. However, most plants occur on vertical sections where goats are not a threat. This unique distribution may be a result of past goat activity. *Melinis minutiflora, Rubus argutus,* and *Erigeron karvinskianus* all threaten the habitat of *H. parvula* and NRS have initiated some control of these species at the ‘Ōhikilolo PU.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hedyotis parvula

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ohikilolo	Manage for stability	Yes	Partial	No

Action Area: Out

TaxonName: Hedyotis parvula

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Halona	Manage for stability	No	No	No

Manage for Stability PUs:

‘Ōhikilolo: The ‘Ōhikilolo PU includes two sites, one makai along the ridge and one mauka. This PU has stable numbers of individuals. Goats have been removed from ‘Ōhikilolo and pigs do not threaten this PU.

‘Ōhikilolo Makai: This site has been monitored regularly by NRS. Mature seed has been collected from many individuals and stored at the Seed Conservation Lab. Ongoing grass control is improving habitat quality. This area is also monitored regularly for goat sign. In the coming year, NRS will continue to collect mature seed from unrepresented individuals for storage and monitor the population for new plants and threats.

‘Ōhikilolo Mauka: This site was particularly affected by goats and has shown great improvement since their removal. NRS observed new *Hedyotis parvula* plants in areas at the tops of cliffs, in goat-accessible habitats. NRS made substantial collections of mature seed from this site for storage at the Seed Conservation Lab. In the coming year, NRS will continue to monitor plants, collect from unrepresented individuals and assess new threats. Control of a nearby *R. argutus* population will continue and weed control may expand to include common weeds.

Hālona: This PU includes two different sites; one large population on State land (75 mature) and another small population (12 mature) on Navy land. These will be treated as one PU, but the portion on Navy land will only be monitored and collected from. In the last year, NRS were able to monitor and collect from part of the State site. There are no immediate threats, however, there are still goats in Lualualei and a couple of potentially bad weeds *E. karvinskianus* and *Morella faya*. These sites will be monitored and collected from in the coming year. Threats will be assessed and controlled in the state owned portion of the PU. In addition, recent fires (2005) in Nānākuli and Lualualei came close to this site and NRS will have to re-assess the threat of fire to this PU.

Other PUs:

Central and East Makaleha: A reintroduction will be conducted within the proposed East Makaleha fence when it is complete. This MU fence is slated for construction in year four of the MIP. Currently, NRS is managing stock from *in situ* PUs to ensure that it is available for future reintroductions.

3.14 *Hesperomannia arbuscula*

Requirements for Stability:

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

Taxon-Level Discussion

There are four remaining populations of *Hesperomannia arbuscula*. One PU in the action area (AA) and two PUs outside the AA have been designated as 'Manage for Stability'. All of the other PUs are designated as manage for 'Genetic Storage'. All of the PUs have experienced severe decline in numbers since the MIP was finalized. Ungulate damage, weeds, and senescence or drought, and some level of inbreeding and genetic drift have reduced the number of mature plants in the wild (S. Ching, pers comm. 2005). NRS, in cooperation with the Board of Water Supply (BWS) and the Genetic Safety Net program (GSN), monitored all of the populations this year. There are many obstacles to reaching stability for this taxon. Population numbers are very low, seeds have very low viability, and there is little recruitment in the wild. Viable seeds germinate in micropropagation, but do not develop a root structure in tissue culture. Vegetative propagation using air-layers is possible. However, this has proven difficult, time consuming, and has had a low success rate thus far.

Taxon Status

Action Area: In

TaxonName: Hesperomannia arbuscula **TaxonCode: HesArbu**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kapuna	Manage for stability	1	0	1	0	0	0	0	0	1	0	0
	Total for Taxon:	1	0	1	0	0	0	0	0	1	0	0

Action Area: Out

TaxonName: Hesperomannia arbuscula **TaxonCode: HesArbu**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Manage for stability	8	0	6	12	0	0	0	0	6	12	0
North Palawai	Manage for stability	6	0	4	0	2	0	0	0	4	0	2
Waianae Kai	Genetic Storage	5	1	4	0	1	0	0	0	4	0	1
	Total for Taxon:	19	1	14	12	3	0	0	0	14	12	3

Genetic storage

Genetic storage for this species so far has been difficult. Seed storage has not yet been attempted because the Seed Conservation Lab received only one collection with viable seed, and since viability is known to be very low for this taxon, all viable seed was germinated for propagation.

In July 2005, 156 seeds from one plant from North Pālāwai were collected. Seeds were sorted by size, color and appearance and all sown on 1% water agar. Of the 30 seeds that appeared to not be empty, 19 germinated (63%) and 19 seedlings were produced. In addition to these seedlings, nursery plants of four air-layers and four seedlings removed from the wild (due to their poor condition) will be used as a source for creating more stock through air-layering or seed collection. This year, two of the plants in the Army Nursery flowered but failed to produce viable seed. Due to the difficulty of establishing clones in tissue culture after germination, NRS is working together with the Micropropagation Lab to germinate immature seed in the lab and propagate the seedlings in the Army Nursery instead of in tubes.

Genetic Storage Summary

Makua 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	1	0	0	0	0	0	0
Makaha	6	12	0	0	2	0	2
North Palawai	4	0	11	0	0	7	1
Waianae Kai	4	0	0	0	3	1	3
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				0	5	8	6

Propagation/Germination Techniques

It has been difficult to time the collections of mature seed. Collections this year were too early, and seed did not have embryos developed enough for germination. When inflorescences are collected too late, most seed is empty and may have aborted or just never developed. Collections must be made when the base of the inflorescence has begun to swell and the top has begun to loosen and open. In previous years, seeds were collected from North-north Pālāwai, Mākaha and Wai‘anae Kai and put into micropropagation where many of them germinated. So far only one of those seedlings has ever produced roots, even though many different treatment methods have been tested. The seedling that did form roots was accidentally placed upside-down in the test tube. That plant was moved to the Army nursery in 2001 but died two years later. Air-layers were attempted this year on plants in Mākaha, Wai‘anae Kai, North Pālāwai, and Kapuna. There are currently four plants from air-layers; three from North Pālāwai and one from Wai‘anae Kai, growing in the nursery at Pahole. Seedlings that were not doing well in the wild in Pālāwai were removed and taken to the Army greenhouse this year and most of them have survived and are growing. The Pahole Mid-Elevation Nursery has proven to be the best growing environment for this species. NRS will continue to pursue adding additional growing space there needed there in order to achieve our production goals.

Unique Species Observations

Plants have poor seed and pollen viability. The flowers are very showy, and apparently were picked off the Wai‘anae Kai plants last year (see Threats discussion below). The Wai‘anae Kai plants also exhibited dieback this year possibly due to trampling.

Outplanting Issues

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

Research Issues

Testing of different types of media in micropropagation (that may promote root development) needs to be continued. Future research should focus on increasing seed viability through cross pollination, as pollen and seed viability were previously found to be low. If the plants at the Pahole Mid-Elevation Nursery flower this spring, the north Pālāwai plants will be cross-pollinated with the Wai‘anae Kai plant to see if this increases seed viability.

Surveys

Surveys for *H. arbuscula* were contracted as part of Urgent Actions 2 and 3 with the HIHNP Botanist. Five survey days were conducted this past year, however, no new plants were found. This coming year more surveys will be conducted in Honouliuli for this species.

Taxon Threats

The Wai‘anae Kai PU occurs along a well used hiking trail. This PU has suffered from trampling and picking of flowers in the past. Therefore, humans are considered a large threat to this population. Additionally, feral pigs are degrading this species’ habitat, and appear to be directly responsible for the death of at least one plant in Mākaha and Wai‘anae Kai. Weeds are also degrading this species’ habitat. However, because this species is fragile NRS are concerned that the physical impact to the plants while weeding in the vicinity may be detrimental.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hesperomannia arbuscula

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kapuna	Manage for stability	No	Yes	No

Action Area: Out

TaxonName: Hesperomannia arbuscula

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage for stability	No	No	No
North Palawai	Manage for stability	Yes	Yes	No
Waianae Kai	Genetic Storage	No	No	No

Manage for Stability PUs:

Kapuna: The number of individuals reported in the final MIP was based on monitoring by the NARS Specialist in 1998. Subsequent monitoring located only one remaining individual. This plant is in poor condition and in need of immediate attention and triage. GSN staff installed air-layers on the plant in 2003 although, none were successful. And at this time no *ex situ* material exists for this individual. NRS have initiated weeding operations around the plant with the guidance of NARS staff. In the coming year, NRS will assist NARS staff in monitoring and collecting from this plant. This plant is an area proposed for fencing in year two of the MIP.

North Pālāwai: While Steve Perlman discovered the first plants in Pālāwai in 2000, the majority of this population was discovered by the HINHP Botanist, in September 2003. In November 2003, NRS and The Nature Conservancy (TNC) staff erected a fence around these plants and weeding operations were conducted. Flowers were observed on the plants and thirteen fruits were collected for germination trials. Most of the seeds floated in water, suggesting they are not viable, but all 156 of them were sown on agar. GSN staff set up air-layers on several of the plants, four of which successfully rooted and are growing at the Pahole Nursery. Four seedlings that were doing poorly at this site were relocated to the Pahole Nursery. One of them died, and the other three are growing in the nursery. There are currently two seedlings remaining in the fenced area. These individuals are growing much slower than those relocated to the Pahole Nursery.

Mākaha: NRS and the BWS Watershed Planner monitor this population. Several of the plants died last year, possibly due to the high level of feral pig activity in the area. GSN set up air-layers on some of these plants in 2003. One was successful but later died in the Pahole Nursery. This past year GSN and NRS again attempted air-layers on these plants, but none of them were successful. This year four new seedlings were found, although they are likely a few years old. A small-scale fence was surveyed for this site in August. The State Environmental Assessment (EA) and Conservation District Use Application (CDUA) for building a small fence around these plants is being processed, and fence construction will begin as soon as permission is obtained. This population also falls within the larger proposed subunit I fence in Mākaha. However, due to the precarious status of this species, the construction of an interim fence is warranted.

Other PUs:

Wai‘anae Kai: NRS and GSN staff monitored this site last year and found that only four mature plants remained alive. Air-layers were attempted, two of which were successful. Both air-layers were taken to the Pahole Nursery. One of the air-layers died when the plant blew over in a windstorm last year. NRS assisted GSN staff with scoping a small fence for this site in 2003. The fence will be constructed this year by GSN staff and upon completion weeding operations will be conducted. Feral pigs and the weeds *Clidemia hirta* and *Rubus argutus* are major problems at this site.

3.15 *Hibiscus brackenridgei* subsp. *mokuleianus*

Requirements for Stability:

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

Taxon Level Discussion

Hibiscus brackenridgei subsp. *mokuleianus* exhibits significant plasticity across its range on O‘ahu. The three manage for stability populations were selected to encompass this plasticity. NRS have also collected from all wild PUs to fully represent the morphological and genetic variability of this taxon. One ‘Manage for Stability’ PU is on Army land at low elevation in Mākua Valley. The other PUs are on State of Hawai‘i and Dole property, outside of the Action Area (AA). Many of the plants on State and Dole land are on cliffs and ledges in severely degraded areas. Reintroductions using this stock will be outplanted into more manageable areas. Stock from three of the five wild PUs has been established in *inter situ* sites around the island by NRS for safe keeping. The major threats to *H. brackenridgei* are weeds, ungulates, and fire. *Panicum maximum* and *Leucaena leucocephala* both alter habitat and greatly increase fuel loads, and comprise the dominant vegetation at all PUs. NRS are optimistic about the probability of success for stabilization of this taxon, but the weed and fire threats which must be overcome are very significant. Reintroduction of this taxon into more manageable areas will play a major role in overcoming these threats.

Taxon Status

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus **TaxonCode: Hibbramok**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makua	Manage for stability	18	8	18	8	11	0	0	0	18	8	11
	Total for Taxon:	18	8	18	8	11	0	0	0	18	8	11

Action Area: Out

TaxonName: Hibiscus brackenridgei subsp. mokuleianus **TaxonCode: Hibbramok**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Haili to Kawaiu	Manage for stability	1	22	3	5	5	0	0	0	3	5	5
Kaimuhole and Palikea Gulch	Manage for stability	7	230	7	230	8	0	0	0	7	230	8
Kaumoku Nui	Genetic Storage	2	750	2	750	0	0	0	0	2	750	0
Kihakapu	Genetic Storage	6	316	6	316	57	0	0	0	6	316	57
	Total for Taxon:	16	1318	18	1301	70	0	0	0	18	1301	70

Genetic Storage

This species grows easily from cuttings. Cuttings only need to be taken once from the wild plants and then additional cuttings can be made from Army Nursery stock or living collections and many plants can be produced quickly. Plants from 36 founders are currently represented at the Army Nursery. This species appears to do well in cultivation, both in large pots and in the ground. Eleven founders from the Mākua PU are currently represented in botanical gardens and at Mākua Range Control.

Mature plants can produce hundreds of flowers in a season and several hundred seeds in a season. In order to reduce NRS impact at wild sites, few seeds have been collected. Instead, more than 12,000 mature seeds were collected for storage testing from clones of the Mākua plants at Mākua Range Control. Unfortunately, much of the seed collected was not viable. It was observed that all seeds that were not viable had slits through their seedcoat and were rotten inside. In addition, there is a long processing time required to get the seed out of the woody capsule, making it difficult to quickly obtain large numbers to offset low viability. NRS and the Seed Conservation Lab investigated the seed collected from other living collections at Koko Head and Ka'ala Learning Center and found similar results. In an attempt to determine causes for low viability, NRS observed growing tips of some plants at Mākua Range Control appeared stressed. To improve vigor and hopefully seed viability in the Range Control plants, they were selectively pruned to reduce plant stress and to direct next season's flowering branches. A slow release fertilizer was broadcast after pruning and insecticide was applied to address the insect pests in the area. In addition to that, while monitoring the plants at Range control this year, NRS found an introduced insect, *Niesthrea lousianica Sailer* (Rhopalidae), covering the inside of the opened fruit. The insect was identified by Hawaii Department of Agriculture (HDOA) and has been studied as a biocontrol agent for *Abutilon theophrasti* because it reduces seed viability by 98%. NRS will work next year during collection to determine if this insect is the source of the predation on seeds and develop techniques to control the insect if necessary to improve seed viability. Seed has been stored at -18˚C and 20% relative humidity for four years with 15% drop in viability (initial viability 100%). Based on these results, collections should be made every eight to ten years.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Hibiscus brackenridgei subsp. mokuleianus							
Haili to Kawaiu	3	5	2	0	0	5	1
Kaimuhole and Palikea Gulch	7	230	0	1	0	11	11
Kaumoku Nui	2	750	0	0	0	0	0
Kihakapu	6	316	0	2	0	8	8
Makua	18	8	5	10	1	19	13
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				13	1	43	33

Propagation/Germination Techniques

Clones are easily grown by sticking cuttings in a powdered growth hormone solution, and placing the cuttings in perlite and vermiculite filled pots on a mist-bench. Roots develop in a few weeks and plants are easily transferred into sterile media. Cutting success is usually 100%. They grow very quickly and can fill pots with their roots in a few months. Because of this, it is difficult to keep the plants in pots for very long. Plants being grown for reintroduction must not be prepared too early in the year or they may become root-bound before planting season. No air-layers have been attempted on this species, but it is likely they would be successful. Some seeds produced by healthy plants have initial viability of 96-100% when sown on paper or 1% water agar after scarification. Many scarification techniques have been tested and sanding is the most effective. However, as mentioned before, few viable seeds are produced considering the volume of seed a single plant produces. Cuttings are the preferred method for propagating this species.

Unique Species Observations

The Mākua PU has undoubtedly been burned many times over the years, yet plants have germinated in new areas of the managed site in the last year, suggesting the seedbank is still viable. The plants in a single region can exhibit small differences in the flower color, leaf size and shape, spine length, and plant size, indicating genetic diversity. This taxon is resilient and persists despite poor habitat. The Kaumoku Nui PU persisted in a cattle pasture for years and still produces seedlings. This taxon does well in cultivation. Plants have exhibited rapid growth, prolific flowering, and significant recruitment at *inter situ* sites.

Outplanting Issues

Plants grown from cuttings from the Mākua plants have been planted into Kaluakauila, Mākua Range Control, Koko Head Botanical Garden and Ka‘ala Learning Center. In general, the plants have thrived, producing flower and some viable fruit. Unfortunately, the Koko Head Botanical Garden site does not appear to be performing as well as the other sites. NRS believe that this is due to a combination of factors. The site is surprisingly wet due to an automated watering system and a heavy mulch layer on the ground. In the past, too much water has caused plants to rot. In addition to that, the plants have experienced significant insect damage. NRS feel that these problems could be addressed should this site become a higher priority in the future. No seedlings have been found at any of these sites. Plants need pruning and fertilizing to remain healthy in a botanical garden setting. The Kaluakauila MU is the only remote reintroduction location to date. It includes three sites, two on the extreme western end of the MU, and one in the central portion of the MU. The sites still harbor 46 plants. These sites are being abandoned by NRS due to the constant fire threat, which diminishes the sites’ long-term viability. In the next year, NRS does not plan to conduct any large-scale reintroductions of Mākua stock, but rather plans to focus on the wild site. NRS is planning reintroductions for the other PUs in the next year to consolidate the remaining wild stock into more manageable sites.

Founders Represented in Outplantings

Makua Implementation Plan - Founders Represented in Outplanting

TaxonName: Hibiscus brackenridgei subsp. mokuleianus **TaxonCode: Hibbramok**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Haili to Kawaiu	Manage for stability	10	0
Kaimuhole and Palikea Gulch	Manage for stability	237	1
Kaumoku Nui	Genetic Storage	752	6
Kihakapu	Genetic Storage	322	0
Makua	Manage for stability	31	11
	Total for Taxon:	1352	18

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

Research Issues

The highest research priority for *H. brackenridgei* is to determine factors impacting seed viability (see Genetic Storage section above).

Surveys

In past years, a number of surveys by the HINHP Botanist and NRS on Dole lands below Lower Ka‘ala NAR revealed hundreds of immature plants and a few mature plants. Some plants were found in gulches where they had been previously reported (Kihakapu, Palikea, Kaimuhole) and others were found in nearby Pu‘ulu Gulch, where they were never reported. It is very likely that more surveys would locate additional sites in these gulches and in nearby gulches, as there is still a lot of under-surveyed habitat in the area. This year, NRS conducted surveys in Haili and Kawaiū, but no new plants were observed. NRS will continue to look for new locations of this taxon while working in the area, but no new surveys are planned.

Taxon Threats

Weeds, ungulates, invertebrates, and fire are threats to *H. brackenridgei*. Due to the low elevation of PUs, weeds, particularly *P. maximum* and *L. leucocephala,* are a major threat at all populations. *Panicum maximum* requires significant effort to control, and poses a major fire risk. The time required to manage this grass is prohibitive for most PUs. Fire is a significant threat to many of the populations because of the high fuel load associated with *P. maximum*. Ungulates, including goats, pigs and cattle, impact populations via browse and trampling. No significant invertebrate damage has yet been observed at any wild population, however, some of the living collections have struggled with invertebrate impacts. This year, NRS noticed significant seed predation on some *inter situ* plantings. Many seeds were bored, but the damage was discovered late in the season, and NRS were unable to monitor the wild PUs for similar damage. In some of the wetter *inter situ* sites, the Chinese Rose beetle (*Adoretus sinicus*) causes major damage to the foliage.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makua	Manage for stability	Yes	Yes	No

Action Area: Out

TaxonName: Hibiscus brackenridgei subsp. mokuleianus

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Haili to Kawaiu	Manage for stability	Partial	No	No
Kaimuhole and Palikea Gulch	Manage for stability	No	No	No
Kaumoku Nui	Genetic Storage	Partial	No	No
Kihakapu	Genetic Storage	No	No	No

Manage for Stability PUs:

Mākua: Individual counts for Mākua are similar to last year's counts. Some new plants have emerged from areas below existing mature plants and may have germinated from seed recently produced by those plants. Other seedlings have emerged from areas with no mature plants that were previously dominated by *P. maximum*. When this PU was discovered, most plants were restricted to areas with thin soil on and near cliffs. Since *P. maximum* removal, plants now germinate in areas containing deep soil which were once dominated by *P. maximum*. NRS collected cuttings from additional plants to supplement the living collection at Mākua Range Control. Clones are also planted at the Ka'ala Learning Center. A full set of clones are not yet established at any one of these living collection sites, but NRS is working to complete this action. There are no ungulates threats to the population as goats were removed from the area approximately four years ago. The table below shows changes in plant numbers since the population was originally discovered. The increase between March 2001 and Jan 2002 is due to the discovery of new plants in a newly surveyed area. The other increases accurately reflect the recruitment of new plants. It definitely appears that the intensive management being exerted for this population has been successful when looking at the growth in numbers of all age classes. The population numbers plateaued this year due to the loss of five plants in a wind storm.

Mākua PU Population Structure

Monitoring Date	Nov 2000	Mar 2001	Jan 2002	June 2003	March 2004	Aug 2005
Mature/Juvenile/Seedling	4/2/2	4/2/3	8/5/2	13/6/2	18/8/11	18/8/11

NRS expects that population numbers will continue to expand with continued management in the area. The intensive management performed by NRS around this PU is discussed in the Weed Management chapter. The time investment is significant, and must be sustained in order to prevent *P. maximum* from re-colonizing the area. As long as NRS maintain current staffing levels, the PU can be managed adequately. However, if funding was to drop, the significant habitat improvements and reduction in fire threat would quickly be lost.

Hibiscus brackenridgei faces a high threat from fire from training and other range activities. Range Control has adopted a new fire-reduction policy that forbids live-fire training when weather conditions are favorable for fire. In addition, Range Control is responsible for maintaining a 30m clear-cut and chemically controlled firebreak inside the firebreak road and a 10m chemically controlled zone outside the firebreak road. These controlled areas are not continuous, and there are gaps in the clear-cut area. One of these gaps is directly below the *H. brackenridgei* population. NRS feel that this area should be clear to the 30m requirement, especially because it is in such close proximity to the *H. brackenridgei*. NRS has been periodically chemically treating this area to keep fuel loads down, and hope to work with Range Control to add the area to their regular fuel-break maintenance schedule. See the map included in the *Chamaesyce celastroides* var. *kaenana* section for a review of fuels in the area. In addition, NRS constructed a 30m wide, 3.5-acre fuel-break directly around the population, beginning October 2001. In the last year, NRS spent 90 hours maintaining the fuel break; this is a significant decrease from the 466 hours required in the first year of fuel break construction. More detailed discussion of this management is given in the Weed Management chapter.

The extensive efforts made by NRS and Range Control do not guarantee the safety of the PU. NRS has documented fires jumping the ‘firebreak’ road in the past. The fuel breaks maintained by Range Control have burned in recent fires. On-the-ground fire fighting, and helicopter support are vital to protect the PU from burning. The most recent fire, in August of 2005, started in the middle of the south firebreak. It was halted before it was able to cross over the firebreak road into the *H. brackenridgei* patch, but it did jump the road in another area and threaten a population of *C. celastroides*. Fire-fighters prevented the fire from burning up to the population. Approximately 2000 acres burned during this fire. Continued fuel management and prompt fire-fighting response are vital to preserving this PU.

Haili to Kawaiū: NRS resurveyed the Haili vicinity for *H. brackenridgei* in the last year. Three mature, four immature, and five seedlings were seen growing on exposed ledges smothered by *P. maximum* and *Sicyos pachycarpus*. This remote, weed-dominated site is not considered viable in long term and NRS does not plan to attempt management at the site. Cuttings were taken and will be grown at the Army Nursery in preparation for outplanting next winter in a site at Dillingham Military Reservation (DMR).

NRS surveyed Kawaiū Gulch for more *H. brackenridgei* again this last year. Of the eight plants observed previously, four had died. Collections were made from one of the plants for genetic storage; the others are already represented. As with Haili, NRS believe the wild site is not viable in the long term due to its steep and weedy nature. Instead, stock from the site will be propagated and out-planted at DMR. Several sites may be selected at DMR to accommodate stock from both Haili and Kawaiū. NRS are not yet sure if it is appropriate to mix these stocks. Weeds will be managed at the outplanting sites. Ungulates are not expected to impact the site, however, NRS will carefully watch and respond if necessary.

Kaimuhole and Palikea Gulch: Two years ago, surveys for *H. brackenridgei* were conducted in areas of the Lower Ka‘ala NAR and Dole lands below the NAR. At least 10 mature, 210 immature and several seedlings were found in four gulches in the area. As mentioned in the Survey section above, some locations were known historically, but the majority were new sites. NRS made collections from the region last year. Collections were made from 50 founders across the whole area where plants are found. NRS has proposed to establish a reintroduction with this stock instead of managing the wild populations. The manageability of the wild sites are questionable, given the steep terrain, fire threat, and complete domination of the habitat by *P. maximum*. Goats, fire, and weeds, in particular *P. maximum, Coffea arabica,* threaten the region. Another complicating factor is that the site is on Dole land and it is unclear to what degree they will support management (including fencing). A fence in this area is scheduled for installation in year six of the MIP. The daunting task of beginning weed control in these degraded sites and the unsustainable nature of the work has made reintroductions in other areas more feasible and attractive. Two possible reintroduction sites are currently being considered, although no decisions have been made. One site is on Dole land, in Kaimuhole Gulch. The other is on State land in Ka‘awa Gulch. Both locations have sites where significantly less management would be needed due to more intact habitat.

Other PUs:

Kaumoku Nui: The known site in Kaumoku Nui Gulch was monitored last year and the number of mature plants appeared stable. In 2002, there were estimated to be at least 750 seedlings at this site. However, this year a large cohort of seedlings was not seen. This PU is partially fenced and the fence is still in good condition. *Panicum maximum* is extremely pervasive and remains a threat. Collections from six founding areas were made in 2002 and are maintained at the Armys Nursery. In this case, founding areas are defined as areas that have mature trees, or once had mature trees and are now apparent by seedling groupings. Other living collections were established at Kaiser High School, Waimea Botanical Garden, and Waialua High School. In the coming year, NRS will work with NARS staff to monitor this site for changes in population and threats. NRS may include this stock in a reintroduction, possibly in Ka‘awa Gulch, as mentioned above.

Kihakapu: This population is almost continuous with the Palikea Gulch site, but will not be included in a larger fence that is planned for year six of the MIP. Plants from this area were collected for genetic storage and are presently maintained at the Army Nursery. NRS may plant this stock into a reintroduction at a manageable site. Some options include the possible fence at Kaimuhole gulch, or a site in Ka‘awa gulch.

3.16 *Melanthera tenuifolia*

Requirements for Stability:

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

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

Taxon Level Discussion

The three largest populations in the best habitat are designated as 'Managed for Stability'. One PU is in the Action Area (AA) and the other two are located off-site. These three PUs already have stable numbers of individuals, but all threats are not controlled and genetic storage research is still ongoing. Since the most significant threat to this taxon is goat predation, NRS have focused initial management efforts on ungulate control. NRS do not consider weeds to be a significant threat to these PUs, because they are found on fairly intact cliffs. Fire has burned and killed plants and severely degraded habitat in all of the PUs within MMR. This taxon can be propagated very successfully from cuttings and a living collection has been kept at the Army Nursery for several years. So far, seed collection from wild plants is challenging and research on germinating and storing seed is ongoing. The use of clones and nursery stock has been a fairly reliable means of maintaining the genetic stock of *M. tenuifolia*. Overall this taxon has a good prognosis for stability. Threat control is underway at all three 'Manage for Stability' sites.

Taxon Status

Action Area: In

TaxonName: Melanthera tenuifolia **TaxonCode: MelTen**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki	Genetic Storage	73	23	54	23	4	0	0	0	54	23	4
Kaluakauila	Genetic Storage	64	20	64	20	40	0	0	0	64	20	40
Keawaula	Genetic Storage	20	20	45	15	0	0	0	0	45	15	0
Ohikilolo	Manage for stability	2008	0	1242	1	0	0	0	0	1242	1	0
	Total for Taxon:	2165	63	1405	59	44	0	0	0	1405	59	44

Action Area: Out

TaxonName: Melanthera tenuifolia **TaxonCode: MelTen**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kamaileunu and Waianae Kai	Manage for stability	796	269	831	269	297	0	0	0	831	269	297
Mt. Kaala NAR	Manage for stability	250	0	300	0	0	0	0	0	300	0	0
	Total for Taxon:	1046	269	1131	269	297	0	0	0	1131	269	297

Genetic Storage

NRS has been using clones of wild plants for genetic storage. While it is possible to meet genetic storage goals for this taxon via vegetative clones, this approach will require significant amounts of nursery space. Thus far, NRS have focused clonal nursery storage on fire-threatened sites. Seed from these nursery plants can be a source for storage testing and genetic storage. Last year, seed was collected from these plants and brought to the Seed Conservation Lab. The lab sent these seeds to the University of Kentucky for dormancy studies (see Propagation and Germination Techniques). This year, larger collections of seed were made from these plants and the Seed Conservation Lab has initiated germination and storage trials. NRS also brought cuttings in April and August 2004 to the Micropropagation Lab to determine if it is possible to store these clones *in vitro* rather than in a nursery.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	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	40	6
Kaluakauila	64	20	0	8	0	15	2
Kamaileunu and Waianae Kai	831	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	13
				Total # Plants w/ >=10 Seeds in Seedbank	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
				35	0	73	21

Propagation/Germination Techniques

Melanthera tenuifolia cuttings root easily with a success rate of 50-75%. In the past, NRS have had difficulty collecting substantial amounts of seed from wild populations because seeds tend to fall off the peduncle easily and are difficult to distinguish from dried sepal parts, without close inspection. Therefore, it is difficult to determine from a distance whether substantial collections can be acquired before embarking on a rappel. Also, NRS have not observed a predictable fruiting season where substantial numbers of seeds are available. This situation makes acquiring seed collections from this taxon very challenging. This year, NRS experimented with collection techniques with plants in the Army Nursery. It was found that a larger number of seed can be collected slightly before maturity and seeds can finish ripening post-harvest. Inflorescences at this stage have already had petals dry up and fall off and seeds are swollen, but seed color ranges from yellow-green to yellow and browning. Completely dried flower heads usually contain very little seed because most seed has already fallen out of the inflorescence. Collecting slightly immature seeds allows for a larger number of seed to be collected as well as a larger window of opportunity to collect.

The other challenge with seed from this taxon is overcoming dormancy to allow for substantial germination. Seeds appear viable during germination testing for at least two years, but little or none germinate. Last year, a collection of seed was sent to Dr. Carol Baskin at the University of Kentucky for dormancy tests. She determined that seeds at temperatures of 20˚C and 15˚C had significantly more germination than seeds kept at 24˚C or higher. Seeds previously tested at the Seed Conservation Lab were kept at 24˚C. All growth chambers are currently set above 20˚C as they are mimicking seasonal temperatures, but more germination and storage tests will be conducted this winter.

Unique Species Observations

A large and catastrophic fire occurred at MMR in July 2003. This fire burned some *M. tenuifolia* plants within the Kahanahāiki PU. Photo points were taken at the site and burned plants were tagged. After one year, more plants were present at the site than had been counted before. It is difficult to know if these plants were new seedlings or clones of the burned plants re-sprouting from buried stems. This site has not been monitored in the last year.

Plants found at the ‘Ōhikilolo Makai site are exposed to extremely dry conditions at a very low elevation. This site is at 400 feet in elevation while some others are near 1000 feet and most are over 1500 feet. NRS have observed very low survivorship of individual plants between years from this site. The plants are small and appear to reproduce mainly via seed rather than vegetatively. NRS have collected from this PU many times in order to preserve this site as a distinct ecotype.

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. Plants have been kept in pots outside at the Army Nursery for years and seedlings have been observed germinating in the pots and coming up through the gravel on the ground.

Research Issues

Research is being conducted as stated above to determine a reliable germination technique for this taxon.

In the next year NRS will consider the application of high-resolution imagery as a monitoring tool. Such a technique, if successful, would allow NRS to detect population trends without needing to conduct a census of the population.

Surveys

No additional surveys have been conducted for this taxon.

Taxon Threats

In Mākua, *M. tenuifolia* was restricted to vertical cliffs and was extirpated or rare in places that were accessible to goats. Due to significant ungulate control, *M. tenuifolia* has re-claimed some of these areas. Pigs are not prevalent in most areas where *M. tenuifolia* resides because of the steep nature of the terrain. However, in the few places that are accessible, pigs can trample and uproot plants. Weeds do not appear to pose a large threat to this taxon except where alien grasses have invaded and may serve as fuel for fire. Fire has burned around plants in the ʻŌhikilolo, Kahanahāiki, Keawaʻula and Kaluakauila PUs in the past and continues to be a threat. In these PUs, fire has burned to the edge of forest patches and up to cliffs, both places where the *M. tenuifolia* is found. After fires, plants have come back to occupy the same places they were. It is still unclear whether this new growth is from seedlings or from mature plants re-sprouting from the base. Rats and slugs have not been observed to be threats to this taxon.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Melanthera tenuifolia

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Genetic Storage	No	No	No
Kaluakauila	Genetic Storage	Yes	Yes	No
Keawaula	Genetic Storage	No	No	No
Ohikilolo	Manage for stability	Yes	No	No

Action Area: Out

TaxonName: Melanthera tenuifolia

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kamaileunu and Waianae Kai	Manage for stability	No	No	No
Mt. Kaala NAR	Manage for stability	Partial	No	No

Manage for Stability PUs:

ʻŌhikilolo: This PU extends from low elevation cliffs just above Farrington Highway to high elevation cliffs along ʻŌhikilolo Ridge. There is a large break in distribution between the makai plants at 400-foot elevation to the next closest plants at approximately 1200 feet. Although NRS have not systematically monitored the ʻŌhikilolo population, incidental observations indicate that *M. tenuifolia* is moving back into habitat where it had been extirpated by goats. Thus, NRS anticipate an increase in the overall population numbers. NRS have observed *M. tenuifolia* at the base of cliffs in Koʻiahi Gulch and Lower Mākua Valley and at the tops of cliffs just off the main

‘Ōhikilolo Ridge crest where it was not previously seen. No weed control has been conducted at this site.

The Makai site along ‘Ōhikilolo Ridge faces distinct challenges. NRS have committed significant resources to the *in situ* protection of this site and to capturing it in storage. Genetic studies conducted in 1999 showed that these makai plants are different from the rest of the plants on ‘Ōhikilolo ridge. NRS contracted the construction of a strategic fence to protect the site because it was outside the larger ridge fence that encircles the valley. It has been goat proof since October 2003. Another significant threat to the Makai site is fire. Fires started from military training in Mākua and arson along Farrington highway have impacted this site numerous times in past years. NRS have never documented burned *M. tenuifolia* plants at this site following a fire, but there remains a high potential for such damage. NRS have excellent *ex situ* representation from this site and are comfortable that the genetic make-up of these plants has been captured. NRS spent many hours on rappel collecting cuttings from plants at this site. Over time many cuttings have been established from founders that have since died so that currently there are more founders being grown at the Army Nursery than have ever been observed in a single monitoring of the site. Clones of the wild plants are maintained as large potted plants for seed storage research, until seed can be stored from these plants.

Kamaile‘unu and Wai‘anae Kai: NRS numbers for this PU are a total based on accurate monitoring at only some sites within this large PU. NRS plan to manage *M. tenuifolia* plants from the eastern most portion of this PU that will be within the first Mākaha fence. In 2004, a total of 63 mature individuals were observed within the proposed fence perimeter. The *M. tenuifolia* habitat to be included in the Makaha fence is very native and has few weeds of concern. Goats may be a threat at this site.

Mt. Ka‘ala NAR: These plants have been monitored in the last year while conducting goat control with the NARS staff. These regular ungulate control efforts have proven valuable as there is currently no goat sign around this area and goats are not considered a threat at this time. Since the goats have been removed, there has been an estimated increase of about 50 plants. NRS will continue to manage ungulates in this area with NARS staff. Other threats in this area are minimal.

Other PUs:

Kahanahāiki: The NRS population number for this site is based on accurate counts made on rappel, but does not represent a complete census of the whole PU. This population has benefited from goat control measures conducted in MMR and pigs are a minimal threat since the plants mainly occur on cliffs. This PU has been a focus of collection efforts since the entire PU was threatened and some individuals were burned by the July 2003 fire. NRS have secured a substantial living genetic storage collection from this site, which are being maintained in the Army Nursery

Kaluakauila: This population is protected from pigs by the Kaluakauila exclosure, which was completed in 2001. Since the fence was completed, *M. tenuifolia* has reclaimed many sites below and above cliffs. The July 2003 fire burned into this MU and dangerously close to *M.*

tenuifolia plants. Since 2002, NRS have been conducting grass control within the Kaluakauila forest patches to minimize the chance that a fire would carry into the forest. This taxon may also benefit from the ecosystem-level weed control being conducted for introduced tree species such as *Schinus terebinthifolius*, *Psidium cattleianum* and *Leucaena leucocephala*.

Keawa‘ula: This PU is highly threatened by fire although it has not burned in the last year. NRS monitored this PU in September 2004 and estimated that there were more than 45 mature plants. In the last year, NRS visited the site and found no change in status. This site will continue to be monitored for new threats and any change in distribution or abundance.

3.17 *Neraudia angulata*

Requirements for Stability:

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

Taxon Level Discussion

There are four populations designated ‘Manage for Stability.’ Together with the other genetic collections and reintroductions, these should represent the full geographic distribution of this taxon and the morphological differences exhibited by the different stock. A new population was found by NRS in Punapōhaku Gulch in MMR. This plant appears to be *var. dentata.* A single leaf collected from the plant was verified by Joel Lau. The PUs with plants of the var. *dentata* are Punapōhaku, Manuwai, and Kapuna. The habitat at all these sites is impacted by ungulates and weeds and is much degraded. Therefore, this stock will be represented in a reintroduction in the managed Kaluakauila MU, where the habitat is appropriate. The Mākaha and Wai‘anae Kai Makai PUs have intermediate stock. These will be represented by the Wai‘anae Kai Makai PU. The Mākua PU is augmented and is also ‘Managed for Stability.’ Only the Mākua population is fenced at this time, but fences are proposed for all ‘Manage for Stability’ PUs and most genetic storage PUs. The increases in population size at the Wai‘anae Kai PU is from finding plants in new areas, not a change in abundance in the same area. Over all it will take a while to stabilize the habitat necessary to support this taxon, but reintroductions have survived and may allow NRS to bring stock out of heavily degraded areas into manageable protected areas and stabilize this taxon. Genetic storage research is ongoing.

Taxon Status

Action Area: In

TaxonName: Neraudia angulata **TaxonCode: Nerang**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kapuna	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
Makua	Manage for stability	12	61	14	41	26	15	19	0	29	60	26
Punapohaku	Genetic Storage			1	0	0	0	0	0	1	0	0
	Total for Taxon:	13	61	16	41	26	15	19	0	31	60	26

Action Area: Out

TaxonName: Neraudia angulata **TaxonCode: Nerang**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Halona	Genetic Storage	15	0	8	0	0	0	0	0	8	0	0
Leeward Puu Kaua	Genetic Storage	3	0	3	0	0	0	0	0	3	0	0
Makaha	Manage for stability	7	4	16	1	0	0	0	0	16	1	0
Manuwai	Manage for stability	0	2	1	0	0	0	0	0	1	0	0
Waianae Kai Makai	Manage for stability (backup site)	46	35	46	35	0	0	0	0	46	35	0
Waianae Kai Mauka	Genetic Storage	49	4	49	4	50	0	0	0	49	4	50
	Total for Taxon:	120	45	123	40	50	0	0	0	123	40	50

Action Area: Reintro

TaxonName: Neraudia angulata **TaxonCode: Nerang**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kaluakauila	Manage reintroduction for storage	7	1	0	0	0	13	0	0	13	0	0
	Total for Taxon:	7	1	0	0	0	13	0	0	13	0	0

Genetic Storage

This taxon does not produce many mature fruit at one time. Fruit can ripen slowly and take months to reach maturity. Because of this, it has been difficult to obtain collections from wild plants that are large enough to run seed storage trials. Plants established in the Army Nursery from cuttings have produced more fruit than wild plants and this seed has been collected for storage trials this year and last year at the Seed Conservation Lab. Preliminary tests on this taxon show a significant decrease in viability after only one year for all tested treatments. Due to the low fresh and stored percent germination, preferred storage treatment as well as storage potential is still unknown. After two years, germination of frozen seeds went from 56% to 11%. Genetic storage through seed collection is hindered by seed dormancy and inability to store at tested treatments. Both elements are currently being studied with seed from nursery stock at the Seed Conservation Lab. Future nursery collections will be stored at conditions that will test whether or not seeds can or cannot tolerate low temperatures and/or drying. This year soil seedbank potential was tested at the Conservation Seed Lab. Seeds were stored in the dark at 24 C and 100% relative humidity for six months and for one year, at which time seeds were placed in the light. Ninety percent of those seeds germinated within two weeks at both time intervals. Further dark tests at different temperatures and for different lengths of time are now being conducted. Results indicate that seeds, if necessary, can be stored in the dark at 100% relative humidity for one year with no decrease in viability. Seeds could therefore potentially store at this condition for a longer time period.

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

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Neraudia angulata							
Halona	8	0	0	0	0	0	0
Kapuna	1	0	0	0	0	1	1
Leeward Puu Kaua	3	0	0	0	0	0	0
Makaha	16	1	0	2	0	8	2
Makua	14	41	10	0	1	31	9
Manuwai	1	0	3	0	0	2	0
Punapohaku	1	0	0	0	0	1	0
Waianae Kai Makai	46	35	0	0	0	0	0
Waianae Kai Mauka	49	4	1	0	0	0	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				2	1	43	12

Propagation/Germination Techniques

Germination tests indicate that seeds germinate best on agar. Seeds may have some type of physiological and/or morphophysiological dormancy. Seeds germinate very slowly over a long period of time. Most germination occurs four to seven months after sowing. There has been over 50% germination on two different seed lots collected in 2003 and 2004, but many other collections have lower viability.

Cuttings are treated with Dip-n-grow® and placed in a pot with vermiculite and perlite on a mist bench. They develop roots within weeks and can be transplanted to sterile media. The plants kept at the nursery have produced much more flower and fruit than the plants in the wild, enabling large collections to be made for seed storage trials. Less than 50% of cuttings made from wild plants in 2005 were successful. Cuttings received in 2005 from Kapuna had a 36% (9:25) success rate and two out of five cuttings from the Punapōhaku founder rooted. Tip cuttings in other years have had a higher success rate at 80-90%. NRS now have established material propagated from collections made in 2003-2004 from the Mākua PU that currently serve as nursery stock plants. NRS have observed that many of these cuttings will flower and set fruit within one year.

Unique Species Observations

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

Outplanting Issues

NRS has reintroduced 13 plants from Kapuna into Kaluakauila, and have augmented the Mākua PU with about 50 plants grown from cuttings. Survivorship has been 100% at Kaluakauila and over 80% at the Mākua augmentation. NRS expects to be able to establish populations using reintroductions in the future once appropriate habitat is secured. In the coming year, NRS will expand the Kaluakauila reintroduction.

Founders Represented in Outplantings

TaxonName: Neraudia angulata **TaxonCode: Nerang**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Halona	Genetic Storage	8	0
Kaluakauila	Manage reintroduction for storage	0	0
Kapuna	Genetic Storage	1	1
Leeward Puu Kaua	Genetic Storage	3	0
Makaha	Manage for stability	17	0
Makua	Manage for stability	65	21
Manuwai	Manage for stability	4	0
Punapohaku	Genetic Storage	1	0
Waianae Kai Makai	Manage for stability (backup site)	81	0
Waianae Kai Mauka	Genetic Storage	54	0
	Total for Taxon:	**234**	**22**

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

Research Issues

NRS will attempt to discover why populations blink out so quickly.

Surveys

No surveys have been proposed for this taxon in the coming year. However, NRS will continue to survey around known populations for additional plants

Taxon Threats

Some PUs, in particular, Manuwai, Kapuna, and Punapōhaku, include degraded areas and are very threatened by ungulates and weeds. Goat browse has been observed on plants at the

Manuwai PU and pigs have been noted as a threat at most sites. Other PUs including Wai'anae Kai Mauka and Makai, Mākua, and Mākaha are relatively intact and have manageable threats. In the last year, rat damage was observed on plants used to augment the Mākua PU. NRS believes this damage was the cause of drought and is not currently baiting at any site because the damage did not continue. It is unknown if slugs are a threat to this taxon. The weeds that are particularly problematic in appropriate habitat for this taxon are *Leucaena leucocephala, Panicum maximum,* and *Ageratina adenophora.*

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Neraudia angulata

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Halona	Genetic Storage	No	No	No
Leeward Puu Kaua	Genetic Storage	No	No	No
Makaha	Manage for stability	Partial	No	No
Manuwai	Manage for stability	No	No	No
Waianae Kai Makai	Manage for stability (backup site)	Partial	No	No
Waianae Kai Mauka	Genetic Storage	Partial	No	No

Action Area: Reintro

TaxonName: Neraudia angulata

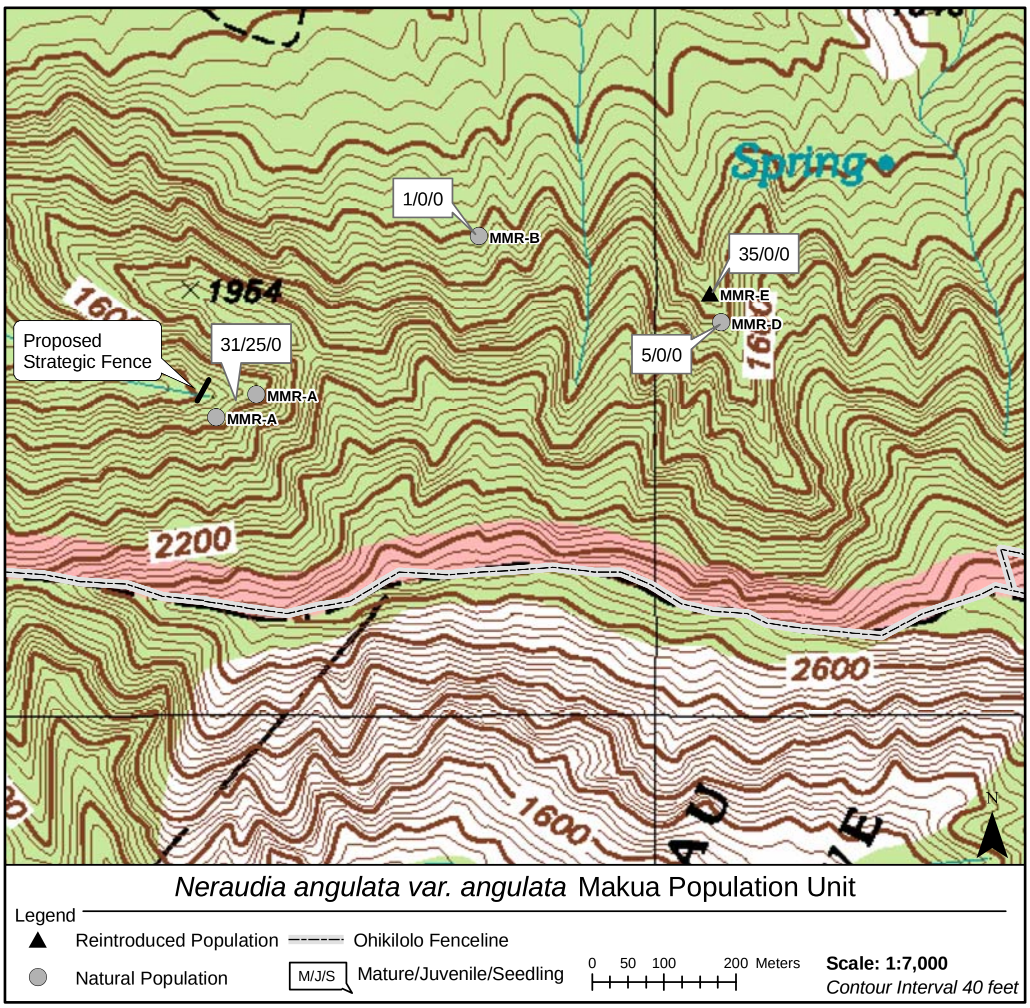
MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaluakauila	Manage reintroduction for storage	Yes	Yes	No

Manage for Stability PUs:

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

There are three *insitu* sites in Lower Mākua: MMR-A, MMR-B, and MMR-D which is augmented and is called MMR-E. MMR-A and MMR-B have been monitored regularly by NRS since 1998 and MMR-D since 2002. However, due to access restrictions, only the MMR-A site was monitored this past year. MMR-A is located in two different subgulches in Ko'iahi Gulch. Seedlings were often seen growing at the base of the cliffs where mature *N. angulata* reside. Only the plants growing on the cliffs were protected from ungulates, therefore, when NRS returned, all plants growing in the soil would usually be dug up by pigs before the next monitoring. In March 2005, two strategic fences were erected protecting the area. NRS hope that this effort will allow *N. angulata* to colonize the area previously controlled by pigs. At the time of fence construction, about 65 mature and 27 immature plants were present. NRS have not returned to monitor this site. In August 2004 NRS observed rat damage on the augmented plants. NRS believes this damage was the cause of droughts and because of access restrictions, NRS is not baiting this site.

