U. S. ARMY GARRISON HAWAI`I
O`AHU TRAINING AREAS
NATURAL RESOURCE MANAGEMENT

FINAL REPORT

Prepared for:

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Contract: Scopes of Work for Ecosystem Management Activities at Various Training Areas, Island of O`ahu; Biological Stabilization Actions at Mākua Military Reservation 3, Island of O`ahu.

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EXECUTIVE SUMMARY

Project Overview

The Natural Resources Staff (NRS), employed by the Pacific Cooperative Studies Unit, University of Hawai`i (PCSU), are charged with managing rare plants and animals and the ecosystems upon which they depend in O`ahu Army training areas. NRS work under the following contracts: Scope of Work for Ecosystem Management Activities at Various Training Areas, Island of O`ahu; and Scope of Work for Biological Stabilization Actions 3, Mākua Military Reservation, Island of O`ahu.

O`ahu training areas include Mākua Military Reservation, Schofield Barracks Military Reservation, Kawailoa Training Area, Kahuku Training Area and Dillingham Military Reservation. A total of 71 endangered species, 58 plants species and 13 animals species, have been reported from O`ahu Army Training Areas since 1982. O`ahu training areas encompass 46,000 acres and range from healthy intact native forests to completely alien dominated areas. NRS implement ecosystem and single-species level management actions, which include weed, rat, ungulate, and invertebrate control, as well as rare species surveying, monitoring, collection and reintroduction.

Purpose

The purpose of this document is to provide an overview of the actions accomplished to date under the Scopes of Work between PCSU and the Army, listed above. This report also serves as a time for NRS to critically analyze management approaches and efforts and to make recommendations for next year's work. Also included is a schedule of actions for the up-coming year.

Endangered Species Act Requirements

The legal requirement driving the Army's ecosystem management program is the Endangered Species Act (ESA) Sections 7(a)(1) and 7(a)(2). These sections of the ESA require that Federal agencies use their authority to carry out programs for the conservation of federally listed species, and ensure that their actions are not likely to jeopardize the continued existence of any federally listed species. Fire and weed spread are the greatest potential threats from military training on O`ahu. Fires have the potential to destroy habitat and kill endangered plants and animals. In addition, a potential secondary effect of military training maneuvers is the spread and introduction of taxa not native to Hawai`i. NRS assist in minimizing negative training impacts by conducting fuel control around highly susceptible native species, making fire preparedness recommendations, conducting road and landing zone weed surveys, and controlling any new invasive species populations.

Mākua Military Reservation (MMR) Draft Implementation Plan

In 1998, the U.S. Army (Army) initiated formal consultation under section 7 of the Endangered Species Act (16 U.S.C. 1531 et seq.) with the U.S. Fish and Wildlife Service (USFWS) to determine if routine military training at MMR would jeopardize the continued existence of 41 endangered species. The Army is responsible for maintaining stability of each of these taxa, and applying additional management specified in this plan to those taxa below stability. The consultation used an action area (AA) (area potentially affected by military training) that extends beyond the boundaries of MMR and is based on vegetation types, fire history, natural and human-made barriers, and a consensus of where fire could be stopped by State, Federal, and Army fire-fighting resources. Taxa for which either a significant portion of the populations occur within the AA or for which no populations are stable, were addressed in the Army's proposed action of military training and conservation measures in such a way as to avoid jeopardy.

In 1999, the USFWS issued a biological opinion concluding that the routine military training and the conservation measures identified by the Army in its Biological Assessment (BA) would not jeopardize the endangered species found within the AA. The conclusion of no jeopardy was based on certain restrictions to military training, preparation and implementation of a wildland fire management plan, implementation of management actions identified in the BA for the 13 endangered species at stability and minimally impacted by Army training, and preparation and implementation of a plan (Implementation Plan) for the additional 27 endangered plant taxa and one endangered snail taxon. The Implementation Plan (IP) would identify additional management actions beyond those the Army was already implementing or agreed to implement in the BA to stabilize the 28 taxa.

It has taken longer than expected to develop the IP because of the extreme level of detail required. Therefore, the Army is implementing the highest priority actions from the draft plan as designated by the Mākua Implementation Team. These actions are covered by the Scope of Work for Biological Stabilization Actions 3, Mākua Military Reservation, Island of O`ahu.

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INTRODUCTION

The Natural Resource Staff (NRS), employed by the Pacific Cooperative Studies Unit (PCSU), are charged with managing rare plants and animals and the ecosystems upon which they depend in O`ahu Army training areas. NRS are currently working under two Scopes of Work, detailed in Tables A and B below. The legal requirement driving the Army's ecosystem management program is the Endangered Species Act (ESA) Sections 7(a)(1) and 7(a)(2). These sections of the ESA require that Federal agencies use their authority to carry out programs for the conservation of federally listed species, and ensure that their actions are not likely to jeopardize the continued existence of any federally listed species. The actions the Army has completed are in compliance with ESA Section 7(a)(1) which relate to stewardship actions as defined by the Army's Integrated Natural Resources Management Plan (INRMP) for O`ahu, 2002-2006, and ESA Section 7(a)(2), which relate to stabilization actions for Army actions as defined by Biological Opinions.

O`ahu training areas include Mākua Military Reservation (MMR), Schofield Barracks Military Reservation (SB), Kawailoa Training Area (KLOA), Kahuku Training Area (KTA) and Dillingham Military Reservation (DMR) (see Figure A). Each of these training areas is described and mapped on the following pages. A total of 71 endangered species, 58 plants and 13 animals, have been reported from O`ahu Army training areas since 1982.

O`ahu training areas encompass 46,000 acres and range from healthy intact native forests to completely alien dominated areas. To prioritize management, NRS have delineated management units (MUs) within each training area. These MUs were chosen based on two criteria: the density of rare species and the degree to which the native ecosystem is intact. NRS implement ecosystem level management actions in these MUs, which can include weed, rat, ungulate, and invertebrate control, as well as rare plant reintroductions. Two areas in Mākua have been designated solely as Ungulate Control Areas (UCAs), whereby goat eradication is the primary goal for management. The forest in these regions is degraded and dominated by alien species, and widespread weed control attention is not feasible. Ungulate control is conducted in these areas primarily to decrease their threat to proximate MUs and other native species. Outside the MUs and UCAs, NRS conduct primarily single species level management. This can involve seed collection for storage or propagation, collection of cuttings for propagation, rare plant and animal monitoring, small-scale threat control, and surveying for new rare species populations.

On O`ahu, Army training can threaten endangered species in two primary ways. First, live ammunition training can cause fires, which can potentially spread beyond the designated firebreak and destroy habitat and kill endangered plants and animals. In addition, fire opens up previously native areas to weedy alien species, which out-compete native species for light and nutrients and lead to the deterioration of an ecosystem. Second, training maneuvers spread existing weedy species and introduce new weeds to areas, exacerbating and intensifying weed impacts to native ecosystems. NRS conduct post-fire surveys to determine impacts to threatened and endangered species, control fuels around rare plant populations, and make recommendations to improve training protocols that may aid in fire prevention. NRS assist in minimizing negative training impacts via weed spread by conducting road and landing zone weed surveys, and by addressing any weed problems that arise through weed control and, where possible, eradication.

The aforementioned actions are a part of the minimization actions set out in the Section 7 Biological Opinion for Mākua Military Reservation dated 23 July 1999.

Through the work performed under the Ecosystem Management Program contract, the Army has become a major contributor to conservation on the island of O`ahu. NRS have established cooperative relationships with land managers and landowners on O`ahu and the neighbor islands to successfully promote ecosystem protection project partnerships.

The following report summarizes the natural resource protection work conducted in the contract period of August 2003 to August 2004. It is organized by chapter to cover the following areas of the natural resource management program: feral ungulate management, weed management, rare plant management, rare vertebrate management, and invertebrate management. This report comes at the completion of the seventh year that PCSU contractors have been conducting natural resource management on Army training lands on O`ahu. NRS use this report to critically analyze management approaches and efforts and to make recommendations for next year's work.

FIGURE A Army Training Lands, Island of O`ahu

A. Mākua Military Reservation

Mākua Military Reservation (MMR) encompasses two valleys, Kahanahāiki and Mākua, which are the two northernmost major valleys on the leeward side of the Wai`anae Mountains. Approximately 4,190 acres in size, MMR is the largest maneuvering/live-fire training area on O`ahu. Elevation within MMR ranges from sea level to just over 3,000 feet. While most of the natural habitats within MMR are highly disturbed, there are large pockets of relatively native dry and mesic forest. The terrain at MMR is extremely steep, exposed, and rocky. There are six MUs and two Ungulate Control Areas within MMR (see Figure B). There are a total of 33 endangered species in Mākua: 30 plants, one bird, one snail and one bat.

Kahanahāiki Management Unit

Kahanahāiki MU is located on the northeast rim of Mākua Valley. At the eastern boundary of the MU is the State of Hawai`i's Pahole Natural Area Reserve (NAR). Kahanahāiki has an elevational range of 1,500 feet to 2,300 feet and an annual rainfall of 1,200 – 3,800 mm. Kahanahāiki MU is approximately 110 acres with vegetation characterized as being diverse mesic forest. Ridges and drainages that feed into the northern half of MMR (Kahanahāiki Valley) bisect the Kahanahāiki MU. Because of its close proximity to the Mākua Valley training area, fires from Mākua Valley threaten this MU. In 2003, a portion of this MU burned after a controlled fire in Mākua Valley jumped the firebreak road. A feral pig exclosure fence surrounds 90 acres of the Kahanahāiki MU. This fence was completed in December of 1996. Kahanahāiki hosts twelve endangered plant species, two endangered animal species, and is the site of the first endangered species outplanting on military lands in Hawai'i. Currently there are six endangered plant species that have been reintroduced in this MU. In addition, Kahanahāiki MU contains the only native tree snail exclosure on Army lands, which protects a population of *Achatinella mustelina* from predators. Because there is good road access and native resources are abundant, Kahanahāiki has been a focal point for volunteer projects.

`Ōhikilolo Management Unit

`Ōhikilolo MU is located on `Ōhikilolo Ridge, which is the southern boundary of Mākua Valley. It encompasses approximately 40 acres. The terrain is extremely steep and rocky, and access to the upper portion of this MU is achieved by helicopter. Ōhikilolo Ridge contains sparse vegetation, and erosion by wind and rain is severe. `Ōhikilolo MU harbors a great deal of intact vertical cliff habitat and small intact mesic forest patches. Intensive goat control measures and a perimeter fence have reduced the feral goat population within the MU. There is a goat-proof exclosure of approximately two and a half acres enclosing the plateau where `Ōhikilolo ridge meets Kea`au ridge from the south, surrounding a nearly pristine patch of dry mesic forest. `Ōhikilolo hosts thirteen endangered plant species and two endangered animal species. `Ōhikilolo is also home to the largest population of *Achatinella mustelina* known on Army lands.