In this coming year, NRS is hopeful that access will be granted which will then allow outplanting of more individuals to the augmented population at MMR-E (the reintroduction site), and a complete monitoring of all sites. NRS will continue to monitor MMR-A on a biannual basis.



Kapuna: There is one remaining plant at the Kapuna site. This plant is growing on a rock shelf and is not threatened by pigs. This site is severely degraded and dominated by weeds. Cuttings of this plant were taken to the Army facility and cloned. In January 2003, three plants were reintroduced into the Kaluakauila MU in MMR. Five more plants were planted in March 2004 and five more in 2005. They were last monitored in June 2005. All 13 plants are mature, in healthy condition and produce a large amount of fruit which is uncommon amongst *N. angulata* in the wild. Kaluakauila was partially burned in the fires of July 2003. Although the reintroduction area was not threatened, fire remains a major threat to this area. This reintroduction site is located in an area where rats are controlled for other taxa. NRS has additional plants in the Army greenhouse and will continue to outplant until the numbers are substantial. In the coming year, this site will be augmented with plants as well. Mature seed collected from this site will be stored at Lyon. NRS will monitor the wild plant in the coming year for additional threats.

Mākaha: The number of individuals in the final Mākua IP was based on 1999 field observations. In April 2005, NRS observed 16 mature and one immature *N. angulata* in Mākaha. Cuttings from 11 of these plants are now growing in the Army Nursery. These plants are threatened by ungulates but will not be included in the larger planned Mākaha exclosure because they are geographically removed from it. Instead, a separate fence scheduled for year five of MIP will be built around this taxon which will also benefit *Nototrichium humile* and *Abutilon sandwicense.* This coming year, NRS, along with Board of Water Supply Watershed Planner, will continue to survey the area around the existing known plants, as well as new areas in Mākaha for additional plants. NRS will also collect from all known individuals that are large and healthy enough to spare cuttings. A fence will be built in this area to exclude pigs.

Waiʻanae Kai Makai: This PU has been monitored in the last year and no change in size or distribution was noted. A fence has been scoped to exclude goats and pigs from this site. Plans were submitted to DLNR and NRS is awaiting there response. There are an estimated 45 mature plants and 35 juveniles at one site (WAI-B) and one mature plant at the second (WAI-D). In the coming year, NRS will monitor these sites and work with DLNR to determine the appropriate ungulate control strategy for this PU. There are some threats from a few invasive trees including *Casuarina glauca* and *Grevillea robusta* in the PU and NRS will work to eradicate these in the coming year.

Other PUs:

Manuwai: 11 mature individuals and one juvenile were found during surveys of Mokulēʻia Forest Reserve in March 2003. When NRS visited the site again to scope a planned fence, there had been damage to the plants from a small landslide and goats had browsed several individuals, leaving only six plants. NRS submitted a proposal to DLNR to build a fence around the plants over a year ago with no response. When the site was visited in June of 2004, only two plants could be found, one in very poor condition. When last visited in 2005, NRS found only one plant alive. Propagules were collected during each visit and are being grown at the Army Nursery. In the coming year, NRS hopes to have permission to fence this area before the plants are all gone. The plants grown at the Army Nursery will be cloned and planted into a secure location in Kaluakauila when ready.

Leeward Puʻu Kaua: No collections have been made from this PU and no management has been done. In the coming year, NRS will monitor the plants, collect for genetic storage and determine the need for management to ensure genetic storage collection can take place.

Hālona: No collections have been made from this PU and no management has been done. In the coming year, NRS will monitor the plants, collect for genetic storage and determine the need for management so genetic storage collection can take place.

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

3.18 *Nototrichium humile*

Requirements for Stability:

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

Taxon Level Discussion

There are 15 *Nototrichium humile* PUs, currently four have been selected as ‘Manage for Stability’. They include Mākua, Kaimuhole and Palikea Gulch, Kaluakauila, and the Wai‘anae Kai. These four PUs have stable population numbers, but not all threats are controlled. Threats to this taxon include fire, ungulates and weeds. Two populations were selected for management off-site and two were selected within the Action Area (AA). These populations were chosen based on their size and habitat quality. For all other PUs, NRS will place collection priority on those found within the AA since they are most at risk from training-caused fires. This genetic stock will be maintained in protected *in situ* sites as augmentations/reintroductions or in the greenhouse. It is difficult to collect large numbers of seed from this taxon because there are very few ripe seed on an inflorescence at any given time. *Nototrichium. humile* is easy to propagate from cuttings and can be maintained in the greenhouse but they take up a lot of space. NRS will experiment with in vitro propagation for this taxon to minimize space necessary to accomplish vegetative genetic storage. NRS feel there is a good prognosis for stability with effective threat control.

There is mixed opinions on how many PUs should be declared as ‘Manage for Stability’ within the NRS. Some say four while others feel that three will be sufficient. The reasons NRS feel four should be designated include the following: there are many large population of *N. humile* and to represent this range four PUs are needed, and this taxon is also potentially the most fire threatened taxon in the MIP. Do these factors justify four PUs? NRS is not clear. If one PU is to be dropped NRS has not agreed on what PU that should be. The IT needs to clarify actions for the upcoming years. (See PU section for more discussion

Taxon Status

Action Area: In

TaxonName: Nototrichium humile **TaxonCode: Nothum**

Makua Population UnitName	Management Designation	Num Mature in Final Makua IP	Num Imm in Final Makua IP	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki	Genetic Storage	32	2	34	0	0	0	0	0	34	0	0
Kaluakauila	Manage for stability	200	0	198	35	0	0	0	0	198	35	0
Keaau	Genetic Storage	21	31	21	31	0	0	0	0	21	31	0
Keawaula	Genetic Storage	200	30	138	5	0	0	0	0	138	5	0
Makua (East rim)	Genetic Storage	1	0	0	0	0	0	0	0	0	0	0
Makua (south side)	Manage for stability	56	1	56	1	0	0	18	0	56	19	0
Punapohaku	Genetic Storage	152	14	302	14	7	0	0	0	302	14	7
	Total for Taxon:	662	78	749	86	7	0	18	0	749	104	7

Action Area: Out

TaxonName: Nototrichium humile **TaxonCode: Nothum**

Makua Population UnitName	Management Designation	Num Mature in Final Makua IP	Num Imm in Final Makua IP	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kaimuhole and Palikea Gulch (Kihakapu)	Manage for stability	8	3	58	7	0	0	0	0	58	7	0
Kealia	Genetic Storage	3	0	3	0	0	0	0	0	3	0	0
Keawapilau	Genetic Storage	5	0	5	0	0	0	0	0	5	0	0
Kolekole (east side)	Genetic Storage	13	0	12	0	0	0	0	0	12	0	0
Makaha	Genetic Storage	159	0	16	3	0	0	0	0	16	3	0
Nanakuli	Genetic Storage	5	0	5	0	0	0	0	0	5	0	0
Puu Kaua (Leeward side)	Genetic Storage	12	0	12	0	0	0	0	0	12	0	0
Waianae Kai	Manage for stability	200	0	224	5	0	0	0	0	224	5	0
	Total for Taxon:	405	3	335	15	0	0	0	0	335	15	0

Genetic Storage

Genetic storage is being achieved via the use of cuttings but this approach consumes too much space and labor. Seed collection has been difficult and germination very low. *Nototrichium. humile* inflorescences are indeterminate spikes. Therefore, very few of the fruit are mature at any one time. There is only one seed per fruit. Only one of the 50 fruits submitted to the Seed Conservation Lab had viable seed that germinated. Of fruit collected for testing, most do not have seeds. NRS will work to increase the number of seed collected from greenhouse plants. NRS will work with the Seed Conservation Lab to determine a reliable germination technique for this taxon. NRS will also bring cuttings to the Micropropagation Lab for testing. Priority for all collections will be on unique fire threatened PUs within the AA.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Nototrichium humile							
Kahanahaiki	34	0	0	5	0	27	14
Kaimuhole and Palikea Gulch (Kihakapu)	58	7	0	0	0	13	13
Kaluakauila	198	35	0	5	0	0	4
Keaau	21	31	0	0	0	0	0
Kealia	3	0	0	0	0	0	0
Keawapilau	5	0	0	0	0	5	4
Keawaula	138	5	0	0	0	0	0
Kolekole (east side)	12	0	0	0	0	0	0
Makaha	16	3	0	0	0	0	0
Makua (south side)	56	1	0	0	0	0	0
Nanakuli	5	0	0	0	0	0	0
Punapohaku	302	14	0	0	0	15	9
Puu Kaua (Leeward side)	12	0	0	0	0	0	0
Waianae Kai	224	5	0	0	0	5	4
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				10	0	65	48

Propagation/Germination Techniques

NRS have had a 70% success rate in propagating cuttings of this taxon. NRS have not attempted to propagate *N. humile* from seed but will try to develop a technique with Seed Conservation Lab.

Unique Species Observations

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

NRS have also observed remarkable potential for re-growth in this taxon. *Nototrichium humile* plants have been broken by falling tree limbs and fence construction crews, only two recovered well. In addition, NRS have observed plants that recovered from being heated by fire to the extent that all the leaves were browned. The plants were not burned but experienced significant heat.

Outplanting Issues

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

Research Issues

NRS will work with the Seed Conservation Lab to determine a reliable germination technique for this taxon and apply this in researching seed storage techniques. NRS will also work with the micro-propagation lab to determine the feasibility of tissue culture.

Surveys

No recent surveys have been conducted specifically for *N. humile* and none are planned for the coming year.

Taxon Threats

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

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Nototrichium humile

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Genetic Storage	Partial	No	No
Kaluakauila	Manage for stability	Yes	Partial	Partial
Keawaula	Genetic Storage	No	No	No
Makua (south side)	Manage for stability	Partial	Partial	No
Punapohaku	Genetic Storage	No	No	No

Action Area: Out

TaxonName: Nototrichium humile

MakuaPopulationUnitName	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:

Below is a table of pros and cons for the four current ‘Manage for Stability’ PUs. The rows define how the PUs fit into the following categories. First, if PUs are in the AA. Second, if PUs are in the high fire threat area as defined in the MIT. Third, the overall fire risk for the PU as NRS has defined it. Forth, the total number of mature individuals at each site. Fifth, whether the land owner is cooperative. Sixth, an assessment of assess at the site. Seventh, whether there is existing management for threats on site. If management is in place perhaps there is not as much of a need for the population to be ‘Manage for Stability’. Lastly, is the population an outlier? If so, then it may be important to protect as it may be genetically distinct from the other PUs.

Current ‘Manage for Stability‘ PU Analysis

Issues	Kaluakauila	Mākua	Wai‘anae Kai	Kaimuhole to Palikea gulch
In or Out of AA	In	In	Out	Out
In or Out of AA high fire threat area	In	In	Out	Out
Overall fire risk	High	Moderate	Low	Moderate
Plant numbers	233	75	229	65
Cooperative land owner	Yes	Yes	Unclear	No
Access Good or Bad	Good	Bad	Good	Good
Existing management	Yes	Partial	No	No
Outlier population	No	No	No	Yes

NRS is unsure of access issues in the future. NRS plans on building a few strategic fences to close off narrow gulches protecting this species, *Neraudia angulata*, and *Tetramolopium filiforme,* as soon as permission is granted from the state.

Kaimuhole and Palikea Gulch: NRS knows of two sites in this PU one in Palikea and one in Kaimuhole. Portions of this population have been monitored by NRS in the last year, but there are likely more plants to be found. Founders from the Palikea site PU are represented in the Army greenhouse. NRS plans to construct a fence exclosure around Kaimuhole gulch to protect *Hibiscus brackenridgei* plants. This fence will also benefit *N. humile*. NRS will also be conducting weed control within the forest protected by the exclosure. NRS may augment this population of *N. humile* once protection is in place, in order to represent the Palikea stock in the exclosure. In the matrix above, the largest hurdle to the management of this PU is that at the present time Dole Foods (the landowner) is not interested in participating. The most important pro for management of this PU is that it is an outlier population in comparison to the other PUs. If NRS it to represent the full range of this taxon in the ‘Manage for Stability’ PU it would be an important one to conserve.

Kaluakauila: This population is in a fence and monitored regularly by NRS. The population is robust, and there are many juveniles. Collections of mature seed for storage have been made from a few of these plants. This PU is threatened by fire and much management has been done to control grass around the PU in the last year (see Weed Control Chapter). In the coming year, NRS will continue to manage the site to control fuel and continue to collect from unrepresented plants for storage. In the matrix above, this PU has high plant numbers but is threatened by fire. There is existing management on site but this is the only MIP taxa in the area and justifies most of the work being done. If this PU were re-designated as ‘collect for genetic storage’ NRS would not have strong justification to work in the area.

Mākua (South Side): A comprehensive monitoring of all the gulches encompassed by this PU has never been conducted. Three strategic fences have been built in this PU. In all three areas, the opening to very deep and steep gulches were blocked. At one gulch site, NRS augmented with 18 *N. humile* plants. NRS built two small fences to block the back of Ko‘iahi gulch. This area contains close to one hundred *Neraudia angulata* plants and fifty *N. humile* plants. The plants have been restricted to the cliffs because pigs impacted the habitat in the gulch bottom. However, NRS is optimistic that seedlings will begin to populate the gulch bottom inside the fence. A major weed threat to this population is *A. adenophora*. This is an easy PU for NRS to work with because it is on Army lands. However, access has been restricted to portions of the PU because of ordnance issues. It is unclear if these access restrictions will be resolved. The number of plants may be misleading as a complete survey has not been conducted.

Wai‘anae Kai: Presently NRS estimates 224 plants from Wai‘anae Kai. There is one site with an estimated 200 plants and multiple other sites with relatively low numbers. The 200 plant site is a very deep gulch surrounded by 2000-foot cliffs on all sides. There is no evidence of goats or pigs at the site, but there is alot of goat sign at the mouth of the gulch. NRS spent a few days trying to determine if there are any routes of entry into the gulch from the cliffs. Goats have been observed on the cliffs around the gulch. NRS feels that through the construction of a few strategic fences, the goats and pigs can be kept out. There are minor weed threats around the *N. humile* plants, and NRS hopes to control these in the coming year. Other populations in Wai‘anae Kai will be collected for *ex-situ* management at a nursery or secured planting site. In the coming year, NRS will propose an ungulate control strategy for this area. The matrix above lists pros of large numbers and low fire risk for this population. Unfortunately, it is unclear whether or not the State will support fencing this area.

Other PUs:

Kea‘au: The number of individuals reported in the final IP was based on John Obata’s 1990 estimate and Joel Lau’s monitoring of one individual in 2001. NRS have not visited this area but will attempt to acquire genetic storage collections as it is in the AA and has small numbers.

Keawa‘ula: NRS visited this site in September 2004 and observed 138 mature and five immature trees. This site was impacted by the July 2003 Yokohama wildfire. The forest patch surrounding this population is shrinking with each successive fire. NRS will acquire cuttings from this site to be kept as a living collection in the nursery of another secure site. Fuel loading *P. maximum* is the biggest threat to this site.

Mākua (East Rim): This PU is believed to consist of a single founder based on the HIHNP Botanists’ 1997 observation. NRS has attempted to re-locate this plant without success. NRS will survey the area once more before considering it dead. If it is re-discovered, NRS will collect propagules for genetic storage.

Kahanahāiki: The current number of individuals is based on NRS monitoring of the populations. NRS has established a living collection in the greenhouse grown from cuttings from almost 30 separate individuals in Kahanahāiki. The wild plants are spread out within the PU; a small group is inside the Kahanahāiki fence and a larger group is on the slopes below the exclosure. NRS designated collection from these plants a high priority because of the fire risk to these plants. The July 2003 fire burned into the perimeter of this forest patch.

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

Ke'ālia: NRS has not been to this site but have conducted other surveys in Ke'ālia gulch for *Hibiscus brackenridgei* and have not observed any *N. humile*. NRS will visit this population in the next year in order to collect genetic representation of this population.

Keawapilau: NRS monitored this population this year. A living collection has already been established from cuttings collected from all five plants. Multiple clones made from these cuttings are now successfully potted in the greenhouse. NRS may reintroduce these plants into the Upper Kapuna management unit once it is complete.

Kolekole (East Side): The number of individuals reported in the final Makua IP was based on the HIHNP Botanist's 1994 observation of nine plants at the southern spot, and a NRS observation of four plants at the northern spot in 2000. Since this time, the Navy built an exclosure fence around this northern site. NRS considers this population managed since it falls under the Navy's jurisdiction.

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

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

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

3.19 *Phyllostegia kaalaensis*

Requirements for Stability:

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

Taxon Level Discussion

All known wild populations of this taxon are now extirpated. The causes for its extirpation from the wild are not well understood; NRS will strive to learn more about these factors. All 'manage for stability' PUs will have to be established with reintroductions. One is inside the AA and two are planned for outside the AA. Management has begun in the Keawapilau to Pahole PU including fence building and weed control. There are two reintroduction sites in this PU. These reintroductions have not been very successful. The other two PUs are Makaha and Manuwai. Reintroductions will be planned for these areas once MU-scale fences are in place. Cuttings were salvaged from the Palikea Gulch, Wai'anae Kai and Keawapilau to Pahole populations and are now being maintained as a living collection. As a priority for this taxon, these *ex situ* stocks will be preserved and given the highest level of care. NRS will also ensure that the stock is represented at as many plant propagation facilities as possible. *Phyllostegia kaalaensis* occurs on rock tallus slopes in open gulch bottoms which have been largely overrun by a few weedy species. This habitat is also susceptible to rock falls whether ungulate or human-induced. Pigs also heavily impact this habitat. Stabilizing this taxon will be extremely difficult.

Taxon Status

Action Area: In

TaxonName: Phyllostegia kaalaensis **TaxonCode: Phykaa**

Makua Population UnitName	Management Designation	Num Mature in Final Makua IP	Num Imm in Final Makua IP	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Keawapilau to Pahole	Manage for stability	0	0	0	0	0	0	19	0	0	19	0
Palikea Gulch	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0
	Total for Taxon:	0	0	0	0	0	0	19	0	0	19	0

Action Area: Out

TaxonName: Phyllostegia kaalaensis **TaxonCode: Phykaa**

Makua Population UnitName	Management Designation	Num Mature in Final Makua IP	Num Imm in Final Makua IP	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0
Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0
Waianae Kai	Genetic Storage	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

Genetic Storage

The Seed Conservation Lab has never received seed for storage testing. NRS, the State of Hawai'i and Lyon Arboretum have been successful in storing this taxon via cuttings. If not for the success of this technique, *P. kaalaensis* would be extinct. In 1998, the Genetic Safety Net Program funded collections from very rare plant taxa; *P. kaalaensis* was one taxa selected for collection. These collections were vital in preserving stock from now extirpated populations. The Micropropagation Lab did most of the propagation work for this project. This year, many cuttings were made from greenhouse plants and brought to the Micropropagation Lab in order to have all greenhouse stock represented in tissue culture. NRS will continue to work with the Micropropagation Lab to continue propagating and maintaining stock in both facilities.

Status of Genetic Storage:

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Phyllostegia kaalaensis							
Keawapilau to Pahole	0	0	4	0	2	1	2
Palikea Gulch	0	0	5	0	0	3	2
Waianae Kai	0	0	4	0	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**
				0	4	6	6

Propagation/Germination Techniques

Very little *P. kaalaensis* seed has ever been collected. Seed Conservation Lab received 12 seeds, which they unsuccessfully tried to germinate using a variety of treatments. *Phyllostegia kaalaensis* can be successfully grown from cuttings. NRS has very successfully transferred clones out of vials from the Lyon Micropropagation Lab. When the Micropropagation Lab was contaminated during construction activities, in 2003, NRS transplanted vials of contaminated *P. kaalaensis* individuals into the greenhouse. In the nursery, this taxon is susceptible to insect pests and pathogens and can be difficult to accommodate because it forms long running stems that stretch out of the pots. Each time greenhouse plants are pruned back, cuttings are used to make more clones.

Unique Taxon Observations

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

Outplanting Issues

Two planting of this taxon have been conducted in the last three years and they have had the lowest rate of survival for any taxa planted by NRS so far. The highest survivorship rate for a *P. kaalaensis* outplanting thus far is 32%. Both are in the Keawapilau to Pahole PU, one in Keawapilau Gulch and the other in Pahole Gulch. Details of the outplanting 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. NRS will not hesitate to mix stock from different populations to increase the success of reintroductions, but separate stock will always be maintained *ex situ*.

Founders Represented in Outplantings

TaxonName: Phyllostegia kaalaensis **TaxonCode: Phykaa**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Keawapilau to Pahole	Manage for stability	4	3
Makaha	Manage reintroduction for stability	0	0
Manuwai	Manage reintroduction for stability	0	0
Palikea Gulch	Genetic Storage	5	0
Waianae Kai	Genetic Storage	4	0
	Total for Taxon:	**13**	**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

Outplanting techniques, as stated above, require further research. When stock is available, research is also needed for seed storage techniques.

Surveys

Due to its recent extinction from the wild, NRS and the HINHP Botanist have recently conducted surveys for *P. kaalaensis*. No additional populations have been found. Surveys were conducted with a focus on gulches where this taxon had previously been known. Pahole gulch, Palikea gulch, Kapuna gulch, Keawapilau gulch and ‘Ēkahanui were surveyed. New areas to survey will be identified and more surveys conducted over the next year with the HINHP Botanist.

Taxon Threats

The ultimate causes for extripation are unknown and NRS will try to determine this taxon’s greatest threat. Ungulates impact the preferred habitat of this taxon. Pigs root for food in gulch bottoms, which is precisely where *P. kaalaensis* existed. Weeds that impact *P. kaalaensis* habitat and potential reintroduction sites include, *Ageratina adenophora, Christella parasitica, Aleurities molokana, Rubus rosifolius, Clidemia hirta*, *Buddleia asiatica* and *Schinus terebinthifolius.* The impacts of slugs and rats on this taxon are unknown. NRS do not expect rats to be a substantial threat to this taxon. *Phyllostegia kaalaensis* is also prone to seasonal infestations of white fly and powdery mildew. It is unclear if these pathogens have a significant long-term effect on individual plant survival.

Population Unit Level Discussion

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

Population Unit Threat Control Summary

Action Area: In

TaxonName: Phyllostegia kaalaensis

MakuaPopulationUnitName	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

MakuaPopulationUnitName	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 HIHNP Botanist acquired collections from the Pahole site during Genetic Safety Net collections in 1998. This population was last observed alive in 2000, by NARS staff. The site is protected by the large Pahole exclosure, constructed in 1998. The *P. kaalaensis* population in Pahole was in good condition just before the fence was completed; therefore pigs are not solely to blame for this population's demise. Drought induced by weed invasion may be another possible cause of the population's demise. The Pahole reintroduction was established in November 2004. Currently, there are only 15 plants left of an original 47 planted, but 10 are healthy. Most of these healthy plants are located in light gaps. When this reintroduction was installed by NRS and NARS, plants were purposefully planted in a wide variety of sites from deeply shaded thick fern areas to open exposed areas. It was a surprise to see that plants seem to do best in open sunny areas. These results will be further investigated in future outplantings. This reintroduction has had a disappointing survivorship of only 29%.

Kapuna: No collections were made before the plants disappeared and therefore no stock is available from the Kapuna site. The site could be used for reintroductions in the future, when a fence is built protecting the area.

Keawapilau: NARS staff collected cuttings from this site in 2000. Some of these cutting survived and are represented at the Pahole Nursery. NARS selected a site to reintroduce these plants, and in February 2004, 35 plants were put back into Keawapilau. By July 2004, 15 plants were dead, and at last monitoring in April 2005 only four plants in poor condition remain. This site has a survivorship of about 11%. In the coming year, NRS will work to get stock established *ex situ* at the Lyon Micropropagation Lab.

Before the plantings of both the Keawapilau and Pahole sites, all the shoots were pruned to limit the transpiration rate and allow for acclimation. The plants that were reintroduced had been growing at the Pahole nursery for a number of years and were extremely root bound. This may have influenced outplanting success. NRS applied this lesson learned and planted younger, not root-bound plants for the more recent Pahole gulch reintroduction. At that reintroduction survivorship has been higher. There was substantial rainfall the year of the planting and in combination with hand watering, outplants may have been over-watered.

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

Mākaha Reintroduction : Wai‘anae Kai stock will be used to establish this reintroduction. Appropriate habitat for this taxon will be protected in the coming year through the construction of a 100-acre exclosure. Once protected habitat is available, NRS will select and prepare a site for outplanting. Until this time, stock from Wai‘anae Kai will be maintained in the Greenhouse and Micropropigation Lab.

Other PUs:

***‘Ēkahanui*:** This population has been extirpated for over five years. The area has been thoroughly searched by TNC and NRS and there is no stock available in *ex situ* collections. No reintroductions will be conducted in the southern Wai‘anaes unless stock is re-discovered.

Palikea Gulch: In March 2003, NRS monitored the five remaining plants at this site. They were in poor condition. When the site was monitored again in 2004, no live plants were observed. Collections were made from all five plants and are kept at the Nursery. Stock will be established in test tubes at the Lyon Micropropagation Lab in the next year.

Wai‘anae Kai: The HINHP Botanist monitored this site in January 2004, and no plants were located. Collections were acquired from this PU during Genetic Safety Net collections in 1998 and this stock is available for use in reintroductions.

3.20 *Plantago princeps* var. *princeps*

Requirements for Stability:

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

Taxon Level Discussion

The current distribution of *Plantago princeps* var. *princeps* is focused on mesic cliffs sprinkled throughout the Wai`anae Mountains, however, three sites are known from wetter cliffs in the Ko‘olaus. Of the three wild sites designated for ‘Manage for Stability,’ two are located in the Waianaes, and one was selected in the Ko‘olau Mountains in order to capture this ecotype. Only one of the selected PUs is located in the Action Area (AA). All three of the chosen populations are located on cliffs or steep gulch sides. While the Mohiākea PU is one of the largest, it was not chosen for management since it is located within SBMR, where access is limited. Last year, two new PUs were discovered. The larger PU, on the Kāne‘ohe side of Pu‘u Konahuanui will be assessed to determine manageability. Based on this site assessment, stabilization priorities may be reassessed. Currently this PU is designated ‘Genetic Storage’. Most of the larger wild populations of this taxon show good recruitment. Since this taxon prefers cliff habitat, ungulate threats and weed threats are low. However, at some PUs, NRS have observed significant habitat degradation due to weeds like *Schinus terebinthifolius* and *Melinis minutiflora*. Rat predation has been observed on mature plants in the North Pālāwai and ‘Ēkahanui PUs. Rats may have extirpated one of two of the Pālāwai populations and pose the greatest threat to this taxon in this PU. However, damage has not been observed at any other site besides Pālāwai and ‘Ēkahanui. NRS have been successful in obtaining good genetic storage collections of mature seed from some of the PUs. Augmentations are being planned for the coming year and NRS believe that this taxon has a good prognosis for stability.

Taxon Status

Action Area: In

TaxonName: Plantago princeps var. princeps **TaxonCode: Plapripri**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
North Mohiakea	Genetic Storage	20	3	15	5	0	0	0	0	15	5	0
Ohikilolo	Manage for stability	22	0	22	0	12	0	0	0	22	0	12
Pahole	Genetic Storage	2	2	3	4	9	0	0	0	3	4	9
	Total for Taxon:	44	5	40	9	21	0	0	0	40	9	21

Action Area: Out

TaxonName: Plantago princeps var. princeps **TaxonCode: Plapripri**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Ekahanui	Manage for stability	33	50	34	52	36	0	0	0	34	52	36
Halona	Genetic Storage	75	0	10	17	11	0	0	0	10	17	11
Konahuanui	Genetic Storage			40	5	0	0	0	0	40	5	0
North Palawai	Genetic Storage	2	2	1	0	1	0	0	0	1	0	1
Nuuanu	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
Waiawa (Koolaus)	Manage for stability	16	17	16	17	50	0	0	0	16	17	50
	Total for Taxon:	127	69	102	91	98	0	0	0	102	91	98

Genetic Storage

Very limited genetic storage testing has been conducted with this taxon. Fourteen of the seventeen seed collections received by the Seed Conservation Lab were made in 2004-2005. There are 10,000 seeds in storage from 55 plants at five PUs. Seed from two other PUs has also been collected but no viable seed was present to store. All of these collections have been for storage and no storage testing has been set up other than one six-month test on five seeds, indicating seeds can be stored at -18 C for six months. Cuttings in the greenhouse have been moderately successful. Because seed from the wild plants is too valuable, NRS will maintain greenhouse plants grown from cuttings of wild stock in order to collect more substantial amounts of seed for testing. Seeds are kept both at 4 C and -18 C at 20% relative humidity. Seeds have been pulled from storage after one year for propagation with no decrease in viability. Storage potential and collection schedule can be further evaluated after seeds have been stored for over two years. One seed collection has been brought to the Micropropagation Lab and has been successfully established in culture.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Plantago princeps var. princeps							
Ekahanui	34	52	2	31	0	6	25
Halona	10	17	0	2	0	0	2
Konahuanui	40	5	0	0	0	0	0
North Mohiakea	15	5	1	6	0	1	6
North Palawai	1	0	0	0	0	0	0
Nuuanu	1	0	0	0	0	0	0
Ohikilolo	22	0	2	12	0	3	7
Pahole	3	4	0	1	0	0	0
Waiawa (Koolaus)	16	17	0	6	0	0	1
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				58	0	10	41

Propagation/Germination Techniques

Germination of fresh seeds of *P. princeps* shows variation between plants with initial germination rates ranging from 25%-100%, though the majority are over 60%. Fresh or stored seeds can sometimes take over one month to start to germinate, and germination can last for over two months. Gibberellic acid (GA3) has been applied to sown seeds in attempt to speed up and increase germination but has been determined to have no effect. Seeds have been withdrawn from storage for the first time this year to germinate for propagation. These germination rates are also variable between plants. Germination rates are typically over 50% and range from 25%-100%. Seedlings are easily transferred from agar to perlite/vermiculite with no mortality when two healthy cotyledons are present. This taxon can also be propagated successfully from cuttings.

Unique Species Observations

Plantago princeps fruits year round, but appears to have increased fruiting activity in the spring. Making collections is difficult as rapelling gear is required to access the plants, and it is difficult to time trips so that many plants have mature fruit, and not just empty capsules. In Honouliuli, rat predation as been noted on *P. princeps*. Rats tend to target the fleshy stems and leaves of the taxa.

Seedlings grown in the growth chamber this year for propagation have shown variation in leaf morphology between plants from two different populations within the ‘Ēkahanui PU. All seedlings from one population (EKA-A) of 30 plants have leaves that are longer and thinner than all seedlings (from 4 plants) from another population (EKA-C).

Outplanting Issues

NRS have not yet conducted an outplanting with this taxon, nor have any other agencies attempted to reintroduce it. To reach stable numbers, NRS will need to conduct augmentations. This cliff-dwelling species poses many difficulties for outplanting. At wild sites, ropes are typically used to access plants for monitoring. NRS will use the upper edges and lower ends of cliffs to limit the amount of rope work required for planting. So far, plants have been grown from cuttings and seed but are difficult to keep alive in the greenhouse. NRS is working on developing methods for keeping plants in pots until they are large enough to plant. Outplanting techniques and success will be tested first at the ‘Ēkahanui PU. This PU hosts many wild plants clustered in groups along a long, broken, contouring cliff face. NRS hope to conduct an augmentation on an unpopulated part of this cliff face. The cliff is approximately 30ft tall, and can be accessed from above and below, making it an ideal trial location.

Research Issues

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

Surveys

The HIHNP Botanist, found a large *P. princeps* population on the windward side of Pu‘u Konahuanui near the Pali Highway. This site has not yet been monitored by NRS. In the coming year, NRS will survey this site to determine its’ manageability and collect for genetic storage. No additional surveys are planned for this taxon.

Taxon Threats

Rats, weeds, fire, pigs and slugs threaten *P. princeps*. Rat damage to mature plants has been observed at the Pālāwai and ‘Ēkahanui populations at Honouliuli. Rats may be responsible for the near disappearance of the Pālāwai PU of this taxon. NRS will closely monitor populations and if any rat damage is observed, NRS will deploy rat bait stations and snap traps to reduce the threat. Weed threats to *P. princeps* and its habitat include *Erigeron karvinskianus*, *Schinus terebinthifolius, Rubus argutus, Ageratina riparia, Melinis minutiflora,* and *Blechnum appendiculatum*. Weeds can degrade the habitat surrounding cliffs, and can also alter the cliffs themselves. For example, at Honouliuli, NRS have observed *S. terebinthifolius* change cliff habitat. This tree can root into cliffs; when it grows too large for the substrate to support, it rips away a portion of the cliff side. The other mentioned species, especially *E. karvinskianus,* have a sprawling, or spreading habitat, and can overgrow small niches on cliff faces. *Melinus minutiflora*, in addition to degrading habitat, also increases fuel loads near *P. princeps* cliffs. The ‘Ēkahanui PU, while fairly remote, could be affected by fires; portions of the ‘Ēkahanui MU and neighboring Lualualei burned this year. Goats and pigs threaten portions of some PUs of this taxon and restrict *P. princeps* to cliff habitat. Though no slug predation has been observed on wild plants, damage has been noticed on leaves of greenhouse plants.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Plantago princeps var. princeps

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
North Mohiakea	Genetic Storage	Partial	No	No
Ohikilolo	Manage for stability	Yes	No	No
Pahole	Genetic Storage	Yes	No	No

Action Area: Out

TaxonName: Plantago princeps var. princeps

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ekahanui	Manage for stability	Yes	Partial	Yes
Halona	Genetic Storage	No	No	No
Konahuanui	Genetic Storage	Yes	No	No
North Palawai	Genetic Storage	No	Partial	Partial
Nuuanu	Genetic Storage	Yes	No	No
Waiawa (Koolaus)	Manage for stability	Yes	No	No

Manage for Stability PUs:

‘Ōhikilolo: Additional plants were located during thorough monitoring of this site in 2004 and account for the change in population numbers. These plants do not represent a true increase in numbers, but rather an increase in surveyed area. The plants were monitored again this past year and substantial genetic collections were acquired. NRS have been controlling ungulate threats to this population since 1995, beginning with the construction of a perimeter goat fence along ‘Ōhikilolo ridge. Since 1995, over 1,500 goats have been removed from MMR and are not thought to threaten this site anymore. Once reintroduction techniques are refined, ‘Ōhikilolo will be augmented. No rat predation has been observed at this site. While there are a variety of weeds at the site, it is difficult to perform weed control while on rappel. NRS will continue to evaluate weed threats, particularly *E. karvinskianus, M. minutiflora* and *S. terebinthifolius,* and will conduct control if necessary. NRS will continue to monitor and collect from this PU in the coming year.

‘Ēkahanui: *Plantago princeps* is clustered in three groups along a long, broken, contouring cliff face in South ‘Ēkahanui Gulch. One of the groups was rediscovered this year. It had not been surveyed in a several years and was thought to be extirpated. This group falls between the other two clusters, and reinforces NRS opinion that this cliff is suitable for additional surveys and possible augmentation. Significant genetic storage collections have been made from this PU. Currently, all three groups of plants are protected from ungulates by fencing, cliffs, and steep terrain. However, these barriers are not totally pig-proof, and all the plants will be included in the large ‘Ēkahanui fence planned for year three of the MIP, which will provide complete ungulate protection. Present barriers prevent the majority of pig activity, and have allowed *P. princeps* to colonize a flat area below the cliff. Rat damage has been observed in this PU and rat control is ongoing at these sites. No predation has been seen since May 2004. In the last year, the baiting grid has been significantly expanded to include snails in the area. Rat control data is shown in the table below. Bait take has continued to be high at the *P. princeps* C site, where there are only 2 stations. NRS will consider expanding this grid and adding snap traps to reduce the amount of rat pressure on these plants.

‘Ēkahanui *Plantago princeps* Rat Control Data

2004	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
Mamane ridge	11	160	91	57%	0	0
Plapripri C	2	128	128	100%	0	0

2005	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
Mamane ridge	11	848	368	43%	6	22
Plapripri C	2	128	108	84%	0	0

There are a number of weed threats in the area, including *M. minutiflora* and *S. terebinthifolius*. Last year, a large *S. terebinthifolius* located low on the cliff fell over, dragging part of the cliff behind it. NRS will expand its understory weeding approach to include other perilous *S. terebinthifolius*. In addition, NRS has been spraying *M. minutiflora* around the cliff. This provides valuable fuel reduction. The plants are located 100m from the crestline that borders Lualualei, which burned several times this year.

In the coming year, NRS will work with TNC to select an augmentation site within the fence, probably along the same contouring cliff, for about 50 plants. Seeds collected and stored at the Seed Conservation Lab have been germinated for this project. In addition, NRS withdrew and germinated seeds for planting into Kalua‘ā by TNC in the coming year. This will be the first attempt to reintroduce this taxon and NRS hopes to develop methods to use in the other PUs in coming years.

Wai‘awa: NRS plan to include this population in an ecosystem-sized fence that will protect it and other species that the Army must manage under the Oahu Implementation Plan. Unlike the other known *P. princeps* populations, this one is not located on a cliff. NRS believe the ungulate threat to this PU is low and no control is planned for the coming year. This population was monitored by NRS and HINHP in 2004. No weed threats were observed, although the habitat as a whole is threatened by *Psidium cattleianum* and *Clidemia hirta*. NRS collected a total of 125 seeds from 11 plants in this PU. No cuttings were collected. The change in the numbers of individual plants is a refinement of the age classes and does not represent a significant change in population size or distribution. NRS will monitor and collect from unrepresented plants and plan for the coming fence.

Other PUs:

Pahole: NRS monitored the PU this year, and found 3 mature and 2 immature plants, and 9 seedlings. Further surveys will be conducted as more plants may be in the area, although most of the available habitat for this taxon has already been surveyed. There are very few threats to the Pahole plants. Rat predation has not been observed at the site, the cliff habitat is very intact and native, and the area is fenced and ungulate free. NRS will continue to monitor the area and collect propagules.

North Mohiākea: The North Mohiākea PU is located within Schofield Barracks West Range. 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. The most abundant ecosystem-altering weeds present at this PU are *R. argutus* and *Erigeron karvinskianus*. NRS have acquired some genetic storage collections from this PU but hope to acquire cuttings in the next year. Access to this population requires a helicopter and is unpredictable and unreliable because of the proximity to the live fire range. Therefore, in the coming year, NRS will continue to monitor the site and will collect mature seeds from unrepresented plants, but will not be able to address weed and ungulate threats.

Hālona: In the last year, NRS monitored this site using defined age classes and refined population numbers. This area has not been completely surveyed and more plants may be found. Some genetic storage collections have been made. NRS will re-visit the site to make more collections in the next year. The fires of 2005 burned close to this PU. NRS feel that in the event of another such catastrophic fire, there would be significant fire threat to this PU. In the coming year, NRS plan to mitigate this threat by conducting grass control of *M. minutiflora* on the ridge near the plants. Other weed threats include *S. terebinthifolius* and *Myrica faya*. The area is inaccessible to pigs, but there are goats still in Lualualei. The goats are known from gulches to the north of Hālona, and don't pose an immediate threat to the plants. NRS are planning proactive goat consultation meetings with the Navy to prevent the ungulates from becoming a problem.

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

Nu'uanu: NRS have not monitored this site. NRS will work with the Oahu Invasive Species Committee and State staff to visit it in the next year to monitor the plants, obtain collections and assess threats. The single known plant only had one growing tip, and is not suitable for cuttings.

Konahuanui: NRS have not monitored this PU. In the coming year, NRS will go with the HINHP Botanist to assess the threats to this PU and monitor and collect from all plants. This PU already has stable numbers of individuals.

3.21 *Pritchardia kaalae*

Requirements for Stability:

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

Taxon Level Discussion

Pritchardia kaalae is found in large numbers in two regions of the Waiʻanae Mountains: ʻŌhikilolo ridge and Makaleha gulch to Manuwai gulch. These areas are located in the historical *P. kaalae* habitat belt, which stretches from ʻŌhikilolo ridge to the Kalena-Kaʻala ridge. Last year, NRS and the MIT determined a modified goal for this taxon of three groupings, with 25 individuals each, spread across the historical habitat. This resulted in two of the 'Manage for Stability' sites being chosen in the Action Area (AA). The separation between PUs that was required for other taxa was waived for this species to avoid creating an artificial separation that the MIT does not believe existed historically, see map below. While two of the sites include wild plants, the third includes only reintroduced plants. *Pritchardia kaalae* is easy to grow from seed and outplantings have been extremely successful. However, *P. kaalae* is highly threatened by ungulates, rats and to a lesser extent, weeds. The major challenge for *P. kaalae* management is that outplanted and naturally recruiting young plants may not mature for decades. A very long-term commitment is required to create stable populations with healthy structures. On the other hand, the long lifespan of this taxon may be a significant benefit to its stabilization as extant populations represent a very old genetic make-up.

Taxon Status

Action Area: In

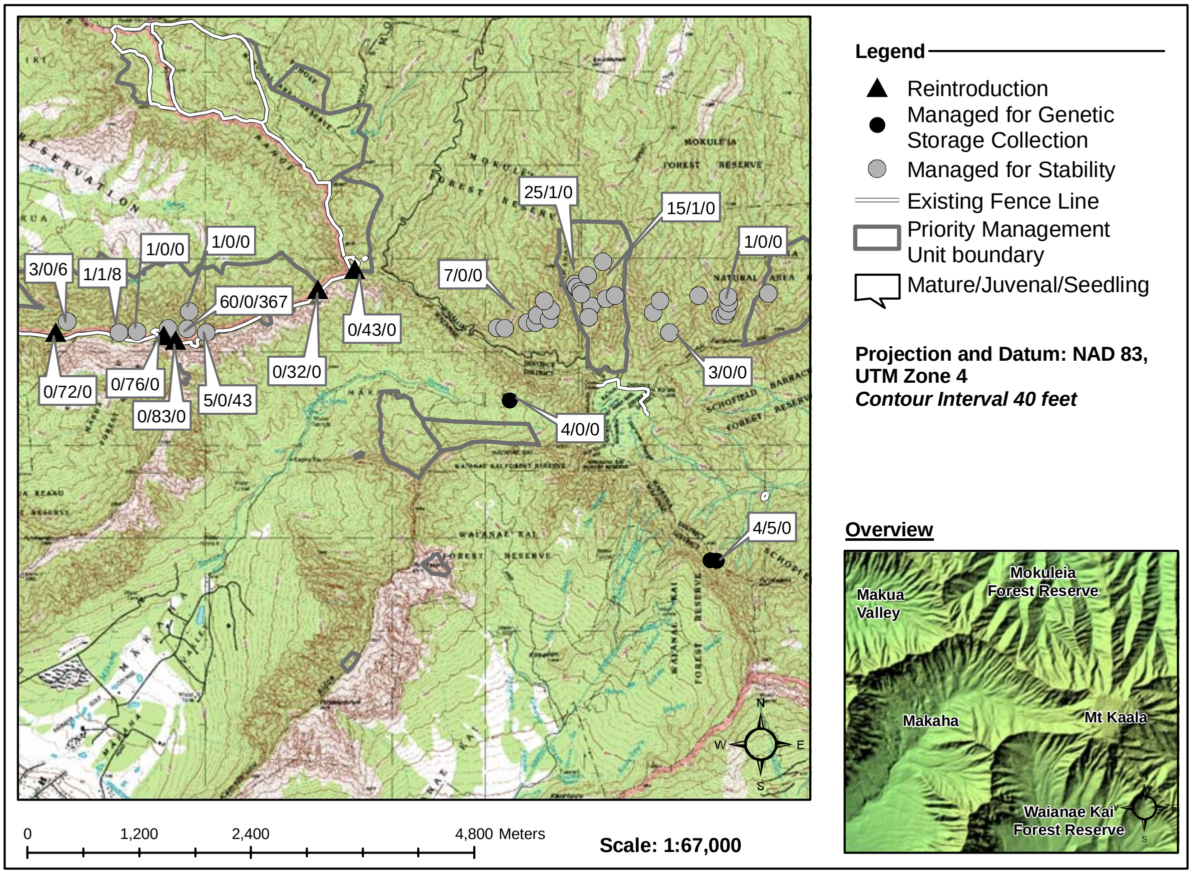
TaxonName: Pritchardia kaalae — **TaxonCode: Prikaa**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Ohikilolo	Manage for stability	72	3	75	3	218	0	274	0	75	277	218
Ohikilolo East and West Makaleha	Manage reintroduction for stability	0	32	0	0	0	0	32	0	0	32	0
	Total for Taxon:	72	35	75	3	218	0	306	0	75	309	218

Action Area: Out

TaxonName: Pritchardia kaalae — **TaxonCode: Prikaa**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Genetic Storage	1	0	4	0	0	0	0	0	4	0	0
Makaleha to Manuwai	Manage for stability	39	3	50	2	0	0	0	0	50	2	0
Waianae Kai	Genetic Storage	7	2	4	5	0	0	0	0	4	5	0
	Total for Taxon:	47	5	58	7	0	0	0	0	58	7	0



***Pritchardia kaalae* Distribution**

Genetic Storage

Seed is the most feasible method of genetic storage, and ongoing research at the University of Hawaiʻi by Hector Perez, a doctoral candidate, will help determine proper storage techniques for this taxon. NRS consulted with A. Yoshinaga from the Seed Conservation Lab regarding the potential for *P. kaalae* to store successfully. He was skeptical that traditional storage methods in refrigeration or freezing would be successful. Based on A. Yoshinaga's recommendation, NRS collected a large batch of fruit to send to the National Seed Storage Lab (NSSL) for further seed storage research. NSSL has the capability to store seed in liquid nitrogen and Mr. Yoshinaga thought this might be required for *P. kaalae*.