Kaluakauila Management Unit

Kaluakauila MU is approximately 250 acres and is located in and around Kaluakauila drainage, just north of Mākua Valley. The area around this drainage is referred to as Keawa`ula. This MU is primarily made up of dry forest on steep slopes and contains some intact native cliff habitat. Kaluakauila MU is very susceptible to fires because the area surrounding the intact native forest patches is comprised of introduced grasses and shrubs, which have very high fire potentials. In addition, proximity to the live ammunition training range makes fire a real threat. Fires burned just inside the edge of this MU in 1998, and again in July 2003 and September 2003 (see Appendix 7) where the fire further reduced the size of the native dry forest and partially burned a rare plant reintroduction site. NRS maintain a firebreak along the ridgeline in parts where flammable vegetation requires control, while other areas of the ridge act as a natural firebreak due to the exposed rocky terrain. NRS also have reduced fuel loads within the patches of endangered *Euphorbia haeleeleana* through weed management (See Chapter 2: Weed Management). A feral pig exclosure fence following the perimeter of Kaluakauila MU was completed in July of 2002, and this area is now pig free. There are a total of six endangered plant species in Kaluakauila MU.

Lower Mākua Management Unit

The Lower Mākua MU is located at the base of the cliffs on the southern back corner of Mākua Valley. Portions of the lower valley contain extensive intact stands of dry forest that become intermixed with mesic forest as elevation increases. The Lower Mākua MU ranges from 800 feet to 2,200 feet in elevation and encompasses an area of 270 acres. NRS believe that the stands of dry and mesic forest found in this MU are the most intact native-dominant forests of this type on O`ahu. The Lower Mākua MU contains eight endangered plant species and two endangered animal species.

Three years ago, NRS were able to obtain approval for a risk assessment, which allowed for helicopter access to this MU and camping at an approved campsite. This greatly increased the amount of management that NRS were able to perform in the MU. Due to concerns registered by the Range Safety Office, NRS need to reapply for approval for this helicopter risk assessment. This has already severely limited access to the MU, and therefore limited the amount management that can be done. NRS hope to resolve this issue and begin camping in Lower Mākua again soon.

C-Ridge Management Unit

The C-ridge MU is located on the north exposure of the large ridge that separates Mākua and Kahanahāiki Valleys. It is a small four-acre patch of native dry forest surrounded on the lower side by introduced grasslands and on the upper side by sheer cliffs between 800 and 1,200 feet. The hike to C-ridge is lengthy; this limits the amount of time spent in the area. Because of the surrounding grasslands, this MU is susceptible to fires from military live-fire training. Much of the C-Ridge forest patch burned in the 2003 Mākua fire. There are a total of three endangered plant species known from this MU.

Lower `Ōhikilolo Management Unit

The Lower `Ōhikilolo MU is located on the moderate southern slope near the makai edge of Mākua Valley. Directly upslope of the firebreak road, this 7-acre MU is surrounded by the highly invasive guinea grass (*Panicum maximum*) and koa haole (*Leuceana leucocephala*). These alien species dominate nearly every dry lowland shrub ecosystem on O`ahu. NRS conduct grass control as a firebreak around the three endangered plant species found in this MU. The firebreak appears to be working, as the 2003 Mākua fire burned around the area cleared by NRS staff, but did not burn any of the endangered plants in the MU. Additionally, NRS are attempting to promote the regeneration of native dry lowland shrub species in the MU. This is the first large-scale restoration attempt on O`ahu for this kind of habitat.

East Rim Ungulate Control Area

The East Rim UCA is 100 acres, situated at the headwall of the southeastern side of Mākua Valley, opposite Pahole Natural Area Reserve. The elevation extends from 1,800 to 2,600 feet, and the substrate varies from loose rocky soil to rocky cliff. There are three endangered plant species in the East Rim UCA that are vulnerable to ungulate browsing. This MU contains small native mesic forest patches but is dominated by non-native canopy and understory species. The invasive Christmas berry (*Schinus terebenthifolius*) dominates large portions of this area. For this reason, NRS do not conduct widespread weed control within this UCA.

Ko`iahi Ungulate Control Area

Ko`iahi UCA is centered on Ko`iahi gulch, which is the southernmost subgulch of MMR. This large gulch is sandwiched between `Ōhikilolo ridge and a large, distinctive spur ridge, named Ko`iahi Finger, which branches off from `Ōhikilolo. The substrate of Ko`iahi ranges from rock talus to rocky cliff and gulch substrates. The UCA extends from 400 to 2,200 feet in elevation and is approximately 230 acres in area. There are a total of eight endangered plant species in Ko`iahi UCA, and they are vulnerable to ungulate browsing, though they primarily occur on the cliffs above Ko`iahi Gulch. Alien scrubby vegetation and kukui (*Aleurites moluccana*) trees dominate this area. For this reason, NRS do not conduct widespread weed control in this area.

FIGURE B Management Units Mākua Military Reservation

B. Schofield Barracks Military Reservation

Schofield Barracks Military Reservation (SBMR) is located in central O`ahu on the west and east sides of Wahiawā town, and is owned by the Army. SBMR is approximately 9,676 acres and encompasses lands that stretch from the summits of the Ko`olau Mountains in the east to the summits of the Wai`anae Mountains in the west. The Army uses the western portion of SBMR for live-fire training and the eastern portion for maneuver training. Vegetation types at SBMR include dry, mesic and wet forests. SBMR is broken up into three ranges: West (SBW), East (SBE) and South (SBS) (see Figure C).

Hazards associated with unexploded ordnance (UXO), in conjunction with scheduling limitations, restrict ecosystem management activities in SBW. The impacts of these limitations are discussed within each chapter.