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

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Pritchardia kaalae							
Makaha	4	0	0	0	0	0	0
Makaleha to Manuwai	39	3	0	1	0	0	0
Ohikilolo	75	3	0	4	1	30	26
Waianae Kai	4	5	0	0	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**
				5	2	30	27

Propagation/Germination Techniques

Germination of *P. kaalae* seed is conducted in moist sphagnum moss. The moss and shucked seeds are placed in gallon-sized Ziploc bags and placed in a warm location. NRS places these bags on the top of a refrigerator for warmth as the heat stimulates germination. In approximately two months, some germination can be seen, but not all seeds germinate at once. Some take many months to germinate. Seedlings are removed from the bag as they appear and are planted in groups into vermiculite and perlite until more substantial leaves are produced. Larger seedlings are placed individually in potting media. Seeds have also been germinated with traditional methods in vermiculite and perlite. *Pritchardia kaalae* seedlings grow very slowly, plants that are two years old only have 2-3 small leaves. This year, mature and immature seeds were collected for propagation, and the immature seeds were brought to the Micropropagation Lab. Embryos were excised and approximately 50% germinated. These seedlings will remain in culture until they can be transferred to the greenhouse.

Hector Perez conducted seedling establishment studies with *P. remota*. He has yet to formally analyze the data, but based on anecdotal observations, seeds buried in the soil can survive for a significant period of time. Although these species grow in different habitats, the results apply to *P. kaalae* (H. Perez pers. comm. 2004).

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

Unique Species Observations

Minimal information is known about the rate of growth or maturity age of *P. kaalae*. It has been documented that *P. munroi* plants take 15 years to mature in garden setting (M. Brueggman pers. comm. 2004). NRS have observed that at the most successful outplanting sites, trees have grown less than 20cm in a year, while at the least successful sites, almost no growth has occurred. It appears that habitat and microsite play a big role in speeding up and slowing down the already slow growth rate of this taxon. The reintroduced plants are about six years old and are not expected to become reproductive for decades. Very few wild immature plants are known, so NRS are unable to compare reintroductions to wild juveniles. However, in the ‘Ōhikilolo PU there are hundreds of seedlings. These appear to be growing much more slowly than Army greenhouse raised stock.

Outplanting Issues

Pritchardia kaalae reintroductions have been conducted with great success. Initially, NRS tried planting seedlings younger than one year, but their survivorship was only 75% after one year. Since then, NRS started reintroducing plants at least two years old. Plants of this age seem to adjust better than younger plants to outplanting. NRS planted 264 individuals of *P. kaalae* into five sites, and 234 plants are still surviving (89% survivorship). Most are healthy, although some are growing more quickly than others. Most of the mortality occurred at two sites: one that was impacted by feral pigs and another located in a windy environment. This year, 37 plants were reintroduced into one site, with 100% survivorship.

NRS work to balance founders at each outplanting site using stock from the appropriate PU. The reintroductions in the ‘Ōhikilolo PU are made with ‘Ōhikilolo stock. No reintroductions have been made in the Makaleha to Manuwai PU. Founders from both of these wild PUs were used in creating the reintroductions in the ‘Ōhikilolo East to West Makaleha PU. The strategy behind this is to simulate the continuum of genetic types that existed before *P. kaalae* populations were fractured into their current disparate state.

Research Issues

The graduate researcher has simulated seed damage in *P. kaalae* by removing endosperm to see how it affects seed germination. Results showed that removal of up to 42.5% of the endosperm actually stimulated germination; germination happened twice as fast as in untreated seeds. Any damage to the endosperm over 42.5% and up to 72.5% decreased germination of *P. kaalae* seeds. This research shows that limited damage to the fruit may facilitate recruitment by breaking seed dormancy early. Also, rapid and complete germination may be an adaptive response to predation.

Seed dormancy research is also being conducted for *Pritchardia kaalae*. Preliminary results show that *P. kaalae* seeds exhibit both physiological and morphological dormancy. (H. Perez, pers. comm. 2004).

Surveys

This year, NRS conducted aerial surveys in Mākaha and found additional plants. See Mākaha PU section for further discussion of this survey.

Taxon Threats

NRS has been monitoring the ʻŌhikilolo population of *P. kaalae* for almost 10 years. Based on this monitoring, NRS believe the largest threats to *P. kaalae* are goat predation of seedlings and rat predation of fruit. For many years, wild populations have shown little or no recruitment because the impacts of both these predators stopped effective reproduction. Prior to management, the wild populations were primarily composed of mature trees with very few immature plants. With management, NRS are seeing many seedlings, some of which are just reaching immaturity. Most of the wild populations are restricted to steep areas where pigs are either not present in high numbers or not present at all. Where pigs are a threat, they should be controlled. In the Koʻolau Mountains, *P. martii* fruit are often eaten by pigs. Pigs can also have an impact on young *P. kaalae*, especially reintroductions. At one reintroduction site unprotected from pigs, nearly 40% of the plants were uprooted by pigs. NRS has not observed impacts to this taxon from slugs. Weeds also impact *P. kaalae.* In particular, *Erigeron karvinskianus* has significantly altered habitat for a related *Pritchardia* species at Honouliuli Preserve. NRS conduct weed control at accessible *P. kaalae* populations.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Pritchardia kaalae

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Ohikilolo	Manage for stability	Yes	Partial	Partial
Ohikilolo East and West Makaleha	Manage reintroduction for stability	No	No	No

Action Area: Out

TaxonName: Pritchardia kaalae

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Genetic Storage	No	No	No
Makaleha to Manuwai	Manage for stability	No	No	No
Waianae Kai	Genetic Storage	No	No	No

Manage for Stability PUs:

ʻŌhikilolo: There are many wild populations and reintroductions included in the ʻŌhikilolo PU. The reintroductions face weed and ungulate threats, while the wild plants face weed, ungulate, and rat threats. Management is conducted around three wild sites, and three reintroductions. Management is not conducted around some very remote wild outliers. Such plants are often located on cliffs and difficult to access, or have poor habitat quality around them. However, all of the wild populations, including the outliers, were monitored this year. NRS observed 72 mature and three immature plants, and approximately 400 seedlings. All the sites are protected from goats by the ‘Ōhikilolo ridge crest fence, constructed in 1998. Since then, almost all goats have been removed from Mākua Valley. Some of the populations are protected doubly by two smaller exclosures, which were erected before goat populations in Mākua were reduced. Due to the steep terrain of ‘Ōhikilolo, the area is inaccessible to pigs.

NRS conducted weed control in the habitat around the six managed *P. kaalae* populations. Some of the most problematic weed species in *P. kaalae* habitat include *Schinus terebinthifolius*, *Blechnum appendiculatum*, *Erigeron karvinskianus,* and various grass species.

NRS administers rat bait and deploys snap traps around the three managed wild sites of *P. kaalae* on ‘Ōhikilolo. NRS re-stock 44 rat traps quarterly, 16 more than last year. Baiting began in 1997 in the Prikaa-A patch (see baiting data table below). This year the amount of bait taken was about average compared to the last four years. The total bait consumed was 92% of the total bait available.

Baiting Data by from 1997-2005

Year	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
1997	6	221	187	85%	5	30
1998	6	176	114	65%	1	24
1999	6	224	180	80%	2	12
2000	6	252	249	99%	3	12
2001	7	448	448	100%	6	12
2002	15	928	488	53%	7	12
2003	15	720	671	93%	7	12
2004	15	720	659	92%	9	12
2005	15	720	661	92%	7	16

NRS has detected a trend in bait take and subsequent rat pressure in the Prikaa-A baiting area. Typically, the take is low in the winter months, specifically during the month of December, and it goes up during the summer months, starting in April into June and August. The amount of bait take has followed this general trend since 1997. NRS recommends that the ‘Ōhikilolo *Pritchardia kaalae* baits be restocked more frequently during these summer months when rat pressure is greatest.

The presence of ripe fruit increased dramatically once predator control began and subsequently the number of seedlings has also increased at all three sites. As a result of management, seedling populations have rocketed in the managed wild populations; approximately 400 seedlings were observed this year. This is a marked increase from previous years. NRS collected from underrepresented plants this year, and will continue to do so in the future.

Makaleha to Manuwai: The number of individuals reported in the final Makua IP was based on Joel Lau’s estimates of trees observed, many from afar, between 1991 and 2001. NRS monitored some of the more accessible trees in the last year. The 50 mature reported reflect these areas monitored by NRS. There are still substantial numbers of inaccessible plants on the cliffs, which have not been included in this total. NRS plans to manage the portion of this PU that is accessible within the East Branch of East Makaleha in year four. This falls within the proposed East Makaleha MU. At least 40 plants will be included in the fence. The threats to *P. kaalae* in this area include rats, ungulates, and weeds.

NRS has just recently begun working at a site in the East Branch of East Makaleha. NRS has coordinated with the NARS Specialist to identify accessible trees for genetic storage collection, as well as to implement a rat control program. NRS administers rat bait twice a quarter to protect the fruit of *P. kaalae*. Nineteen bait stations and 24 snap traps are currently deployed in three grids around three groups of accessible trees at this site (see Rat Data for Makaleha table below). There are 25 mature trees and one immature encompassed in the baiting grid. Only two trees are represented in genetic storage; the fruit from these trees were collected from bags tied on to inflorescences three years earlier by the NARS Specialist. NRS will continue rat control to facilitate genetic storage collection and population health and will consider the bagging technique used by the NARS Specialist.

Rat data for Makaleha *P. kaalae*

Year	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
2004	19	480	374	78%	10	23
2005	19	1024	477	47%	36	24

Both pigs and goats abound in the area. NRS will work with DLNR to develop fencing plans for East Makaleha and implement those once permissions are in place. This fence is scheduled to be built in year four of the MIP. In the meantime, NRS continues to conduct goat control hunts in the adjacent Mt. Ka‘ala NAR. These hunts are likely also reducing goat numbers within East Makaleha. This control will continue and NRS will pursue acquiring permission to implement more directed goat control in the vicinity of the *P. kaalae* plants in East Makaleha as goat sign has been observed at the site. Weed control at the site will begin once a plan is developed with the State.

‘Ōhikilolo East to West Makaleha (reintroduction): This PU consists of two reintroductions established at sites mid-way between the core wild populations. One reintroduction was established in 2002 in West Makaleha. It is within a two-acre exclosure originally constructed to protect *Cyanea grimesiana* plants. Forty-six plants were outplanted and only three died. Although survivorship is high at this site, it is windward-facing and exposed. During windy periods, the *P. kaalae* outplants experience more wind than they would in a more forested site. The most protected plants exhibit greater growth and are healthier than the exposed plants. If NRS supplements this planting, it will be done in a more forested portion of the fenced area. The primary weed threats to the plants are *Rubus argutus* and *Melinis minutiflora*. While rats are not a threat to the young outplants, they do threaten the *C. grimesiana* in the exclosure, and a rat grid is in place. The grid encompasses part of the outplanting.

The second reintroduction site was established in exceptional habitat along the eastern portion of ‘Ōhikilolo ridge in 2002. The site is within the ‘Ōhikilolo ridge fence, and is protected from goat predation. The terrain is very steep. However, the reintroduction is on one of the few ridges which connects smoothly to the valley floor, and is not protected from pigs. Plantings were initially successful, but were later decimated by pigs. Many plants were ripped out of the ground. NRS believe the pigs were attracted to the potting soil as the plants were not destroyed just uprooted. NRS sets snares in the area, but they did not provide enough protection from pig damage. The plants that have survived are growing very well, and NRS believe this site is very viable. Prior to further outplanting, NRS plans to construct an exclosure around the site. The fence has been surveyed, and building permission is being sought. Since the area is of high quality, little weed control has been done in the area. The primary weed threats are *S. terebinthifolius* and *M. minutiflora*.

Other PUs:

Mākaha: NRS had monitored this site from afar through binoculars, and this year conducted an aerial survey by helicopter. Four mature plants are now mapped as a result of this survey, and all are in very inaccessible areas. NRS will further scope the area to determine if plants can be reached. Surrounded by weeds, these plants are tall and spindly. Goats are known from the area, and NRS assumes that rats are present as well.

Wai‘anae Kai: NRS conducted rat control at this site to facilitate genetic storage collections. Some fruit was collected and put into *in vitro* storage at the Micropropagation Lab. Seed was also germinated and grown into healthy plants, which are now being held at the Lyon Arboretum greenhouse. Rat control at the site is very expensive, as helicopters are needed for access. NRS halted rat control efforts as the population is already represented *ex-situ*. NRS will attempt to gain 100% representation from the wild. If rat control is deemed necessary to reach this goal, NRS will revisit this as an option. Future collections will also be put into *in vitro* storage or grown out and stored in a botanical garden setting. Furthermore, NRS will work to find a location to plant *ex-situ* plants in the ground.

3.22 *Sanicula mariversa*

Requirements for Stability:

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

Taxon Level Discussion

Presently there are four known locations of *S. mariversa*. Three of the populations are designated as ‘manage for stability.’ Two of thes are located in the Mākua Action Area (AA) (‘Ōhikilolo and Kea‘au). ‘Ōhikilolo is in the lowest fire threat area of the AA. The third population is located off-site, at Kamaile‘unu. The last site is designated for ‘genetic storage’ and is located off-site at Pu‘u Kawiwi.

As a taxon, *S. mariversa* is challenging to monitor. Changes in population numbers since the final IP do not necessarily represent trends. *Sanicula mariversa* is perennial, lying dormant for the summer and becoming foliated in winter. In addition, individual plants sometimes do not appear each year. This taxon flowers inconsistently, but when plants flower, they do so in spring. Plants appear to die after flowering. Because of these characteristics, an effective monitoring program has been difficult to develop. NRS has experienced some success in reintroducing both *S. mariversa* and *S. purpurea*. The stability requirements for this taxon need to be revisited by the IT. NRS propose using an average of plants at various stages of maturation. Perhaps a five year average of 25 matures, 50 immatures, and seedlings present yearly would be a more suitable goal for this taxon. The stability prognosis for this species is mixed. There are large PUs and NRS has been able to control ungulate threats and plan to expand control measures. NRS has also made substantial collections. Challenges remain with monitoring issues and reintroduction techniques.

Taxon Status

Action Area: In

TaxonName: Sanicula mariversa **TaxonCode: Sanmar**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Keaau	Manage for stability	7	100	14	69	0	0	0	0	14	69	0
Ohikilolo	Manage for stability	1	62	0	51	0	0	0	0	0	51	0
	Total for Taxon:	8	162	14	120	0	0	0	0	14	120	0

Action Area: Out

TaxonName: Sanicula mariversa **TaxonCode: Sanmar**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kamaileunu	Manage for stability	13	22	3	16	0	0	0	0	3	16	0
Puu Kawiwi	Genetic Storage	0	32	0	32	4	0	0	0	0	32	4
	Total for Taxon:	13	54	3	48	4	0	0	0	3	48	4

Genetic Storage

Since cuttings are not a potential method of collection due to this taxon's solitary stem habit, seed is the only means of genetic storage. However, the Seed Conservation Lab and the Micropropagation Lab have not had success germinating fresh *S. mariversa*. Possibly reflective of this species' lifecycle, seeds appear to have some complex type of dormancy. Seeds withdrawn this past year after three and five years of storage had over 60% germination. Stored seeds sown in May took over seven months to start germinating. Stored seeds sown in December only took two months to start germinating. This information may infer that seeds need a period of colder temperatures to break at least one level of dormancy. No preferred storage condition has been identified. Seeds from this taxon obviously have some degree of storage potential, and overcoming dormancy of fresh seeds will help define the taxon's potential and preferred storage condition. NRS has good storage representation of the three *in situ* 'manage for stability' populations. There are 4,750 seeds in storage from 42 plants (one with < 10 seeds) in the Kea'au PU, 5,339 seeds from 42 plants in the Kamaile'unu PU, 2,071 seeds from 48 plants in the 'Ōhikilolo PU, and 186 seeds from one plant in the Pu'u Kawiwi PU. Refinement of genetic storage goals for this taxon are uncertain until better seed storage data is obtained.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Sanicula mariversa							
Kamaileunu	3	16	41	42	0	0	36
Keaau	14	69	29	41	0	0	32
Ohikilolo	2	100	74	48	0	0	15
Puu Kawiwi	0	32	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**
				132	0	0	84

Propagation/Germination Techniques

At the Seed Conservation Lab, fresh seeds sown on multiple substrates under many different germination treatments were tested for two years with no germination. If a period of cold temperature is necessary to break dormancy in stored seeds but not fresh, seeds may have a deeper, more complex level of dormancy. Fresh seeds tested prior to 2005 were kept in a greenhouse set at one temperature and not exposed to seasonal variation. Seeds collected this year are being tested in a growth chamber with seasonal variation starting in June. If still unsuccessful, hopefully a bulk collection of seeds can be made for dormancy testing by Dr. Carol Baskin at the University of Kentucky. Also, based on the previous success of NRS to germinate seeds in potting media (50% germination), germination methods at the Seed Conservation Lab may be inappropriate for this taxon, and further collections can be tested in potting media.

Unique Species Observations

NRS have observed very unpredictable population fluctuations in this taxon. NRS feels there are many factors that contribute to these fluctuations. Individual plants take many years to mature and do not appear to emerge each year. Environmental conditions might also impact a plant's life cycle, including length of time to reach maturity and length of dormancy periods. In addition, there may be a succession of cohorts that move through age classes at similar rates after large seed production years or favorable germination conditions. As far as mature reproductive plants, NRS has never observed a *S. mariversa* plant to reproduce twice. They appear to die after flowering. The unpredictable fluctuation in population numbers is well illustrated in the Population Unit Status Table. For example, the IP number was 34 mature, compared to this year with two matures. The IP year was one of the best years we have seen for this population. In contrast, the Pu'u Kawiwi population had two matures in the final IP and although there are no matures today, NRS recorded 32 immature individuals where none were seen in previous years. There is much more to be understood about the population fluctuations in this species. NRS feels that the IT needs to reconsider the population targets for this taxon and consider developing a system that looks at trends over a longer period to better understand what constitutes stability for *S. mariversa*.

Outplanting Issues

NRS reintroduced *S. mariversa* into the 'Ōhikilolo fence exclosure in 2001. Plants were observed in 2002 and 2003 but have never been seen again. NRS suspect that all plants are dead but are not certain. The dormancy cycle of *Sanicula* makes it difficult to rate reintroduction success. NRS will continue to monitor this reintroduction in hope that plants will re-emerge.

NRS initiated two seed sowing trials in 1999 at two different sites on Ohikilolo. Only one plant was ever observed. NRS has not monitored the seed sowing sites consistently since the initial planting and thus do not have reliable data on results. NRS will re-monitor the sites in the coming wet season. NRS will not conduct future seed sowing trials or reintroductions until a better understanding of this taxon is obtained.

Research Issues

The primary research issue for this taxon is the determination of stability goals through understanding population fluctuation dynamics. See discussion above.

In addition, seed storage research needs to be conducted to determine the optimal seed storage technique. See Genetic Storage and Propagation/Germination Techniques discussions above.

Surveys

No surveys were conducted for this taxon in the last year.

Taxon Threats

The largest threats to this taxon are goats and weeds. *Sanicula mariversa* are found on exposed ridge crests, habitat also preferred by feral goats. Goats traverse areas that contain *S. mariversa* populations, destroying habitat and causing erosion. NRS has observed direct goat browse on *S. mariversa* at Kea‘au. Weeds also invade *S. mariversa* habitat. In particular, alien grasses such as *Melinus minutiflora, Setaria gracilis*, *Andropogon virginicus* and *Rhynchelytrum repens* are well established to varying degrees at all the populations of this taxon. NRS has begun controlling weed threats at ‘Ōhikilolo and will begin to do the same for other populations once goat exclosures have been constructed.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Sanicula mariversa

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kamaileunu	Manage for stability	No	No	No
Puu Kawiwi	Genetic Storage	No	No	No

Manage for Stability PUs:

‘Ōhikilolo*:* There are two sites on ‘Ōhikilolo where *S. mariversa* is found. The makai site has been monitored regularly since the inception of the Army program in 1995. The makai site has many more plants than the mauka site. The most current and accurate monitoring number for the makai site is two mature and 51 immature plants. The table below illustrates monitoring numbers since 1998 for this site.

Monitoring Date	March 1998	May 1999	March 2001	January 2000	March 2002	March 2003	April 2004	February 2005
Mature/Immature/Seedling	0/12/0	27/35/0	80+ total	15/35/20	48/60/30	10/0/0	1/50/0	0/51/0

This year NRS searched but saw no plants at the Mauka site. In addition, there are no plants known at the augmentation site that was established in 2001. Substantial collections have been made from the Makai site in 1999 and 2002. Population numbers vary drastically by year. It is difficult to determine actual population size for reporting purposes but NRS are working to better understand population trends for this taxon. NRS have been controlling ungulate threats to this population since 1995, beginning with the construction of a perimeter goat fence along ‘Ōhikilolo ridge. There have been no goat impacts to this area. NRS has been conducting weed management around the *S. mariversa* sites. (See weed chapter for discussion.)

Kamaile‘unu: This population of *S. mariversa* was discovered just before the MIP was finalized. Since NRS has acquired a substantial seed collection from the site. The most significant threat to the Kamaile‘unu population is goats. Goats have made many trails through the population. NRS flagged some flowering plants in the spring of 2003 so that the fruit could be more easily located upon return in the summer. Goats had trampled the dried peduncles and disturbed the ground so much that even these flags were difficult to see and in a few cases impossible to find. NRS surveyed a route for a fenced exclosure to protect this population and expects that this fence will be completed within the next year, once permitting is complete. When the fence is finished NRS will begin to address the weed threat on-site and develop plans for control.

Kea‘au: NRS has monitored the Kea‘au population of *S. mariversa* since 1999. As discussed above, monitoring data varies dramatically for this taxon as a whole because of its life history.

Monitoring Date	May 1999	June 2001	June 2002	July 2004	June 2005
Mature/Immature/Seedling	16/13/0	1/7/3	21/22/5	7/100/0	3/16/0

No goat control has been conducted in the vicinity of this population because it is located within a State of Hawai‘i Public Hunting Area. In the Hunting Area, goats are the managed resource. Unfortunately, the *Sanicula* site is at the back of the hunting area and thus is not frequently hunted. NRS will pursue the construction of the Kea‘au and Mākaha MU, which will protect this population from goat impacts. This population, similar to the others, has been impacted by goat-induced erosion. The Kea‘au population has the same suite of alien grasses present at other populations, but NRS has not yet conducted any weed control at the site. NRS will acquire permissions necessary to fence this population and conduct weed control at the site once fencing is complete.

Other PUs:

Pu‘u Kawiwi: NRS has been monitoring this population since July 2003 and only immature plants have been observed over the years. This year, NRS had expected to find some mature plants as there were many immature plants seen in 2004. However, a thorough search failed to identify mature plants. NRS will continue to monitor this population and expect that immature plants seen in previous years should reach mature stages in the next couple years. NRS has proposed strategic fencing to protect the population from goat impacts. NRS expects to install this fencing in the next year.

3.23 *Schiedea kaalae*

Requirements for Stability:

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

Taxon Level Discussion

At last years meeting, the IT and NRS chose three Wai‘anae PUs to manage for stability. Two are wild populations with one lying inside the Action Area (AA). The third PU is an introduction site in Central Kalua‘ā. NRS believes that the population designations should be re-visited by the IT. At present, NRS believe that there are five populations that should be considered for the ‘manage for stability’ designation. These include Ma‘akua, Pahole, Kalua‘ā, ‘Ēkahanui and Kahana. There is further discussion of this topic in the PU section. To date, none of the PUs have “stable numbers”. NRS is unsure of the stability prognosis for this species. NRS has had success collecting seed and reintroducing this species. Outplantings have performed well. NRS can control ungulate threats to PUs and *S. kaalae* appears to be resilient in weedy conditions. Unfortunately, NRS has only seen regeneration of this taxon in Ko‘olau PUs and suspect that slugs severely impact this taxon’s ability to germinate in the wild.

Taxon Status

Action Area: In

TaxonName: Schiedea kaalae **TaxonCode: Schkaa**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Pahole	Manage for stability	1	0	1	0	0	0	0	0	1	0	0
	Total for Taxon:	1	0	1	0	0	0	0	0	1	0	0

Action Area: Out

TaxonName: Schiedea kaalae **TaxonCode: Schkaa**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0
Kahana	Genetic Storage	11	0	5	2	0	0	0	0	5	2	0
Kaipapau	Genetic Storage	2	0	0	0	0	0	0	0	0	0	0
Maakua (Koolaus)	Genetic Storage	4	0	16	0	0	0	0	0	16	0	0
Makaua (Koolaus)	Genetic Storage	2	0	1	1	0	0	0	0	1	1	0
Mohiakea	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
North Palawai	Genetic Storage	1	0	1	0	0	0	0	0	1	0	0
South Ekahanui	Manage for stability	5	0	14	0	0	0	46	0	14	46	0
	Total for Taxon:	26	0	38	3	0	0	46	0	38	49	0

Action Area: Reintro

TaxonName: Schiedea kaalae **TaxonCode: Schkaa**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kaluaa and Waieli	Manage for stability	0	0	0	0	0	40	25	0	40	25	0
	Total for Taxon:	0	0	0	0	0	40	25	0	40	25	0

Genetic storage

Sufficient collections for genetic storage have been difficult for this taxon. It is difficult to secure a large number of seeds at any given time as plants often do not produce high numbers of mature seed at one time. Rather, seeds mature in slow succession over a period of months and frequent visitation would be necessary. In addition, many of the Ko‘olau PUs are in remote areas that are difficult to access and frequent visitation is impractical. However, both seed and cuttings have been tested and can be established in tissue culture or in the greenhouse at the Micropropagation Lab. There are 6,496 seeds stored from 19 plants from four PUs. Over half of the stored seeds were received from Dr. Stephen Weller from first generation greenhouse plants at U.C. Irvine. Weller made these original seed collections from four plants in the late 1980’s to early 1990’s, three of which died before NRS was able to collect. The majority of the remaining banked seeds are from plants in the South ‘Ēkahanui PU.

Only one small seed lot has been designated for testing. Results suggest that seeds store better frozen than at room temperature. Seeds were withdrawn from storage this year for propagation. Refrigerated seeds stored for three years had 100% germination. This is the oldest collection in storage. If possible, a bulk collection from the greenhouse may be used to further test storage longevity for this taxon. Dr. Stephen Weller has also successfully stored refrigerated seed for several years. Based on this data and high storage potential for *S. obovata*, storage potential for this taxon is probably high, and seeds can be stored for at least five years before recollection is necessary.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Schiedea kaalae							
Huliwai	0	0	1	1	0	1	1
Kahana	5	2	0	0	1	0	0
Kaipapau	0	0	2	0	2	0	1
Maakua (Koolaus)	16	0	0	0	3	0	2
Makaua (Koolaus)	1	1	0	0	2	0	0
Mohiakea	1	0	0	0	1	0	0
North Palawai	1	0	0	1	0	0	1
Pahole	1	0	2	2	0	2	2
South Ekahanui	17	0	0	12	2	12	14
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				16	11	15	21

Propagation/Germination Techniques

Testing of fresh seeds at the Seed Conservation Lab indicates that no special germination requirements are necessary, and seeds sown on agar are easily transferred to perlite/vermiculite. Seedlings are grown in an environment-controlled growth chamber for one-three months before moving to the greenhouse. Germination rates for fresh seeds vary; most germination is over 75%, but occasionally some collections have very low germination, less than 15%. Three small collections from one single plant in the South ‘Ēkahanui PU were made this year. No seeds germinated from the first two collections, yet the third collection had 100% germination. Seeds need to be collected when fruit capsules have dehisced and are dry and brown (see picture). Seeds of this taxon, similar to other species in this family, may also have some varying degree of physiological dormancy. TNC has worked with this species for some years and has successfully collected seed, grown plants in the greenhouse, and reintroduced plants. Thus, NRS do not expect any propagation challenges.

Mature fruit of *Schiedea kaalae*

Unique Species Observations

NRS observed vegetative reproduction in two forms. A plantlet was seen growing off of a mature infructescence in Ma‘akua gulch. Dan Sailer from TNC reported that he had seen this once previously in Honouliuli. In Makaua, a leaf lying on the soil developed roots. NRS hasn’t returned to monitor progress of this plant since it was first seen. NRS will return to the area in the next year and the GSN program may go sooner.

Outplanting Issues

To date, there are three different outplanting sites in Honouliuli. Two are managed by TNC staff, one in South ‘Ēkahanui and the other in Central Kalua‘ā. These two sites were planted with a mix of stock from the wild populations in ‘Ēkahanui, Kalua‘ā, and Pālāwai. NRS worked with TNC staff to establish a third large outplanting site in Central Kalua‘ā this year which blended stock from wild populations in ‘Ēkahanui, Mohiākea, and Pālāwai. NRS plan to balance founders from these areas and add stock from Kalua‘ā and Huliwai. Mixing is performed because of extremely low population numbers and few protected sites. In all three sites, there appears to be good survivorship but F1 seedlings or juveniles have not been observed.

Founders Represented in Outplantings

TaxonName: Schiedea kaalae **TaxonCode: Schkaa**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Huliwai	Genetic Storage	1	0
Kahana	Genetic Storage	7	0
Kaipapau	Genetic Storage	2	0
Kaluaa and Waieli	Manage for stability	0	0
Maakua (Koolaus)	Genetic Storage	16	0
Makaua (Koolaus)	Genetic Storage	2	0
Mohiakea	Genetic Storage	1	1
North Palawai	Genetic Storage	1	1
Pahole	Manage for stability	1	0
South Ekahanui	Manage for stability	14	5
	Total for Taxon:	45	7

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

Research Issues

Slugs are thought to pose the most significant threat to this population. TNC has initiated trials to begin to determine the impacts of slugs on this taxon. Formal investigation into a related species (see Research Issues *S. obovatum*), suggests slugs likely impact *S. kaalae* as well. Federal biologists consider slugs to be an "immediate and significant threat" to *S. kaalae* survival (U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices), though these conclusions are based on anecdotal observations. NRS recently hired an Invertebrate Research Specialist to investigate slug control options for this species.

Surveys

Presently, there are surveys planned to look for this taxon with the HINHP Botanist. In addition, NRS will assist GSN staff to survey more areas in the Ko'olau Mountains.

Taxon Threats

As mentioned previously, NRS believe that slugs are a major threat to the natural recruitment of this species. Pigs are also a significant threat as this species prefers gulch bottom and lower slope habitats. Some *S. kaalae* PUs are located in poor quality habitat consisting of predominately alien forest. Rats have not been seen to impact this taxon, however, they may be a possible threat.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Schiedea kaalae

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Pahole	Manage for stability	Yes	No	No

Action Area: Out

TaxonName: Schiedea kaalae

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Huliwai	Genetic Storage	Yes	No	No
Kahana	Genetic Storage	No	No	No
Kaipapau	Genetic Storage	No	No	No
Maakua (Koolaus)	Genetic Storage	Yes	No	No
Makaua (Koolaus)	Genetic Storage	Yes	Partial	No
Mohiakea	Genetic Storage	Yes	Yes	No
North Palawai	Genetic Storage	Yes	Yes	No
South Ekahanui	Manage for stability	Yes	Yes	Partial

Action Area: Reintro

TaxonName: Schiedea kaalae

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kaluaa and Waieli	Manage for stability	Yes	Yes	Yes

Manage for Stability PUs:

As noted in the introduction, NRS believes that the PU designations should be re-visited by the IT. At present, NRS believe that there are five populations that should be considered for the ‘manage for stability’ designation and that changes are needed. The PUs include Ma‘akua, Pahole, Kalua‘ā, ‘Ēkahanui and Kahana. There have been new plants discovered in the Ma‘akua PU making it many times larger than other PUs. In addition, there has been natural regeneration seen on site. Lastly, the site is topographically protected from ungulates and has high quality habitat. In contrast, the Pahole PU (that is currently designated ‘manage for stability’) has only one plant and no germination has been reported. This site is in the AA but NRS has not seen the site and access issues are unclear with the State. The ‘Ēkahanui PU has large numbers of wild plants but most are nested within outplantings of greenhouse stock of unknown parentage. NRS is unclear how this may impact proposed augmentations as the population founders are unclear. The Kalua‘ā reintroduction was designated as a ‘manage for stability’ site in part because of this mixing at ‘Ēkahanui. However, NRS is unsure that a reintroduction site should be designated instead of relatively healthy wild populations like Ma‘akua. The Kahana PU is also worth consideration as there has been regeneration at the site. Unfortunately, it would be difficult to fence and there are significant weed threats in the area. More details on these PU are discussed below.

Pahole: The NARS Specialist monitors the remaining plant and collects propagules. NRS have obtained seeds for both genetic storage and augmentation into the Pahole PU. Some of the seeds have been germinated for planting this winter, pending permission from NARS staff. No weed control has been conducted around the plant. NRS will continue to seek permission to visit the site.

South ‘Ēkahanui: NRS has observed 14 mature wild plants in ‘Ēkahanui. NRS and TNC staff have been monitoring these plants quarterly. All of the plants are within fences and seeds have been collected from all plants for genetic storage and augmentation. In the coming year, NRS will continue to assist TNC in monitoring the plants, collecting mature seed, maintaining the fences, and conducting weed control. Propagules collected from these wild plants will be grown and introduced into protected areas in Kalua‘ā. Currently, TNC maintains an augmentation site around the wild plants that is comprised of plants from ‘Ēkahanui, Kalua‘ā, and Pālāwai. NRS assists TNC in making seed collections from these planted individuals for their use in this and other outplanting sites. As mentioned above NRS has outplanted this stock into the Kalua‘ā PU and are unclear about augmentations at this site.

Central Kalua‘ā: There are two separate outplanting sites located in the larger Kalua‘ā fence. TNC maintains one site in the gulch that consists of plant stock from ‘Ēkahanui, Kalua‘ā, and Pālāwai. NRS manages another site, higher in the gulch, that contains genetic stock from ‘Ēkahanui, Mohiākea and Pālāwai. 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 plan to introduce more plants to balance the number of founders and also introduce genetic stock from North Kalua‘ā and Huliwai at the site NRS manages.

Other PUs:

Huliwai: In July of this year, a cutting was taken to the Lyon Arboretum Micropropagation Lab for tissue propagation and storage. NRS has not been managing the habitat at this site as it is heavily degraded. A lot of seed has been collected from this plant and will be used for reintroduction and storage.

Kahana: NRS collaborated with GSN staff and volunteers to monitor the population this year. The gulch understory is thick and this may account for why only seven of the eleven plants were found. Five plants were mature, and seed was collected for genetic storage and future augmentation. Cuttings have been collected and are being grown at Lyon. These will be used as a propagule source in the future and serve as a living collection of these plants. NRS volunteered to help GSN staff construct a small ungulate exclosure around *Cyanea truncata* near this PU. This exclosure could be used as an augmentation site. GSN has preformed weed control and rat control at this site.

Kaipapaʻu: The two mature plants known from this PU have since died. The last remaining plants were taken out by a landslide.

Maʻakua: In 2005, NRS accompanied GSN staff to Maʻakua PU for monitoring and collection. A total of 16 plants were observed and the area was well surveyed. Seeds and cuttings were collected for genetic storage and to serve as a living collection. Access is difficult to this PU because there are multiple waterfalls that must be scaled. Fortunately, these waterfalls also exclude pigs. Although there are under story weed challenges, the habitat is overall in good condition. Much of the canopy is native. As mentioned above, NRS believe this sites should be considered for a ʻManage for Stabilityʼ designation.

Makaʻua: GSN staff is the primary management staff monitoring this PU. There are still one mature and one immature plant known from this site. Cuttings have been collected from both plants at this site and they are growing successfully at Lyon Arboretum to serve as a living collection. Seed was collected from the mature individual this year for genetic storage.

Mohiākea: There is still one extant plant in this PU. Seeds have been collected and individuals grown from these collections were outplanted in Kaluaʻā this past planting season. NRS constructed a small fence around this PU because ungulates are a significant threat in the area.

North Pālāwai: There is one mature plant in Pālāwai; it seeded prolifically in past years. On multiple visits this year, NRS worked with TNC to secure stock for storage. NRS constructed a small exclosure around the plant to protect it from ungulates and small scale weeding was conducted. The site is almost completely dominated by *S. terebithtifolius* and large scale weed control it not feasible. NRS will continue to work with TNC to monitor this site.

North Kaluaʻā: This population has not been observed since 2000, when a single mature plant was observed. NRS was able to obtain seed stock from this PU that Dr. Stephen Weller and Mr. John Obata collected some years past. This stock is both in genetic storage and being grown for reintroduction into the Central Kaluaʻā outplanting site.

3.24 *Schiedea nuttallii*

Requirements for Stability:

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

Taxon Level Discussion

Schiedea nuttallii is extremely rare, with only two known extant populations known. NRS plan to manage both populations, which lie within the portions of the Action Area (AA) with the lowest fire risk. The third PU site slated for management is a proposed reintroduction in Mākaha that will be comprised of mixed genetic stock from the wild extant PUs. The two wild PU's are well represented *ex situ*. There is recruitment at only one wild site, and individual plants often show sign of invertebrate damage. As a result, *in situ* plants do not appear to be vigorous. Reintroductions have not yet been successful for *S. nuttallii* because reintroduced plants suffer from the same invertebrate damage as wild plants. NRS will work on controlling the invertebrate threats to this taxon to improve its chance of reaching stability.

Taxon Status

Action Area: In

TaxonName: Schiedea nuttallii **TaxonCode: Schnut**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to Pahole	Manage for stability	31	8	23	7	1	35	10	0	58	17	1
Kapuna-Keawapilau Ridge	Manage for stability	3	0	3	0	0	0	0	0	3	0	0
	Total for Taxon:	34	8	26	7	1	35	10	0	61	17	1

Action Area: Out

TaxonName: Schiedea nuttallii **TaxonCode: SchNut**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Manage reintroduction for stability	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

Genetic Storage

All methods of genetic storage have been utilized or are being tested. Both seeds and cuttings have been brought to the Seed Conservation Lab and the Micropropagation Lab. Plants have been successfully established in tissue culture from seed. Plants have also been grown in the Army Nursery and the Micropropagation Lab greenhouse from cuttings. A small collection of seed has been banked at the Seed Conservation Lab. There are 1475 seeds stored from 29 plants in the Kahanāhaiki to Pahole PU, though many are collections with less than 10 seeds and, therefore, do not appear in the Genetic Storage Summary table below. This year, NRS withdrew stored seed for propagation for outplanting. No formal storage tests have been designed for this species because collections are too small and valuable. However, important information has been collected by monitoring germination rates. Though initial germination rates for most of the withdrawn seed lots were not tested, when the data was available, stored seed often had higher germination rates than fresh seeds. Fifty percent of seeds withdrawn from frozen storage after five years germinated. Seeds withdrawn from two of five collections after three years of frozen storage had 100% germination and another collection had 70% germination. These observations indicate that seeds can be stored frozen with little or no decrease in viability. Until tests can be conducted to determine the preferred storage treatment, collections should be made every five years, when possible, to maintain a sufficient number of viable seed to meet storage goals. Dr. Stephen Weller's incidental observations at the University of California at Irvine also indicate that *Schiedea* seeds store well. NRS will continue to store seed from natural populations, but will conduct testing on seed collected from greenhouse plants and reintroductions. Many of the reintroduced plants are clones of wild plants, so seed collected from these reintroductions are of the same value as those collected from the wild populations.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua 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 nuttallii							
Kahanahaiki to Pahole	23	7	19	13	4	21	11
Kapuna-Keawapilau Ridge	3	0	1	0	0	2	0
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				13	4	23	11

Propagation/Germination Techniques

The Seed Conservation Lab has not done germination testing of this taxon and has few results for initial germination rates. Of the fresh seed sown on agar, rates are variable, but the majority is over 50% germination. Though most seeds germinate within one month after sowing, some take three months to germinate. Seedlings are easily transferred from agar to perlite/vermiculite. Both seeds and small seedlings have been germinated and grown in an environment-controlled growth chamber. This taxon can also be propagated through the use of cuttings. A 10-50% success rate has been observed with cuttings. Either technique can be used based, on propagule availability and destination.

Unique Species Observations

No unique species observations have been made for this taxon.

Outplanting Issues

Two reintroductions have been conducted with this taxon in Kahanahāiki and one in Pahole. The Kahanhāiki sites are referred to as the “Maile Flats Site” and the “Pink Trail Site.” Reintroductions were conducted at three sites in Kahanhāiki and Pahole. At all sites, plants are found in all vigor classes from healthy to poor. Survivorship is in the 50-75% survivorship range. Although survivorship is not high as compared to other species NRS has outplanted, NRS believes that this level of population fluctuation is not unexpected given observations of wild populations. Of greatest concern is the lack of regeneration at the reintroduction sites. Perhaps there are some microhabitat needs that NRS are unaware of which trigger seedling production. NRS will continue to monitor to refine reintroduction methods and will apply this knowledge to future reintroductions.

Founders Represented in Outplantings

TaxonName: Schiedea nuttallii **TaxonCode: Schnut**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kahanahaiki to Pahole	Manage for stability	49	17
Kapuna-Keawapilau Ridge	Manage for stability	4	0
Makaha	Manage reintroduction for stability	0	0
	Total for Taxon:	53	17

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

Research Issues

Both slugs and insects have been observed to frequently attack seedlings of this species. Formal investigation into a related species (see Research Issues *S. obovatum*), suggests slugs likely impact *S. nuttallii* in a similar manner. Federal biologists consider slugs to be an “immediate and significant threat” to *S. nuttallii* survival (U.S. Fish and Wildlife Service, 1998, Recovery Plan for O‘ahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices), though these conclusions are based on anecdotal observations. NRS recently hired an Natural Resources Research Specialist to investigate slug and insect control options for this species. Research will begin by assessing the abundance and species of slugs present at reintroduction and wild sites.

Surveys

No new *S. nuttallii* occurrences were discovered in the last year and no surveys specifically targeting this species were conducted.

Taxon Threats

Schiedea nuttallii is threatened by feral pigs, weeds, slugs and arthropods. Although the Kahanahāiki to Pahole PU is fenced, the Kapuna-Keawapilau PU isn’t. Feral pigs do not directly target this taxon, but do seriously impact its habitat. Major weed threats to this taxon include *Melinus minutiflora* and *Schinus terebinthifolius*. One of the largest threats to *S. nuttallii* is slug predation. NRS observed slugs actively eating the leaves of this taxon; which may account for some of the leaf damage observed at all wild and reintroduced sites. NRS works with University of Hawaii Agricultural Extension Agents to investigate arthropod threats to this species. Many different types of arthropods have been observed impacting this taxon. NRS will continue to investigate these impacts and search for possible control strategies.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Schiedea nuttallii

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Pahole	Manage for stability	Yes	Yes	No
Kapuna-Keawapilau Ridge	Manage for stability	No	Yes	No

Action Area: Out

TaxonName: Schiedea nuttallii

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No

Manage for Stability PUs:

Kahanāhaiki to Pahole: This is by far the largest extant PU and represents over 90% of the total plants in the taxon. This is the only PU where ecosystem level habitat protection is in place. All but one *S. nuttallii* wild site are within fenced exclosures where habitat quality is good. One of the Pahole sites is at low elevation and is entirely weed-dominated and weed control actions are not planned. In the last year, NRS controlled weeds at the other two sites in this PU. NRS and NARS continue to collect seeds and cuttings from this PU for storage and reintroduction. NRS augmented this PU with three reintroduction sites and plan to conduct supplemental plantings to balance founders.

Kapuna-Keawapilau Ridge: This year, NRS assisted the NARS Specialist with monitoring and collecting from this PU. The population is within the area slated for fencing by the Division of Forestry and Wildlife next year. The construction of an ungulate fence is the single most important management step for this population. Once the fence is constructed, adequate habitat will be protected to stabilize this taxon in Kapuna and Keawapilau. NRS has begun to conduct limited weed control in the area. However large scale weeding will not begin until the fence is complete.

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

3.25 *Schiedea obovata*

Requirements for Stability from MIP:

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

Taxon Level Discussion

Once found in six sites, *Schiedea obovata* now occupies only two, both within the Action Area (AA) and managed as separate PUs (see table below). Prior to the disappearance of *S. obovata* from four sites, seeds were collected and are now being used to augment the two remaining populations (Kahanahāiki to Pahole and Keawapilau to west Makaleha), both of which are highly unstable. Threats to this taxon include trampling and browsing by ungulates, competition from non-native plants and herbivory by non-native slugs. Slugs have the potential to completely halt seedling regeneration in several sites (see Research Issues, this document). While techniques to control ungulates and weeds have been in place for some time, we have only recently begun to address problems associated with slugs. To our knowledge, systematic control of slugs in natural areas has not yet been attempted in Hawai‘i. On ridges, dry conditions appear to reduce slug numbers and strong seedling recruitment has been observed. Effective slug control is expected to greatly enhance regeneration and stabilization of *S. obovata* populations.

Taxon Status

Action Area: In

TaxonName: Schiedea obovata — **TaxonCode: SchObo**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki to Pahole	Manage for stability	0	0	0	0	0	58	34	149	58	34	149
Keawapilau to West Makaleha	Manage for stability	21	12	42	1	33	0	0	0	42	1	33
	Total for Taxon:	21	12	42	1	33	58	34	149	100	35	182

Action Area: Out

TaxonName: Schiedea obovata — **TaxonCode: SchObo**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Makaha	Manage reintroduction for stability	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

Genetic Storage

Seed storage is the preferred method of genetic storage due to its success and efficiency. Since 2000, NRS collected over 228,588 seeds from all PUs. Reintroduced plants have proven to be an excellent source of seed for storage. *Ex situ* plants in the Army greenhouse can also serve as a seed source. Dr. Steve Weller at U.C. Irvine has valuable stock represented in his greenhouse, which will be used in stabilizing this taxon. Since seeds of *S. obovata* are viable for long periods of time, NRS collected seeds from Bishop Museum specimens for propagation. Seeds did not appear viable and none of them germinated. Populations of *S. obovata* in the wild have been known to disappear for a number of years and then reappear after large rainfall events. Particularly if cooler temperatures were associated with the large rainfall events, this observation is reflective of the physiological dormancy in the seeds of this taxon and allows for at least temporary soil seed banks to be maintained. Four of the five original founders from the Kahanahāiki to Pahole PU are represented in the seed bank. The fifth founder is in micropropagation and will be grown in the Army greenhouse in preparation for reintroduction. Once plants are reintroduced, seeds will be collected to meet storage goals.

Schiedea obovata stores well under refrigeration and freezing. The preferred seed storage technique for is refrigeration (4°C) or freezing (-18°C) at 20% humidity. Seeds tested after five years show 0-4% decrease in viability for each year of storage. Therefore, replacement collections, where applicable, could conservatively occur every ten years.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Schiedea obovata							
Kahanahaiki to Pahole	0	0	5	5	0	4	5
Keawapilau to West Makaleha	42	1	3	27	0	8	26
				Total # Plants w/ >=10 Seeds in Seedbank	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
				32	0	12	31

Propagation/Germination Techniques

The optimal collection time is when fruit are not fleshy but beginning to dry out and dehisce. Germination appears to be stimulated by fluctuations in temperature and can sometimes take six to ten months, depending on time of year of collection, to start germinating. Initial germination on 1% water agar is typically > 90%, and seedlings can easily be transferred to perlite/vermiculite with very low to no mortality. Stored seeds germinate within a few weeks after sowing. Germination in vermiculite and perlite and on wet paper towels is also very successful (Dr. Stephen Weller, pers. comm., 2004).