There are a total of three MUs within SBMR (see Figure C). These MUs encompass the most intact portions of the training areas. The only MU within SBW is on Mt. Ka`ala (see Figure C). At present, additional management work in SBW is limited to the single species level. NRS will continue attempting to survey this year in SBW to better identify potential additional MUs. The Schofield-Waikāne MU covers the portion of SBE near the summit of the Ko`olau Mountains (see Figure C). In SBS, there is one small MU at Pu`u Hāpapa. There are a total of 38 endangered species in SBMR, six of which are animal species, including the `Elepaio (*Chasiempis sandwichensis ibidis)*, four tree snail species (*Achatinella sp.)*, and the `Ōpe`ape`a, or Hawai`ian hoary bat (*Lasiurus cinereus*).

Ka`ala Management Unit

The Ka`ala MU encompasses approximately one half of the wet forest atop the summit of Mt. Ka`ala at 4,100 feet, and extends downslope to the east to approximately 3,200 feet in elevation. The total area within this MU is approximately 80 acres. The flat summit forest portion is characterized by drenched soils and mossy ground cover and is considered to be an immature bog. The sloped region contains both wet forests with very organic soils and windward-facing cliff habitat. There are three endangered plants within the Ka`ala MU. NRS have also detected the state listed endangered `i`iwi on several occasions in this MU. Currently the MU is partially protected by a feral pig exclosure fence, built in cooperation with the Board of Water Supply and the State of Hawai`i. There is still some pig ingress into the fenced area, and NRS will be working to close the holes in the fence this year.

Pu`u Hāpapa Management Unit

The Pu`u Hāpapa MU is located at the top of Pu`u Hāpapa, the first peak south of Kolekole Pass. The MU is approximately nine acres, ranging in elevation from 2,400 to 2,900 feet (see Figure C). The forest is wet-mesic and extends down the north-facing slopes of Pu`u Hāpapa. This area is the only native forest patch deemed worthy of intensive ecosystem management in SBS. The habitat in the lower mesic portion of SBS is very degraded; single species management is the focus there. The Pu`u Hāpapa MU is home to a large population of the endangered *Achatinella mustelina,* and populations of the rare terrestrial snails, *Laminella sanguinea* and *Amastra* *micans*. There are also three endangered plants located within the MU. A small fence was constructed in this MU in 2003 to protect a population of *Laminella* and *Amastra*.

Schofield-Waikāne Management Unit

This MU encompasses 780 acres in the northern Ko`olau Mountains between 1,600 feet and 2,600 feet in elevation. The northern-most portion of the MU is in KLOA, and the summit portion is in SBE (see Figure C). The forest types within the Schofield-Waikāne MU include short-stature wet forest near the Ko`olau summit region, and tall-stature wet forest at lower elevations. The terrain is dissected by deep ravines characteristic of the Ko`olau mountains. The Army leases the portion of this MU between the Poamoho and Schofield-Waikāne Trails from the State of Hawai`i. The State of Hawai`i, Division of Forestry and Wildlife, has primary management responsibility and authority for this portion of the MU. The Schofield-Waikāne MU is home to 13 endangered plant species and three endangered animal species.

FIGURE C Management Units and Training Ranges Schofield Barracks Military Reservation

C. Kawailoa Training Area

Kawailoa Training Area (KLOA) is located on the leeward slopes of the northern Ko`olau Mountains, O`ahu. It is the Army's largest training area on O`ahu and consists of approximately 23,348 acres of land leased from various private landowners. The elevation within KLOA ranges from 1,000 feet to 2,800 feet. The Army principally uses KLOA for helicopter training. Terrain is very rugged, consisting of steep cliffs, deep gullies, thick vegetation, and wind-swept summit areas. KLOA is a very important watershed for the island of O`ahu. Because of the rugged terrain, management is centered around trails. Trails in KLOA include the Poamoho, Pe`ahināi`a, and Kawailoa summit access trails, as well as the Ko`olau Summit trail which runs along the spine of the northern Ko`olau Mountains. There are five management units in Kawailoa, four of which are contiguous and centered along the Ko`olau summit trail (see Figure D). Kawailoa is home to 18 endangered plant species and nine endangered animal species.

Poamoho Management Unit

The Poamoho MU is approximately 545 acres and extends from 2,000 to 2,700 feet in elevation. Wet summit and lower elevation forests characterize Poamoho MU. There are two major drainages within this MU, Poamoho and Helemano. Because of their rugged nature, many areas within this MU have yet to be explored. The Army leases the portion of this MU south of the Poamoho trail to the Schofield-Waikāne trail from the State of Hawai`i, and the state has primary management responsibility and authority here. There are seven endangered plants and six endangered animals known from the Poamoho MU.

Upper Pe`ahināi`a Management Unit

The Upper Pe`ahināi`a MU shares the same forest types as Poamoho. The MU extends from 2,200 to 2,800 feet in elevation and encompasses 575 acres. There are six endangered plants and two rare snails known from this MU. This area is a very high priority for management because of its susceptibility to damage from feral pigs. The area is rather flat, unfortunately making it ideal ungulate habitat. Roughly 150 acres of the Upper Pe`ahināi`a MU were fenced under the `Ōpae`ula Watershed Protection Project, a cooperative effort between the Army, Kamehameha Schools, the State of Hawai`i, and the U.S. Fish and Wildlife Service (USFWS). An additional fence is being planned to encompass roughly 250 acres of the upper portion of Helemano stream drainage.

Lower Pe`ahināi`a Management Unit

The Lower Pe`ahināi`a MU is 205 acres centered along the middle portion of the Pe`ahināi`a Trail. The MU ranges from 1,600 to 2,200 feet in elevation. This area represents some of the few remaining patches of intact and healthy mid-elevation Ko`olau mesic-wet forest. The forest is tall in stature and very diverse. The terrain is very steep and varies in its native and weedy species composition. There are patches of forest within this MU which are nearly intact, having few weeds and little sign of ungulate damage. There are five endangered plants and two endangered tree snails found in the Lower Pe`ahināi`a MU.

Castle Management Unit

The junction of the Summit and Castle trails lies within this MU. The Castle MU is 370 acres, and it ranges in elevation from 2,000 to 2,600 feet. It primarily encompasses wet summit forest ecotype, but also contains the only mature bog ecosystem on the island of O`ahu. This portion of KLOA receives the greatest average rainfall on O`ahu. This area is similar to the Upper Pe`ahināi`a MU in that it has very flat areas and the vegetation is very susceptible to ungulate damage. The Army and Kamehameha Schools initiated a cooperative Ko`olau ecosystem management project in this MU by erecting pig fencing to protect the Lehua Maka Noe Bog, which contains two endangered plant species and encloses approximately 3 acres. The entire Castle MU contains seven species of endangered plants and one endangered O`ahu tree snail species.

Kahuku Cabin Management Unit

The Kahuku Cabin MU is approximately 280 acres and extends from 2,200 to 2,600 feet in elevation. It encompasses the uppermost portion of the Kawailoa Trail and portions of the Ko`olau Summit Trail. The area is more heavily degraded than the other Ko`olau MUs because of the prevalence of alien vegetation and feral pig damage. The wet forest in this region is intact in patches but there are large stands of alien vegetation, including areas dominated by manuka (*Leptospermum scoparium*). Endangered species in this management unit include seven plant species and two snail species.

FIGURE D Management Units Kawailoa Training Area

D. Kahuku Training Area (KTA)

KTA encompasses approximately 9,400 acres of land, and ranges in elevation from 80 feet to approximately 2,100 feet (see Figure E). After years of leasing the land, the Army recently purchased KTA from The Estate of James Campbell. The Army uses KTA for pyrotechnic training and foot maneuver training. The terrain consists of rolling hills dissected by broad drainages in lower elevations, and relatively steep and windswept ridges in upper elevations. Habitat within KTA is highly disturbed with some small, predominantly native forest patches in upper elevations. There are five endangered plants found at KTA.

FIGURE E Kahuku Training Area

E. Dillingham Military Reservation

Dillingham Military Reservation (DMR) is approximately 665 acres, and ranges from sea level to about 400 feet in elevation. It is located near the northwestern tip of O`ahu, between Moku`lē`ia and Ka`ena Point (see Figure F). The Army uses DMR for para-drop and night-vision goggle exercises. Habitat within DMR is highly disturbed with very little of the native flora surviving; however, small stands of native forest and shrubland can still be found on the cliffs and talus slopes in the southwest portion of the reservation. Most of the management at DMR is conducted within the small stands of native forest dominated by the native soapberry, *Sapindus O`ahu ensis* or lonomea. However, this area does not fulfill the necessary biological criteria to be considered a MU when comparing the number of endangered species and intactness of native habitat to other Army training areas. DMR also harbors a perennial spring seep habitat that begins at the uppermost portions of the reservation and has running water to about 60 feet in elevation. There is one endangered plant known from DMR.

FIGURE F Dillingham Military Reservation

Contract Line Item Requirements Tables

Table A. Line Items from the Scope of Work for Ecosystem Management Activities at Various Training Areas Island of O`ahu

Line Item	Description	Status
1(a)	Monitoring established ungulate transects in SB (3 transects) and KWTA (8 transects). Transects are 500 meters in length and 2-1/2 meters on either side of the middle walked line and shall be monitored every quarter where intensive ungulate control is being implemented and bi-annually in all other areas. Findings shall be entered on the form entitled "DPW Environmental Ungulate Transect Data Sheet" (Enclosure 1). Based on ungulate transect findings, recommendations shall be made for management actions. To also support transect monitoring, incidental observations of ungulate activity shall also be noted and included in management recommendations.	Ongoing. See Chapter 1.
1(b)	Implementing snaring/firearms use in Management Units and Ungulate Control Areas to control feral pigs and goats, if necessary. Should snaring/firearms use be implemented, data shall be noted on Enclosure 2. Firearms use shall be conducted as described in the U.S. Army Garrison, Hawai`i, Directorate of Public Works Standard Operating Procedure entitled, "DPW Standard Operating Procedure for the Safe Handling, Storage, Use, and Transport of Firearms." All data shall be analyzed and recommendations made for management actions.	Ongoing. See Chapter 1. NRS continue to employ snares and firearms as management tools in SB.
1(c)	Implementing the ungulate control plans developed for SB and KWTA. These plans shall be re-evaluated and updated on an annual basis based on findings/data from items (1) (a) and (1) (b).	Ongoing. See Chapter 1. The plans for each management unit are based on a variety of factors including transect data, hunting and snaring effort/success, the type of on-going management in each management unit, land uses in adjacent parcels, accessibility, safety, and resource/staff limitations.
1(d)	Inspecting the fence in the upper Pe`ahināi`a Management Unit, KWTA every quarter and performing repairs, if necessary.	Ongoing. See Chapter 1. All fencing in KLOA has been inspected and continues to be secure from any vandalism, corrosion, and ungulate breaches.
1(e)	Monitoring vegetation plots in areas where management is underway for weeds or ungulates. The purpose of these plots is to monitor any secondary effects of management on native species, to monitor effective control of these species, and to quantify positive or negative vegetation trends. Findings shall be analyzed and recommendations made for management actions.	Ongoing. See Chapter 2.