Unique Species Observations

Within and between populations, there is wide variation in morphological traits such as leaf morphology and branch development. For example, leaf length among similarly-aged cohorts ranged from 2-8 cm. The widest variation in leaf length was observed in a single population (northwest Makaleha). Plastic morphology may help *S. obovata* adapt to changing conditions.

Outplanting Issues

Using seed collected from three sites: Kahanahāiki, Pahole, and west Makaleha, NRS have been rearing and outplanting *S. obovata* to augment those same wild populations since 1999. Stock is not mixed. A joint effort between NARS staff and NRS led to the reintroduction of *S. obovata* into an area just below the Pahole rim. Notably, seedling recruitment has been extremely high in this area, with hundreds of seedlings seen on multiple occasions. Whether the absence of slugs or some other factor is responsible for the observed recruitment is unknown. There is only one additional site in Kahanahāiki where NRS has seen limited recruitment. This site will also be investigated for slug impacts.

Founders Represented in Outplanting

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Total Num Plants based upon Plants that have been numbered

MakuaPopulationUnitName	Management Designation	Number of Founders	Number of Founders Represented
Kahanahaiki to Pahole	Manage for stability	5	4
Keawapilau to West Makaleha	Manage for stability	46	0
Makaha	Manage reintroduction for stability	0	0
	Total for Taxon:	51	4

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

These reintroductions have allowed us to compare the performance of offspring reared from the three *S. obovata* founder populations. Until NRS were able to observe the performance of the two other stocks in a single site, reintroduced Kahanahāiki material seemed fairly successful in terms of individual plant vigor. After observing growth in the Pahole and west Makaleha stocks however, we found the Kahanahāiki stock has fairly poor vigor. In addition, the Kahanahāiki stock appears less tolerant of herbivory. When exposed to slug herbivory, (see Research Issues, this document) these plants have very few leaves and these leaves are often tattered in comparison with those of southwest Makaleha plants. Branching development also differs between offspring from different founder populations. For example, the Kahanahāiki stock begins branching right away after outplanting whereas the West Makaleha stock has not begun branching at all. While it is difficult to say what impact early branching may have on plant fitness, greater resistance to slug herbivory would certainly have a positive effect on plant survival. Therefore, it may be advantageous to mix stock prior to outplanting to allow for more genetic exchange. NRS have not mixed stock previously because *S. obovata* was believed to be facultatively self-fertile and, thus relatively unaffected by inbreeding depression. In light of these new observations, however, NRS will revisit IT recommendations and discuss whether *S.*

obovata stock should be mixed. If a mixed reintroduction is agreed upon, Makaha would be an appropriate site.

This year, NRS coordinated with Dr. Steven Weller to acquire seed stock grown from two now extinct populations, one from Pahole Gulch and another from Keawapilau. Dr. Weller isolated his greenhouse plants from these populations in order to collect pure seed from them. Plants grown from this stock are in propagation at the Army greenhouse and will be used in MIP augmentations/reintroductions.

Research Issues

Slugs are seriously hampering NRS efforts to establish stable, reproducing *S. obovata* populations in the wild. Research concluded in September 2004 by UH graduate student Stephanie Joe, showed seedling mortality doubled when exposed to slug herbivory.

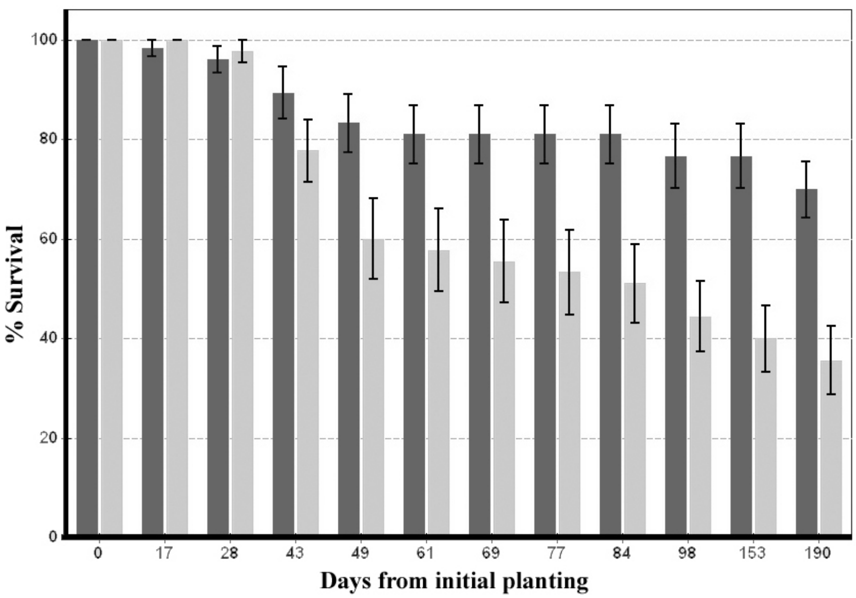


Figure Description. Fate of 120 *S. obovata* seedlings, half of which were exposed to slugs (light grey bars), and half of which were protected from slugs (dark grey bars). Plants in the latter group were protected from slugs using a combination of molluscacide and copper mesh. Intervals shown in black are one standard error from the mean.

Seedlings were reared in the greenhouse and transplanted into Kahanahāiki Management Unit (MU) after attaining a height of four cm, at which time most individuals had six leaves. They were subsequently planted into experimental plots where they were either exposed to, or protected from slug attack. Discrepancies in seedling survival due to treatment ("slug-exposed" vs. "slugs-excluded") were evident after 1 month and differed significantly by day 45 (Kruskal-Wallace Test $P<0.05$).

These results illustrate the need to control slugs in areas surrounding *S. obovata* populations. Stephanie Joe has recently joined the NRS team and is currently investigating ways to protect *S. obovata* from slug herbivory.

Surveys

NRS have contracted HINHP, to conduct surveys for *S. obovata* this year. Surveys have not yet been conducted nor have NRS discovered any new sites or individuals.

Taxon Threats

Ungulates, weeds and slugs all threaten the survival of *S. obovata*. NRS are using various pest control programs in order to mitigate these threats.

Population Unit Level Discussion

Population Unit Threat Control Summary

Population Unit Threat Control Summary

Action Area: In

TaxonName: Schiedea obovata

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki to Pahole	Manage for stability	Yes	Partial	No
Keawapilau to West Makaleha	Manage for stability	Yes	Partial	No

Action Area: Out

TaxonName: Schiedea obovata

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Makaha	Manage reintroduction for stability	No	No	No

Manage for Stability PUs:

Kahanahaiki to Pahole: This PU encompasses three former sites of *S. obovata*; two in Pahole and one in Kahanahāiki. The wild populations in Kahanahāiki and Pahole were gone from the wild by 2001. NRS and NARS staff visited all of the former wild populations in the past year to check for new seedlings, but none were found. Reintroduced *S. obovata* in Kahanahāiki have performed poorly compared to those reintroduced to Pahole (see Outplanting Issues section above). NRS perform weed control at all extant sites but not at historic locations. NRS will work to balance founders at all reintroduction sites in the coming year. Presently, NRS plan to mix only stock from the two historic Pahole sites within the Pahole reintroduction. However, NRS would like to discus alternatives with the IT.

Keawapilau to West Makaleha: This PU encompasses three former sites of *S. obovata*; one in Keawapilau (extirpated by 2000), and two in west Makaleha. NRS conduct weed control at both extant sites and the northwest Makaleha site is fenced. At west Makaleha most plants occur on a cliff minimizing ungulate impacts. NRS plan to outplant stock from the west Makaleha population into an adjacent exclosure. Stock from Keawapilau will be used to augment the Pahole PU. Following discussion with IT, NRS plan to outplant this stock in a separate site from the original.

Mākaha: The suitability of this site for *S. obovata* reintroduction will depend upon whether the proposed 100 acre ungulate fence, scheduled for completion in 2006, is approved. NRS will begin selection and preparation of outplanting sites for *S. obovata* in Mākaha pending exclosure construction and subsequent removal of feral ungulates. At that time, NRS will need to discuss with the IT whether or not the founders used to establish the new population will come from mixed stock.

3.26 *Tetramolopium filiforme*

Requirements for Stability:

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

Taxon Level Discussion

Tetramolopium filiforme occurs in five sites in the northern Waianae Mountains. All but two of the designated PUs are inside the Mākua Action Area (AA). On ʻŌhikilolo Ridge, it is known from both the Mākua and Mākaha sides. This site was split into two PUs in order to show the management differences between the two sides of the ridge. The ʻŌhikilolo PU is on the Mākua side and contains over 2500 plants. This PU is inside the ʻŌhikilolo ridge fence and is therefore protected from goats. This PU is within the AA and the lower portion is highly threatened by fire. This PU has still been designated as a ʻmanaged for stability' PU because this population is the center of abundance for this species and is the most stable. The PU on the Mākaha side of the ridge is called Mākaha /'Ōhikilolo Ridge; it is also within the AA but has been designated to be ʻmanaged for genetic storage'. Goats are abundant in this PU as it is outside the ʻŌhikilolo fence. The populations in Waiʻanae Kai, Keaʻau, Kahanahāiki, and Pūhāwai are all small, with less than 50 plants each. The Waiʻanae Kai and Pūhāwai PUs will be managed for stability while the other two will be managed for genetic storage. Threats to this taxon include fire, weeds, and ungulates. The threats for this species are manageable and NRS believe that with reintroductions and the protection and management of additional habitat stability is attainable.

Taxon Status

Action Area: In

TaxonName: Tetramolopium filiforme — **TaxonCode: TetFil**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Kahanahaiki	Genetic Storage	34	0	45	0	0	0	0	0	45	0	0
Keaau	Genetic Storage	16	4	16	4	0	0	0	0	16	4	0
Makaha/Ohikilolo Ridge	Genetic Storage			300	0	0	0	0	0	300	0	0
Ohikilolo	Manage for stability	2500	0	2445	552	0	0	0	0	2445	552	0
	Total for Taxon:	2550	4	2806	556	0	0	0	0	2806	556	0

Action Area: Out

TaxonName: Tetramolopium filiforme — **TaxonCode: TetFil**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Puhawai	Manage for stability	2	0	2	3	8	0	0	0	2	3	8
Waianae Kai	Manage for stability	20	2	30	8	1	0	0	0	30	8	1
	Total for Taxon:	22	2	32	11	9	0	0	0	32	11	9

Genetic Storage

There are over 40,000 seeds in storage at the Seed Conservation Lab. However, over half of these seeds are from greenhouse stock from the Pūhāwai PU. Three collections from plants in Mākua in 1999 and one also from Mākua in 2000 have been used for seed storage trials. These four collections have recently undergone 5-year storage testing. No decrease in viability has been noted for stored seeds at three different temperatures: 24˚C, 4˚C, -18˚C. The main challenge with this taxon is its low seed viability. Fresh and stored germination on average ranges from 12-30%. Any variation in germination can probably be attributed to storage and testing methods by researchers. Before germination and storage tests on recent collections, researchers have screened the seeds prior to sowing to remove obviously empty, non-viable seeds, while past collections and tests had a more random sampling and were less selective. An apparent difference in germination tests was detected and initially attributed to physiological dormancy in the seeds, until variation in processing procedures between researchers were realized. Bulk collections from the greenhouse plants could be acquired for testing to help refine preferred storage conditions and storage potential. NRS will continue to collect seed from wild populations, knowing that once a sufficient number of seed is collected from a given plant, these collections will probably last for at least ten years if not longer in storage. Unfortunately, due to such low viability for all seed lots, a large amount of seed will be needed for banking.

The Micropropagation Lab has been unsuccessful in establishing *T. filiforme* in culture via seeds. Many species in the family Asteraceae are very sensitive to the sterilization techniques necessary for Micropropagation. The lab has been continually and successfully researching methods to avoid oversterilizing while remaining free of contamination (Nellie Sugii pers. comm., 2005). NRS will collect cuttings from greenhouse stock in attempt to establish these in tissue culture. As shown in the table below, NRS has focused seed collections on the Kahanahāiki and the lowest plants in the ‘Ōhikilolo PU because of the high fire threat. In the coming year, NRS will collect from the unrepresented PUs.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			Storage Goals Met
Makua Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Tetramolopium filiforme							
Kahanahaiki	45	0	32	66	0	0	41
Keaau	16	4	0	0	0	0	0
Makaha/Ohikilolo Ridge	300	0	0	0	0	0	0
Ohikilolo	2445	552	0	50	0	0	30
Puhawai	2	3	7	5	0	4	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**
				122	0	4	75

Propagation/Germination Technique

Timing of collection may play an important role in increasing the number of viable seed collected at a given time. Mature, viable seeds of *T. filiforme* are much heavier than non-viable seeds. Therefore, they are likely the first seeds to fall from a drying inflorescence, leaving the non-viable seeds for longer and increasing their chance of being collected. If an inflorescence could be collected right before complete maturation, when all seeds are developed yet the flower head is not completely dry or open, collections may contain a higher number of viable seeds, especially from wild collected individuals. Cuttings and seed are both appropriate propagation techniques. Many germination treatments have been tested with seed collected from greenhouse stock, and no special germination requirements are necessary. Propagation from cuttings is extremely successful, showing over 90% success rate. Since *T. filiforme* is such a small plant, greenhouse plants can be used as ex-situ seed sources without placing a huge burden on greenhouse staff and space. Plants grown in the greenhouse can grow to be at least three times the size of wild plants and fruit year-round.

Unique Species Observations

There are no unique observations to report.

Outplanting Issues

NRS have not yet attempted to outplant *T. filiforme* but predict that site selection will be a key factor in the success of reintroductions for this taxon. *Tetramolopium filiforme* grows in very exposed, open and rocky slopes. In many cases, plants are rooted in very shallow cracks in the rock cliffs. When outplanting is conducted, attention should be given to planting depth and substrate. It may be difficult to transition plants that are grown in large pots with plenty of root space to wild sites that are mainly rock and little soil. Seed sowing is another possible technique for establishing new sites of this taxon. TNC staff have sown seed successfully with *Tetramolopium lepidotum*. This approach allows for seed to germinate at favorable spots and is less labor-intensive. In the coming year, NRS will augment the Pūhāwai PU with plants grown from stored seed.

Research Issues

A comparison of germination rates between wild and greenhouse-collected seed was conducted this year to determine if greenhouse propagation may improve the viability and storage characteristics of seeds. Due to low seed viability in both groups no differences were determined. Nursery seeds appear larger and more numerous, but do not show an increase in the number of viable seed. However, trials have shown that germination time was shorter for nursery collected seeds than for wild seeds. NRS is interested in investigating high resolution photography as a possible monitoring technique for the large populations on cliffs.

Surveys

NRS contracted the HINHP Botanist to re-visit the Kea‘au and Wai‘anae Kai PUs in previous years. No surveys were planned for this past year however, a new site within the Wai‘anae Kai PU was discovered by NRS. There are no surveys planned for this taxon in the coming year.

Taxon Threats

Goats and fire are the largest threats to this taxon. *Tetramolopium filiforme* grows on very steep slopes and cliffs and goats are the only ungulates on O`ahu that are capable of climbing to these sites. *Panicum maximum* is present at some lower elevation *T. filiforme* sites and is the largest weed threat due to its ability to carry fire. NRS have not observed any impacts from rats or slugs but will monitor for any new threats to *T. filiforme*.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Tetramolopium filiforme

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Kahanahaiki	Genetic Storage	Yes	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Puhawai	Manage for stability	Yes	No	No
Waianae Kai	Manage for stability	Partial	No	No

Manage for Stability PUs:

‘Ōhikilolo: The ‘Ōhikilolo PU contains well over the 50 mature individuals required for stability. Estimates given to the MIP in 2000 were based on multiple observations from over fifteen sites on ‘Ōhikilolo Ridge. In the last year, NRS compiled over fifty observations from all over ‘Ōhikilolo Ridge since 1997 and found that the summary numbers of plants estimated in each of these observations exceeds the estimate given in the MIP. NRS have been attempting to visit each of these sites in an effort to gauge any population fluctuations in this large PU. Weeds are not considered a significant threat to this PU and ungulates no longer threaten plants in this

PU due to successful fencing and hunting efforts. Fires are only a high threat to the plants found in the lowest makai site. Within the makai site, fire would likely not reach all of the plants as most are on very large steep cliffs that do not harbor much fire 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. NRS have focused collection efforts at the makai site and have secured collections of 10 or more seeds from 50 individual plants and 50 or more seeds from 30 plants. This has required a substantial amount of effort; NRS will continue this effort in the next year to obtain collections of 50 or more seeds from at least 50 individuals. NRS will also continue to monitor the upper portion of the PU and collect mature seeds for storage.

Pūhāwai: The table below displays the population trend that NRS has observed since monitoring first began in 1999. This population has declined steadily and this year, no immature plants or seedlings were found.

Rare Plant Monitoring Data

Monitoring Date	Mature	Immature	Seedling	Total Mat. & Imm.
November 1999	6	6	0	12
January 2001	4	7	2	11
October 2001	9	0	3	9
May 2003	5	0	8	5
March 2004	2	3	8	5
July 2005	3	0	0	3

Distinguishing between seedling and immature plants can be quite difficult and this may have affected the counts for these size classes. The only conclusive trend in the Pūhāwai PU is that the number of plants in all age classes has decreased over the years. NRS have observed the Pūhāwai site to be a much drier habitat than ʻŌhikilolo ridge. There appear to be no other obvious limiting factors to the Pūhāwai population. Ungulates are not known from this area and weeds have not been noted as a threat. Collections of cuttings have been grown in the Army nursery and these plants have produced thousands of seeds which have been stored at the Seed Conservation Lab.

The amount of appropriate habitat present at Pūhāwai is a key limiting factor to the continued existence of this population. Therefore, NRS propose introducing plants comprised of genetic stock from Pūhāwai to a chosen MIP reintroduction site below Puʻu Kūmakaliʻi. NRS will select the specific reintroduction sites over the next year and outplant next winter. NRS have large clones in the nursery representing four wild founders, which can be used as reintroduction stock. NRS may use the greenhouse produced seed to conduct this augmentation.

Waiʻanae Kai: The Waiʻanae Kai PU as a whole is not robust and most plants are not accessible for management because they occur on an inaccessible cliff with unstable rocks. This area is also very under-surveyed. NRS will conduct more surveys for this taxon with the HINHP Botanist in the coming year. NRS will attempt to secure genetic stock from any plants that are accessible but do not expect to acquire complete genetic representation from this population. NRS will attempt to develop creative collection techniques for plants that are out of reach.

Other PUs:

Kahanahāiki*:* The Kahanahāiki population of *T. filiforme* is located on a small cliff surrounded by *Diospyros sandwicensis* forest. This cliff is fairly devoid of vegetation, with only small, sparse shrubs present. This PU is located in an area affected by the July 2003 fire, which burned to within 20m of the site. The population is now buffered by only a small strip of forest and subsequent fires could wipe out this population. NRS monitored the area after the fire, and monitored it again this summer. NRS secured substantial genetic storage collections from this population and genetic storage is complete for this PU. NRS have over 25 seeds from 54 separate individual plants in this PU. This site is not fenced and ungulates are not a threat to this population. There are really no weed threats present on the *T. filiforme* cliff, so NRS have not spent time controlling weeds there. NRS have conducted weed control in the forest above and below the *T. filiforme* cliff, specifically targeting weedy tree species. NRS may begin controlling *P. maximum* in the forest closest to the *T. filiforme* cliff in order to reduce the amount of available fuel for fire.

Kea'au: The HINHP Botanist monitored this population in 2002 and noted that goats posed a threat to the integrity of the site. This population is not considered a priority for management because it is located in such close proximity to the larger 'Ōhikilolo populations and is probably very similar genetically. This populations is also within a state game management area and is not fenced. No significant weed threats have been observed at this site.

Mākaha /'Ōhikilolo Ridge: This PU was originally lumped with the 'Ōhikilolo PU due to the close proximity of the sites but was later treated separately to emphasize the differences in management (see taxon level discussion). The site is not fenced but this population is not considered a priority for management as it is located in such close proximity to the larger 'Ōhikilolo populations. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the 'Ōhikilolo stock. No significant weed threats have been observed.

3.27 *Viola chamissoniana* subsp. *chamissoniana*

Requirements for Stability:

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

Taxon Level Discussion

Two of the three ‘manage for stability’ populations are located within Action Areas (AA). The ‘Ōhikilolo population is within the Mākua AA and the Pu‘u Kūmakali‘i population is within the SBMR. NRS chose these two PUs for management because of the limited options for management outside the Action Area. Outside the AA, populations not currently chosen as ‘manage for stability’ include, Kamaile‘unu, Pu‘u Hāpapa and Hālona. The Kamaile’unu PU is very spread out in degraded habitat, the Pu‘u Hāpapa PU is on SBMR, has small plant numbers and may be included in the SBMR in the future and the Hālona PU is located on Navy land so management of that PU could not include augmentation. A focus on surveys offsite will be high priority in the coming year. Next year, management designations will be re-considered based on any new discoveries. NRS split the ‘Ōhikilolo PU into two: the ‘Ōhikilolo PU, which is on the Mākua side of the fence on ‘Ōhikilolo ridge, and the Mākaha/‘Ōhikilolo Ridge PU which is on the Mākaha side of the ridge outside the fence. This was done to differentiate between the plants inside of the fence that will be managed for stability and those on the outside that are designated collect for ‘Genetic Storage’. NRS also discovered an additional location for this taxon within the Mākaha PU (see Mākaha PU discussion below). In the last year, NRS continued to better organize the database population and count for this PU. This process has resulted in a much more accurate count of individuals. NRS do not monitor this taxon every year since they are located on cliffs and access requires rappel work. Collecting seed of this taxon for genetic storage is difficult to time, therefore, NRS has established a sizable living collection. Goats are the most significant threat to this taxon as it grows primarily on cliffs. NRS believe the prognosis for stability for *V. chamissoniana* is good as long as goats are controlled and genetic storage challenges are overcome.

Taxon Status

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana **TaxonCode: Viochacha**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Keaau	Genetic Storage	40	10	40	10	0	0	0	0	40	10	0
Makaha/Ohikilolo Ridge	Genetic Storage			32	0	0	0	0	0	32	0	0
Ohikilolo	Manage for stability	250	0	377	2	0	0	0	0	377	2	0
Puu Kumakalii	Manage for stability	53	0	44	0	0	0	0	0	44	0	0
	Total for Taxon:	343	10	493	12	0	0	0	0	493	12	0

Action Area: Out

TaxonName: Viola chamissoniana subsp. chamissoniana **TaxonCode: Viochacha**

Makua Population UnitName	Management Designation	NRS Mature 2004	NRS Immature 2004	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	Total Mature	Total Immature	Total Seedling
Halona	Genetic Storage	32	3	32	3	0	0	0	0	32	3	0
Kamaileunu	Genetic Storage	38	0	35	0	0	0	0	0	35	0	0
Makaha	Manage for stability	50	0	24	0	2	0	0	0	24	0	2
Puu Hapapa	Genetic Storage	10	0	10	0	6	0	0	0	10	0	6
	Total for Taxon:	130	3	101	3	8	0	0	0	101	3	8

Genetic Storage

Determination of the most appropriate genetic storage technique is ongoing. Micropropagation has not been a successful means of genetic storage for the immature seed tested at the Micropropagation Lab, but cuttings from Army Nursery plants were brought to that Lab in August 2004 for further tissue culture attempts. The cuttings were cloned via tissue culture and are healthy. A collection of seed made in 1999 from ‘Ōhikilolo has undergone testing. Seeds were split into two storage treatments. Seeds tested after five years of storage at -18 C and 8% relative humidity had a germination rate of 60% (15:25), which was significantly higher than the other treatment (24 C). Seeds stored at 18 C but at a slightly higher level of humidity should potentially last longer and this is the recommended storage condition for this species.

The only storage challenge remaining is collecting ample seed. Wild plants produce very few flowers at a time and each capsule contains less than 10 seeds. In order to overcome this hurdle, NRS have collected cuttings from some of the wild populations and these are in the Army greenhouse. The greenhouse plants were their healthiest this past year, and mass flowering was achieved in spring/summer. Unfortunately, the majority of fruit aborted at various stages. Some of these aborted fruit contained unfertilized ovules and others contained immature seed. Despite the long period of flowering, only 150 mature seeds were collected from stock from three PUs. Pollination experiments were conducted this summer and will continue next summer (details in Research Issues section) in an attempt to collect bulk seed for additional testing and storage purposes. NRS is waiting to see if this seed production technique is successful before taking more cuttings to meet genetic storage goals for all PUs.

Genetic Storage Summary

Makua Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in Seedbank	# Plants >=1 Microprop	# Plants >=1 Army Nursery	Storage Goals Met: # Plants that Met Goal
Viola chamissoniana subsp. chamissoniana							
Halona	32	3	0	0	0	0	0
Kamaileunu	35	0	0	0	0	0	0
Keaau	40	10	0	0	0	0	0
Makaha	24	0	0	0	0	0	0
Makaha/Ohikilolo Ridge	32	0	0	0	0	0	0
Ohikilolo	377	2	0	0	0	10	0
Puu Hapapa	10	0	0	2	0	6	3
Puu Kumakalii	44	0	0	1	0	21	7
				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	37	10

Propagation/Germination Techniques

This taxon is easy to propagate from both seeds and cuttings. NRS have observed an approximate 60% success rate for cuttings. Seeds tested had the highest germination on agar with no special germination requirements. It is uncertain how successfully these seedlings can be transferred from agar to perlite/vermiculite, as the only two attempted do not look healthy and have yet to grow. Seeds may need to be sown directly in pots.

Unique Taxon Observations

NRS have not observed any unique traits for taxon.

Outplanting Issues

NRS have yet to conduct an outplanting with this taxon. If one is conducted, NRS will use the upper and lower ends of cliffs to limit the amount of rope work required. NRS conducted a trial cliff reintroduction at ‘Ōhikilolo with good success using *Lysimachia hillebrandii* and do not expect *V. chamissoniana* to be much more difficult.

Research Issues

As stated in the Genetic Storage Section, pollination experiments were conducted on greenhouse stock in an attempt to produce the most viable seed by determining effects of different pollination techniques. NRS wanted to determine if conditions in the greenhouse or lack of a pollinator may have caused the large number of aborted fruit. Flowers were tagged as controls, self-pollinated by hand, or had their perianth removed with and without self-pollinating. Since such a low percent of fruit monitored in the study reached maturity, results were inconclusive.

Hand-pollinated outcrossings will be conducted next year to rule out inbreeding depression due to selfing.

Surveys

No new locations of this taxon have been found in the last year. However, NRS have found additional plants within existing PUs and additional locations within the Mākaha PU. No surveys for this specific taxon were conducted this year.

Taxon Threats

Threats to this taxon include pigs and goats. Since it grows mainly on cliffs, the majority of *V. chamissoniana* are naturally protected from feral ungulates. Weed species that affect the habitat of this taxon include, *Erigeron karvinskianus, Schinus terebinthifolius* and *Melinus minutiflora.* NRS will continue to monitor all potentially ecosystem-altering weeds in the vicinity of this taxon. Although NRS has performed limited weed control while on rappel, it is difficult and dangerous, and presently large scale cliff weed control is not feasible.

Population Unit Level Discussion

Population Unit Threat Control Summary

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana

MakuaPopulationUnitName	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

MakuaPopulationUnitName	ManagementDesignation	Protected from Ungulates	Weeds Managed	Rats Controlled
Halona	Genetic Storage	No	No	No
Kamaileunu	Genetic Storage	Partial	No	No
Makaha	Manage for stability	Partial	No	No
Puu Hapapa	Genetic Storage	Yes	No	No

Manage for Stability PUs:

ʻŌhikilolo: NRS have been controlling ungulate threats to this population since 1995 beginning with the construction of a perimeter goat fence along ʻŌhikilolo ridge. Presently, NRS believe that all goats have been eradicated from Mākua. Weeds that threaten *V. chamissoniana* include *E. karvinskianus* and *M. minutiflora*. NRS has conducted weed control in the vicinity of *V. chamissoniana* populations focusing on areas that do not require rope access. Collections will continue to be made from this PU in the next year.

Puʻu Kūmakaliʻi: NRS made three visits to this PU in the last year to obtain full genetic representation. During collection work, NRS would rappel on old sites and as well as nearby unexplored cliffs. Each time additional plants were located. The table below shows monitoring data for this population since 1998.

Monitoring Date	May 1998	June 1999	January 2001	October 2001	May 2003	November 2004
Mature/Juvenile/Seedling	4/0/0	10/1/0	15/0/0	19/0/0	24/0/0	44/0/0

This population is peculiar for the taxon, as many of the plants found here are not located on a cliff. Large portions of the plants at this PU are found on steep slopes just above cliffs. NRS have never observed ungulate sign at this PU and no goats are known from the area. Pigs do use the main ridge trail on occasion, but pig sign has never been observed amongst the *V. chamissoniana* plants. *Melinus minutiflora* is present, but NRS have yet to implement grass control. NRS will control grass in the more accessible portions of this PU.

Mākaha: With the discovery of one new site, there are now two sites in the Mākaha PU. The new site is west of the known site on a side ridge about half a kilometer away, outside of the proposed fence unit. There is also habitat between the two locations appropriate for this taxon, but it has been surveyed and no plants were found. The new site is also about 800 feet lower in elevation. The plants in the original location occur both in vertical areas as well as areas that are accessible to ungulates. NRS expect that this site will benefit from fencing. NRS has not begun any weed control actions in the area but will begin once fencing is complete. The plants in the new location are all in a vertical environment and not at risk from ungulates. There are threatening weeds in the area and NRS will monitor their spread. NRS suggest that plants from this location be added to stock for augmentation within the fence should it be necessary.

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 Kawiwi. The second site is near a prominent Puʻu called "F" Puʻu. This site has not been visited by NRS since 1999.

These areas will be priority for monitoring in the next year. NRS will request support from former NTBG employee, Ken Wood in finding his Pu‘u Kawiwi site. NRS does not have plans to control goats or weeds in the vicinity of these sites.

Hālona: NRS monitored this population last year. NRS believe that with additional surveys, more *V. chamissoniana* can be found. This habitat is vulnerable to goat predation but there are currently no goat populations at the site. Goats have been observed recently in North Hālona. The same set of weeds which are present at other populations of this taxon are present at Hālona. However, these weeds are not abundant at the Hālona Site. NRS consider the weed threat to this site low. In May of this year there was a wildfire burned over from the neighboring valley into the lower elevations of Hālona. Although the fire did not immediately threaten this PU, fire is certainly considerable threat to this PU.

Pu‘u Hāpapa: NRS last monitored this population in 2002, and observed 10 seedlings in addition to the 10 mature plants. The site is not threatened by ungulates and the weed threat is low. *Erigeron karvinskianus* is present around this PU but it is not having a direct impact on *V. chamissoniana* at this time.

Kea‘au: HIHNP Botanist discovered this population in 2002. He noted that goats threaten the site. No significant weed threats were observed. This population is not a priority for management as it is located in such close proximity to the larger ‘Ōhikilolo populations. Monitoring and collecting from the site has not been a high priority because it is assumed to be genetically similar to the ‘Ōhikilolo PU.

Chapter 4: *Achatinella mustelina* Management

The Final MIP Stabilization Plan for *Achatinella mustelina* was revised last year to better reflect the results of genetics studies by Holland and Hadfield (2002) (See previous report for details of this revision). The plan is based on the concept of Evolutionarily Significant Units, or ESUs. Each ESU is considered a genetically distinct group. 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 8 field locations to encompass the extant range of the species and to include all 6 genetically defined Evolutionarily Significant Units (ESUs).
- Achieve at least 300 snails per population.
- Maintain captive populations for each of the 6 recognized ESUs.
- Control all threats at each managed field location.

Grouping of *A. mustelina* sites into ESUs

ESUs A through F show the relative positions of each in the Wai‘anae Mountains of Western O‘ahu (Figure 4.1). The threshold of genetic distance separating the ESUs was set at 1%. Each population within a given ESU has a pairwise genetic distance to all other populations with the same ESU of 1% or less. Note that the exact shape and extent of each ESU is unknown and therefore the contours depicted are partially theoretical.

Captive Propagation

One of the requirements outlined in the MIP stabilization plan is to represent in captive propagation snails from each of the six ESUs and from the two extra sites in ESU-B and ESU-D. All sites are represented and the snails are prospering at Dr. Hadfield’s laboratory at the University of Hawai‘i. Detailed snail captive propagation data is shown in Table 4.13 below. All eight field sites proposed as “manage for stability” are represented and growing in the laboratory.

A number of issues related to the MIP captive propagation requirement for *Achatinella mustelina* needs to be discussed at the next MIT meeting. The following is a list of important discussion topics:

1. Determine the goals of captive propagation as they relate to the MIP requirements. These goals may include two primary topics: 1. Maintenance of captive stock in case of cataclysmic decline in the wild. 2. Reintroduction and augmentation using lab-reared snails to wild sites.
2. Based on these goals, re-visit minimum collection requirements for establishing lab populations.
3. Based on these goals, re-visit site selection for obtaining collections.
4. Establish minimum lab population maintenance requirements as far as supplementing lab populations with new wild collected snails. The MIP stabilization plan states that lab populations should be refreshed with wild stock if the lab population remains small or

declines in numbers. The current USFWS permit does not allow this activity. Discuss modifying the USFWS permit to include this activity. Discuss whether this activity is biologically sound (for extant populations, too).

5. Discuss logistical problems of the successful population growth of some species; what is the burden of caring for rising numbers of snails?. The MIP states that lab populations should be refreshed every two years and lab-reared snails rotated back out into the wild. The current USFWS permit does not allow this activity. Discuss modifying the USFWS permit to include this activity.
6. Based on these goals, discuss reintroduction of lab snails. What protective measures should be in place? What sites hold most potential? How viable are reintroductions/augmentations as a restoration measure. What is the progress of *Achatinella* predator control?
7. Genetic sampling of lab populations to ensure adequate genetic variability over time.

Table 4.1 below shows detailed *A. mustelina* captive propagation data. Only one initial collection was made to establish each of the lab populations listed in the table. Any increases in the number of snails in each population are the result of births in the lab, not additional wild field collections. Initial collections were made from Peacock Flats and Palehua by Dr. Hadfield. NRS consider these lab populations “old” and worthy of MIT discussion. All the other populations were established through collections made by NRS in 2003, in combination with tissue-sample collections for genetics work. NRS collected on average 10 mature snails from each site. This is the minimum number recommended by Dr. Hadfield for starting a lab population. At no time did the MIT methodically select field sites from which to collect nor did the MIT discuss what the ideal number of snails would be for establishing a captive population. These issues are raised in the list above for MIT discussion and the table below can serve as background information to begin these discussions.

The lab populations all show the same general trends. After 2+ years of being in captivity, many of the adults have died and some population numbers have leveled off. Total population growth was more dramatic during the first year of captivity and has since slowed down. This may be due to the snails reaching a maximum capacity for the space available, becoming inbred, or perhaps the faster growth during the first year is anomalous and slower growth is normal.

Table 4.1 Captive Snail Propagation Data

Population	ESU	Date	# juv	# sub	# adult	# Individuals
Peacock Flats	A	1995	0	0	6	**6**
		2003				**21**
		4/2004	8	11	4	**23**
		9/2005	3	15	2	**20**
ʻŌhikilolo – Makai	B1	2003	0	0	10	**10**
		4/2004	27	0	4	**31**
		9/2005	15	8	0	**23**
ʻŌhikilolo – Mauka	B1	2003	0	0	8	**8**
		4/2004	20	5	0	**25**
		9/2005	18	7	0	**25**
Kaʻala S-ridge	B2	2003	0	0	10	**10**
		4/2004	23	0	6	**29**
		9/2005	19	5	0	**24**
Alaiheihe Gulch	C	2003	0	0	10	**10**
		4/2004	14	4	4	**22**
		9/2005	17	5	0	**22**
Palikea Gulch	C	2003	0	0	10	**10**
		4/2004	20	1	8	**29**
		9/2005	22	3	2	**27**
Schofield Barracks West Range	C	2003	0	0	10	**10**
		4/2004	15	1	9	**25**
		9/2005	27	1	2	**30**
10,000 snails	D1	2001	0	0	9	**9**
		2003				**29**
		4/2004	8	22	0	**30**
		9/2005	3	24	3	**30**
Schofield South Range	D1	2003	0	0	10	**10**
		4/2004	18	7	3	**28**
		9/2005	24	2	0	**26**
Mākaha	D2	2003	0	0	10	**10**
		4/2004	16	0	8	**24**
		9/2005	23	0	3	**26**
ʻĒkahanui - Honoʻuliʻuli	E	2003	0	0	10	**10**
		4/2004	24	2	3	**29**
		9/2005	22	2	0	**24**
Palehua Gulch	F	4/2004	4	0	4	**8**
		9/2005	20	0	2	**22**
TOTAL		2003				**138**
TOTAL		4/2004				**303**
TOTAL		9/2005				**299**

Monitoring

Monitoring is an important tool for determining the effectiveness of management. This year a Mākua Monitoring Program Manager was hired to increase monitoring efforts and guide adaptive management. The complete list of questions related to MIP management is very long, but the following is a short list of high priority rare snail related monitoring questions. NRS will need to prioritize monitoring tasks.

- Determine best method for detecting predation at ESUs without conducting a ground search across the entire population.
- Monitor population trends over time at each ESU and determine monitoring frequency. In the last year, NRS did not complete ESU wide monitoring with the expectation that the Monitoring Manager would address this issue soon after beginning work. The ESU numbers have changed for only these ESUs where additional surveys were conducted since last MIP status update.
- Most effective rat grid set-up in topographically challenging areas (like Pu‘u Kaua)
- Densities of *Euglandina rosea*.

Research

For the next three years, NRS will be supporting a PhD student from the University of Hawai‘i investigating *Euglandina rosea* in Hawai‘i. He will be trying to discern what *E. rosea* is eating in Hawai‘i and why; if there are particular chemicals in the prey slime trails that is preferred; and can this be mimicked and used in controlling *E. rosea*. He will be investigating the use of native habitats to determine if there are any predictable patterns that can be useful in control. Finally, his research we hope will culminate in the development of a control method for *E. rosea* in Hawai‘i’s native environment. An example of needed research related to *Achatinella* stabilization is the development of a protocol for reintroducing *Achatinella* from lab-reared populations, and for moving snails from an unprotected field site to a protected field site close by.

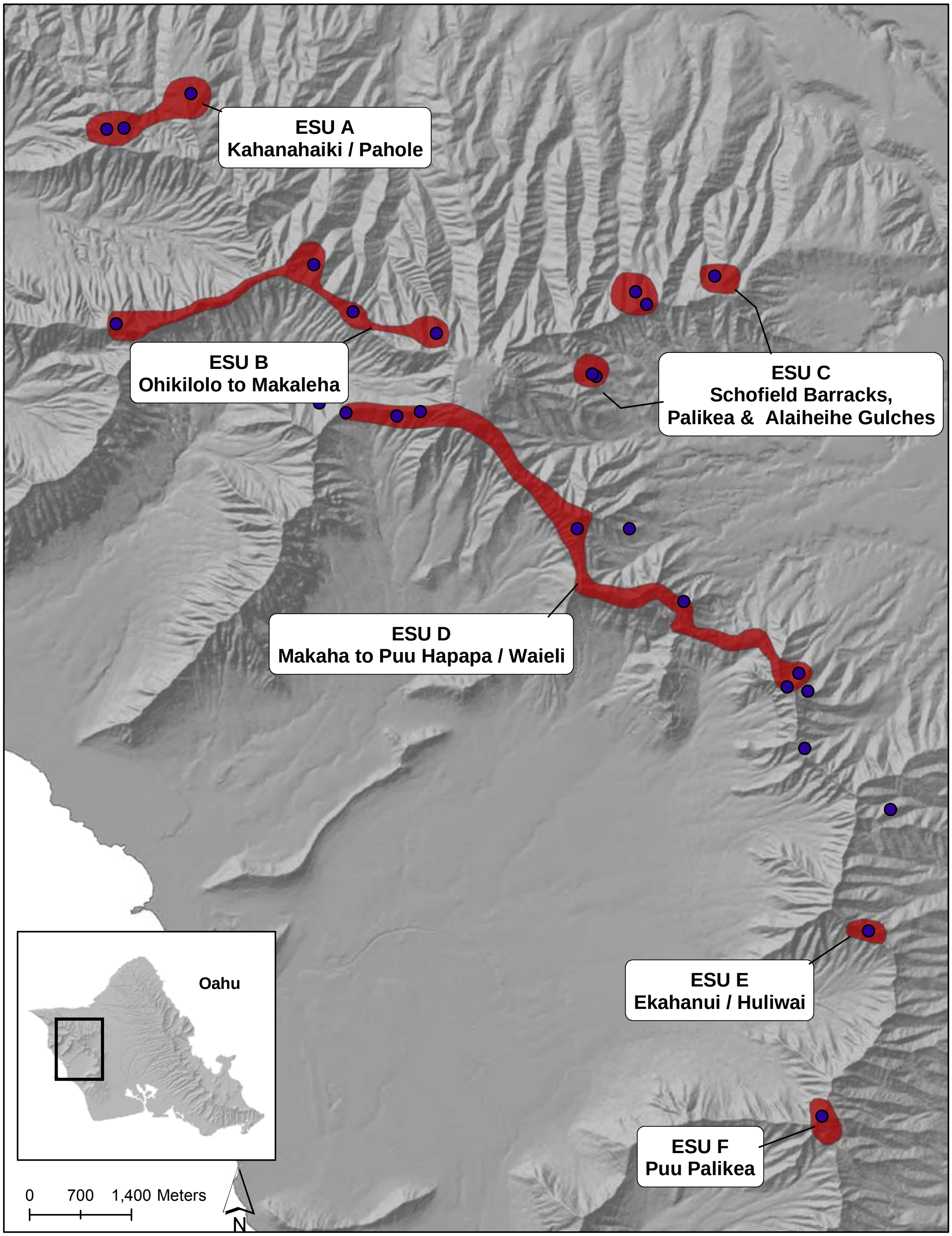


Figure 4.1 Grouping of 18 *A. mustelina* sampling sites into 6 ESUs

ESU Updates

NRS staff did not census snails in most ESUs this past year in anticipation of a more extensive monitoring program being established with the new Monitoring Program Manager.

ESU-A Pahole to Kahanahāiki

Table 4.2 Number of snails counted from ESU-A

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
			Lg	Med	Sml				
MMR-A Kahanahāiki Exclosure	70	7/04	50	20		X	X	X	X
MMR-B Pahole Exclosure	39	5/04	39			X	X	X	X
MMR-C Maile Flats	157	8/04	117	32	8	X	X	X	X
TOTAL	**266**		**206**	**52**	**8**				

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

Management for ESU-A is well underway. This ESU encompasses a relatively flat forest area in the uppermost reaches of Kahanahāiki Valley. This area is dominated by *Acacia koa* and *Metrosideros polymorpha*. *Nestigis sandwicensis* is a common canopy tree in this area and is favored by *A. mustelina*. Two exclosures were constructed to protect snails from rats and *Euglandina rosea*. The numbers of snails in these exclosures from recent observations in 2004 are shown above as MMR-A and MMR-B. MMR-C is the area between the two existing exclosures called "Maile Flats." *Achatinella mustelina* from ESU-A are represented at the UH Tree Snail Laboratory.

<u>MMR-A Kahanahāiki Exclosure</u>
For a detailed description of the Kahanahāiki snail exclosure, see PCSU Report 2003. NRS continue to maintain and monitor the Kahanahāiki exclosure by re-stocking salt troughs, ensuring the electrical barrier is functioning and conducting rat control outside the exclosure. Rat control is conducted just outside the perimeter because rat damage on *Nestigis sandwicensis* fruit has been observed inside the exclosure in past years. Bait is not placed within the exclosure because NRS do not want to provide any attractant that may encourage rats to cross the barrier. Rat control has been conducted regularly since 2001 and a total of six bait stations and 12 snap traps are deployed. Weeds have been controlled in the forest around the exclosure. *Nestigis sandwicensis* has been out-planted inside the enclosure and *Acacia koa* has been out-planted outside.

Table 4.3 Kahanahāiki Snail Enclosure Rat Bait Grid Information

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of rats trapped	# of snap traps
2002	4	351	309	88%	1	6
2002-2003	6	832	591	71%	7	6
2003-2004	6	958	732	76%	16	12
2004-2005	6	882	546	62%	38	12

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

<u>PAH-A Pahole Exclosure</u>

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

<u>MMR-C Maile Flats</u>

NRS conducted a thorough survey of the Maile Flats area in 2004 to determine if there are any large concentrations of snails outside the existing exclosures. NRS surveyed each of six quadrants that were installed for facilitating weed control efforts in the area. The results of this survey are displayed spatially on the map (Figure 5.5). *A. mustelina* is most dense in the area just outside the Kahanahāiki snail exclosure and to the south, into the Southeast and Southwest quadrants. NRS spent a considerable amount of time weeding in Maile Flats this year. A total of 508 hours were devoted to ecosystem-wide management of weeds and a lot of this work included primary snail habitat. Understory weeds were targeted in these efforts, as well as *Psidium cattleianum* and *Schinus terebinthifolius.* This also included controlling grasses like *Melinus minutiflora* and *Paspalum conjugatum.* Controlling these grasses will help to improve the general habitat and reduce the threat of fire.