Line Item	Description	Status
1(f)	Performing weed control (manual, herbiciding and/or biocontrol) in KTA, SB, KWTA, and DMR (combined acreage is approximately 20 acres) for weeds such as ginger, manuka, strawberry guava, Christmas berry, Haole koa and Koster's curse (melastomes and immediately related families). Data shall be evaluated and incorporated into the current weed control plan. Habitat restoration shall be conducted in conjunction with weed control efforts by planting common native plant species.	Ongoing. See Chapter 2.
1(g)	Identifying locations using field mapping or Global Positioning System (GPS) of rare species, and entering data into GIS rare species database. Developing interfacing rare plant database that captures monitoring data and will interface with ARCVIEW software. All location data shall be noted on rare plant field data forms (Enclosure 3).	Ongoing. See Chapter 3.
1(h)	Monitoring and controlling the ingress of incipient weeds at frequently used roads and training areas. Weed monitoring and control will be conducted in all areas where the Army trains on the ground to detect any new incipient weeds. The frequency and location of monitoring and control will be in proportion to the training usage in strategic locations. Monitoring will be frequent enough to minimize near zero the establishment of any incipient weeds. Baseline data have been obtained for incipient weeds at the various locations in KWTA (Poamoho and Paala-Uka); KTA (Gate Access Roads A-D); DMR (unnamed roads south of the runway); and SB (Schofield-Waikane, Schofield West Range Firebreak Road and South Range Roads). In addition, ten landing zone (six military and 4 natural resources shall be monitored annually with weed control being performed, if necessary.	Ongoing. See Chapter 2.
1(i)	Monitoring Management Category (MC) 1, MC 2, and MC 3 plant species (any species having less than 150 individuals with less than 10 populations) quarterly or annually at KWTA, SB, KTA, and DMR to determine phenology. Conduct rat control on species fruiting if found susceptible. Propagules shall be collected, if possible. Determine the potential of pollination biology for plants while conducting rare plant monitoring. Parameters as described on Enclosure 4 shall be noted. All rare plant monitoring and collection will be conducted using the Hawai`i Rare Plant Restoration Group (HRPRG) form. Based on the analysis of data, recommendations shall be made for management actions.	Ongoing. See Chapter 3.
1(j)	Collecting and providing soil samples from native-dominated areas to Lyon Arboretum for incorporation of mycorrhizae into traditional greenhouse propagation methods. Based on the analysis of data from Lyon, management recommendations shall be made for Army lands.	Ongoing. See Chapter 3.
1(k)	Monitoring the discrete populations of rare birds (O`ahu '`elepaio and O`ahu I'iwi) in SB and KWTA. Identification of individual birds shall be accomplished by banding, as appropriate and morphological measurements taken of the bill, tarsus, and wing length. Two (2) color-banded O`ahu `elepaio in SBMR South Range, 34 O`ahu `elepaio in SBMR West Range will be monitored. Attempts will be made to color band I'iwi birds in SBMR East Range. Predator control shall be conducted where there are breeding pairs.	All banded O`ahu `elepaio in both Schofield Barracks South and West Ranges were monitored for survival. NRS were able to monitor the `i`iwi (*Vestiaria coccinea*) during the Audubon Society's Christmas Bird Count in Schofield Barracks East Range but did not see or hear any. See Chapter 4.

Line Item	Description	Status
1(n)	Assessing and establishing two stream monitoring plots in the Opaeula Stream of KWTA to determine watershed health. Plots shall be approximately 100 meters long with 5-meter intervals and monitored on a semi-annual basis based on the Hawai`ian Stream Bioassessment Protocol, Version 1.0. Based on the analysis of data and observations, recommendations shall be made for management actions.	Stream plots were established and monitoring takes place intermittently.
1(o)	Monitoring the Special Ecological Areas (SEAs) within each training area to determine whether an impact has occurred from military training activities. Findings shall be evaluated and recommendations made for management actions.	Ongoing. See Chapters 2, 3 and 4.
1(p)	Participate in meetings to keep abreast of issues discussed within the following groups: - Toxicant Working Group - Hawai`i Rare Plant Restoration Group convened by the Center for Rare Plant Conservation - Waianae Feral Animal Working Group - O`ahu Fountain Grass Working Group - Snail Working Group convened by the U.S. Fish and Wildlife Service Recommend to the DPW Biologist, O`ahu Natural Resources Manager, and Entomologist how the Army can participate in supporting the ongoing efforts of each group and participate in management issues on its lands.	NRS actively participate in these groups and others, such as the O`ahu Invasive Species Committee (formerly the O`ahu Fountain Grass Working Group).
1(q)	Maintain a facility for rare and common native plant propagation. Utilize traditional greenhouse methods for rare plant propagation in accordance with standards required in USFWS permit. Propagate common native species needed for out-planting in conjunction with weed control. Coordinate with the Army's Biologist and O`ahu Natural Resources Manager to ensure that any reintroduction of rare plants is acceptable to the 25th Infantry Division, G3/DPTM, Range Division.	NRS maintain a greenhouse on-site and coordinate with the State to maintain the Pahole Mid-Elevation Nursery. See Chapter 3 for details on reintroductions.
2	All information/data gathered on natural resources shall be entered and compatible with the U.S. Army's Integrated Training Area Management GIS. An electronic copy of information/data gathered during the period of the contract shall also be submitted.	A copy of all data will be submitted to ITAM at the end of the year.
3	The tasks may include work with Federally listed species or species of concern which will be covered under the permit issued to the U.S. Army Garrison, Hawai`i, Directorate of Public Works Environmental Division.	The permit was renewed in 2003.

Table B. Line Items from the Scope of Work for Biological Stabilization Actions at Mākua Military Reservation, Island of O`ahu . 5 March 2003 (UA3)

Line Item	Description	Status:
1(a)	*Achatinella mustelina* shall be collected in accordance with U.S. Fish and Wildlife Service (USFWS) collection standards for captive propagation from the following locations: Alaiheihe; Ohikilolo; Palikea Gulch; Puu Kaua; Puu Palikea; and Schofield West Range (Haleauau).	See Chapter 5.
1(b)	Genetic analysis shall be performed on *Achatinella mustelina* from the following locations: Central and North Kaluaa; Huliwai; Makaha; Mohiakea; and Puali`i to Palawai.	Genetic analysis completed in FY03. See Chapter 5.
1(c)	Develop alternative predator exclosure designs and predator repellant for the exclosures. Select two sites and test design the exclosure fence at each site.	Dr. Mike Hadfield was contracted to do this work. The current exclosure design was deemed adequate. See Chapter 5.
1(d)	Manage for stability, three identified populations of *A. mustelina* in the following locations: Kahanahāiki to Pahole, Ohikilolo, Schofield West Range (Haleauau). These populations to be managed shall take into consideration land ownership and level of threat(s)	Pahole, Kahanahaiki, and Ohikilolo were managed. Additional sites have been selected for management. See Chapter 5.
2(a)	The following species shall be maintained as propagule sources: Alectryon macrococcus, Cyanea grimesiana, Delissea subcordata, Flueggea neowawraea, Hibiscus brackenridgei, Schiedea kaalae.	Details on collection are included in Chapter 3.
2(b)	Genetic storage. Inter situ (living) collections shall be maintained for 24 listed taxa. Collections shall be made for those species listed in SOW Enclosure 1.	Details on living collection are included in Chapter 3.
2(c)	Maintain reintroduced *Hibiscus brackenridgei* spp. *mokuleianus* to the Kaluakauila area.	Additional plants were outplanted this year. See Chapter 3 for details.
2(d)	Maintain the rare plant database for monitoring, collection, and propagation data.	The database has been updated and is being maintained by Natural Resources staff.
3	Perform field surveys for *Cenchrus agrimonioides*, *Chamaesyce herbstii, Dubautia herbstobatae, Flueggea neowawraea, Neraudia angulata, Phyllostegia kaalaensis, Sanicula mariversa*, and *Schiedea kaalae.*	Field surveys are in process. See Chapter 3 for details on completed surveys.
4(a)	Control weeds around the *Hibiscus brackenridgei ssp. mokuleianus* population in the Lower `Ōhikilolo area.	Weed control is ongoing. See Chapter 2.
4(b)	Control weeds around the *Chamaesyce celastroides var. kaenana* population in the Kaena and Keawaula area. (i.e. grasses).	Weed control is ongoing. See Chapter 2.
4(c)	Control weeds around the *Cyanea superba* - Monitor and control weeds around the Pahole reintroduction area.	Weed control is ongoing. See Chapter 2.
4(d)	Control weeds around the Kaluakauila Management Unit - Maintain control of *Panicum maximum* (Guinea grass).	Weed control is ongoing. See Chapter 2.
4(e)	Participate in weed control on access roads (Mokuleia, Kealia, Kuaokala and Lower Kaala) with the State of Hawai`i.	NRS assisted the State with road maintenance. See Chapter 2.

Line Item	Description	Status:
5	Manage for stability the small population units identified in SOW Enclosure 2. Stabilization efforts shall include monitoring and threat abatement.	Ongoing. See Chapter 3 for details.
6	Input and manage field data.	Data management is ongoing, and this report serves as a summary of data collected over the course of one year.
7	Ensure that all information/data gathered on natural resources can be entered and is compatible with the U.S. Army's Integrated Training Area Management Geographical Information System (GIS). An electronic copy of information/data gathered during the period of the contract shall also be submitted.	All data will be submitted to ITAM at the end of the year.
9	Ensure that the tasks involving Federally listed species or species of concern are covered under the U.S. Fish and Wildlife Service permit issued to the U.S. Army Garrison, Hawai`i, Directorate of Public Works Environmental Division.	The permit was renewed in 2003.

CHAPTER 1: FERAL UNGULATE MANAGEMENT

1.1 Introduction to Feral Ungulate Management

Feral ungulates have long been recognized as a major threat to the health and integrity of native Hawaiian ecosystems. Their ability to alter entire native habitats, as well as jeopardize the component species that comprise these areas, makes feral ungulate management a high priority.

The ungulate threats to listed species found on U.S. Army (Army) training lands on O`ahu are from feral pigs (*Sus scrofa*) and goats (*Capra hircus*). Feral pigs are found on all of the Army training areas on O`ahu. Pigs directly impact the flora of ecosystems through direct consumption of vegetation (Giffin 1973, Tate 1984, and Kroll 1985). Rooting and digging activities may also have indirect impacts on ecosystems such as changing successional patterns, altering soil properties, accelerating erosion, and altering water infiltration rates (Spatz and Mueller-Dombois 1975, Springer 1977, Singer *et al*. 1982 and 1984, Tate 1984, Kroll 1985). Feral pigs act as vectors of weed spread by transporting propagules in feces and by carrying seeds in their fur (Personal observations). These animals have been known to carry diseases that are transmittable to livestock and humans, including brucellosis, psuedorabies, tuberculosis, and leptospirosis (Giffin 1973, Texas Animal Health Commission 1992). They also create favorable breeding habitats for the introduced night-biting mosquito, *Culex quinquefasciatus,* which is a known vector for avian malaria (*Plasmodium relictum*) and West Nile Virus (*Flavivirus* spp.), a human, equine, and avian neuropathogen. West Nile Virus has not yet reached the islands but there are serious concerns that it will as it makes its way across the contiguous 48 states.