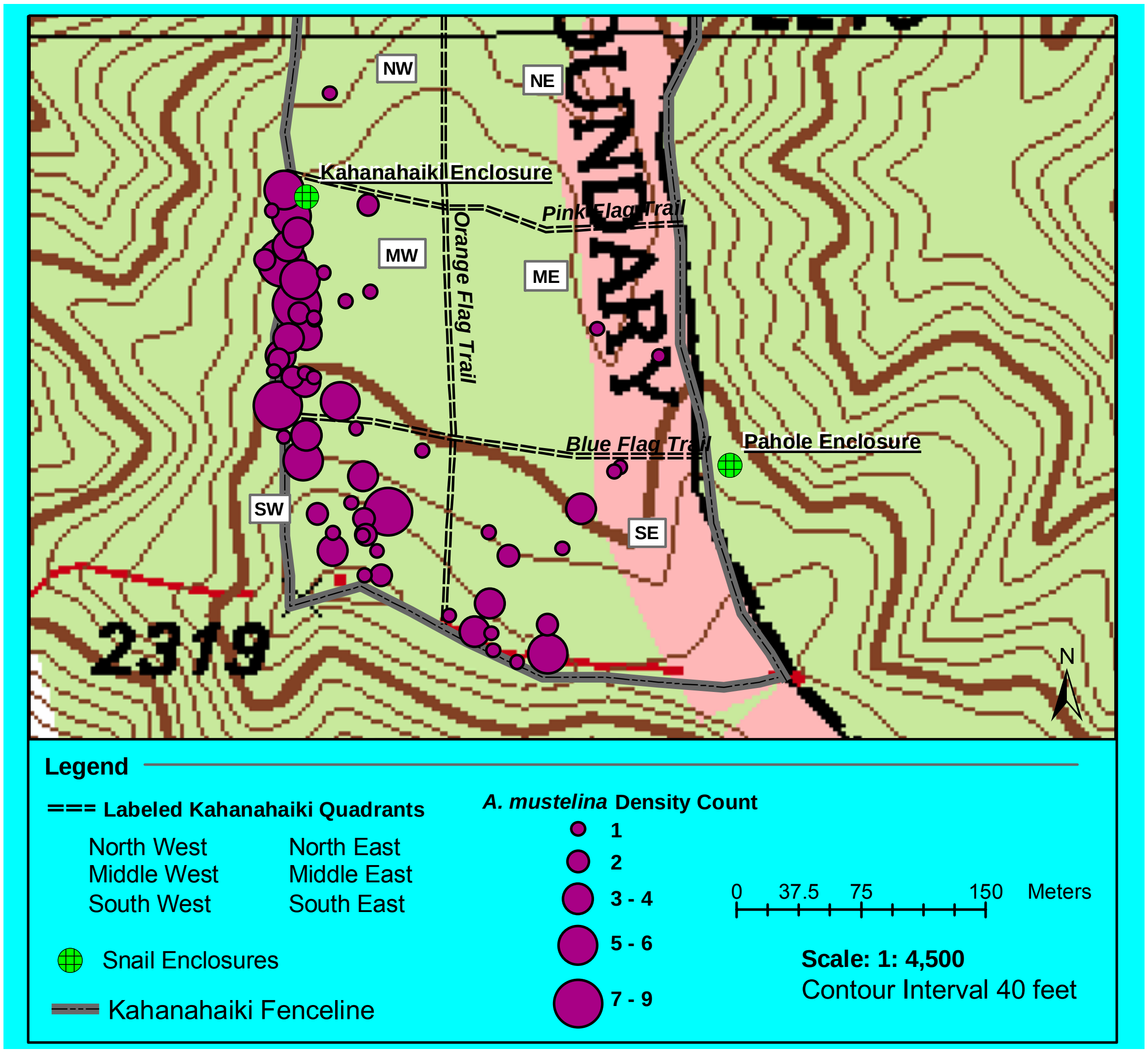


Figure 4.2 ESU-A/ Population MMR-C Survey Results

In 2004, one live *E. rosea* was exterminated in the middle-west quadrant near the Kahanahāiki snail exclosure. There was some concern among NRS that rat control designed to take predatory pressure off *A. mustelina* may actually relieve pressure on *E. rosea* and at the same time serve as an *E. rosea* attractant. Since then, NRS has been tracking numbers of any *E. rosea* found in bait stations and only one was reported from ESU-E. The monitoring manager will begin work to develop methods to monitor for evidence of predation at Kahanahāiki, as there is detailed and recent survey information, and the need for detection is great.

ESU-B1 ʻŌhikilolo

ESU-B is very large. Based on Holland's 2002 genetic studies, it stretches from East Makaleha to ʻŌhikilolo Ridge. Because of this large range, two sites have been chosen within the ESU for management. These two sites are at the extreme ends of the ESU perimeter; they are the East Branch of East Makaleha (B2) and ʻŌhikilolo (B1). The habitat present at these two sites is very different (See 3.2.c. ESU-B2 for a description of the E. Makaleha site). Most of the snails found on ʻŌhikilolo ridge are located within the ʻŌhikilolo Forest Patch. This forest area is dominated by *Acacia koa* and *Metrosideros polymorpha*. *Myrsine lessertiana* is also a common canopy tree on ‘Ōhikilolo and is favored by *A. mustelina*. *Myrsine lessertiana* underwent a dieback 3-5 years ago and is still recovering. Other common native trees at ‘Ōhikilolo preferred by *A. mustelina* are *Melicope spp*. and *Freycinetia arborea*. The number of snails and threats at each of these sites are presented in the tables below. *Achatinella mustelina* from ESU-B1 are represented at the UH Tree Snail Laboratory.

Table 4.4 Number of Snails Counted at ‘Ōhikilolo

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
			Lg	Med	Sml				
MMR-E ‘Ōhikilolo Mauka	77	8/04	62	8	7	X	X	X	
MMR-F ‘Ōhikilolo Makai	210	8/04	166	22	22	X	X	X	
MMR-G Alemac Site	24	6/04	20	4		X	X	X	
MMR-H ‘Ōhikilolo Ko‘iahi Prikaa Reintro Site	16	6/04	9	7		X	X	X	?
MMR-I Hedpar MMR-B	2	5/04	2			X	X	X	X
MMR-J Lower Mākua site above camp	5	11/00				X			
TOTAL	**334**		**259**	**41**	**29**				

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

<u>MMR-E ‘Ōhikilolo Mauka</u>

The ‘Ōhikilolo Mauka population encompasses the full area in the main forest patch “mauka” of the landing zone. NRS observed significant rat predation at this site and began controlling rats in 1999. The rat control currently being conducted is centered on a high-density snail area and the rare plant *Pteralyxia macrocarpa*. *Euglandina rosea* has never been observed at this site. Extensive surveys were conducted in August of 2004 and many snails were discovered outside the previous grid but are now included within the new grid. The rat bait stations in this area were expanded from six to fourteen. Currently this site is protected from pigs because of the steep cliffs that surround the site. No evidence of goat browse has been observed in the last three years. Weed control at this site is extensive and on-going.

<u>MMR-F ‘Ōhikilolo Makai</u>

The ‘Ōhikilolo Makai site consists of the main forest patch “makai” of the landing zone. The core of the *A. mustelina* population on ‘Ōhikilolo ridge is located here. NRS have observed significant rat damage to *Prichardia kaalae* fruit near ‘Ōhikilolo Makai snails and are currently baiting to protect this fruit year-round. Prior to 2004, no evidence of rat predation on snails had ever been observed at this site. Hence, rat control was never initiated at ‘Ōhikilolo Makai. However, comprehensive snail monitoring was conducted at ‘Ōhikilolo Makai in the summer of 2004 and eight rat-predated shells were observed at one site. All the predated shells were estimated to be between three and six years old. With this new information, NRS will reconsider the best rat control/monitoring approach for this site. No evidence of *Euglandina rosea* has ever been observed at this site. NRS will continue to monitor for *E. rosea* in ‘Ōhikilolo Makai. Care will be taken to ensure that all field gear that has the potential to transport *E. rosea* to the site is strictly inspected. This site is completely protected from ungulates by fencing. Extensive canopy and understory weed control efforts are underway.

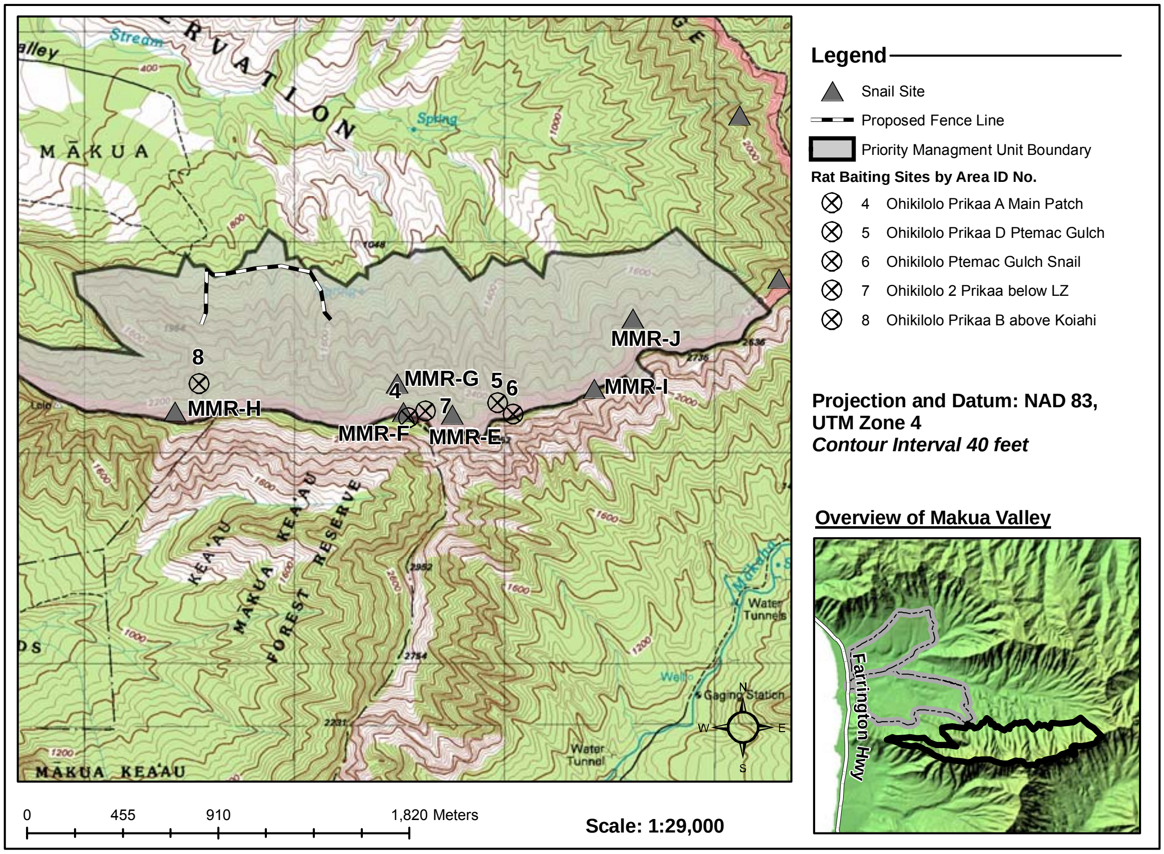


Figure 4.3 ESU-B1 ʻŌhikilolo

MMR-G *Alectryon macrococcus* Site

MMR-G is located just below the ʻŌhikilolo makai forest patch at the 2,700 ft. elevation. The endangered plant *Alectryon macrococcus* var. *macrococcus* is also located at this site and most of the *A. mustelina* found were observed on these plants. NRS have not observed rat damage to *A. mustelina* at this site although NRS are certain that rats are present in the area. NRS have not observed *E. rosea* at this site either. NRS will continue to monitor for any signs of predation. Currently this site is protected from pigs by the steep cliffs that surround the site. The threat from goats is minimal as none have been detected recently in the valley. Although some weed control has been conducted at this site, extensive weed control will be more difficult than at the Mauka and Makai sites because of the steep terrain and high density of weed cover.

MMR-H ʻŌhikilolo Koʻiahi *Pritchardia kaalae* Reintroduction Site

MMR-H is located at 2,200 ft., just below the junction of ʻŌhikilolo and Koʻiahi ridges. This forest was dominated by *Myrsine lessertiana*, which experienced a large dieback over the last five years. NRS outplanted the endangered plant *Prichardia kaalae* into this site and have conducted weed control in combination with this effort. Observations indicate that *M. lessertiana* is making a comeback as numerous juveniles are now seen in areas previously dominated by this taxon. NRS have not observed rat damage to *A. mustelina* at this site although NRS are certain that rats are present in the area. NRS will conduct ground searches for *E. rosea* shells at this site in order to determine if it is present. Currently MMR-H is protected from pigs because of the steep cliffs that surround the site. The site has a small population of *A. mustelina* (16 counted in 6/04).

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

MMR-J Above Lower Mākua campsite
This site was only surveyed one time in November 2000. NRS has not camped at the Lower Mākua site for a few years and therefore, has not been able to re-monitor this site.

ESU-B2 East Branch of East Makaleha

Table 4.5 Number of Snails Counted in East Branch of East Makaleha

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

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

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

LEH-D Culvert 73

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

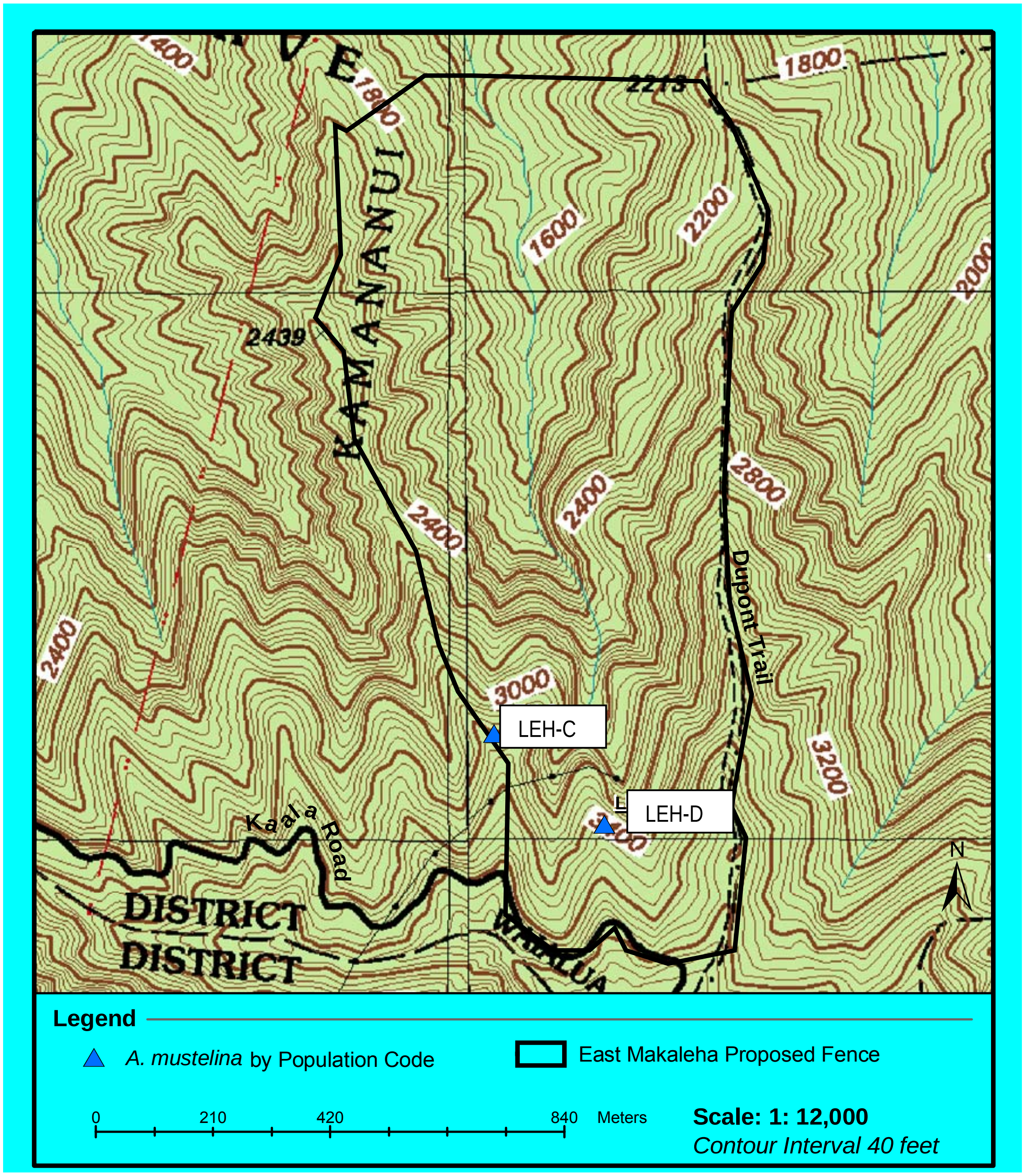


Figure 4.4 ESU-B2 East Branch of East Makaleha

ESU-C Schofield Barracks West Range, Alaiheihe and Palikea Gulches

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

Table 4.6 Number of Snails Counted in ESU-C

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
			Lg	Med	Sml				
SBW-A North Hale‘au‘au, Hame Ridge	8	1/05	5	2	1	X	X	X	X
SBW-B North Hale‘au‘au, one ridge north of Hame	0	1/05				X	X	X	X
SBW-C North Hale‘au‘au, just above *Pouteria* pair territory	7	1/05	4	3		X	X	X	X
SBW-P Stekaa site	10	1/05	3	7		X	X	X	X
ALI-B Western Palikea Gulch	6	3/23/05	4	1	1	X	X	X	X
ANU-A Manuwai Gulch	1		1			X	X	X	X
IHE-B Alaiheihe Gulch	10	3/22/05	5	4	1	X	X	X	X
TOTAL	**42**		**22**	**17**	**3**				

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

<u>Schofield Barracks West Range-A, B, C, and P</u>

These four sites will be discussed collectively because their situations are similar and related. All of these sites are located in Hale‘au‘au gulch between 2,500 and 2,600 ft in elevation. The habitat is infested with pigs. This area is off-limits to hunters, therefore the pig population is un-checked. There are no fences installed here for snail management. The high pig numbers facilitate the spread of *Psidium cattleianum*, which is a dominant canopy tree in the area. Native forest areas have a very tall canopy in Hale‘au‘au, which is dominated by *Metrosideros polymorpha*. The subcanopy is composed of *Antidesma platyphyllum*, *Melicope spp*., *Cheirodendron platyphyllum* and *Elaeocarpus bifidus*. This area was proposed for management because the terrain is relatively flat in portions of this ESU and suitable for constructing snail exclosures similar to those in ESU-A. However, since these exclosures require intense maintenance, Hale‘au‘au may not be suitable because of access restrictions. This being said, if management of *A. mustelina* overlapped with management of other species in SBW, then adequate access may be possible to obtain. The Oahu Biological Opinion (Oahu BO) mandates that two species must be managed within SBW, *Stenogyne kanehoana* and O‘ahu ‘Elepaio. In this last year, one new *A. mustelina* site was discovered in the south fork of Hale‘au‘au in a spot where the other two Oahu BO taxa are present. This is referred to in the table above as SBW-P. If substantial numbers of *A. mustelina* are found at the SBW-P site, rat baiting could be conducted in conjunction with O‘ahu ‘Elepaio predator control and a fence could be constructed to protect all three species together. Additional surveys in the vicinity of the *S. kanehoana* in South Hale‘au‘au for *A. mustelina* are recommended. Genetic analyses of tissue samples placed these snails in ESU-C, same as the other snails sampled in North Hale‘au‘au Gulch. So far, a total of ten snails were counted here on 19 January 2005.

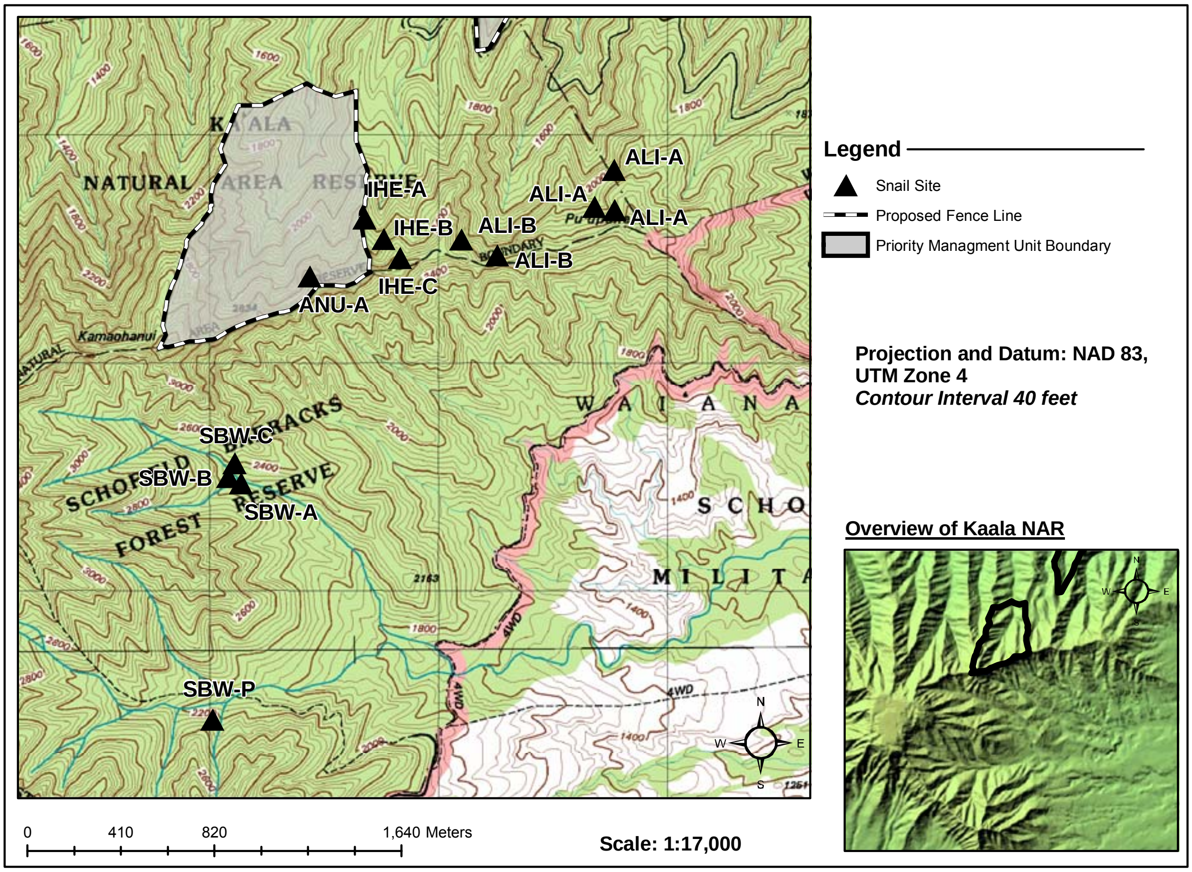


Figure 4.5 ESU-C Schofield Barracks West Range, Alaiheihe and Palikea Gulches

<u>ANU-A (Manuwai)</u>

Manuwai is one of the gulches in Lower Mt. Ka‘ala Natural Area Reserve (NAR). Lower Mt. Ka‘ala NAR as a whole is characterized by very steep-walled gulches, which limit management options. There are plans for a fence in Manuwai in order to protect some rare plant populations found there. NRS theorized that *A. mustelina* could be managed in combination with these plants in one large fenced unit; however, based on the poor numbers of snails discovered during the survey conducted last year, NRS are re-evaluating again where and how to conduct management for *A. mustelina* in ESU-C. Other sites in Lower Mt. Ka‘ala NAR are available for management. More surveys will be conducted in other gulches within this portion of ESU-C in order to determine if there are populations located in moderate terrain, within a healthy native forest. If no other populations of snails are found, NRS may be forced to choose a site in SBW.

ALI-B (Palikea Gulch)
Some areas of Palikea Gulch had been surveyed before and in fact, ten snails had been collected in the eastern side in 2003 and brought to the UH Laboratory for Captive Propagation. The most recently discovered snails were found in the western side of the gulch, in an area little surveyed in the past.

IHE-B (Alaiheihe Gulch)
This area was partly surveyed at night during a camping trip in March 2005. More time is necessary for surveys here to get a more accurate count of how many snails are found in this area.

ESU-D North Kalua‘a , Wai‘eli, Pu‘u Hāpapa, SBS, and Mākaha

ESU-D is by far the largest ESU. For management purposes it has been split into two portions. D1 includes North Kalua‘a, Wai‘eli, Pu‘u Hāpapa, and SBS, and D2 includes Mākaha.

Table 4.7 Number of Snails Counted in ESU-D1

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
			Lg	Med	Sml				
KAL-A Kalua‘a and Wai‘eli	481	8/04	158	237	86	X	X	X	X
SBS-B Pu‘u Hāpapa	196	8/04	131	44	21	X	X	X	X
TOTAL	**677**		**289**	**281**	**107**				

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

ESU-D1 North Kalua‘a, Wai‘eli, Pu‘u Hāpapa, and SBS
Management for ESU-D1 is promising. The numbers of snails found at the sites is substantial and habitat quality is good. The Kalua‘a /Wai‘eli and Pu‘u Hāpapa sites are continuous and encompass most of the Pu‘u Hāpapa summit. Rat baiting is already being conducted at both sites and the fence line has been cleared and construction will commence in September 2005. Weed control is also conducted at both sites. The native species in this ESU preferred by *A. mustelina* include *Freycinetia arborea* and *Myrsine lessertiana*. The native forest canopy is primarily *Metrosideros polymorpha*. Slow growing *Freycinetia arborea* is extremely susceptible to pig damage as it grows low to the ground. ESU D1 was managed prior to the MIP and the number of snails in the area reflects this. *A. mustelina* from ESU-D1 are represented at the UH Tree Snail Laboratory.

KAL-A, Kalua‘a and Wai‘eli (Land of 10,000 Snails)
NRS and TNC conducted a joint survey of this site. The total reflected in the table above is the result and shows that this site is one of the most robust in the Wai‘anae Mountains. The Nature Conservancy (TNC) has been working here for the last three years, as it is located within the Honouliuli Preserve. They have been administering rat bait to protect snails from rat predation and have been controlling pig populations in the area. NRS and TNC maintain 16 bait boxes and 16 snap traps near the core of the population (See Table 3.7). In 2004 the Army funded a full-

time field position to work on species covered in Army consultations located on Honouliuli Preserve. This staff person has been assisting with the rat baiting and ungulate control efforts at the Kalua‘a and Wai‘eli *A. mustelina* site. TNC obtained grant money for fence materials for a new exclosure to protect this site. The fence should be constructed by winter 2005. NRS has been assisting TNC with fence line clearing and fencing material delivery. NRS will work with TNC staff to cooperatively maintain the rat bait stations, expand the rat-baiting grid if necessary, and conduct weed control.

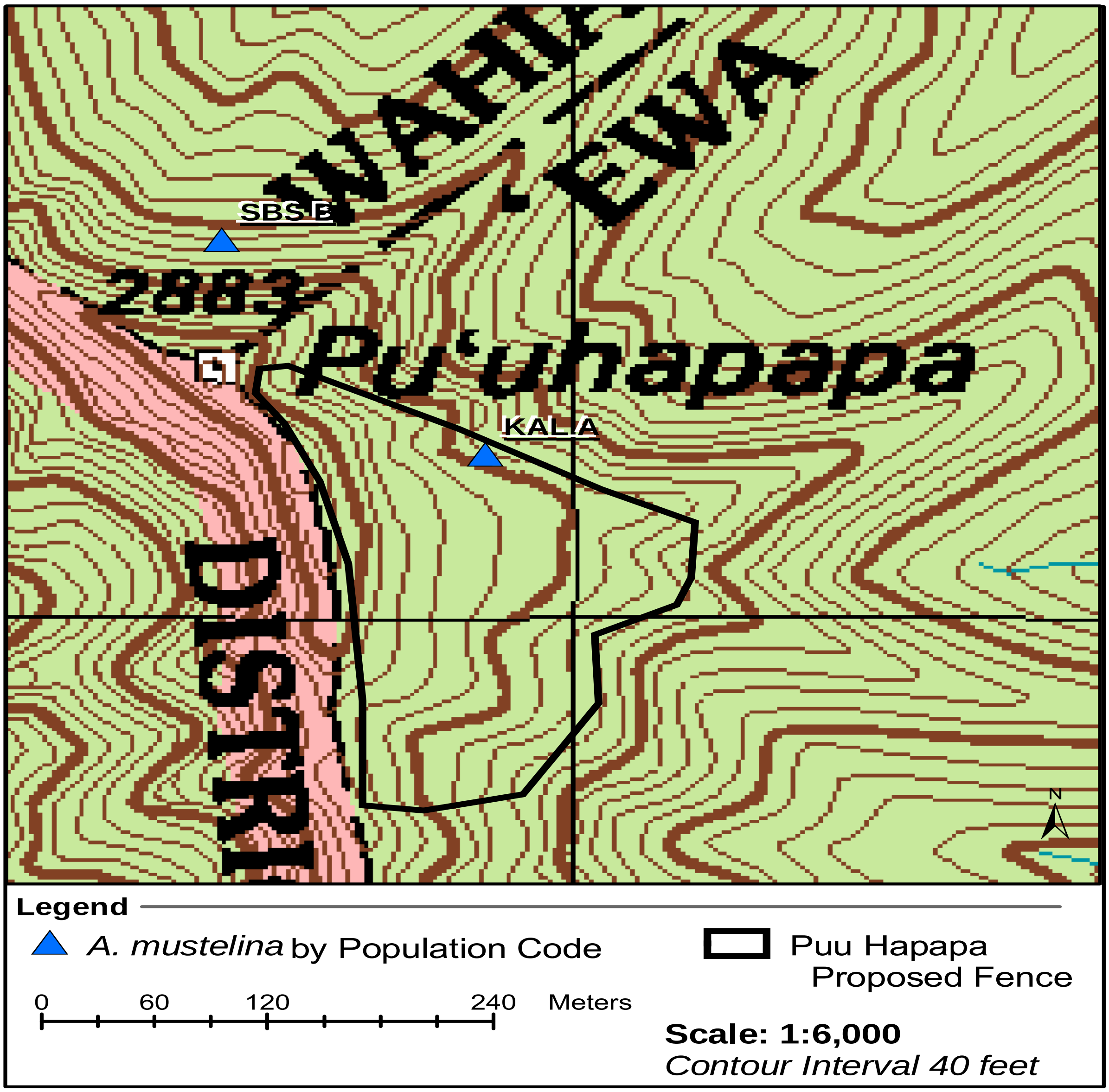


Figure 4.6 ESU-D1 Kalua‘a, Wai‘eli and Pu‘u Hāpapa

Table 4.8 Rat Data for Kalua‘ā and Wai‘eli

Year	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
2004	16	680	547	80%	0	0
2005	16	1280	655	51%	11	16

SBS-B Pu‘u Hāpapa

North Wai‘eli gulch is situated within Schofield Barracks South Range (SBS). A portion of Pu‘u Hāpapa, which is the peak at the top of Wai‘eli gulch, is also a part of SBS. This portion of Pu‘u Hāpapa is referred to as SBS-B. NRS have been controlling rats since 2000. This year a total of 768 bait blocks were put out in 8 stations. Rat control also protects two other species of native snails that are found in overlapping habitat at this site. These taxa are *Laminella sanguinea* and *Amastra micans*. During the August 2004 survey at Pu‘u Hāpapa, NRS counted 196 *A. mustelina* in an area less than 10 acres in size. This portion of Pu‘u Hāpapa is very steep, which renders management efforts challenging. For safety, NRS work while on rappel in some areas. Weed control is underway at Pu‘u Hāpapa and should directly improve the quality of habitat for *A. mustelina* in the area. One recent difficulty with working in SBS is significantly reduced access due to increased live-fire training. Previously, access was unlimited but now NRS must wait for “cold” days when the military is not shooting live rounds. NRS need to work with Range Control to determine the long term feasibility of managing this site.

Table 4.9 Rat Data for Pu‘u Hāpapa

Year	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
2000	8	488	292	60%		0
2001	8	432	254	59%		0
2002	8	880	503	57%		0
2003	8	512	273	53%		0
2004	8	896	502	56%		0
2005	8	768	281	37%	24	14 newly deployed

ESU D2 Mākaha

Mākaha MAK-A, B, C, D

NRS has just begun to do comprehensive surveys of Mākaha Valley for snails. One overnight trip was conducted in the Kumaipo area and areas were searched at night. Fifteen snails were counted. There is still more habitat to survey in the area and additional trips are necessary. Another survey was conducted in the Kumaipo area in June 2005. This area is within the proposed MU fence. On this trip, sites MAK A, C, and D were surveyed. Only two staff participated and NRS believes that estimates may still be low. Night surveys in these areas would be used to gauge total numbers. NRS has not surveyed intensively for threats but believe that rats and *E. rosea* are impacting populations. From a management perspective, Mākaha presents some challenges. Unlike many of the other areas where NRS conduct predator control, snails appear to be spread across a large area in Mākaha. NRS suspect that once surveys are completed the population will be more or less continuous across the upper reaches of the exclosure and into the Kumaipo area. In the next year, NRS will work to complete surveys and investigate threats. Once this is complete, a threat control strategy can be developed. NRS began weed control operations in Mākaha this year and have conducted weed control in and around snail populations. *Achatinella mustelina* from ESU-D2 are represented at the UH Tree Snail Laboratory, however, NRS should evaluate these collections to see if they represent the full range of this ESU and perform additional collections if necessary.

Table 4.10 Number of Snails Counted in ESU-D2 Mākaha

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
			Lg	Med	Sml				
MAK-A (Isolau ridge)	24	6/05	21	1	2	X	X	X	X
MAK-B (Kumaipo ridge crest)	15	1/05	11	4		X	X	X	X
MAK-C (Hesarb ridge)	2	6/05	2			X	X	X	X
MAK-D (ledge below Mauka LZ)	27	6/05	21	3	3	X	X	X	X
TOTAL	**68**		**55**	**8**	**5**				

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

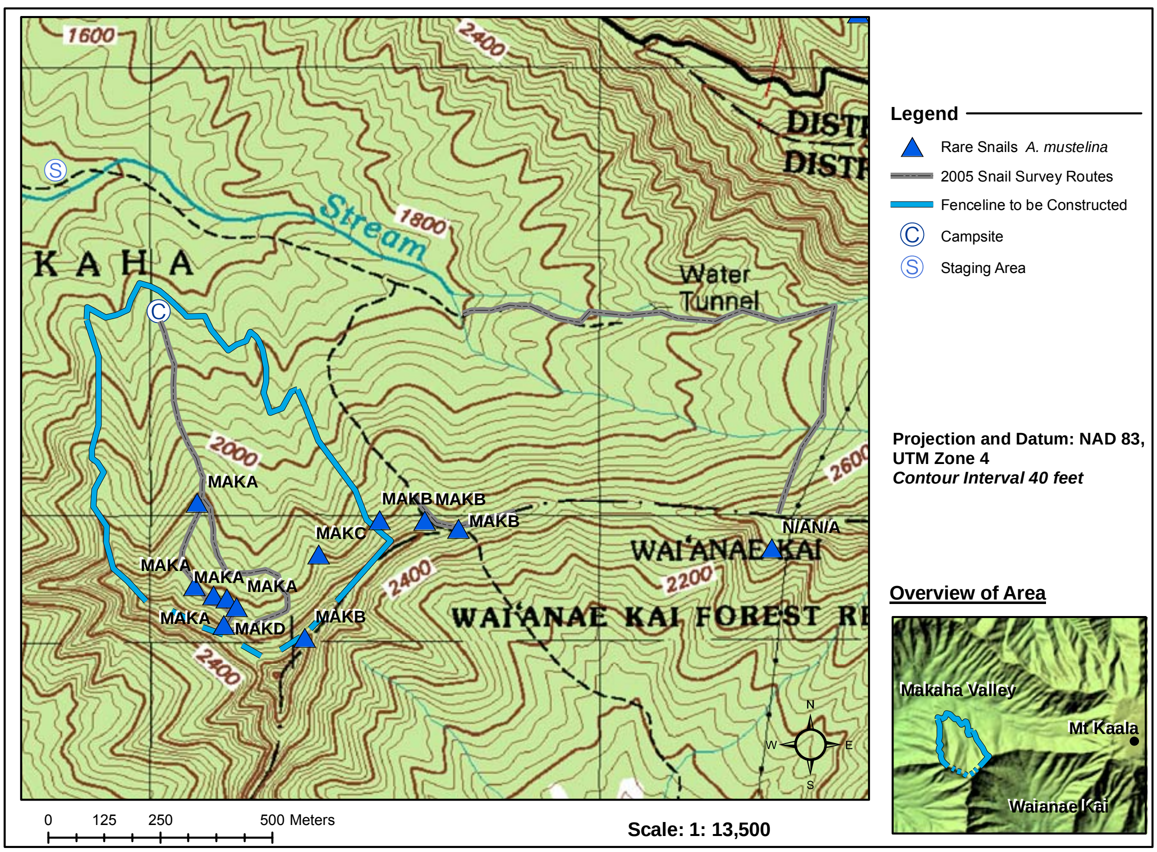


Figure 4.7 ESU-D2 Mākaha

ESU-E Pu‘u Kaua/‘Ēkahanui

Pu‘u Kaua/‘Ēkahanui EKA-A, B, C, and E

Management for ESU-E has increased dramatically this year. Extensive snail surveys were conducted on 12-14 October 2004 and the results are shown in the table below. The rat baiting grid has been expanded to include eleven bait stations and twenty-two snap traps. This ESU encompasses a few large concentrations of snails within the ‘Ēkahanui drainage and along the ridge crest above the drainage. The ridge crest forest type is comprised mainly of wet forest species including *Metrosideros polymorpha*, *Metrosideros tremuloides*, *Melicope peduncularis*, and *Dicranopteris linearis*. Most of the snails found in this area are on *Myrsine lessertiana*. Both EKA-A and EKA-B are situated in this type of ridge crest vegetation. The ‘Ēkahanui gulch area is a mix of alien and native forest patches. The native vegetation in areas within ‘Ēkahanui that have high concentrations of *A. mustelina* consists of *Freycinetia arborea, Diospyros hillebrandi, Nestigis sandwicensis,* and *Antidesma platyphyllum*. The Nature Conservancy is currently conducting rat control in the vicinity of an *Amastra spirazona* population. *Achatinella mustelina* do occur in the same habitat (EKA-E). In addition, rat control is conducted during the nesting season (January to June) in the vicinity of `Elepaio and this baiting may benefit *A. mustelina* that are nearby. NRS will assist TNC in these efforts. An ungulate exclosure that protects approximately 50 acres of forest already exists in the southern fork of ‘Ēkahanui , however, only EKA-A and EKA-E are located within this fence. The Army staff person working with TNC developed plans for additional fencing to protect the remaining portions of ‘Ēkahanui gulch and all the snails in EKA-B. The EA for the fence has been completed and the CDUP has been obtained. Ten snails were collected from the Mamane Ridge site for captive propagation and are doing well at the UH Tree Snail Laboratory (See Captive Snail Propagation Data).

Table 4.11 Number of Snails Counted in ESU-E

Pop Ref Code	No. Snails	Date of Survey	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
			Lg	Med	Sml				
EKA-A (Mamane Ridge)	183	10/04	93	30	60	X	X	X	X
EKA-B (Plapri EKA-A site)	55	10/04	46	6	3	X	X	X	X
EKA-C (Plapri EKA-C site)	6	10/04	6	-	-	X	X	X	X
EKA-D (near summit of Pu‘u Kaua)	202	10/04	158	31	13	X	X	X	X
EKA-E (Amastra site)	5	10/04	5	-	-	X	X	X	X
TOTAL	**451**		**308**	**67**	**76**				

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

Table 4.11 Pu'u Kaua/'Ēkahanui Rat Bait Grid Information

2004	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
Mamane ridge	11	160	91	57%	0	0
Plapripri C	2	128	128	100%	0	0

2005	# of Stations	Bait Available	Bait Taken	%Take	Rats Snapped	# of Snap Traps
Mamane ridge	11	848	368	43%	6	22
Plapripri C	2	128	108	84%	0	0
Myrsine ridge	6	160	74	46%	2	9

Pu'u Kaua EKA-D

EKA-D is near the summit of Pu'u Kaua in steep habitat. There has been discussion of possibly moving snails from here to the lower areas where rat baiting is on-going. Dr. Hadfield and Steve Miller (USFWS) have both advised NRS to collect more data on the status of the snails in this habitat, such as population stability. This question will likely be discussed further at future Snail Working Group and MIT meetings.

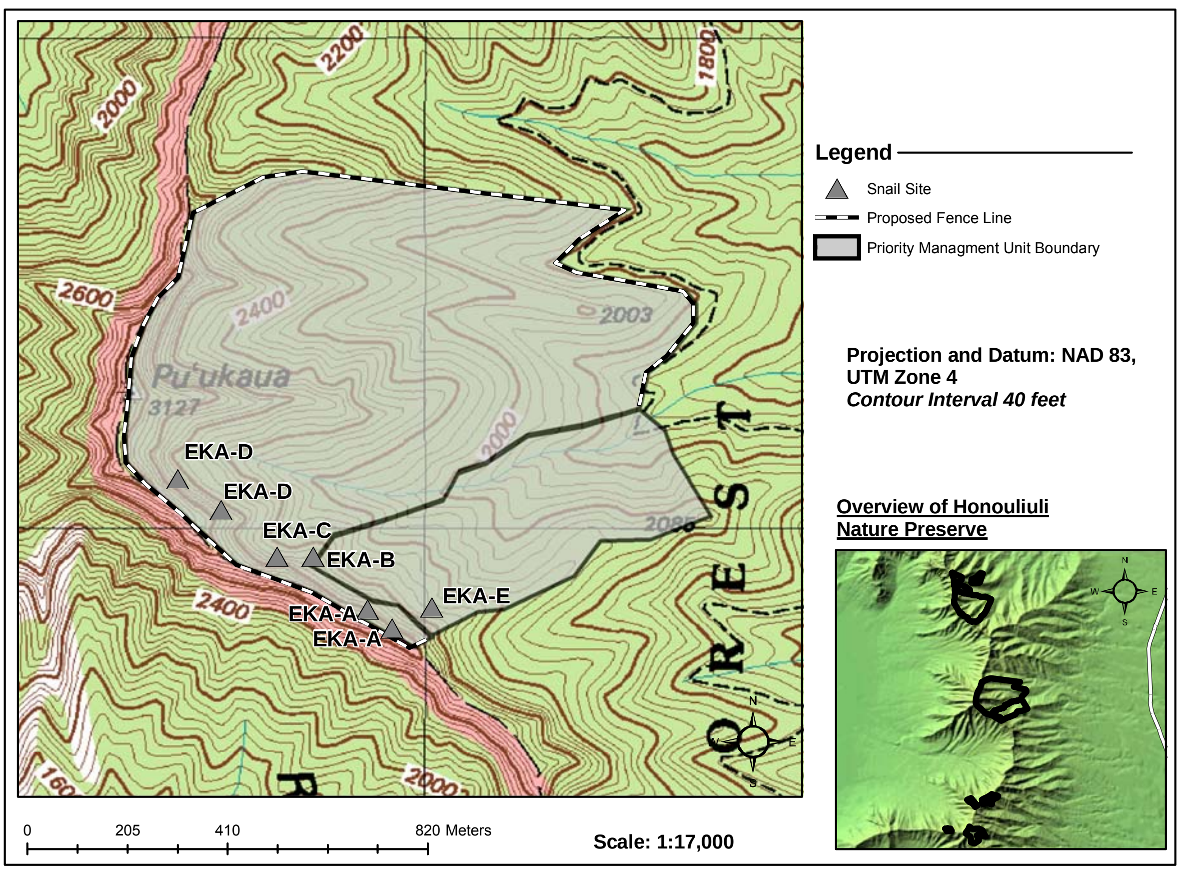


Figure 4.8 ESU-E Pu'u Kaua/'Ēkahanui

ESU-F Pu'u Palikea

Pu'u Palikea PAK-A-G

Populations in this ESU are scattered around Pu'u Palikea and across the rim of the S. Pālāwai drainage. The area has both native habitat as well as some weedy areas. In general, most of the snail sites are in native habitat. NRS surveyed the areas between the populations without finding snails. NRS surveyed the area in September of 2005 and plans to return next year and survey further. NRS began wide-spread rat control at Palikea this year. Rat control grids are maintained at all populations except the outlier to the north, PAK-D. There are a total of 28 baits stations and 28 snap traps in place. NRS and TNC restock these grids once a month. A larger fence unit has been scoped for this area and an EA has been prepared. Fencing is likely to proceed in the next couple of years. NRS performed weed control in the vicinity of the exclosure constructed around *Cyanea grimesiana* subsp. *obatae* and will expand weed control once the larger fence is complete. NRS have seen *E. rosea* at the site but do not yet know the extent or impact of this predator. Since this is a very accessible site, NRS plan to work with the UH researcher to do further investigations. Snails collected from this ESU are represented at the UH Tree Snail Laboratory.

Table 4.12 Numbers of Snails Counted in ESU-F

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

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

Table 4.13 Palikea Snails Rat Bait Grid Information (Baiting initiated 16 Sept 2004)

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of rats trapped	# of snap traps
2004 - 2005	28	3342	970	29%	83	28

TNC previously baited the PAK-C site and PAK-B site prior to NRS baiting which started in September 2004. NRS currently bait PAK-A, PAK-B, PAK-C, PAK-E, PAK-F, PAK-G.

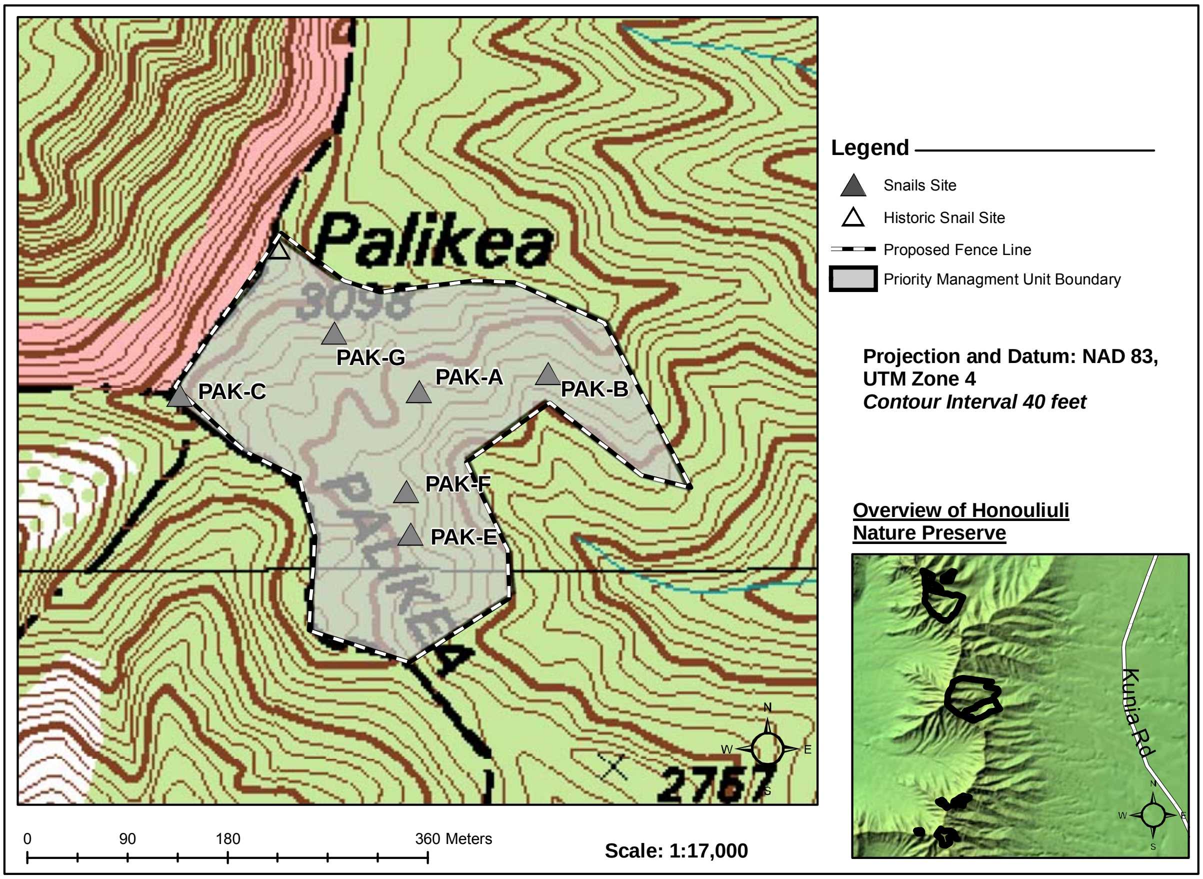


Figure 4.9 ESU-F Palikea

Chapter 5: 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. Most recently in September 2004, the Service issued another BO that covered newly designated critical habitat within the action area for plants and ‘Elepaio. This BO outlined additional requirements related to this critical habitat. The sections below outline the status of the required actions from MMR Section 7 Consultations since 1999.

Current Status of ‘Elepaio in Mākua Action Area

Surveys & Monitoring

Extensive surveys for ‘Elepaio have been conducted in the Mākua AA within MMR. Currently at MMR, ‘Elepaio are known from the Kahanahāiki and ‘Ōhikilolo MUs, as well as from the East Rim Ungulate Control Area (UCA) (Figure 5.1). A total of 15 ‘Elepaio currently are known within MMR. Of these birds, there are three pairs: one in the ‘Ōhikilolo MU, one in the UCA, and one pair in the Kahanahāiki MU. Seven of the 15 known birds within the MMR have been captured and banded (Table 5.1). Areas outside the MMR, but within the Mākua AA that have had ‘Elepaio in the past include the Mokulē‘ia Forest Reserve (Kuaokalā) and the Pahole Natural Area Reserve. Surveys for ‘Elepaio in these two areas by State Biologists in 2004 resulted in no detections. Mākaha Valley is currently the only location outside of MMR, but within the Mākua AA that ‘Elepaio are still found in large numbers. Presently, 44 individual birds including 10 pairs are known from the Mākua AA in Mākaha Valley (Figure 5.2). This represents a substantial increase in the number of ‘Elepaio known in the Mākua AA. The estimated number of pairs as stated in the 1999 BO was six. Currently there are 13 pairs known from the Mākua AA.

<u>Kahanahāiki MU</u>
Currently, NRS know of four ‘Elepaio in the Kahanahāiki MU and one just outside. Of these birds, there is only one pair (GBAR and BABW) (Table 5.1). In 1996, three males and one female were banded. Since that time, two of the males have not been detected since prior to 2001 and these birds are thought to be dead. The last confirmed observation of the only Kahanahāiki pair was in 2004. During the 2005 breeding season, nine site visits were made for both rodent control and monitoring of the pair. A bird was heard on four visits without a visual confirmation. Two birds were never heard or sighted together in 2005. A bird was very

unresponsive to tape playbacks through the breeding season. It is a possibility that one of the birds from this pair is dead.

‘Ōhikilolo MU

As of 2004, five ‘Elepaio are known from the ‘Ōhikilolo MU. Of these birds, there are three single males and one pair. Two of the three single males were last sighted in 2000 and the third male was sighted in 2004. The male of the known pair in this MU was banded in 2002 (Table 5.1). The pair was resighted in 2004.

East Rim Ungulate Control Area (UCA)

Five birds are known from the East Rim Ungulate Control Area. These five known birds consist of three single males and one pair. The three single males were last resighted in 2001, while the pair was observed in 2004. The male of the pair was banded in 2001 and the female was banded in 2004. The female had active avian pox lesions when captured and the current fate of this bird is unknown. Additional surveys are needed in the UCA below the cliffs. The best way to access this area is via the ‘Ōhikilolo MU. Access to the UCA has been hampered by restrictions imposed by the Army’s Safety Office following realignment of the suspected Improved Conventional Munitions (ICM) Area boundary. Once realignment is finished it is anticipated that access to this area will be regained, so surveys can continue.

Table 5.1. ‘Elepaio Banding Data, Makua Military Reservation

Bird[1]	Date Banded	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
ARRB	3/4/96	3/4/01	2/7/02	Y	N	Kahanahāiki	M
GBAR	3/4/96	5/26/04	6/6/05	Y	Y	Kahanahāiki	M
BABW	3/4/96	2/11/04	6/6/05	Y	Y	Kahanahāiki	F
BGAW	3/4/96	12/9/99	3/18/02	Y	N	Kahanahāiki	M
ARGB	12/03/02	1/24/04	5/5/04	Y	Y	‘Ōhikilolo	M
ABBB	12/11/01	5/5/04	5/5/04	N	Y	UCA	M
AGWR	5/5/04	5/5/04	5/5/04	Y	Y	UCA	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)

Kaluakauila MU

Two single male ‘Elepaio were known to exist in Kaluakauila in 1999, but have disappeared from this area.

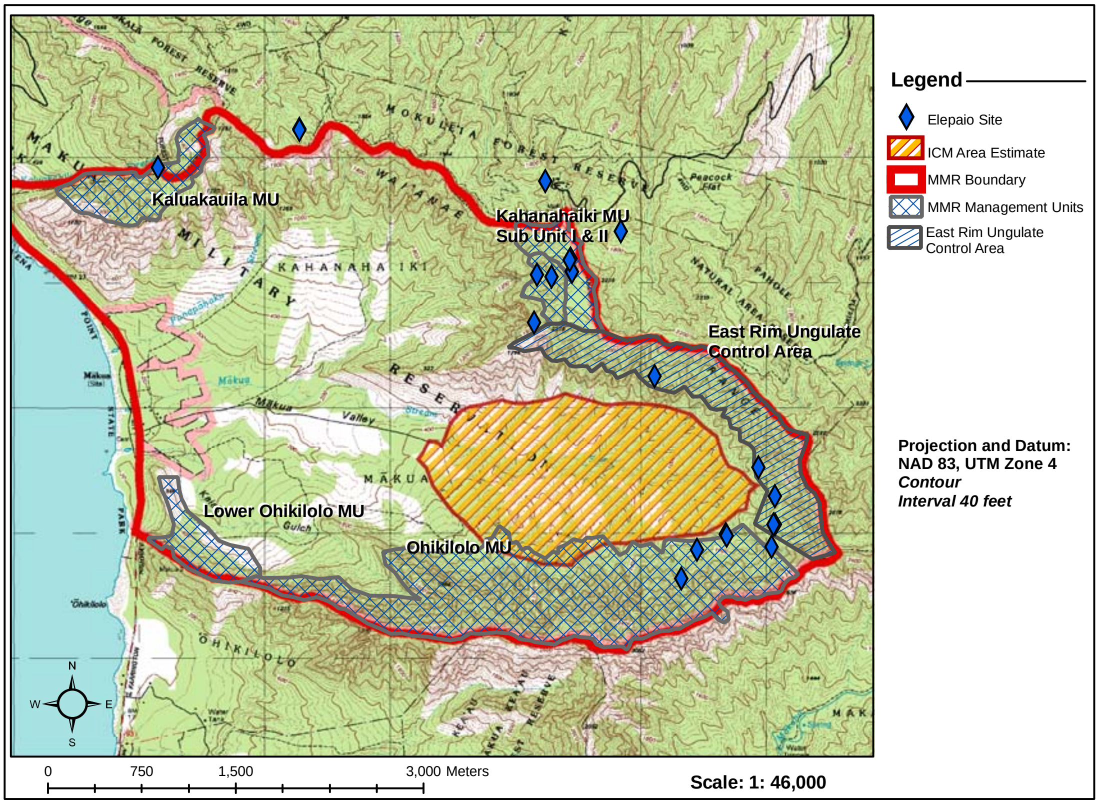


Figure 5.1. ‘Elepaio Distribution in Mākua Military Reservation (MMR)

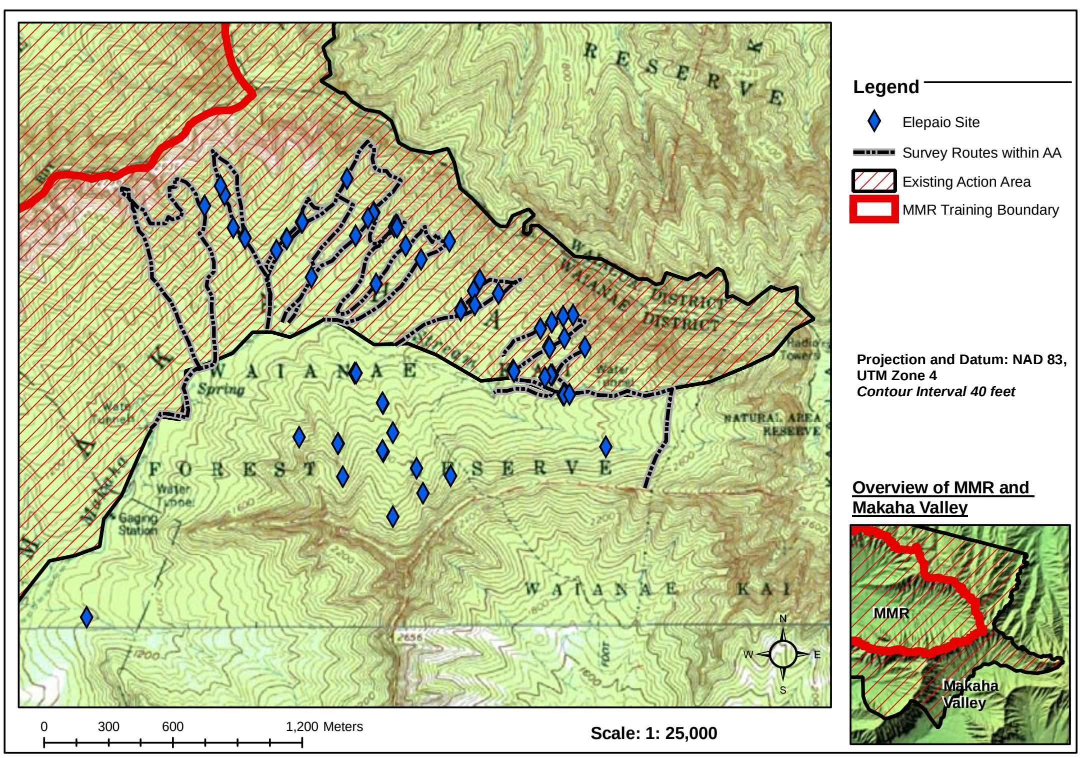


Figure 5.2. ‘Elepaio Distribution on the North Slope of Mākaha

Mākaha Valley
In 2005, NRS conducted extensive ‘Elepaio surveys on the north side of Mākaha Valley in the Mākua AA. A total of 44 birds were located during nine surveys conducted from January through August (Figure 5.2). Twenty single males, 10 pairs, and four juvenile (hatch year) birds were located during the surveys. NRS will continue to surveying for ‘Elepaio in Mākaha Valley in the coming year.

Mokulēʻia Forest Reserve (Kuaokalā)
Surveys were conducted along forested gulches within the Kuaokalā area in February of 2001. During these surveys, three birds were observed. Two of these birds were a breeding pair. In addition, one lone male was observed in 2000 below the State’s Nike Site Facility, it has not been observed since. The State of Hawaiʻi Wildlife Program has continued monitoring these birds. In the last year, none of the birds could be detected (E. Shiinoki, pers. comm., August 2004). NRS will assist the Hawaiʻi Division of Forestry and Wildlife (DOFAW) in additional surveys in Kuaokalā in the coming year and will assist DOFAW with predator control if any ‘Elepaio pairs are found. The Kuaokalā birds are very important to the conservation of ‘Elepaio in the Waiʻanae Mountains because they represent the northwestern most birds. Also the fire of July 2003 burned into Kuaokalā in a number of places. Measures will be taken to ensure that these birds are not impacted by fires from MMR training. With the Integrated Wildfire Management Plan in place, future fire encroachment into this Forest Reserve should be averted.

Pahole Natural Area Reserve
During the spring of 2004, NRS spent a couple of days surveying for ‘Elepaio throughout Kapuna, Keawapilau, and Pahole Gulches. Special emphasis was paid to locations of known birds in order to relocate them. Playbacks were used but no birds were detected. Recently, NAR Staff have indicated that birds have not been detected in these areas.

Keaʻau Game Management Area
NRS have not conducted surveys for ‘Elepaio within Keaʻau.

Management Actions

‘Ōhikilolo MU & East Rim Ungulate Control Area (UCA)
In 2001, NRS initiated predator control efforts for the pair within the ‘Ōhikilolo MU. Predator control was initiated in 2002 for the pair located in the UCA. The two pairs located within the ‘Ōhikilolo MU and the UCA are approximately 400 meters apart in the back of Mākua Valley. Four monitoring trips were conducted each in 2001 and 2002, three trips in 2003, five trips in 2004, and no trips in 2005. Predator control efforts during the ‘Elepaio breeding season from 2001 through 2005 are presented in Figure 5.3. Access to these areas in 2005 was denied over concerns of potential passage through the suspected ICM Area in the back of Mākua Valley (Figure 5.1). The boundaries of the suspected ICM Area were expanded in 2005. This expansion of the suspected ICM Area usurped the access trail used to monitor ‘Elepaio in the ‘Ōhikilolo MU and UCA. Currently, a new boundary for the ICM Area is being designated and hopefully access will be regained in time for the 2006 breeding season.

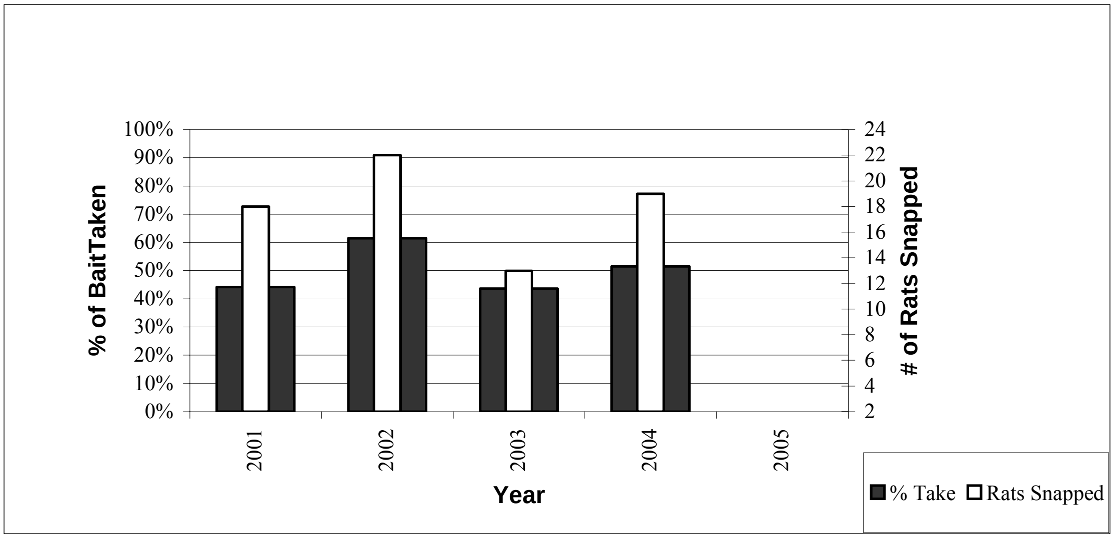


Figure 5.3 ‘Ōhikilolo MU & Ungulate Control Area Rodent Control 2001- 2005

Kahanahāiki MU

NRS have conducted predator control around pair GBAR and BABW since 1996. This pair has successfully fledged young over the years. Predator control for the 2005 breeding season was implemented from 13 January through 06 June (Figure 5.4). NRS conducted bi-monthly maintenance of 10 Protecta® rodent bait stations, 14 Victor® rattraps, and three Tomahawk® live traps. A total of 406 blocks (11.5 kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone), were taken from bait stations. Bait take remained moderate through the breeding season with 44% of the bait taken. A total of 10 rats were caught in snap traps, with an average of 1.1 rats caught per monitoring trip (9 monitoring trips). One feral cat was caught in a Tomahawk® live trap in 2005. Predator control efforts during the ‘Elepaio breeding season from 1998 through 2005 are presented in Figure 5.5.

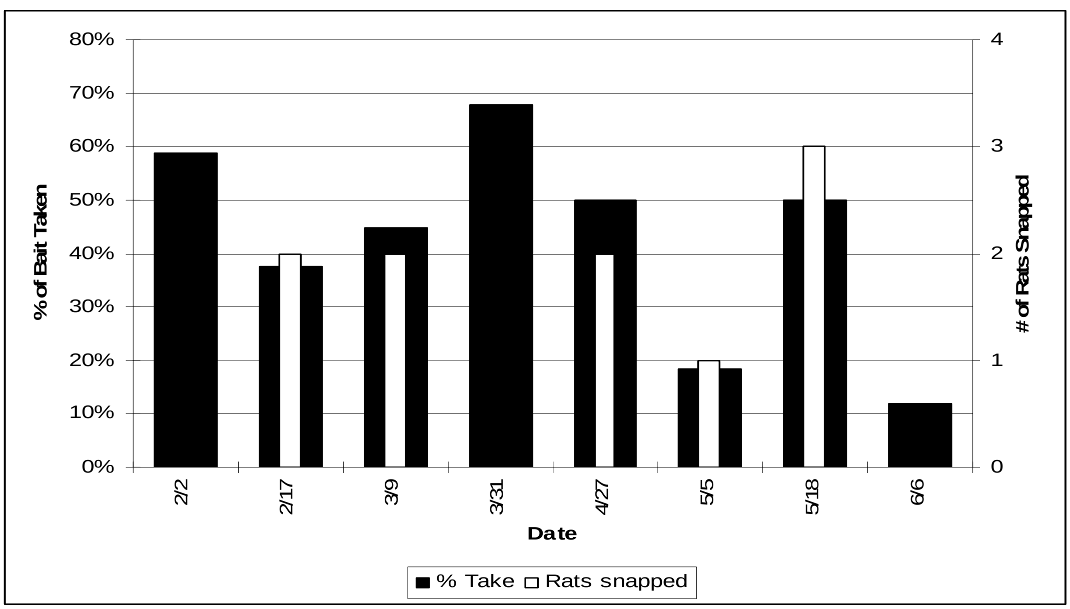


Figure 5.4 Kahanahāiki MU Rodent Control Results, 2005

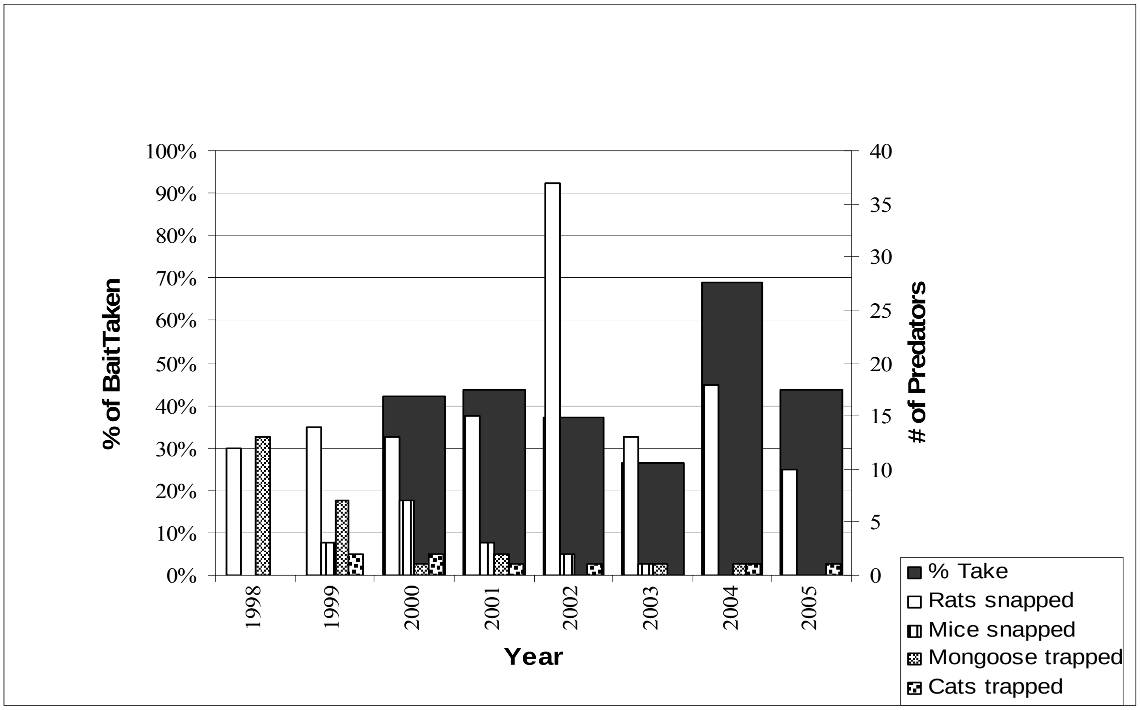


Figure 5.5 Kahanahāiki MU Predator Control Efforts, 1998-2005

<u>Mākaha Valley</u>
During the 2005 breeding season, NRS assisted the Honolulu Board of Water Supply (BWS) with predator control and monitoring for three pairs of ‘Elepaio on the south side of the valley (Mākaha MU) and five pairs on the north side (Mākua AA). Predator control efforts for the 2006 breeding season will include the eight pairs protected in 2005 plus an additional five pairs on the north side of the valley to meet O‘ahu Implementation Plan (OIP) requirements. NRS will continue to conduct surveys to locate additional birds in this area.

Critical Habitat in the Mākua Action Area

<u>‘Ōhikilolo MU and Kahanahāiki MU</u>
In 2003, a prescribed burn that got out of control and crossed the fire break road, subsequently burned nearly 61 ha of designated critical habitat (Figure 5.6). The USFWS recommend the revegetation of burned critical habitat in their September 2004 Mākua BO. At present, no actions have been taken to revegetate the burned areas in Mākua. The section of the critical habitat that burned in the ‘Ōhikilolo MU has not been assessed because of the restricted assess to the ICM Area. This area contains unexploded ordnance (UXO), which would make revegetating this area very difficult. The fire was more extensive on the C-Ridge area west of the Kahanahāiki MU. The section of critical habitat that burned on C-Ridge is difficult to access because of steep terrain. The majority of critical habitat that burned was composed of introduced grasses prone to fire. This area consists of steep grass covered side ridges with *Aleutrites moluccana* forest in gulch bottoms. At present there are no proven techniques for revegetating steep exposed dry rocky terrain with native species that are either fire resistant or fire tolerant. With the Integrated Wildfire Management Plan in place, future fire encroachment into ‘Elepaio

critical habitat should be averted. Possible alternatives to revegetation in these difficult areas could be to increase predator control within existing ‘Elepaio territories and potential territories within MMR or additional predator control in areas outside MMR, but within the Mākua AA, that currently have breeding pairs.

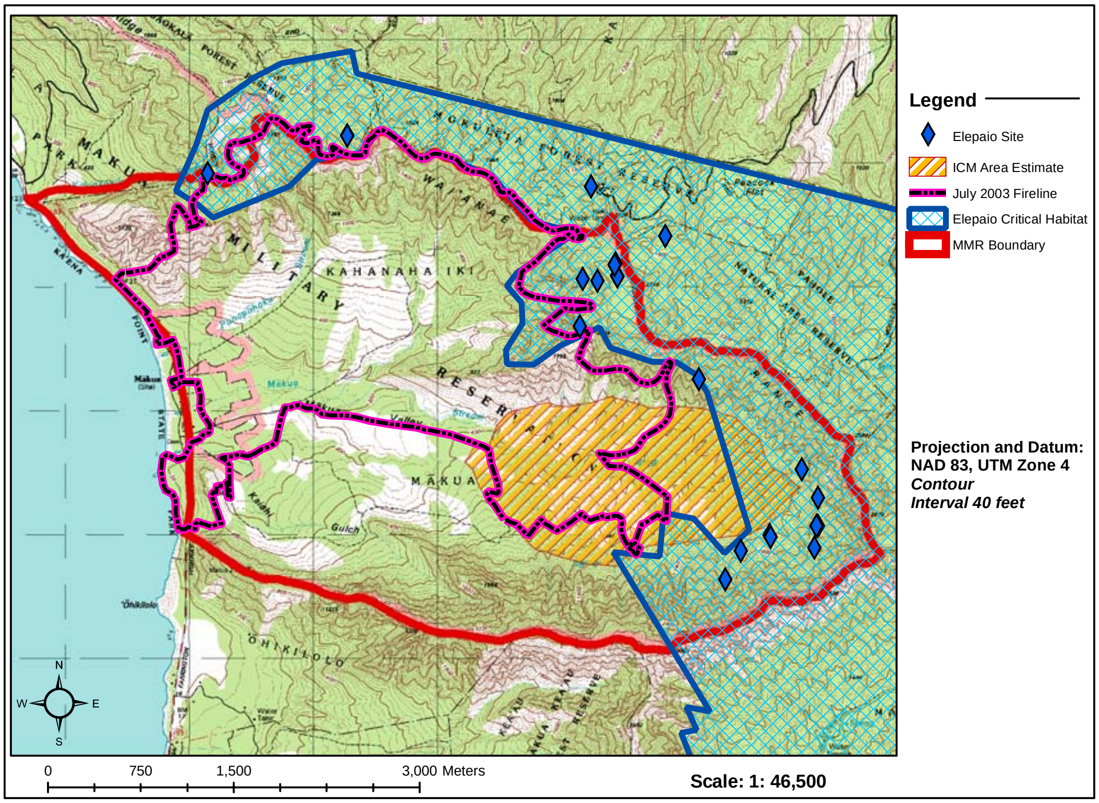


Figure 5.6. MMR 2003 Wildfire and ‘Elepaio Critical Habitat

Chapter 6.0 Oahu Implementation Plan Status Update 2005

In 2003, the Army began consultation with the USFWS regarding federally listed endangered species on the O‘ahu Training Areas. These training areas are Schofield Barracks Military Reservation –West Range (SBMR), Schofield Barracks East Range (SBER), Kawailoa Training Area (KLOA), Kahuku Training Area (KTA), South Range Acquisition Area (SRAA) and Dillingham Military Reservation (DMR). A draft Oahu Implementation Plan (OIP) was recently completed to guide the conservation efforts for the 23 plant, four snail, and one avian species potentially affected by military training on these installations. Nine additional plant species and one additional snail species were also covered in this consultation but are overlapping with the existing Makua Implementation Plan (MIP). These overlap species have been discussed in the MIP status update 2005.

Current status of the OIP

Presently, the draft OIP is out for review. A number of agencies including the USFWS, the State of Hawai‘i, private landowners and field experts were sent copies of the draft. We anticipate having the final draft approved and signed sometime in early 2006.

Urgent Actions

Although the OIP is not finalized at this time, the Army has completed some actions considered to be urgent by the USFWS in the Oahu Biological Opinion (USFWS 2003) (see Urgent Actions Table below). Major projects included the ‘Ēlepaio threat control for a total of 47 pairs, fuel reduction around *Eugenia koolauensis* in KTA, and fencing of rare plant populations in critical need. The Urgent Actions table below outlines recommended urgent actions by the USFWS in their Oahu Biological Opinion (2003). Significant actions done in the past year, in bold, are discussed in detail below (Table 6.1).

Table 6.1 Urgent Actions Specified by the USFWS in the Oahu Biological Opinion

Oahu Implementation Plan Urgent Actions		
Range	**Action #**	**Status**
SBMR		
Fence *Schiedea kaalae*	1	Completed in 2003
Fuel reduction plan for fire break road	2	Completed in 2003
‘Ēlepaio predator control for 75 pairs	3	Predator control conducted for 47 pairs
Review SBMR target locations- >150m from firebreak rd?	4	Completed 2003
SBMR access > or = 45 days/yr	**5**	**See discussion**
Fence *Stenogyne kanehoana* and secure stock	6	Completed 2003
SRAA		
Ungulate control/fencing/monitoring	**7**	**working with TNC-to be completed FY06**
DMR		
Pond survey for T & E avian species	8	Pond has not existed since 2000
Construct noise barriers for any T & E species	9	Pond has not existed since 2000
KTA		

Fence all *Eugenia koolauensis* @ KTA	**10**	**Fences prioritized and scoped. To be constructed with in-house fence crew.**
Minimize habitat degradation from motorcyle/offroad use via cooperation with Army and State	**11**	**need to contact state**
Fuel reduction around *Eugenia koolauensis*	**12**	**2/3 done & 1/3 planned**
KLOA		
Assess urgent actions to minimize impacts to *Melicope lydgatei* along Peahinaia trail	13	trail not in use by military or hiking groups
Minimize threats to *Myrsine juddii* along trails	14	Trails are monitored for impacts from humans, though trails have not been in use near occurrences of this species.
Monitor *Cyrtandra viridiflora* 2x/yr for impacts along trails	15	Plants monitored 2x/yr. Trail has not been in use.
Other Important Oahu Issues		
Wildland Fire Management Plan	16	Completed in 2003
Invasive Plant Control	**17**	**Road and landing zone surveys. Incipient species control.**
Invasive Animal Control	**18**	***Eleutherdactylus coqui* control in Wahiawa**
Minimize effects of foot traffic	**19**	**See discussion**
Minimize effects from ITAM	**20**	**Quarterly meetings. Provide guidance on plant selection for revegetation projects (island sources, native species).**
Drum Road construction	**21**	**Army DPW will work with COE**
Miscellaneous Proactive Actions	**22**	**See discussion below**

Discussion

3. Elepaio Predator Control for 75 Pairs
See Chapter 6.1

5. Schofield Barracks Military Reservation Access Issues
According to the USFWS's 2003 Oahu BO (see conservation measures SBMR #5, page 45):

"The Army will increase the number of days per year available for resource management at SBMR to 45. This increased access will enhance ability of the Natural Resources Staff (NRS) to effectively remove ungulates, control weeds, maintain rat bait stations, and conduct monitoring."

Thus far, NRS have scheduled approximately 6 days per quarter (24 days per year). This low number of scheduled days reflects the NRS strategy to send several teams per day to work within various areas of the range. However, with an increase in Army training, NRS have been asked to leave the range by 2:45 pm. In the future, NRS will work with Range Control to schedule days that training does not occur such as holidays and some weekends in order to have full days on the range or starting out earlier on scheduled days.

7. Ungulate control/fencing/monitoring in SRAA
With the purchase of the new South Range or Kunia Training Area, the Army agreed to build an ungulate fence to prevent additional ingress of pigs from Army training areas into the Nature

Conservancy's Honouliuli Nature Preserve. This agreement was made with the stipulation that the money to build this fence not come out of the Natural Resources Management budget. However, NRS feel an ungulate fence in this area may not be the best solution, especially if there will be no hunting allowed in the area. Additionally, the Army Range Control program is required to fence all training installations. NRS will discuss the usefulness of an ungulate fence in this area and consult with USFWS before plans are made in FY06 for fence construction.

10. *Eugenia koolauensis* Fencing

NRS scoped fences for the three largest populations of *Eugenia koolauensis*. These sites were deemed the highest priority for fencing because they are in the closest proximity to roads, trails, and motocross trails and face the highest impact from troops, motocross riders, and pigs. The other sites consist of single trees or tiny groups of trees and are remote from existing trails. Three proposed fenced sites will encompass populations in ʻŌʻio gulch, Pahipahiʻālua gulch, and Kaunala gulch. The scoped distances for each fence are 425m, 385m, and 365m respectively. NRS are currently hiring a fencing specialist and are planning to hire a fencing crew in the near future to complete projects such as this.

11. Minimization of Habitat Degradation by Motocross

NRS will contact the motocross organizers to learn more about motocross at KTA. In particular, NRS hope to learn more about frequency of trail use, trail locations, and any procedures which may be in place for establishing new trails and cleaning bikes and gear. Known trails will be mapped and document any significant impacts from motocross use. NRS hope to work with motocross users to change and/or implement policies to make motocross use more environmentally sensitive in the KTA area. If possible, NRS will try to limit trail use to established main trails. If motocross users are interested, NRS may conduct a presentation on native plants and the threats posed by incipient weeds and erosion. NRS will also develop posters/brochures to be distributed to motocross users.

12. *Eugenia koolauensis* Fuel Reduction

In July 2003, a fire was started in the construction of a Landing Zone (LZ) above the Pahipahiʻālua *E. koolauensis* population. The fire spread into *Casuarina glauca* stands bordering the LZ, and spread in the duffy, root-thick layer below the trees. It smoldered and reflared several times and was very difficult to put out. The fire burned to within a meter of mature *E. koolauensis*, and most likely killed some seedlings. While there are few grassy fuels around *E. koolauensis* in KTA, *C. glauca* is very common, and borders many *E. koolauensis* sites. NRS identified three populations most threatened by excessive fuels, and are working to reduce the *C. glauca* fuel load around and in them. The populations are KTA-A/Pahipahiʻālua, KTA-F/'Ōʻio, and KTA-B/Kaunala (Table 6.2) and will be fenced in the coming year.

Table 6.2 Threat of Fire to *Eugenia koolauensis*

Eugenia koolauensis Site	*Casuarina glauca* Present?	Proximity to Active Road	Proximity to Inactive Road	Proximity to Hiking or Motocross Trail	Previously Affected by Fire?	Fire Threat
KTA-A/ Pahipahiʻālua	Yes, Abundant, < 10m away and above	< 100 m	>500 m?	< 10 m	Yes, 2003	High
KTA-F/'Ōʻio	Yes, Abundant, within site and above	720 m, separated by a gulch	230 m, separated by a gulch	230 m, separated by a gulch	No	Moderate
KTA-B/ Kaunala	Yes, Abundant, within site and above	700 meters, separated by a large valley and gulch	40 m	200 m, in the bottom of the gulch	No	Moderate

In order to reduce the fire threat to these populations, NRS contracted a tree removal service through DPW to remove large *C. glauca* trees from in and around the three sites. NRS opted to use experts for this job due to the size of the trees and their proximity to *E. koolauensis*. Twenty-one trees were removed from the Pahipahiʻālua site, and 45 trees were removed from the ʻŌʻio site. The number of trees cut at each site varies due to the location and size of the trees. No trees were cut at Kaunala because of lack of funding. However, the site was assessed and 51 trees were marked for removal. NRS used the information in Table 6.2 above to prioritize fuel reduction at the three sites. NRS hope to have additional funding in the next fiscal year for the remaining trees. Due to the remote nature of the sites, NRS decided to leave the fallen trees in the patches. Minimal bucking of slash was done by the contractors in order to stretch funds farther. NRS will determine if any slash needs to be moved or cleared and will do so in the coming year.

17. Invasive Plant Control

Invasive species detection and control are very high priorities for NRS. The proposed invasive plant control program for the OIP is very similar to that which is already in place for the MIP. It includes regular surveys of high traffic areas, and regularly scheduled monitoring and control visits to infestation sites.

The Invasive Plant Survey Table 6.3 summarizes the regularly conducted weed surveys carried out by NRS. Road surveys and LZ surveys allow NRS to observe any new weeds which enter an area via either military or NRS activity. Weed transect surveys track weed community changes along lines of high ungulate activity.

Table 6.3 Summary of Regular Invasive Plant Surveys

Training Area	# Road Surveys (each road surveyed 1x/yr)	# LZ Surveys	# Weed Transect Surveys (1x/quarter along trails)
KTA	3	4	No weed transects set up
SBW	1	N/A	No weed transects set up
KLOA	6	19	3
SBE	1	3	1
SBS	1	1	No weed transects set up
DMR	1	N/A	No weed transects set up

The Incipient Plant Control Table 6.4 summarizes on-going incipient and single species weed control efforts on O‘ahu training areas, excluding Makua Military Reservation. Typically, incipient weed control includes quarterly monitoring trips to an infestation site for treatment, ground surveys, and sometimes aerial surveys.

Table 6.4 Summary of Incipient Plant Control on O‘ahu Training Areas 2005. Person hours/# of visits reflect NRS time and do not include ITAM or OISC control efforts.

Training Area	Invasive Species	Probable Cause of Introduction	Person Hours/ # of Visits	Comments
KTA	*Acacia mangium*	ITAM revegetation project	20.25/7	4 known sites. Control conducted quarterly. No known mature plants remain. Continue to find seedlings and juveniles. This year, used aerial survey to aid in more complete detection; very successful.
KTA	*Rhodomyrtus tomentosa*	Vehicle traffic, construction, Motocross	0.5/1	1 plant known from 1 site. Plant removed. NRS will survey area to determine if there is a larger population present.
KTA	*Pennisetum setaceum*	Foot or Vehicle traffic, from PTA or Diamond Head	3.5/2	1 known site. Area surveyed quarterly. No mature plants seen since (11/03). No plants of any age class as of August 2005. To stimulate any seed bank, thick weedy grasses sprayed and area opened up.
KTA	*Melochia umbellata*	Foot or Vehicle traffic, from PTA, National Guard in Keaukaha	13/4	2 known sites. 1 site only had 1 plant; it was removed and no plants seen since. Other site was much larger infestation. This year, visited all old aerial survey points and treated all plants found, including 2 mature. Also, surveyed road portion of site and sprayed quarterly. Aerial survey conducted annually.
SBW	*Caesalpinia decapetala*	Vehicle traffic	0/0	Infestation along the firebreak road. Control will be focused along roadways to prevent spread.
SBW	*Callitris* sp.	ITAM or Forestry planting; old	0/0	Significant infestation along both sides of the firebreak road. NRS will monitor, and consider control.
KLOA	*Setaria palmifolia*	Foot traffic along trails	8.5/2	Along the KST. Control focused within fenced areas. Control will be expanded to KST if it is used by troops
KLOA	*Arthrostemma ciliata*	Foot or Vehicle Traffic	~1/3	2 sites known. Control focused along roadways to prevent spread. Sites sprayed quarterly
SBE	*Arthrostemma ciliata*	Foot or Vehicle Traffic	1.25/1	1 site known. Site needs to be revisited.

SBE	*Buddleia madagascariensis*	Foot or Vehicle Traffic, ornamental plantings in Wahiawa	5.5/2	2 sites known. No plants known at present. Large effort for detection and eradication underway, including road and aerial surveys with OISC. Sites monitored quarterly
SBE	*Smilax* sp.	Foot or Vehicle Traffic	0/0	1 infestation site found (07/05). Voucher sent to Bishop for identification. Survey and control work scheduled.
SBE	*Pennisetum setaceum*	Foot or Vehicle traffic, from PTA or Diamond Head	0/0	1 known site. 1 plant seen on (5/02). No plants known at present.
SBE	*Rhodomyrtus tomentosa*	Foot or Vehicle Traffic, ornamental plantings in Wahiawa	35.5/ 4	1 infestation site discovered (4/05). Large effort for eradication underway, including ground surveys, aerial surveys, and control.
SBS	*Senecio madagascariensis*	Foot or Vehicle traffic, from PTA	0/0	1 known site. NRS passed control of this site to ITAM. ITAM visits monthly. NRS assists with large scale spray efforts periodically. Low numbers of plants still present
DMR	*Pennisetum setaceum*	Foot or Vehicle traffic, from PTA	0/0	1 known site. No plants seen since (8/01). Population eradicated.

18. Invasive Animal Control

There is only one incipient invasive animal on O‘ahu training lands, *Eleutherodactylus coqui*, commonly known as coquí. Coqui have been found in several locations on Army land. The largest site is in SBER, on forested land. NRS regularly help conduct coqui control at this site. The other sites are discussed below. The coqui infestation encompasses approximately 9 acres of land, half on SBER, and half in a residential Wahiawa neighborhood. Originating from a residential greenhouse, the frogs multiplied and spread throughout the neighborhood and onto Army land. NRS work collaboratively with the Directorate of Public Works (DPW), Dept. of Agriculture (DOA), the USFWS, and the Oahu Invasive Species Committee (OISC), to eradicate coqui from Wahiawa. Previous eradication efforts are discussed in the 2004 PCSU Report. This year, NRS assisted with eradication efforts in a number of ways:

- Coqui Strategy Group: NRS assisted in discussing control approaches and planning control efforts.
- Citric acid: NRS purchased a third of the citric acid needed for sprays; 150 bags, $8K.
- Transects: NRS contracted a private company to bulldoze temporary roads to facilitate speedy and efficient nighttime spray efforts; $2.5K. NRS will also maintain transects through the off season to ensure they are usable next year.
- Access: NRS coordinated access to the SBER portion of the infestation.
- Personnel: NRS assisted OISC staff in conducting nighttime sprays.

Other coqui sites on Army land include a military exchange store, and a brush clump at Tripler Hospital. The exchange store sold plants from a nursery which was contaminated with coqui. There are only a few remaining frogs in the store. The source of the frog at Tripler is unknown. DOA, USFWS, and NRS counterparts at DPW are working to eradicate frogs at these sites.

19. Minimize Effects of Foot Traffic

Training maneuvers require troops to use a variety of trails, roads, and rallying points. It is impossible to survey every area used, and it is impossible to monitor the activities of each soldier. Negative effects of foot traffic include weed introduction and spread, erosion, and littering. These impacts are very real; NRS suspect that most of the weeds listed in Table 6.4 were introduced via foot or vehicle traffic. This year, two new species were discovered on O'ahu training lands: *Rhodomyrtus tomentosa* and *Smilax* sp. The *Smilax* species may be a record for Hawai'i. NRS work to mitigate the threat of weeds using a combination of surveys and control, described in #17 above. The ITAM office works to mitigate the effects of erosion.

Thus far, NRS efforts have focused on surveys and control. In the coming years, NRS would like to begin a closer dialogue with Range Control and with trainers, and work on prevention, as opposed to reaction. In the future NRS will pursue answers to the following issues:

- Awareness: ITAM and NRS collaborated on a soldier training card in the past. The project was turned over to ITAM. NRS will follow up on the project and work to get the card distributed to trainers. NRS may also prepare a short presentation to be used either by trainers, or NRS, in briefing troops prior to training exercises.
- Personal gear sanitation: boots, bags, etc. What procedures are in place for soldiers to clean gear between training areas and between islands?
- Vehicle sanitation: How often are vehicles washed? Are wash racks functional and fully utilized? Can vehicles be washed upon exiting KTA, the weediest training area?
- Trails: Which are affected by soldier training? How often are they used?

20. Minimize Effects from ITAM

The Integrated Training Area Management, or ITAM, office is charged with maintaining training areas to facilitate military training requirements. They assist Range Control in maintaining roads, performing erosion control, and assessing range condition. Due to high personnel turnover rates at the ITAM office, it has been difficult for NRS to maintain a close working relationship with ITAM. This year, however, NRS were able to collaborate with ITAM on several projects:

- Informational presentation: ITAM arranged for NRS to give a presentation to the Range Maintenance road crew. The presentation included identification of top incipient weeds, common native plants, and a few endangered species.
- Incipient weed booklet: ITAM used the information from the presentation to create a field booklet focusing on the top incipient weeds. The booklet was reviewed by NRS. NRS hope to work with ITAM to distribute it to both Range Maintenance personnel and trainers.
- Survey of infestation sites: NRS gave a tour of various weed infestations on SBER to ITAM. ITAM has the ability to use this information to limit training in areas with invasive weeds. In particular, NRS surveyed the *R. tomentosa* site.
- Maintaining lines of communication: NRS and ITAM are working to schedule meetings twice a year. In addition, NRS are working to keep communication lines open to allow for the discussion on various issues, like lists of candidate species for revegetation efforts. Previous revegetation efforts have resulted in the introduction of a weedy tree, *Acacia mangium*, which NRS now control quarterly.

21. Drum Road Construction

To date the contract for the construction of Drum Road has not been awarded. When the contract is awarded, the Army NRS will work with the Army Corps of Engineers to attend a pre-construction briefing and flag and point out any sensitive areas to construction crews. Additionally, NRS will conduct regular monitoring throughout the construction process.

22. Miscellaneous Proactive Actions

I. Ungulate Management for OIP

The proposed feral ungulate control and monitoring program for the O'ahu training areas will be similar to that which already exists both for O'ahu and Mākua training areas. This includes a program of monitoring, control, and fencing.

Control

This year the Army, in collaboration with the Koolau Mountains Watershed Partnership (KMWP), initiated an ungulate control program within the Kawailoa Training Area (KLOA). Public pig control efforts will begin soon and will focus on the lower elevations of KLOA between the Mc Cormmick and Ashley gates along Drum road. The Army helped to fund an ungulate specialist position with KMWP to organize these efforts with the public on Army leased property and other State and privately owned land.

Fencing

Kaala MU: The Army has recently completed most of the strategic fencing around the summit of Mount Kaala. This fencing protects the 170 acre management unit. Areas of possible ingress remain on Board of Water Supply (BWS) and State lands. NRS will assist these agencies in monitoring these areas to see if additional fencing is necessary. Several rare plant species will be protected by this strategic fencing including: *Cyanea acuminata, Labordia cyrtandrae,* and *Schiedea trinervis.* Additionally, *Cyanea calycina, Gunnera petaloidea, Melicope christophersenii,*and *Neraudia melastomafolia* are also found within this management unit.

Helemano MU: The Helemano fenceline in the KLOA training area will be adjacent to the existing Opaeula management unit fenceline. The 'Ōpae'ula MU encompasses 121 acres. The Helemano fenceline will enclose another 113 acres. This fenceline construction will begin soon, to be completed by September 2006. Federally listed endangered species protected by the Opaeula/Helemano fencelines include: *Achatinella lila, A. sowerbyana, Chamaesyce rockii, Cyanea koolauensis, C. st.-johnii, Cyrtandra viridiflora, Phyllostegia hirsuta,* and *Viola oahuensis.* Other rare species within the existing and soon to be built fenceline include: *Arachnoides insularis, Anoectochilis sandvicensis, Cyanea calycina, C. humboldtiana, Joinvellia ascendens* subspecies *ascendens, Lobelia gaudichaudii* subspecies *gaudichaudii,* and *Zanthoxylum oahuensis*.

Gardenia mannii fence, SBW: This fence was constructed this past year to protect *Gardenia mannii* in Schofield Barracks West Range (SBW). This species is known predominantly from the Koolau Mountain Range. Therefore, this fence protects a significant occurrence of *G. mannii* in the Waianae Mountains. This small fence measures approximately 27 X 67 m and encompasses two mature individuals. This population is currently designated as 'Manage for Stability' in the Draft OIP.

See the Draft OIP (US Army Garrison, 2005) for details on the OIP MUs.

II. Rare Snail Surveys

The Oahu Biological Opinion (Oahu BO) lists a total of ten *Achatinella* species as currently found within the O‘ahu action area (AA). However, there are currently only five species with extant populations inside the AA. The extant species are: *A. byronii, A. lila, A. livida, A. mustelina,* and *A. sowerbyana* (for more information see the Draft OIP, 2005). Active management for these populations is ongoing. The five species with no known extant populations either inside or outside the AA are: *A. apexfulva, A. bulimoides, A. curta, A. leucorraphe*, and *A. pulcherrima*. NRS feel it is important to conduct surveys for these non-extant species.

Recently, NRS rediscovered extant individuals of *A. bulimoides* just outside the Kawailoa AA to the east of the Koolau Summit. To date, NRS have collected all seven individuals observed for captive propagation with the University of Hawai‘i Snail Propagation Lab. As mentioned in Chapter 4: *Achatinella mustelina* management, the minimum number of individuals needed to start a captive snail population with is ten. NRS will continue to survey for *A. bulimoides* until a total of ten individuals are collected for the captive population. Additional snail surveys are planned on an annual basis for each of the other species (US Army, 2004).

Chapter 6.1 OIP ‘Elepaio Management

The initial Biological Opinion (BO) that triggered the development of the O‘ahu Implementation Plan (OIP) was issued on 23 October 2003. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the O‘ahu ‘Elepaio (*Chasiempis sandwichensis ibidis*) endangered species status under the federal Endangered Species Act and designated critical habitat on O‘ahu for the ‘Elepaio in 2001. The 2003 BO requires the Army to manage 75 ‘Elepaio pairs through the control of alien rats during the breeding season at Schofield Barracks Military Reservation (SBMR). The BO presents three alternative methods for the management of 75 pairs at SBMR. Any or all of the following alternative methods can be followed in order to achieve the desired 75 pairs: 1) increase access for NRS at SBMR to a minimum of 45 days per year for the deployment and maintenance of rat bait stations in a larger number of ‘Elepaio pair territories than currently being managed. 2) the construction of three fenced exclosures consisting of 40 ha each to facilitate ungulate control, as well as rat bait stations and/or when registration is approved, broadcast of diphacinone to control rats. 3) if three such exclosures cannot be constructed at SBMR, then the Army will manage the remaining number (75 less the number managed at SBMR) of ‘Elepaio pair territories at an appropriate off-site location agreed upon by NRS and USFWS biologists. In 2005, predator control was implemented during the breeding season for 44 pairs at three locations (SBMR, Honouliuli Forest Reserve, Mākaha Valley). Twenty-two pairs successfully fledged young for a total of 25 fledglings. Table 6.5 summarizes the monitoring data collected during the 2005 breeding season and includes the projected number of pairs to be protected during the 2006 breeding season. Pono Pacific has been contracted to implement predator control and monitoring for 50 pairs during the up coming 2006 breeding season.

Table 6.5 Summary of ‘Elepaio Monitoring and Protection

Areas Managed	# of Pairs Known	# of Pairs Protected	# 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	Projected # of Pairs to be Protected in 2006
SBMR	15	15	10	11	3(4)	2(2)	6	15
Honouliuli	21	21	17	10	4(5)	11(12)	17	21
Mākaha	8	8	6	2	0	2(2)	2	14
Moanalua[4]	--	--	--	--	--	--	--	20
Totals	44	44	33	23	7(9)	15(16)	25	69

1 = The number of active nests found may include more than one nesting attempt in a given territory
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 = Moanalua Valley will be included in the areas of ‘Elepaio management in 2006

O‘ahu Training Areas

Schofield Barracks South Range (SBS)

Six ‘Elepaio were believed to be in SBS when NRS first began monitoring the area in 1996. All of these birds were males and two of them had been banded (Table 6.6). In 2004, only one bird

(RGAR) responded to playbacks. Due to the lack of females within the population, predator control has never been initiated and monitoring has not been consistent.

Schofield Barracks East Range (SBER)
Shallenberger (1977) reported one bird from SBER in 1977. NRS has conducted five surveys (1997 – 1, 1998 – 1, 2002 – 2, 2003 – 1) in SBER with no ‘Elepaio detections (Figure 6.1). The 2003 survey was conducted in South Kaukonahua Stream in the area of SBER that Shallenberger had detected ‘Elepaio. NRS will continue to survey areas in SBER in hopes of locating a remnant population of ‘Elepaio.

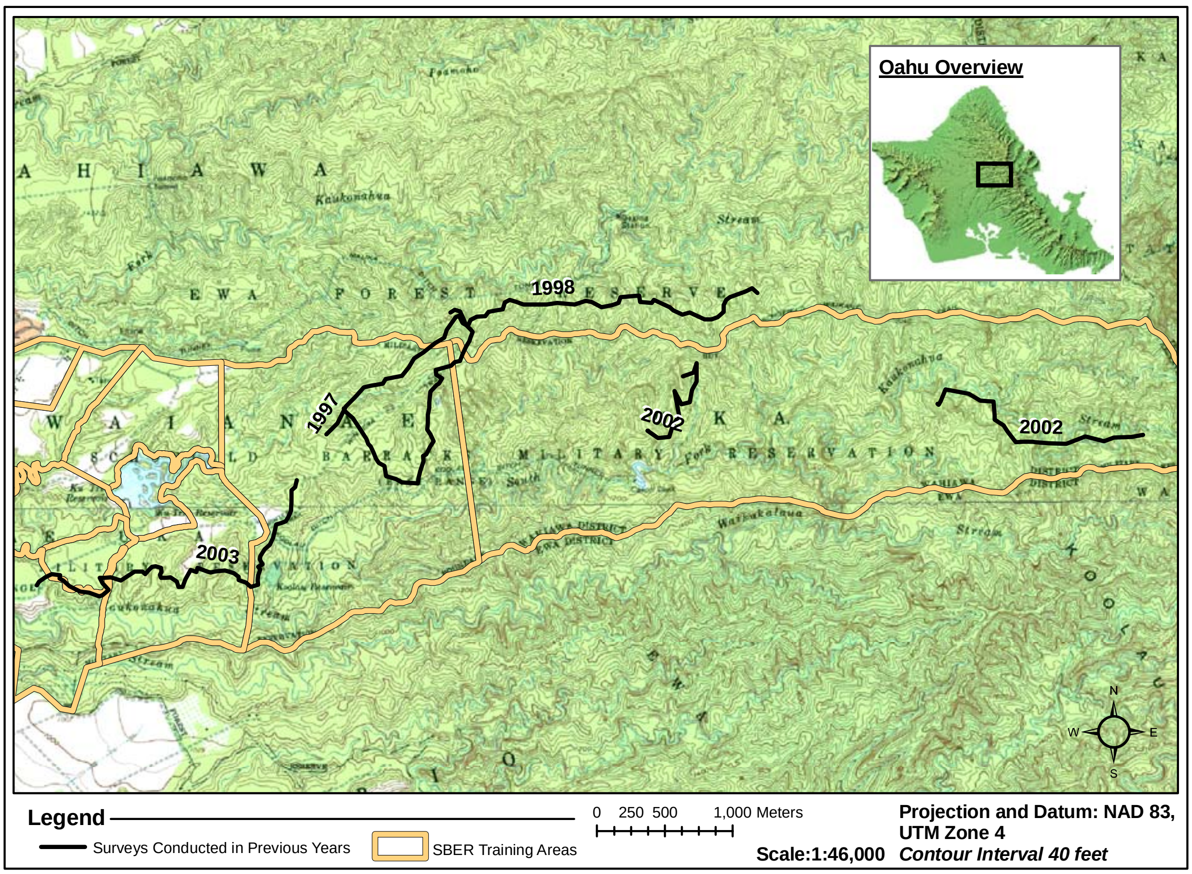


Figure 6.1 ‘Elepaio Survey Routes in Schofield Barracks East Range

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 61 birds over a ten year period in SBMR. NRS has been monitoring these birds as frequently as access allows. Of the 61 banded birds, 18 of them have not been observed since prior to 2002. Banding has been conducted in five gulches in SBMR (S. Mohiākea, N. Mohiākea, Hale‘au‘au, Baby Water, W. Pule‘e) (Table 6.6). In 2005, NRS monitored 31 territories of which 15 territories contained pairs (Figure 6.2).

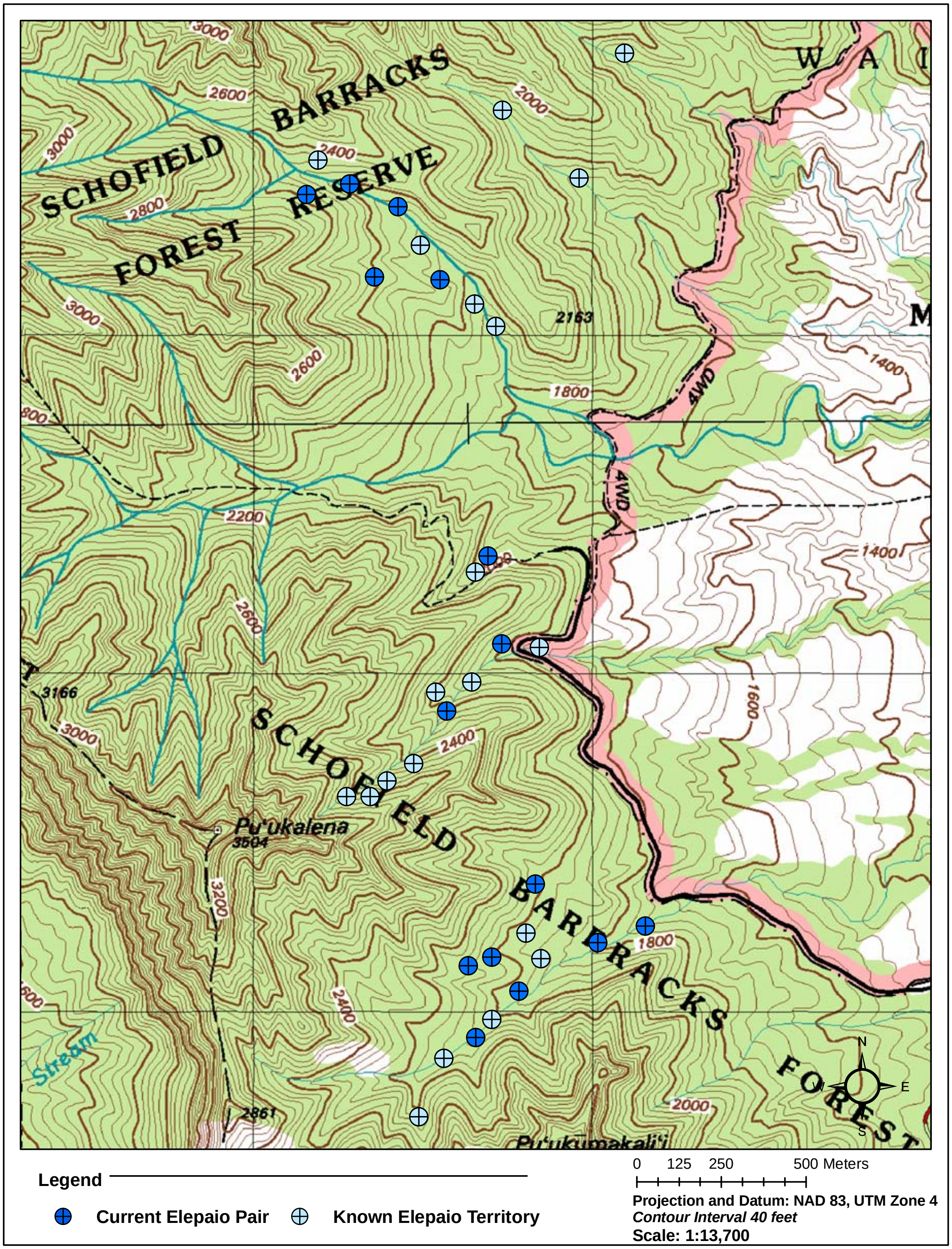


Figure 6.2 ‘Elepaio Distribution on Schofield Barracks Military Reservation

Rodent Control

NRS initiated predator control for the 2005 breeding season from 19 January 2005 to 25 May 2005. Eighty-seven Protecta® rodent bait stations and 164 Victor® rat traps were installed in 15 ‘Elepaio territories in four gulches (Hale‘au‘au, N. Mohiākea S. Mohiākea, Baby Water). A total of 1,900 blocks (54kg) 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 28.1%. A total of 211 rats were caught in snap traps with an average of 26.4 rats per monitoring trip (8 monitoring trips). Rodent control efforts from 2001 through 2005 are shown in Figure 6.3. In 2005, the number of rats caught in snap traps increased nearly 46% and percent bait taken declined about 40%. The increase in the number of rats snapped and decrease in the percent bait taken can be attributed to the increased number of site visits in 2005 compared with the number of site visits in prior years (year, access days: 2001, 9; 2002, 11; 2003, 9; 2004, 9; 2005, 21). With the increased number of site visits, NRS were able to reset snap traps more often subsequently reducing the resident rat population. With the high number of rats snap trapped, less bait was consumed than in previous years.

Table 6.6 ‘Elepaio Banding Data, Schofield Barracks Military Reservation

Bird[1]	Date Banded	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
RGAR	03/06/97	01/15/02	01/15/02	Y	N	SBS	M
BGAG	03/06/97	08/06/98	01/15/02	Y	N	SBS	M
BGAB	08/30/96	12/14/96	03/29/02	Y	N	Hale‘au‘au	M
RGGA	08/30/96	03/29/02	03/29/02	Y	N	Hale‘au‘au	M
RBAB	08/30/96	08/30/96	03/29/02	Y	Y	Hale‘au‘au	F
BGAR	08/30/96	02/13/03	02/13/03	N	N	Hale‘au‘au	M
ABGR	09/02/96	12/22/00	03/29/02	Y	N	Hale‘au‘au	M
ABGG	09/02/96	02/27/00	03/29/02	Y	Y	Hale‘au‘au	F
ABWB	09/02/96	11/29/96	02/27/00	Y	N	Hale‘au‘au	M
RBBA	09/02/96	09/02/96	02/27/00	Y	N	Hale‘au‘au	M
BAWG	09/02/96	04/03/99	04/03/99	Y	N	Hale‘au‘au	M
WGBA	09/02/96	09/02/96	03/17/99	Y	N	Hale‘au‘au	F
GBBA	02/14/97	02/18/02	02/18/02	Y	N	Hale‘au‘au	M
RABW	03/20/97	05/23/97	04/03/99	N	N	Hale‘au‘au	M
ARRG	06/13/97	05/05/04	05/05/04	Y	N	Hale‘au‘au	M
WBAR	09/03/99	08/29/02	08/29/02	N	Y	Hale‘au‘au	M
WWRA	05/02/04	04/13/05	06/13/05	N	N	Hale‘au‘au	M
WARG	05/02/04	05/17/05	06/13/05	Y	Y	Hale‘au‘au	F
BBAR	05/02/04	05/02/04	05/02/04	N	Y	Hale‘au‘au	M
BBAG	05/02/04	06/13/05	06/13/05	Y	N	Hale‘au‘au	M
GGAG	02/23/05	02/23/05	02/23/05	N	N	Hale‘au‘au	M
GWAW	02/23/05	03/30/05	06/13/05	N	Y	Hale‘au‘au	F
AGWR	02/23/05	02/23/05	06/13/05	N	Y	Hale‘au‘au	F
BGWA	01/25/05	05/18/05	05/18/05	Y	Y	Baby Water	M
AGWR	01/25/05	05/18/05	05/18/05	N	Y	Baby Water	F
RGAW	02/14/96	02/14/96	02/14/96	N	N	N. Mohiākea	M
WGWA	02/14/96	02/18/01	07/13/01	N	Y	N. Mohiākea	F
BWAG	02/14/96	05/15/99	05/15/99	N	Y	N. Mohiākea	M
WRAG	02/14/96	02/14/96	02/14/96	N	Y	N. Mohiākea	M
BRAW	02/14/96	02/18/01	07/13/01	N	N	N. Mohiākea	M
BWAB	08/31/96	08/31/96	08/31/96	Y	N	N. Mohiākea	M

Bird[1]	Date Banded	Last Observed	Last Monitored	Disease[2]	Mate Observed[3]	Range or Gulch	Sex
BGBA	09/29/96	06/16/03	06/16/03	Y	N	N. Mohiākea	M
WBRA	09/29/96	04/28/98	05/15/99	Y	N	N. Mohiākea	M
GWRA	09/29/96	09/29/96	05/15/99	Y	N	N. Mohiākea	M
GRBA	09/29/96	08/28/02	08/28/02	Y	N	N. Mohiākea	M
WGAR	11/20/98	02/26/00	02/26/00	N	Y	N. Mohiākea	M
RWBA	11/20/98	02/26/00	02/26/00	N	Y	N. Mohiākea	M
GAWW	11/20/98	07/13/01	07/13/01	N	Y	N. Mohiākea	F
BWGA	11/20/98	07/13/01	07/13/01	Y	N	N. Mohiākea	M
BABB	11/20/98	12/29/98	02/18/00	Y	N	N. Mohiākea	M
AGGW	08/28/02	06/13/05	06/13/05	N	Y	N. Mohiākea	M
WARW	08/29/02	06/22/04	06/22/04	N	Y	N. Mohiākea	M
GABG	08/29/02	02/15/03	02/15/03	N	Y	N. Mohiākea	F
WRAR	08/29/02	08/29/02	08/29/02	N	N	N. Mohiākea	M
WWBA	01/24/05	01/24/05	04/14/05	N	N	N. Mohiākea	M
AWWB	01/24/05	01/24/05	05/18/05	N	Y	N. Mohiākea	M
RRAR	01/25/05	01/25/05	01/25/05	N	N	S. Mohiākea	M
ABGB	06/15/97	01/20/05	01/20/05	Y	N	S. Mohiākea	M
WRGA	06/15/97	01/26/05	06/14/05	Y	N	S. Mohiākea	M
GAGB	06/15/97	06/14/05	06/14/05	N	N	S. Mohiākea	M
GBAB	06/15/97	06/14/05	06/14/05	Y	N	S. Mohiākea	M
AWRR	01/17/00	02/17/00	02/17/00	N	N	S. Mohiākea	M
WWAB	01/17/00	03/27/02	03/27/02	Y	N	S. Mohiākea	M
RARG	01/17/00	05/19/05	06/14/05	Y	N	S. Mohiākea	M
RABB	01/17/00	03/27/02	03/27/02	N	N	S. Mohiākea	F
BWWA	01/17/00	05/29/05	06/14/05	Y	N	S. Mohiākea	M
GRAR	01/17/00	06/14/05	06/1405	Y	N	S. Mohiākea	M
WRAB	01/17/00	05/18/03	05/18/03	N	N	S. Mohiākea	F
GARW	01/20/05	06/14/05	06/14/05	N	Y	S. Mohiākea	M
ABRB	09/01/96	02/21/00	02/21/00	Y	N	W. Pule‘e	M
BRAB	09/01/96	09/01/96	02/21/00	Y	N	W. Pule‘e	M
ARGW	09/01/96	01/10/01	01/10/01	Y	Y	W. Pule‘e	M
AWGW	01/14/00	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, and M=Mauve color bands.
2 = Presence of disease when banded: (Y)es or (N)o
3 = Presence of a mate when last observed: (Y)es or (N)o

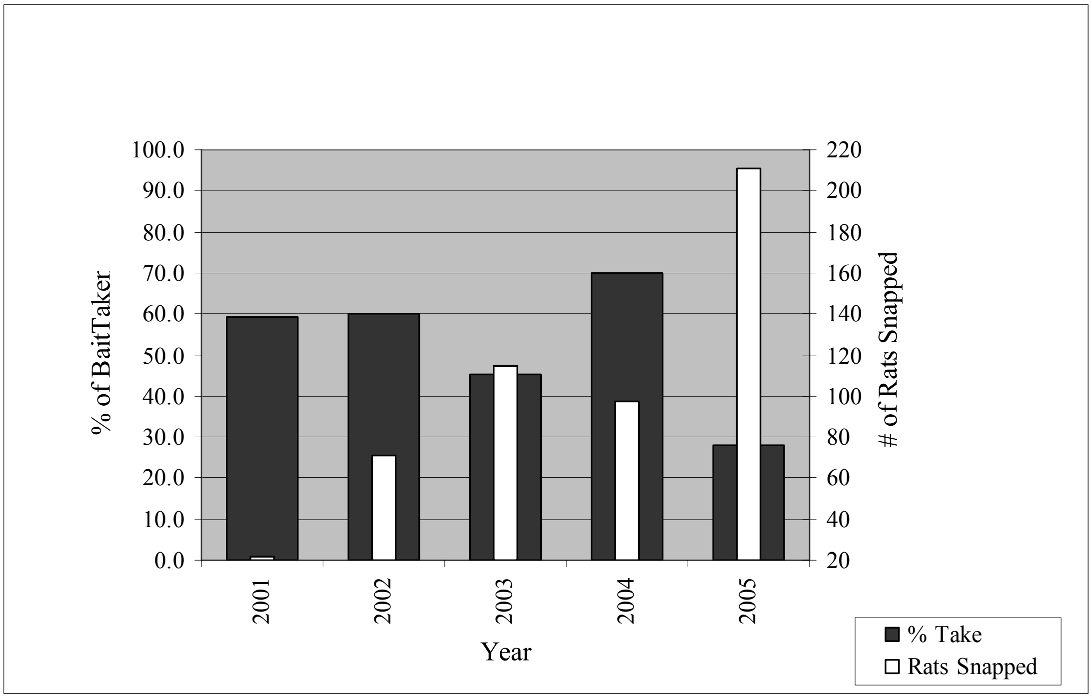


Figure 6.3 Schofield Barracks Military Reservation Rodent Control 2001-2005.

Breeding Behavior

Of the 15 pairs being monitored in SBMR, only 10 were observed to have breeding activity occurring during NRS site visits. A total of 13 nests were observed in various stages (10 – building stage, 3 – nestling stage). The mean nest height was 9.0 meters (*n* = 13). Nests were located in seven tree species (*Psidium guajava* - 5, *Psidium cattleianum* - 3, *Schinus terebinthifolius* - 1, *Aleutrites moluccana* - 1, *Elaeocarpus grandis* - 1, *Ilex anomala* - 1, *Psychotria* spp. - 1). Two nests were found in the very initial stages of building (construction starting that day), but on the next visit the nesting material was absent. The pairs apparently disassembled what little material they had placed and continued to construct their nests in new locations. Two of the eight other nests in the building stage successfully fledged one nestling each. Of the three nests found in the nestling stage, only one fledged two nestlings. The cause of failure of nests was undetermined because of the high heights of nests. Only three observed nests fledged a total of four young. However an additional two family groups were observed with one fledgling each. Family groups were pairs with fledglings in which nests were not located during prior site visits. Five of 15 pairs (33%) were successful in fledgling young (6 fledglings, 0.4 fledglings per total number of pairs in SBMR monitored). The three pairs for which breeding activity was not observed, most likely attempted nesting but were not detected by NRS due to timing of site visits or failure in nesting attempts.

2006 Breeding Season

NRS will continue to strive for increased access to SBMR during the breeding season, to increase the known number of pairs by additional surveys, to continue to band pairs to assess survival, and to perform predator control. The projected number of pairs to be protected during the up coming breeding season is 15 paris.

Kawailoa Training Area (KLOA)

Shallenberger (1977) detected 12 ‘Elepaio while surveying in the KLOA. Shallenberger and Vaughn (1978) detected ‘Elepaio on both the Poamoho and Schofield-Waikāne trails in later surveys. In 1992, surveys conducted by The Nature Conservancy’s Hawaii Natural Heritage Program detected an ‘Elepaio along the Schofield-Waikāne Trail (HHP 1994). NRS have visited all of the areas in which these birds were reported without detecting any birds. NRS has conducted 16 surveys in KLOA from 1997 through 2005 (1997 – 1, 1998 – 2, 2000 – 1, 2002 – 2, 2003 – 2, 2004 – 3, 2005 – 3)(Figure 6.4). During these surveys no ‘Elepaio have ever been detected. NRS will continue to survey areas in KLOA in hopes of locating a remnant population of ‘Elepaio.

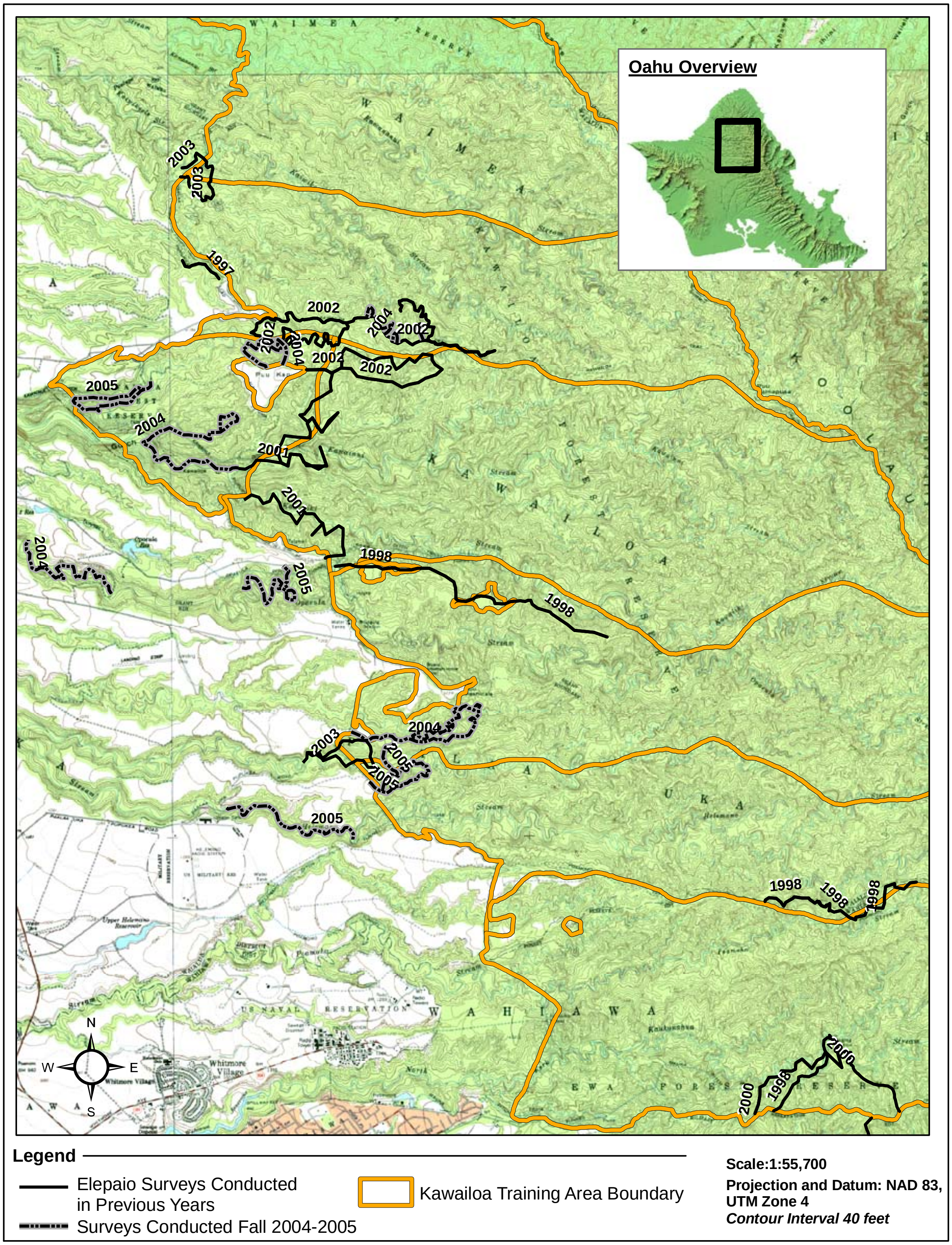


Figure 6.4 ‘Elepaio Survey Routes in Kawailoa Training Area, 1997-2005.

Kahuku Training Area (KTA)
Shallenberger (1977) reported a single observation of ‘Elepaio in KTA. NRS has conducted 13 ‘Elepaio surveys (1998 – 8, 2002 – 2, 2003 – 3) in KTA (Figure 6.5). In 1998, NRS visited the site where Shallenberger had reported ‘Elepaio and were unable to detect any birds. All surveys to date in KTA have not revealed the presence of ‘Elepaio. Additionally, during extensive routine management work in this area over the years by NRS, no ‘Elepaio have ever been detected. NRS will continue to survey other areas at KTA in hopes of locating ‘Elepaio.

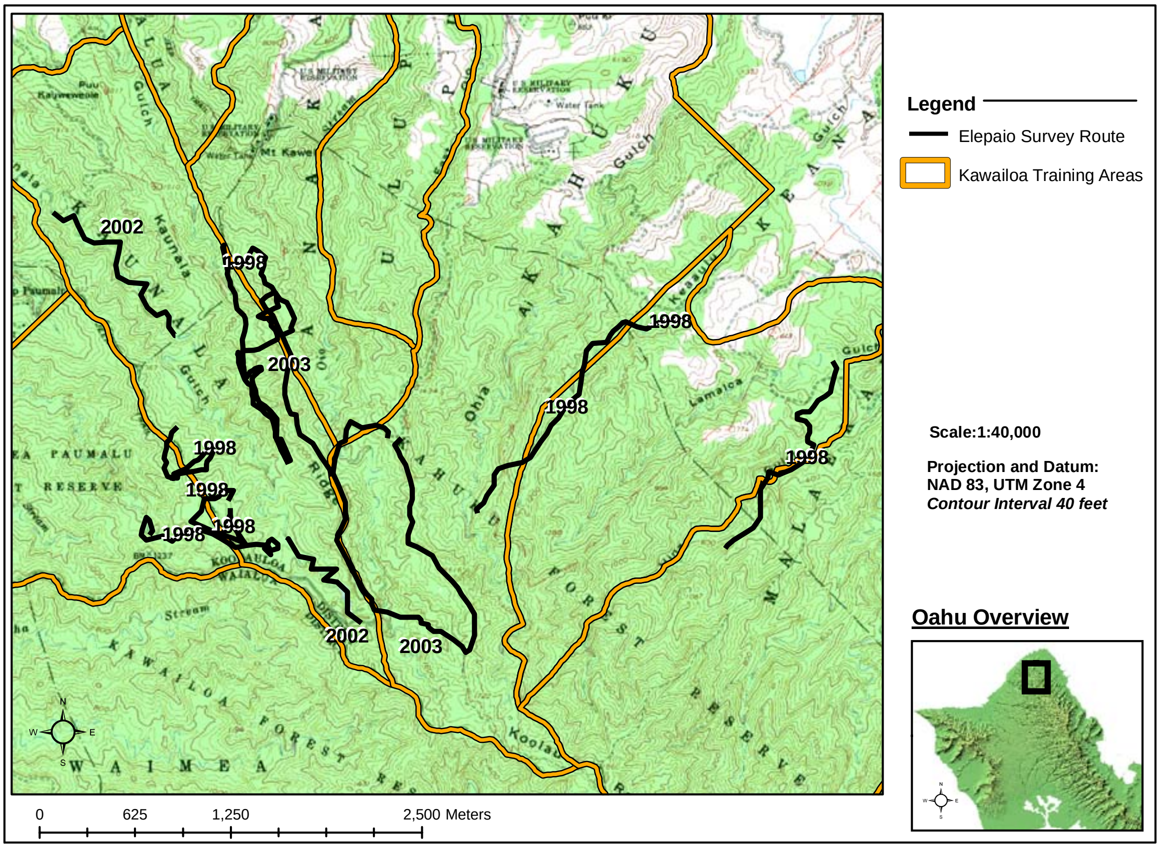


Figure 6.5 ‘Elepaio Survey Routes in Kahuku Training Area

Dillingham Military Reservation (DMR)
All suitable habitat at DMR has been surveyed for ‘Elepaio. No birds have been detected.

Offsite ‘Elepaio Areas

Currently there are five offsite locations (Mākaha Valley, ‘Ēkahanui area of Honouliuli Forest Reserve, Moanalua Valley, North Halawa Valley, Waikāne/Kahana Valley) that NRS either monitors ‘Elepaio and conducts predator control or only monitors ‘Elepaio. During the 2005 breeding season, NRS assisted in monitoring and conducting predator control in Mākaha Valley and in the ‘Ēkahanui. Surveying and monitoring were conducted in Moanalua Valley, North Halawa Valley and Waikāne/Kahana Valley.

<u>Mākaha Valley – Honolulu Board of Water Supply (BWS)</u>

The sixth largest population of ‘Elepaio on O‘ahu is located in Mākaha Valley. The population is estimated at 123 birds, comprising roughly 56 breeding pairs (VanderWerf et al. 2001). NRS and Dr. VanderWerf have banded 6 birds since 1999 (1999 – 1, 2003 – 3, 2004 – 1, 2005 – 1)(Table 6.7). All six banded birds were observed in 2005. Extensive surveys were conducted in Mākaha Valley from January through August of this year. Nine surveys were conducted on the north facing slopes of Mākaha Valley. These surveys found 44 birds (20 single males, 10 pairs, and four hatch year birds)(Figure 6.6). The surveys increased the number of known territories from 15 to 45, the number individuals from 18 to 62, and the number of pairs from 3 to 13. Several drainages have yet to be surveyed so these numbers will increase once these surveys are completed.

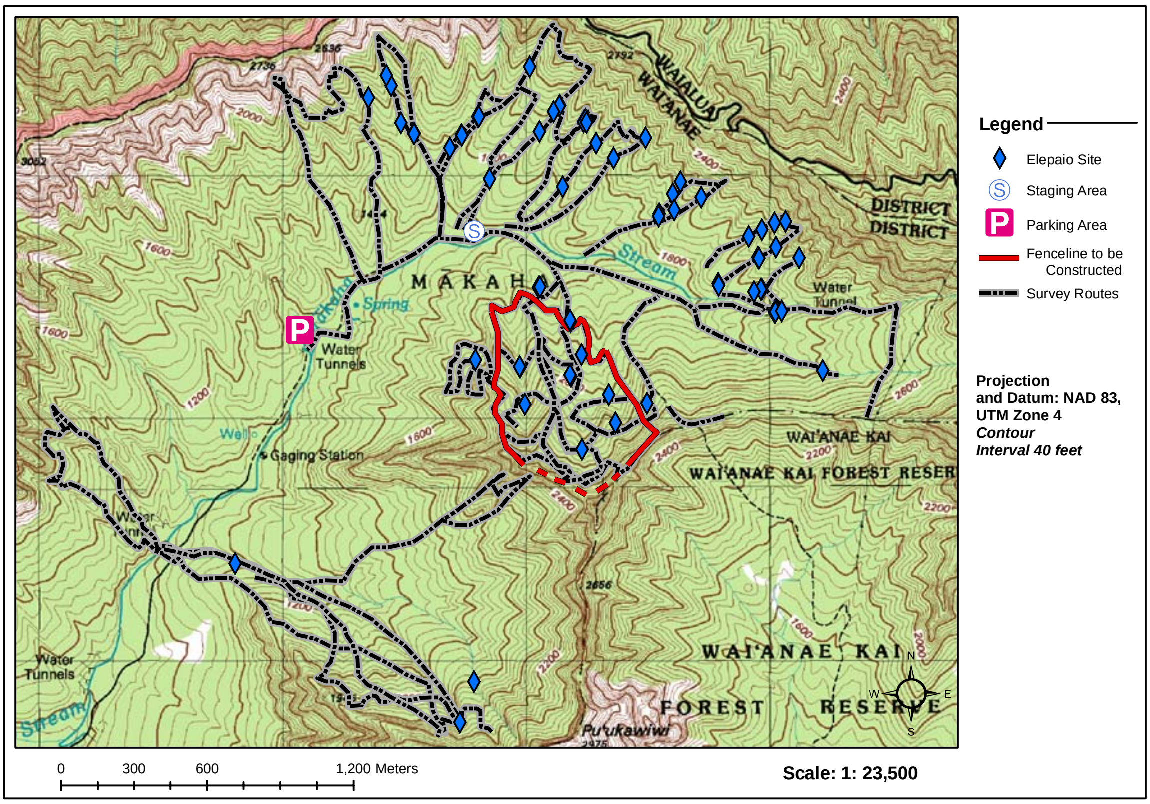


Figure 6.6 ‘Elepaio Distribution in Mākaha Valley

Rodent Control

NRS assisted BWS with predator control operations during the 2005 breeding season for eight pairs. Predator control in 2005 was initiated during the breeding season from 11 January 2005 to 30 June 2005. Twenty-eight Protecta® rodent bait stations and 54 Victor® rat traps were installed in eight ‘Elepaio territories. A total of 717 blocks (20kg) 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 for the season was 34.5%. A total of 145 rats were caught in snap traps with an average of 18 rats per monitoring trip (8 monitoring trips). Four of the eight pairs being protected had baiting initiated in early April, which was over halfway through the breeding season. A spike in the number of rats trapped occurred in April (Figure 6.7). This spike was attributed in part to the addition of four new protected territories in April, as well as to an increase of rats. On 25 April, during a monitoring visit, 43 out of 54 (80%) snap traps contained rats or rat remains. The late start in the protection of these pairs was the result of just finding the pairs during surveys in early April.

Table 6.7 ‘Elepaio Banding Data, Mākaha Valley

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	Sex
RWAB	01/28/99	06/28/05	06/28/05	N	Y	M
ARGB	12/19/03	01/11/05	01/11/05	N	N	M
ARWW	12/19/03	02/16/05	06/28/05	N	Y	M
AWRB	12/19/03	06/29/05	06/29/05	Y	Y	M
BARW	11/10/04	08/23/05	08/23/05	N	Y	M
RABM	04/06/05	04/06/05	04/25/05	N	N	M

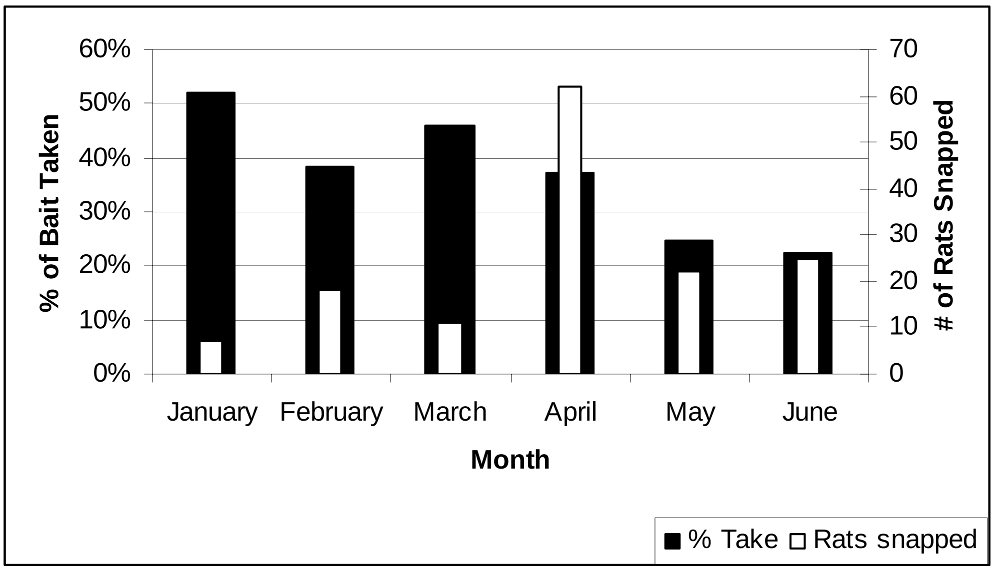


Figure 6.7 Mākaha Valley Rodent Control 2005.

Breeding Behavior

In previous years, the BWS had been protecting two ‘Elepaio pairs in the valley. In the 2005 breeding season, NRS assisted in protecting six additional pairs for a total of eight pairs. A total of four nests were found from fours pairs at different stages (building stage – 1, nestling stage – 1, inactive – 2). The mean nest height was 10.8 meters (*n* = 4). Nests were located within two tree species (*Psidium cattleianum* – 3, *Antidesma* spp. – 1). The nest in the building stage was about finished when found, but most likely failed, since no further activity at the nest was observed, as well as no fledglings in the territory were observed. The outcome of the nest in the nestling stage is unknown, no fledglings were observed in the territory upon the next visit. The inactive nests were most likely failed nests, as well, since no fledglings were ever sighted in these territories. Two pairs were found to be family groups late in the season, each with one fledgling. Two of eight pairs (25%) were successful in fledgling young (2 fledglings, 0.25 fledglings per total number of pairs in Mākaha monitored). Greater effectiveness of rodent control is anticipated for the 2006 breeding season with more pairs protected from the start of the season.

2006 Breeding Season

NRS will continue to assist BWS in 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 Mākaha Valley will be contracted to Pono Pacific for the 2006 breeding season. The projected number of pairs to be protected during the up coming breeding season is 14 pairs.

Honouliuli Forest Reserve - The Nature Conservancy of Hawaii

In 2005, NRS assisted The Nature Conservancy with monitoring (banding and nest searching) ‘Elepaio pairs in the ‘Ēkahanui area of the Honouliuli Forest Reserve, as well as assisted in funding predator control and monitoring (contracted to Pono Pacific).

The second largest population of ‘Elepaio on O‘ahu is located in the Honouliuli Forest Reserve with an estimated population of 418 birds, comprising roughly 209 breeding pairs (VanderWerf et al. 2001). Within the Honouliuli Forest Reserve, NRS and Dr. VanderWerf have banded 24 birds (1999 – 2, 2000 – 6, 2002 – 2, 2003 – 6, 2004 – 7, 2005 – 1) in the ‘Ēkahanui area (Table 6.8). Of the 24 banded birds at ‘Ēkahanui, 13 were observed in 2005. In 2005, NRS assisted in monitoring about 25 territories (Figure 6.8). Of these 25 territories, 21 were pairs and four contained single males.

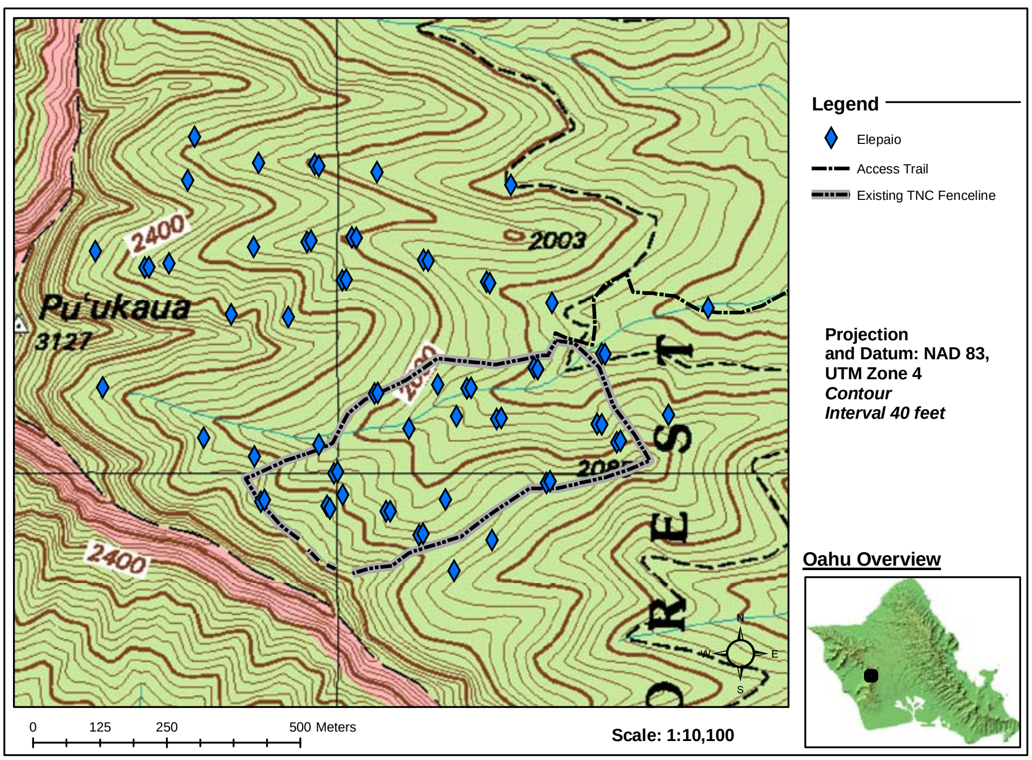


Figure 6.8 Distribution of ‘Elepaio in ‘Ēkahanui

Predator Control

NRS assisted The Nature Conservancy in contracting Pono Pacific for predator control and monitoring of 21 ‘Elepaio pairs. Predator control for the 2005 breeding season was from 21 December 2004 to 21 June 2005. Sixty-one Protecta® rodent bait stations and 99 Victor® rat traps were installed in 21 ‘Elepaio territories in the ‘Ēkahanui area. A total of 1,496 blocks (42kg) 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 12.1% for the season. Monthly bait take was very low throughout the breeding season (Figure 6.9). A total of 127 rats were caught in snap traps with an average of 7.9 rats per monitoring trip (16 monitoring trips). The number of rats trapped peaked in January then slowly declined over the breeding season (Figure 6.9).

Table 6.8 ‘Elepaio Banding Data, ‘Ēkahanui, Honouliuli Forest Reserve

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	Sex
RRGA	02/17/99	NA	NA	N	NA	M
ABGW	02/17/99	03/2004	12/2004	N	Y	M
AGBG	01/10/00	04/2004	04/2004	Y	N	M
WARB	01/10/00	04/22/05	04/22/05	N	Y	M
ABBR	01/10/00	04/2004	04/22/05	Y	Y	M
GWAG	01/10/00	04/22/05	04/22/05	Y	Y	M
BWRA	01/19/00	04/22/05	04/22/05	N	Y	M
BBWA	01/19/00	04/22/05	04/22/05	Y	Y	M
BARB	11/29/02	NA	NA	N	NA	M
GAWB	11/29/02	NA	06/15/05	N	Y	M
BAWB	10/22/03	03/2004	12/2004	N	Y	F
GABB	10/22/03	10/2003	06/15/05	N	Y	F
GARR	10/22/03	05/18/05	06/15/05	N	Y	M
WRRA	10/22/03	05/31/05	06/15/05	N	Y	M
RWAG	11/07/03	03/2004	01/13/05	N	N	M
BAGR	11/07/03	01/13/05	01/13/05	Y	Y	F
WWAR	09/29/04	09/29/04	09/29/04	N	N	M
GRGA	12/14/04	03/10/05	03/10/05	N	N	M
WGRA	12/14/04	01/25/05	01/25/05	N	Y	M
WAWR	12/14/04	02/28/05	06/15/05	N	Y	M
WAGG	12/15/04	03/10/05	03/10/05	N	Y	M
RAWG	12/20/04	03/10/05	03/10/05	N	Y	M
BWAW	12/28/04	05/10/05	05/10/05	N	Y	F
BWBA	02/28/05	02/28/05	02/28/05	N	Y	M

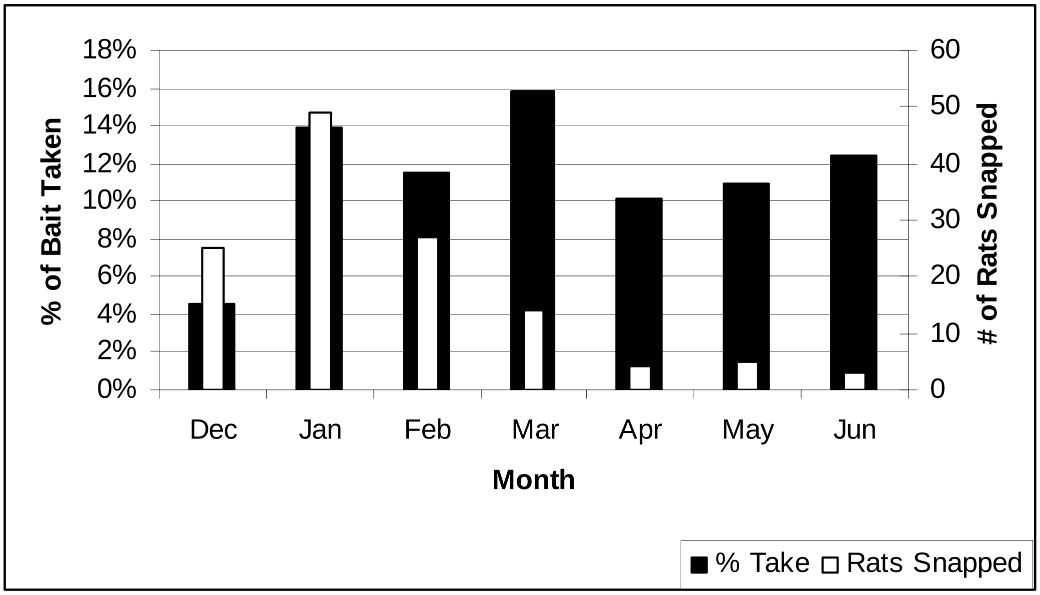


Figure 6.9 ‘Ēkahanui Rodent Control 2005

Breeding Behavior

At the start of the breeding season, rat control was initiated in18 territories in which pairs were present with an additional three pairs were included more then halfway through the breeding season, for a total of 21 pairs. Ten nests were located within seven territories: four nests fledged five nestlings, three nests failed, and three nests had unknown outcomes (may have fledged or failed). Eleven family groups were located with a total of 12 fledglings. Family groups were pairs that no nest was found in their territory, but observations were made during monitoring revealed the pair with a fledgling. The mean nest height at ‘Ēkahanui was 13.5 meters (n = 8). Nests were found in four tree species (*Psidium cattleianum* - 6, *Aleurites moluccana* - 2, *Persea americana* - 1, *Fraxinus uhdei* - 1). Locating nests can be difficult depending on canopy cover and terrain. Three pairs exhibited no breeding activity during our site visits. This breeding season was an especially successful year with 15 out of 21 pairs (71%) successfully fledging seventeen young (0.81 fledgling per pair) at ‘Ēkahanui.

2006 Breeding Season

Predator control and ‘Elepaio monitoring will be contracted to Pono Pacific for the 2006 breeding season. NRS will continue to assist with surveying for additional pairs, banding birds, and monitoring. The projected number of pairs to be protected during the up coming breeding season is 21 pairs.

<u>Moanalua Valley – Damon Estate</u>

In order to meet the goals of the BO to manage 75 pairs, NRS will attempt to manage 20 to 25 pairs in Moanalua Valley. A Right of Entry has been established with Damon Estate to allow NRS to manage ‘Elepaio during the 2006 breeding season. NRS conducted five surveys in 2004 and two in 2005 to determine the number of pairs present. Through these surveys 56 birds were observed (23 pairs + 2 fledglings and 8 single males) (Figure 6.10). During these monitoring visits, 13 birds were banded (11 – males, 1 – female, 1 – juvenile) by NRS and Dr. VanderWerf (Table 6.9). Pono Pacific will be contracted to control predators and monitor breeding success for the 2006 breeding season. The projected number of pairs to be protected during the 2006 breeding season is 20 pairs.

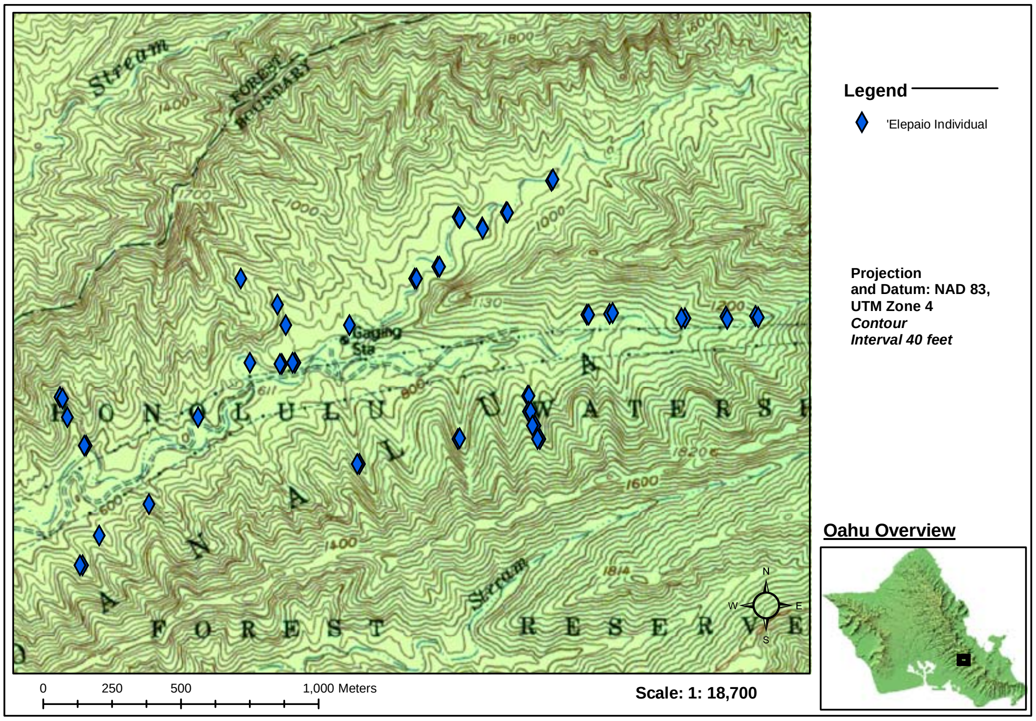


Figure 6.10 Distribution of 'Elepaio in Moanalua Valley

Table 6.9 'Elepaio Banding Data, Moanalua Valley

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	Sex
RWAR	10/01/04	01/24/05	01/24/05	N	Y	M
BBRA	10/01/04	05/31/05	05/31/05	N	Y	M
AWBB	10/01/04	10/01/04	10/01/04	N	Y	M
RWWA	10/01/04	10/01/04	10/01/04	N	N	U
GRGA	12/15/04	12/15/04	12/15/04	Y	Y	F
AGGG	12/15/04	12/15/04	12/15/04	Y	Y	M
ABRR	12/15/04	12/29/04	12/29/04	N	Y	M
ABBB	12/15/04	12/15/04	12/15/04	N	Y	M
GAWR	12/16/04	12/16/04	12/16/04	Y	Y	M
BAWW	12/16/04	05/31/05	05/31/05	N	Y	M
RAWR	12/16/04	12/16/04	12/16/04	N	N	M
ABRR	12/16/04	12/16/04	12/16/04	Y	Y	M
WAGB	12/29/04	12/29/04	12/29/04	N	Y	M

<u>North Halawa Valley</u>

Two side gulches of North Halawa Valley were surveyed by NRS in September 2004 to determine the number of pairs present for potential future management actions. During this survey, 14 birds were observed (4 pairs and 6 single males) (Figure 6.11). A site visit in September 2005 revealed that one of the previous territories that contained a single male was now a pair with a fledgling. This visit changed the number of pairs from four to five. A total of 10 birds have been banded in North Halawa (Table 6.10). Eight birds were banded in 1996 (6 – males, 1 – female, 1- juvenile) by NRS and Dr. VanderWerf. Dr. VanderWerf banded an additional two birds (1 – female and 1 – juvenile) in 2005. With additional surveys more pairs could potentially be found. This site has easy road access making it a strong potential management site. NRS will pursue formal access through Kamehameha Schools in the coming year and may conduct predator control if access is not adequate in SBMR.

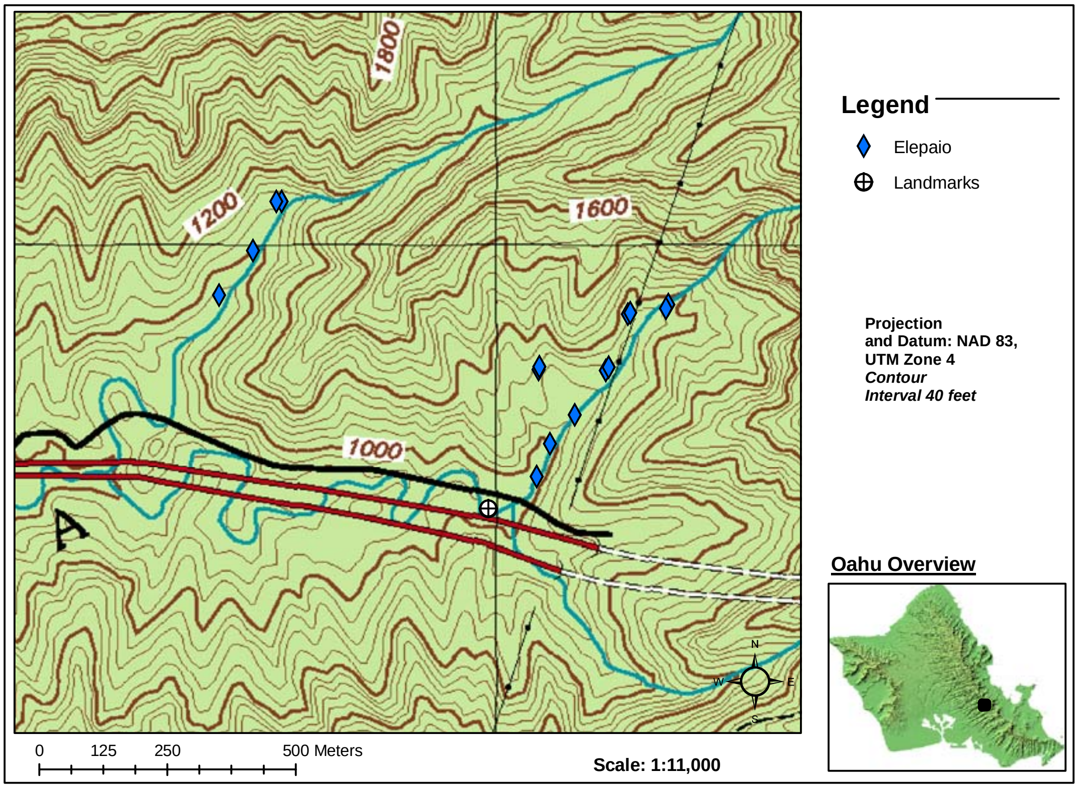


Figure 6.11 Distribution of ‘Elepaio in North Halawa Valley

Table 6.10 ‘Elepaio Banding Data in North Halawa Valley

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	Sex
RBWA	07/09/96	09/08/04	09/08/04	N	Y	F
BRAR	07/09/96	09/08/04	09/08/04	N	N	M
GABW	07/09/96	07/09/96	07/09/96	N	Y	M
ARWR	07/09/96	07/09/96	07/09/96	N	Y	M
AGWB	07/09/96	07/09/96	07/09/96	N	NA	M
WBBA	07/09/96	07/09/96	07/09/96	N	NA	M
GBAB	07/09/96	07/09/96	07/09/96	N	NA	U
GBRA	07/22/96	07/22/96	07/22/96	N	NA	M
WWAG	02/09/05	02/09/05	02/09/05	N	Y	F
WBAW	02/09/05	09/05	09/05	N	NA	U

Waikāne Valley/ Kahana Valley

NRS conducted a survey in October 2004 to determine the number of ‘Elepaio present for potential future management actions. During this survey 12 pairs were observed for a total of 24 birds (Figure 6.12). The survey was conducted along the Ditch Trail walking north along the trail from Waikāne Valley into Kahana Valley. This survey covered a distance of approximately 2 kilometers. The area along the Ditch Trail has a high density of birds over a short distance. This survey only covered a small portion of the trail and with further surveys additional pairs are likely to be found. This area has high potential for possible future management. However, the Waikāne landowner has been difficult to contact and may not be interested in ‘Elepaio monitoring and predator control programs.

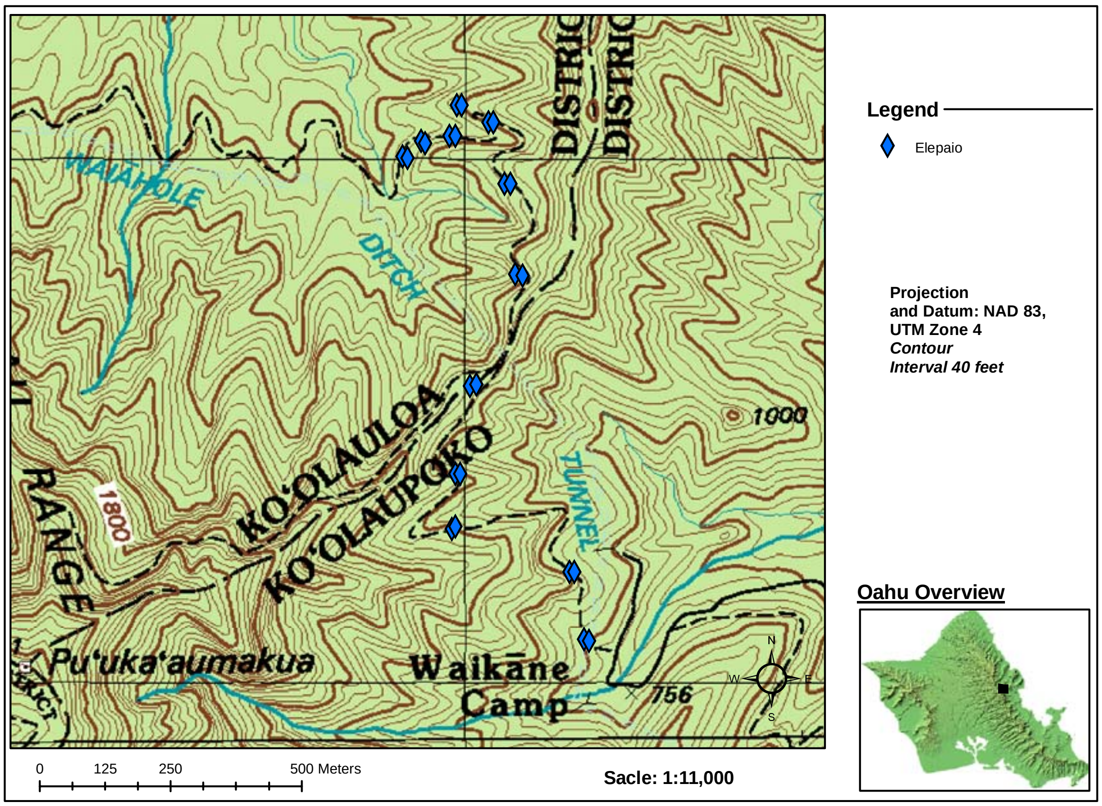


Figure 6.12 Distribution of ‘Elepaio in Waikāne Valley / Kahana Valley

APPENDICIES

Palikea Fire Reconnaissance

APVG-GWV (200-3) 20 June 2005

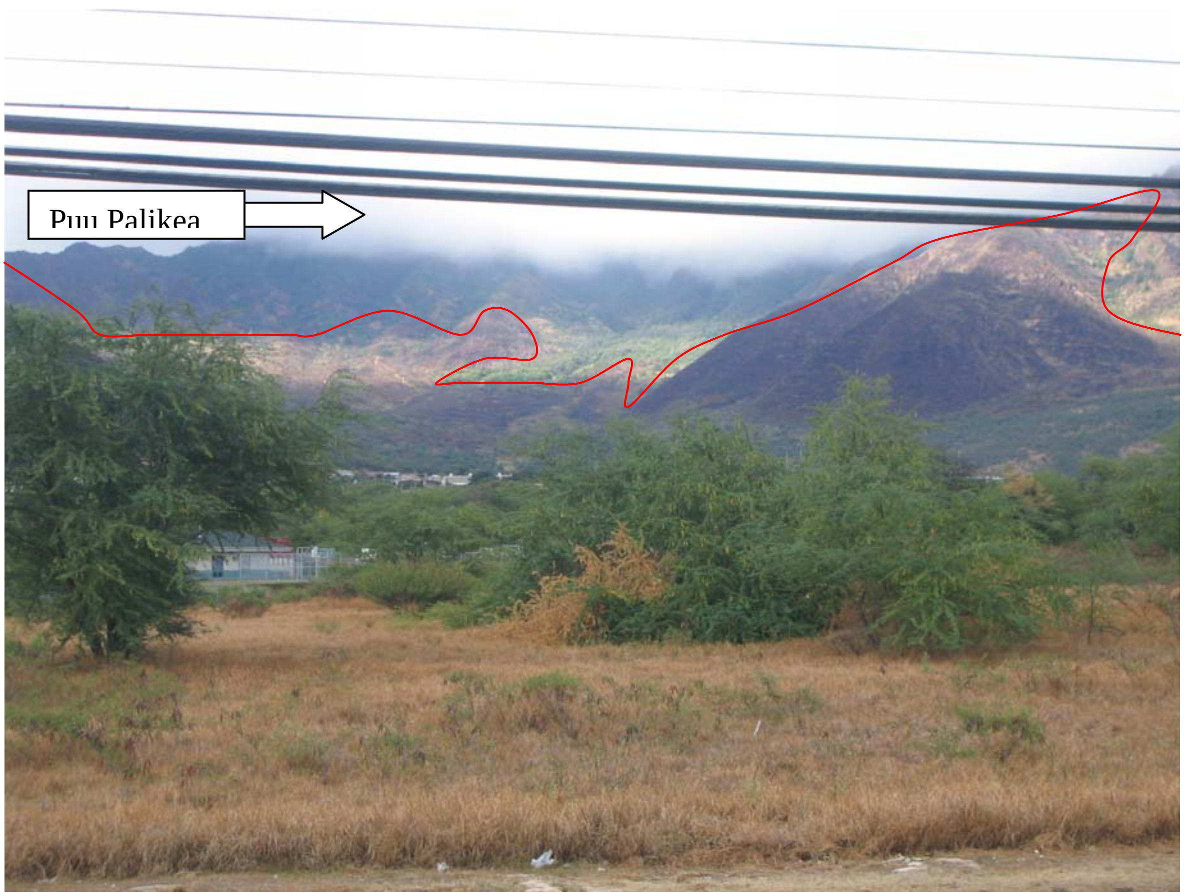
MEMORANDUM FOR RECORD

SUBJECT: Reconnaissance for Nanakuli fire that threatened Puu Palikea

1. On 16 June 2005, Michelle Mansker, Gayland Enriques, Kapua Kawelo and Dan Sailer (Nature Conservancy Staff) hiked out to Puu Palikea to discuss the Nanakuli fire that occurred in May 2005. The fire was climbing out of Nanakuli valley in the direction of Puu Palikea (Honouliuli Preserve) and threatening the rare resources atop the Puu. The Army funded a Huey helicopter to fly water drops in Nanakuli to fight the fire. The Army spent $17K on helicopter time for the first Thursday of May. The fire was not completely extinguished until over a week later.

2. A photo showing the extent of the fire is attached. More than 3,000 acres burned. The fire started near the residential area in Nanakuli Valley. The cause of the fire was determined to be arson.

3.



View from Farrington Highway looking up into Nanakuli Valley toward Puu Palikea. Puu Palikea is in the clouds but proximity of the fire to Puu Palikea is visible. The fire burned everything below the red line.

4. The site visit conducted on 16 June 2005 was conducted as an after action review of fire response. The following topics were discussed:

Huey Helicopter

Dan Sailer stated that the most useful resource committed by the Army during the fire operations was the helicopter support. The incident command (IC) system was discussed as it related to directing helicopter resources. Mr. Enriques stated that it really does not matter how the helicopter is intended to be used, the incident commander has control of all the helicopter assets. Mr. Enriques said it was really important to be clear about the intent of use of the helicopter with the IC from the start and then to have someone at the IC center representing your interests.

Ms. Kawelo asked if the Huey could be hired to fight fires on Army training lands particularly in areas of natural resource value. Mr. Enriques said that he fully supports their help.

Fire line clearing atop Puu Palikea

The Nature Conservancy cleared an area of bare earth along and on the leeward side of the ridge crest at Puu Palikea. The intent of this cleared zone was as a fuel break for use in the event the fire did reach Puu Palikea. Mr. Sailer intended to wet the area with a fire retardant and water if the fire climbed the ridges to near Puu Palikea. The swath that was cleared along the ridge crest averaged six feet in width. Mainly alien grasses were cleared.

Communication

Communication during the fire was essential. Gayland Enriques stated that it was important for us to be in constant communication with the IC center below in the event that the fire began to climb quickly toward the Puu. Ms. Kawelo stated that communication was very cumbersome during the fire and that one person should do nothing but communicate.

Safety

Mr. Enriques stated that is was very important to be in communication with the IC when involved in a fire. Mr. Sailer contends that the operation atop the ridge was an independent Nature Conservancy effort for which they did not need IC approval. Mr. Enriques stated that we should have had a permanent look out to inform us of the fire's status and exact location. The smoke below in the valley limited visibility from above.

Kapua Kawelo discussed training for her staff. All support more involvement by natural resources staff in fires in order to assist in directing fire fighting resources. Two risk assessments will be prepared, one for Army Civilian staff and one for contract RCUH staff. David Duffy said that his RCUH staff can clear fire line but should have appropriate training. Mr. Enriques said that his new fire crew would be starting in July and that he'd be coordinating a basic fire fighting training course soon after they begin.

5. POC is the undersigned, 656-7641/7741.

KAPUA KAWELO
Biologist, Environmental Division

APVG-GWV (200-3) 18 Aug 2005

MEMORANDUM FOR RECORD

SUBJECT: Reconnaissance for Makua Military Reservation Fire started 8/3/05

On 3 August 2005, a fire started at MMR within the South firebreak road. Suspected cause was a White Phosphorus (WP) round which heated up and spontaneously ignited. The winds were strong easterly winds. The fire began close to 1200 hours. The fire burned a total of approximately 280 acres.

1. Natural Resources Involvement: On this date, Ms. Kapua Kawelo was conducting a site visit at Kaluakauila fence unit with a few visiting conservation biologists from New Caledonia. The site visit was to compare issues with dry forest restoration in Hawaii to those in New Caledonia. The group emerged from the forest at approximately 2:45pm and immediately saw the smoke coming from the MMR fire. Ms. Kawelo called the Natural Resources Center and was updated on the fire. This raises issues related to poor communications in Kaluakauila. NRS will work to acquire a pager and cellular phone service that uses radio towers at Yokohama.

Ms. Kawelo hiked up to the ridge crest and was able to observe the fire. It was possible to see that the fire had jumped outside the firebreak near the lower *Chamaesyce celastoroides* patch at Lower Ohikilolo but from above it looked as if it was stopped along the perimeter of the patch. Ms. Kawelo asked base to notify Howard Esterbrook the owner of Pacific Helicopters that his services may be needed for fighting fire on Thursday. He stated that Gayland Enriques, Fire Chief had already spoken with him and he was on standby.

Natural Resources Staff headed back to the vehicle on Kuaokala Road and drove out via the Kaena Point Air Force Tracking Station. Ms. Kawelo wanted to get on site at the fire to assist Mr. Enriques with directing fire attack resources.

When Ms. Kawelo reached Makua Range Control, Mr. Enriques had been on site for sometime and was directing fire fighting ground crews and helicopters. The Honolulu City and County helicopter was on scene as was one Army Blackhawk. By the time Ms. Kawelo reached the site, the fire along the perimeter of the *Chamaesyce* had been extinguished. Fire was still burning inside the firebreak road just below the *Hibiscus brackenridgei* population where grass was tall and thick. Fuels modification is not conducted in this area as it is too steep for weed whacking contractors. Ms. Kawelo drove out along the road with Mr. Tom Piskel to obtain a closer view and give guidance to Mr. Enriques. The fire crews were at the point just below the *Hibiscus* and were actively fighting the fire with fire trucks. In addition, the air one helicopter was dropping water drops at this location. Ms. Kawelo felt comfortable that fire crews on site were being skillfully deployed with natural resource protection as a priority. She departed after providing Mr. Enriques an assessment and left him her contact information.

2. Extent of Fire. Please see attached map for extent. In addition photos are also included to illustrate the fires extent where natural resources are a concern.

MMR - Burn Area
Fire occured 3August2005 covered ~185 acres

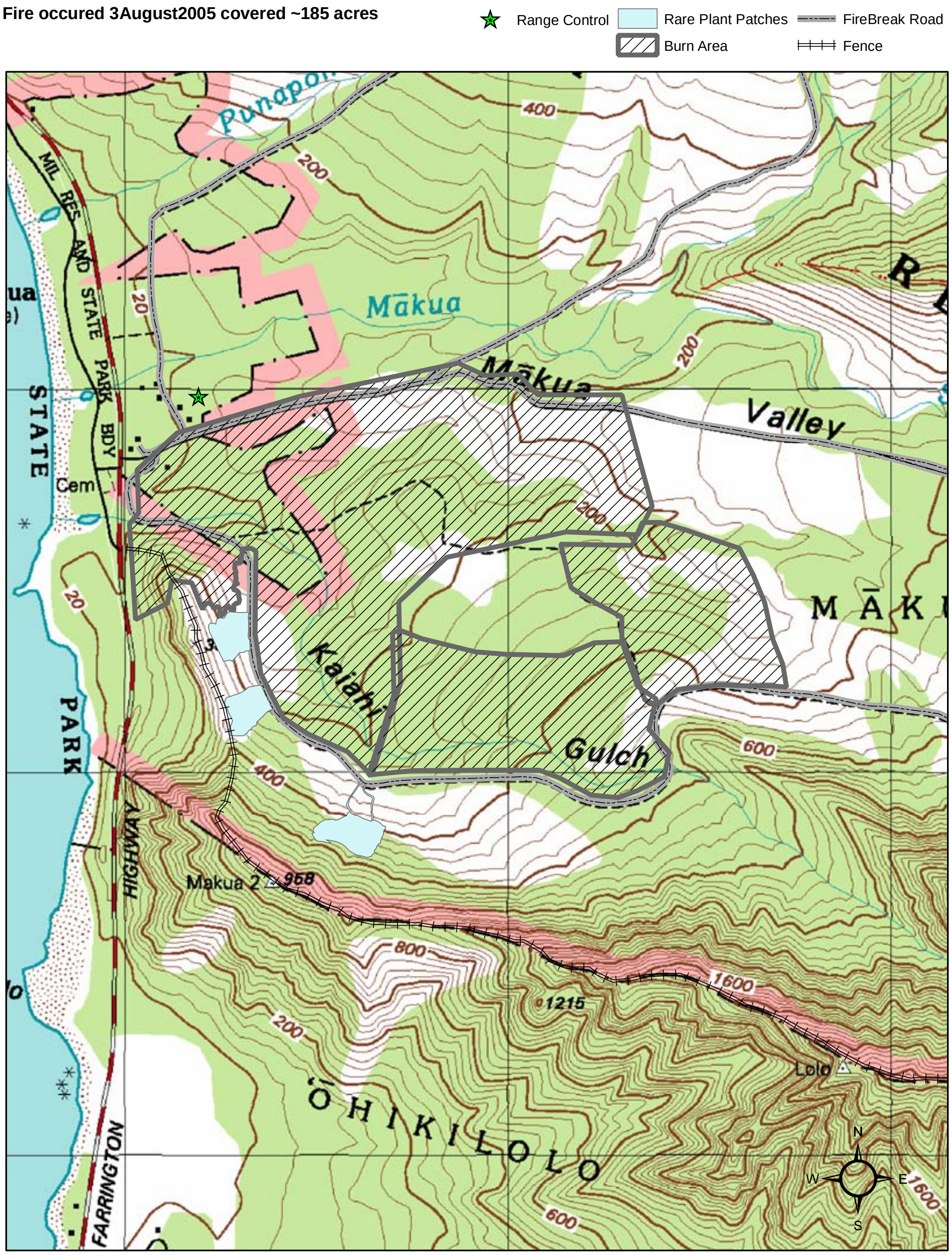


Photo taken from south firebreak below Ko`iahi gulch on 4 Aug 2005.

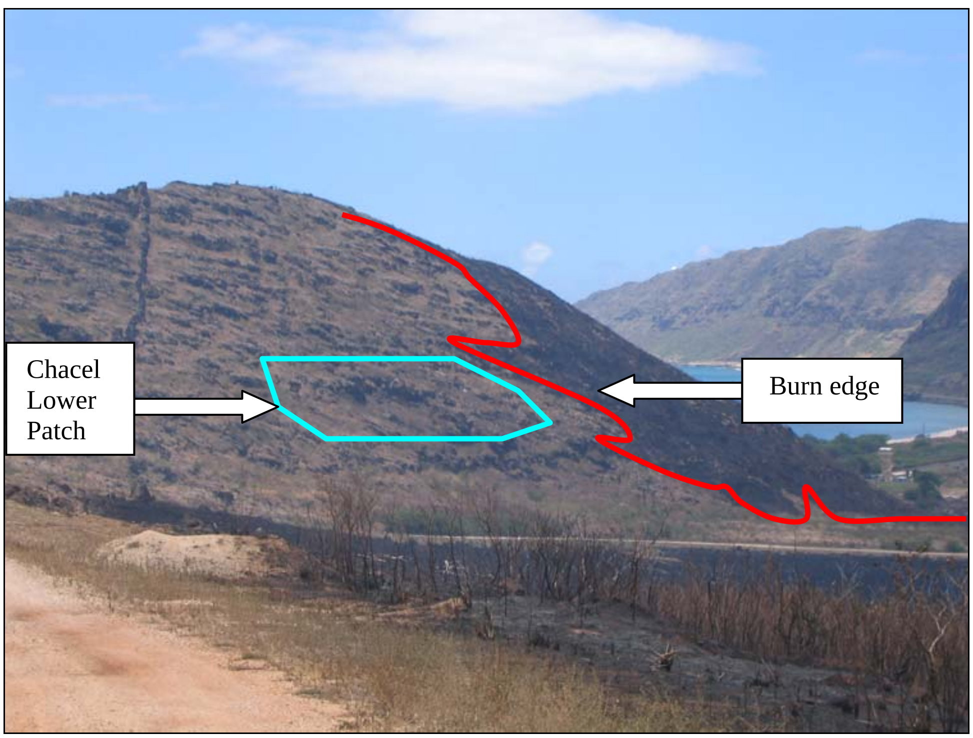


Photo shows edge of fire closest to *Chamaesyce celastroides* population.

3. Natural Resource Impact. There were no rare native resources impacted in this fire. Common native species and alien species burned are listed in the table below. A thorough survey of the *Chamaesyce celastroides* population was conducted on 30 August 2005. Although the fire did

not burn any *C. celastroides* plants, the burn perimeter at its closest was 10 meters away from an outlier plant.

Native Plant Species	**Alien Plant Species**
*Heterpogon contortus (*Pili*)*	*Leucaena leucocephala* (Koa Haole)
*Waltheria indica (*Uhaloa*)*	*Panicum maximum* (Guinnea grass)
*Sida fallax (*Ilima*)*	*Prosopis pallida* (Kiawe)
Dodonaea viscosa (A`ali`i)	*Andropogon virginicus*
Argemone glauca (Puakala)	*Acacia mearnsii* (Klu)
	Rhyncheletrum repens
	Chloris barbata
	Leonotis nepetifolia

4. POC is the undersigned, 656-7741/7641.

Encl

KAPUA KAWELO
Biologist, Environmental Division

Ekahanui Fire Chain of Events

APVG-GWV (200-3)
26 September 2005

MEMORANDUM FOR RECORD

SUBJECT: Chain of Events of fire that threatened Ekahanui Special Management Area (SMA)

1. On 22 September 2005, Michael Walker (Army NRM/ The Nature Conservancy), Chad Koide, Kahale Pali, Stefanie Loo Jefts, Pauline Sato, Lynette Williams, and Dan Sailer (The Nature Conservancy) assembled at TNC's Kunia baseyard to discuss the wildfire that occurred on September 2005 and threatened the Ekahanui SMA. The fire burned for 2 days, smoldered for an additional 11 days, with minor flare ups on 4 of those days. The fire consumed 170 acres, five of which were in the preserve. A map showing the extent of the fire is attached. The Army spent $2450 on Helicopter time to combat the fire on 4 September 2005, while DOFAW spent ____ on helicopter time. TNC/Campbell Estate spent $~6,000 on helicopter time. TNC also spent another $10.5k on travel expenses for neighbor island staff and personnel time.The Ekahanui SMA contains 78 threatened and endangered species and a 40 acre fence, which would cost $200,000 to replace today.

2. The following is a record of the chain of events reconstructed by the afore mentioned personnel.

- 3 September 2005
  - 1300 hours, Del Monte staff report a fire in a gulch in their pineapple fields. Chief Lochran from Honolulu Fire Department takes command as the Incident Commander (IC), and Pat Costales (DOFAW) Dan Sailer, Stefanie Loo Jefts, Chad Koide, and Pauline Sato (TNC), arrive soon after.
  - Air One is the only helicopter working the fire as no contract helicopters were available.
  - Mid-afternoon Chief Lochran informed Dan Sailer that he requested federal assistance through the Civil Defense fire center and was denied. He also asked his supervisor, the deputy chief of the department (Tomita?), to request assistance and he was also denied.
  - Pauline Sato contacts Gayland Enriques concerning the denied request for federal assistance. Gayland was informed that no one had made an official request to the fire center. Chief Lochran was adamant that he had made the request through the proper channels.
  - Dan Sailer notifies Chief Lochran ~7pm of his plans for the next morning.

- 4 September 2005
  - TNC field staff arrive at Kunia baseyard at 0500 hours to prepare equipment. TNC staff (crew of four) meet Paradise Helicopter pilot Richard Potts at 0700 for reconnaissance flight of burned area. Several small fires are burning. TNC staff then hike into the burned area and initiate coordinated water drops with the contract helicopter, paid for by DOFAW.
  - ~0800 hours HFD arrives at the Kunia Golf Course to began operations, Air One begins water drops soon after. Chief Manny Neves assumes IC position.
  - Kapua Kawelo contracts Pacific Helicopters to assist with coordinated water drops.
  - Two more TNC from Molokai arrive and join the TNC crew. Matt Keir of the Army assists with logistical support.
  - Federal Fire Deparment arrives in the late morning with Chief Casserly and a ground crew of ~ six personnel. Pat Costales of DOFAW is present as well.

- Dan Sailer requests additional help, Pauline Sato calls Gayland Enriques and urges him to contact Chief Casserly and discuss options for more air support and activating the Army's wildfire control crew.
- Gayland informs Pauline Sato in the afternoon that the U.S. Army Garrison does not have funding to send a Blackhawk helicopter to assist fire fighting measures.
- During TNC staff's lunch break the Air One pilot lands and asks TNC staff if they requested a specific water drop. Since they were not working on the fire at that point, they replied no. Somehow this statement was interpreted by the pilot that no further assistance was needed by TNC, and he reported to Chief Neves that TNC requests no further assistance. Chief Neves reports this to Chief Casserly, who when speaks to Gayland Enriques reports that no further assistance is required.
- After the afore mentioned communication breakdown, Gayland informs Pauline that the wildfire control crew is not properly trained and can not come out. He then says that he will talk to the crew members and ask them if they can come out on a volunteer basis the next day. TNC staff discuss the situation afterward, and were perplexed since the hot shot crew were on scene at the Nanakuli/Palehua fire a month earlier. TNC staff surmise that the garrison can not afford to pay the crew weekend and holiday overtime pay to work the fire.
- TNC Hawaii Island crew of three arrives and joins the TNC team. HFD fire personnel are assigned to assist. They bring a water pump to facilitate pumping water from TNC's water tank transported via contract helicopter to the upper edge of the burn site.
- Further discussions Pauline has separately with Chief Casserly and Gayland Enriques reveals that they have opposing view points on the federal fire response chain of command. Casserly says he has no say over the deployment of the hot shot crew, while Enriques maintains that the hot shot crew is to report to the federal fire department when called for duty.
- By the end of the evening the fire is contained by HFD and TNC staff.

- 5 September 2005
  - Mop up work begins in the AM with TNC staff and HFD. Air One performs a few water drops, but for the majority of the day is not needed.
  - Army wildfire crew does not come as volunteers.

- 6 September 2005
  - Small spot fire flares up, but is contained by HFD.

- 8 September 2005 -
  - Small spot fire flares up, but is contained by TNC staff.

- 14 September 2005
  - Last flare up occurs and is put out by TNC staff and HFD.

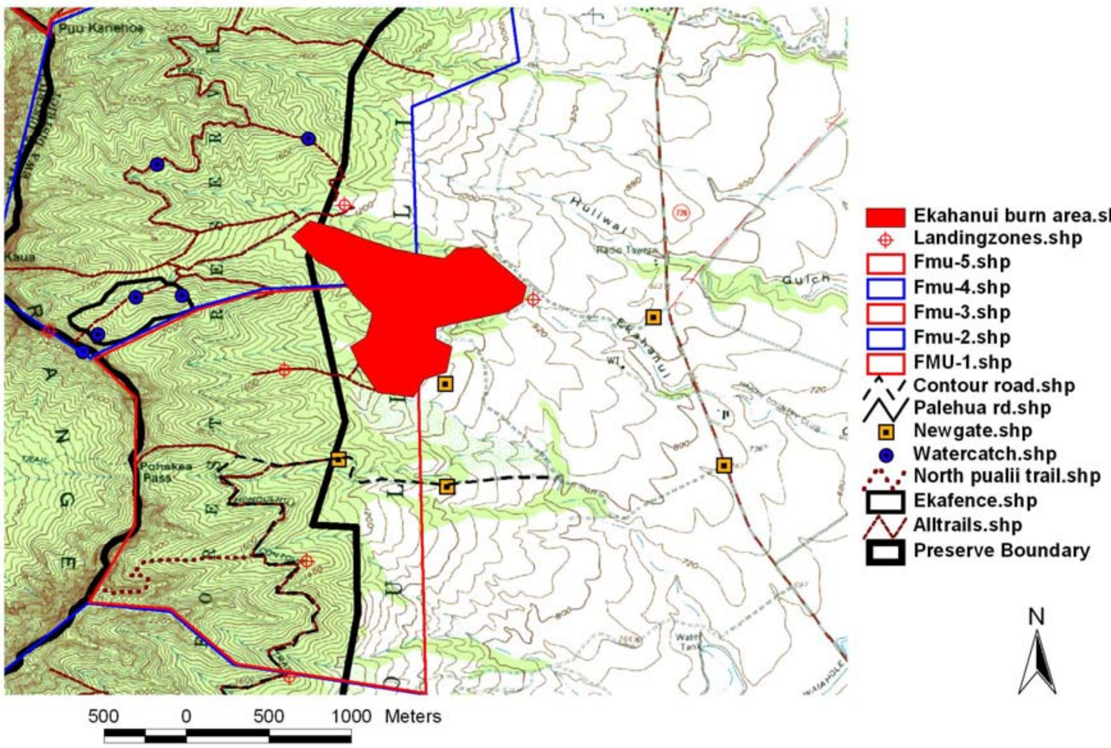
3. Communication and Safety Items of Concern
   - While TNC staff are convinced that on the ground coordination of water drops was crucial in extinguishing the fire early, HPD was concerned that too much radio traffic was potentially hazardous as contract helicopter radios were tied up with ground crews repeatedly when Air One was attempting to contact the contract helicopters. (This could be resolved in the future by having HFD personnel work side-by-side with TNC's crew.)
   - The chain of command issues between HFD, Federal Fire Department and the Army must be resolved.
   - Who HFD Chief Lochran spoke to (Civil Defense) that denied Federal assistance should be determined to understand why the request was denied and if proper protocol was followed.

- o Overtime/holiday pay for Army wildfire control crew should not be an issue during a fire that threatens endangered species.

4. POC is the undersigned, 656-7641/7741.

Michael Walker
Senior Natural Resource Management Specialist
Environmental Division

Ekahanui/Puumaialau Fire



‘Ēkahanui flora and fauna list

** = Reintroduction to PMA
E = Federally listed Endangered
SOC = Federally listed as a Species of Concern
C = Candidate for listing as endangered
NCN = No common name
* = Endemic to Honouliuli Preserve

Life form	Scientific Name	Common Name	Federal Status	Known only Historically From Preserve
Plant Community	*Acacia koa/Metrosideros polymorpha* Lowland Mesic Forest		None (rare on Oahu)	
Plant Community	Oahu Diverse Lowland Mesic Forest		None (rare on Oahu)	
Plant Community	*Metrosideros polymorpha* Lowland Mesic Forest		None (rare on Oahu)	
Plant	*Abutilon sandwicense*	NCN	E	
Plant	*Alectryon macrococcus var. macrococcus*	Māhoe	E	
Plant	*Bobea sandwicensis*	Ahakea	SOC	
Plant	*Chamaesyce herbstii*	‘Akoko	E	X
Plant	*Cenchrus agrimonioides var. agrimonioides**	Kamanomano	E	
Plant	*Clermontia persicifolia*	‘Ōhā wai	SOC	
Plant	*Cyanea calycina*	Hāhā	C	
Plant	*Cyanea grimesiana subsp. obatae*	Hāhā	E	
Plant	*Cyanea membranacea*	Hāhā	SOC	
Plant	*Cyanea pinnatifida**	Hāhā	E	
Plant	*Delissea subcordata*	Hāhā	E	
Plant	*Diellia falcata*	NCN	E	
Plant	*Diellia x lauii*	NCN	None (rare on Oahu)	
Plant	*Diellia unisora*	NCN	E	
Plant	*Dissochondrus biflorus*	NCN	SOC	
Plant	*Exocarpos gaudichaudii*	Heau	SOC	
Plant	*Fluggea neowawraea*	Mēhamehame	E	X
Plant	*Hedyotis parvula*	NCN	E	X
Plant	*Labordia kaalae*	Kāmakahala	SOC	
Plant	*Lobelia yuccoides*	Pānaunau	SOC	

X

Plant	*Melicope christophersenii*	Alani	C	X
Plant	*Melicope saint johnii*	Alani	E	
Plant	*Morinda trimera*	Noni Kuahiwi	SOC	
Plant	*Neraudia angulata var. angulata*	Ma‘aloa	E	X
Plant	*Neraudia angulata var. dentata*	Ma‘aloa	E	X
Plant	*Neraudia melastomifolia*	Ma‘aloa	SOC	
Plant	*Nothocestrum longifolium*	‘Aiea	SOC	
Plant	*Phyllostegia parviflora var. lydgatei*	NCN	E	
Plant	*Phyllystegia kaalaensis*	NCN	E	X
Plant	*Phyllostegia mollis*	NCN	E	
Plant	*Plantago princeps var. princeps*	Ale	E	
Plant	*Platydesma cornuta var. decurrens*	Pilokea	C	
Plant	*Pleomele forbesii*	Halapepe	C	
Plant	*Pteralyxia macrocarpa*	Kaulu	SOC	
Plant	*Schiedea hookeri*	NCN	E	
Plant	*Schiedea kaalae*	NCN	E	
Plant	*Schiedea pentandra*	NCN	SOC	
Plant	*Solanum sandwicense**	Pōpolo ‘aiakeakua	E	
Plant	*Sophora chrysophylla*	Māmane	None (rare on Oahu)	
Plant	*Stronglyodon rubber*	Nuku ‘i‘iwi	SOC	
Plant	*Tetramolopium lepidotum subsp. lepidotum*	Lali‘i	E	
Plant	*Urera kaalae*	Ōpuhe	E	
Plant	*Zanthoxylum dipetalum var. dipetalum*	A‘e	SOC	
Vertebrate	*Chasiempis sandwichensis subsp. Ibidis*	O`ahu `elepaio	E	
Vertebrate	*Asio flammeus sandwichensis*	Pueo	None (rare on Oahu)	
Vertebrate	*Vestiaria coccinea*	‘I‘iwi	None (rare on Oahu)	X
Invertebrate (snail)	*Achatinella concavospira*	Pūpū Kuahiwi	E	
Invertebrate (snail)	*Achatinella mustelina*	Pūpū Kuahiwi	E	
Invertebrate (snail)	*Amastra crassilabrum*	NCN	None (rare on Oahu)	X
Invertebrate (snail)	*Amastra cylindrical*	NCN	SOC	
Invertebrate (snail)	*Amastra elephantine*	NCN	None (rare on Oahu)	X
Invertebrate (snail)	*Amastra micans*	NCN	SOC	

Invertebrate (snail)	*Amastra spirizona*	NCN	SOC	
Invertebrate (snail)	*Armsia petasus*	NCN	None (rare on Oahu)	X
Invertebrate (snail)	*Auricullela ambusta*	NCN	SOC	
Invertebrate (snail)	*Auricullela perpusilla*	NCN	None (rare on Oahu)	
Invertebrate (snail)	*Auricullela tenella*	NCN	None (rare on Oahu)	
Invertebrate (snail)	*Catanella rotundata*	NCN	SOC	
Invertebrate (snail)	*Cookeconcha sp. 1**	NCN	None (rare on Oahu)	
Invertebrate (snail)	*Endodonta sp. 1*	NCN	None (rare on Oahu)	
Invertebrate (snail)	*Laminella sanguinea*	NCN	SOC	
Invertebrate (snail)	*Leptachatina sp. 2*	NCN	SOC	
Invertebrate (snail)	*Leptachatina sp. 8*	NCN	SOC	
Invertebrate (snail)	*Philonesia sp.*	NCN	SOC	
Invertebrate (snail)	*Pleuropoma sandwichensis*	NCN	SOC	
Invertebrate (snail)	*Pterodiscus heliciformis*	NCN	None (rare on Oahu)	
Invertebrate (fly)	*Drosophiles aglaia*	pomace fly	C	
Invertebrate (fly)	*Drosophila ambochila**	pomace fly	C	
Invertebrate (fly)	*Drosophila montgomeryi**	pomace fly	C	
Invertebrate (fly)	*Drosophila tarphytrichia*	pomace fly	C	
Invertebrate (fly)	*Drosophila flexipes*	pomace fly	None (rare on Oahu)	
Invertebrate (lacewing)	*Anomalochrysa sylvicola*	Sylvan green lacewing	None (rare on Oahu)	
Invertebrate (bee)	*Nesoprosopis unica*	Unique yellow-faced bee	None (rare on Oahu)	
Invertebrate (psyllid)	*Gen. nov. sp. 1*	Nothocestrum psyllid	None (rare on Oahu)	
Invertebrate (planthopper)	*Dictyophorodelphax mirabilis*	‘akoko planthopper	None (rare on Oahu)	
Invertebrate (moth)	*Hedylepta monogramma*	Hedylepta moth	None (rare on Oahu)	X
Invertebrate (beetle)	*Nesopeplus serratus*	Souring beetle	None (rare on Oahu)	X
Invertebrate (weevil)	*Pentarthum obscurum*	Pentarthum weevil	None (rare on Oahu)	X

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

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.

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.

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

Literature Cited

Bruegmann, M. 2000. Personal communication. Biologist. Pacific Islands Ecoregion, U.S. Fish and Wildlife Service. Honolulu, HI.

Carr, G. D. 2005.Personal communication. Emeritus Professor, Botany Department. University of Hawaii at Manoa, Honolulu, HI.

Hawaii Heritage Program, The Nature Conservancy of Hawaii. 1994. Biological inventory and management assessment for the Kawailoa Training Area Oahu, Hawaii. Prepared for: 25th Infantry Division (Light) and United States Army, Hawaii. Contract No. M67004-91-D-0010

Joe, S. 2005. Personal communication. MS Candidate, Botany Department, University of Hawaii at Manoa, Honolulu, HI.

Lau, J. 2005. Personal communication. Botanist. Hawaii Natural Heritage Program. Honolulu, Hawaii.

Makua Implementation Team. 2003. Final Draft: Makua Implementation Plan. Prepared for the U.S. Army Garrison, Schofield Barracks, HI.

Rivers, J. 2005. Personal communication. Biologist. US Navy, NAVFAC Pacific. Honolulu, HI.

Shallenberger, R. J. 1977. Bird and mammal survey of Army lands in Hawaii. Ahuimanu Productions, Honolulu, HI.

Shallenberger, R. J. and G. K. Vaughn. 1978. Avifaunal survey in the central Koʻolau Range, Oʻahu. Ahuimanu Productions, Honolulu, HI.

Takahama, T. 2005. Personal communication. Natural Area Reserves Specialist. Department of Land and Natural Resources, Department of Forestry and Wildlife. Honolulu, HI.

U.S. Fish and Wildlife Service. 2003a. Biological opinion of the U.S. Fish and Wildlife Service for routine military training and transformation of the 2nd brigade 25th infantry division (light) U.S. Army Installations Island of Oahu. Unpublished. 351 pp.

USARHAW and 25th ID(L) (25th Infantry Division (Light)). 2003. *Integrated Wildland Fire Management Plan, Oʻahu and Pōhakuloa Training Areas.* Signed on December 2, 2003. October 2003.

US Army Garrison, Hawaii, Directorate of Public Works, Environmental Division. 2004. US Army Garrison Hawaii, Oahu Training Areas Natural Resources Management Final Report. Unpublished.

US Army Garrison, Hawaii, Directorate of Public Works, Environmental Division. 2005. Draft Oahu Implementation Plan (Draft OIP). Prepared for the U.S. Army Garrison, Schofield Barracks, HI.

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.

Weisenberger, L. 2005. Personal Communication. Propagule Management Specialist. Seed Conservation Lab, Lyon Arboretum, Honolulu, HI.