Presently, feral goats are known from Mākua Military Reservation (MMR) and Schofield Barracks West Range (SBW). Feral goats browse on almost any type of vegetation, including native grasses, shrubs and small trees. Goats are adept climbers and can be found in extremely steep, rugged terrain. This is of particular concern because many rare and endangered plants occur only in these otherwise inaccessible areas. Feral goats also accelerate erosion and spread weeds. NRS believe that goats on Army lands have come from two goat ranches located in the Wai`anae Mountains. According to sources familiar with the Wai`anae 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 SBW, Lower Ka`ala Natural Area Reserve (NAR), Makaleha, Mākaha and other areas adjacent to the ranches. Impacts and threats to resources from pigs and goats occur on all Army lands containing these feral animals. Generally, areas with higher numbers of feral animals exhibit higher levels of impact.

The basic goal of the Army’s ungulate program is to reduce the impacts of feral ungulates on endangered species and native habitats by excluding ungulates from biologically sensitive areas. The strategies and methods employed by NRS include both lethal and non-lethal techniques. Non-lethal measures involve exclusion by way of fence construction. Lethal techniques include neck snares, hunting, and aerial shooting using helicopters. Ungulate monitoring is used to assess ungulate impacts and gauge the effectiveness of ungulate control efforts.

Figure 1-1 Feral Ungulates on O`ahu

Feral goat (*Capra hircus)*

Feral pig (*Sus scrofa*)

1.2 Feral Ungulate Monitoring

Monitoring for ungulate sign takes place along ungulate monitoring transects. NRS use monitoring transects as a primary tool to detect and track ungulate activities on Army lands. Placement of transects is dictated by management needs, terrain, and manageability. For example, in areas where NRS conduct only single species management, transects are located in the vicinity of those species. In areas where habitat management is a priority, transects are located throughout the managed habitat. Transect monitoring in SBW and MMR, which contain unexploded ordnance (UXO), is limited to areas that have been cleared by Explosive Ordnance Disposal Technician (EOD).

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. All data is recorded on DPW Environmental Ungulate Transect Data Sheets (Appendix 1-A).

Monitoring transects does not provide information on ungulate population dynamics and densities. However, they help detect gross changes in ungulate presence and provide managers with a general idea of changes in ungulate activity for a given area over time. It is often difficult to draw clear conclusions from transect data because there are many factors affecting field observations and ungulate activity. These factors may include; inclement weather, observer bias, transect placement, and/or topography. To improve monitoring efficacy, incidental observations of ungulate activity are also made every time NRS go into the field. NRS believe that this combined approach is the most effective way to gauge the large-scale changes expected in response to ungulate control efforts.

Data collection from transects and ungulate control is from six or seven years of monitoring. Some of the data sets show a correlation between management effort and ungulate sign. Generally, it appears that there is a definite decline of the resident population of ungulates in the area but then there are spikes of activity and catches as new animals move into the areas again. The only way to completely protect the biologically sensitive areas is through fencing. Lethal techniques just serve to reduce impacts until fences can be erected.

1.3 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. Snare locations and catches are documented on DPW Environmental Snare Report Forms (Appendix 1-F). Where possible, catches are sexed, and sized. Feral pigs are also aged using a tooth eruption chart.

Shooting

Firearms are used to control ungulates wherever permissible.

Aerial Shooting
Aerial shooting only occurs at MMR. When first instituted, aerial hunting proved 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. To eradicate the last of the goats, NRS are looking to further reduce aerial operations and increase ground hunts and snaring operations.

Radio-tracking
Radio tracking has only been used at MMR. In 2004, NRS will try to use new radio tracking collars with the use of a helicopter hook-up, which allows the pilot to track the collared animals from the helicopter. NRS has also purchased a satellite-tracking collar as a different means of locating herds of goats. To date, NRS is just waiting for a frequency clearance with the satellite collar. The paper work involved with this process has been lengthy. The new rancher in Kea`au has graciously granted NRS permission to capture the goats needed for this operation on his land. NRS has contracted USDA's Wildlife Services (WS) to attempt net-gunning animals from a helicopter. If this fails, NRS will attempt to snare individuals using locking snares so as to not harm any of them.

Dog Hunting
The use of hunting dogs has been implemented at Mt. Ka`ala, Kaluakauila, and at West Makaleha. In 2004, the use of hunting dogs as an ungulate management tool has proven to be a highly successful method of removing feral pigs from areas.

1.4 Fencing
The use of fencing as a management tool has proved to be an effective barrier to keeping unwanted ungulates out of biologically sensitive areas. As part of the long-term strategy for rare species and ecosystem protection, NRS has scheduled fence construction in areas with high densities of rare species potentially impacted by Army training, both on and off Army lands. Currently, 17 fences are proposed for construction over the next 10 years (Table 1-1).

NRS fences are generally constructed of two types of fencing materials: traditional hog wire fence, and stock panels. The terrain and other features of the area being fenced, such as the necessity of helicopter support, usually dictate the type of fencing to be used. NRS fences are usually either enclosure-type fences that totally enclose an area, or strategic type fences which use a combination of topography and fencing to stop ingress/egress of feral ungulates into an area. NRS knows 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.

Additional ungulate control measures include the Division of Forestry and Wildlife's (DLNR) public hunting programs, which take place on portions of O`ahu Army training lands. Due to budget constraints and lack of manpower and access, this program is ineffective as a means of controlling ungulate populations highly due to the lack of access.

Table 1-1 Proposed Ungulate Fences

MU Name	Proposed Construction Start Year	Total Proposed Length (m)
Mākaha (subunit I)	2005	2,890
Lower Kahanahāiki	2006	584
Lower Opae`ula	2006	1,240
Upper Kapuna	2007	1,720
West Makaleha	2007	1,375
`Ēkahanui	2008	3,100
Central & East Makaleha	2009	4,360
Keaau and Mākaha	2010	671
Mākaha (subunit II)	2010	2,480
Palikea	2010	1,000
Ala`ihe`ihe to Palikea Gulch (Kihakapu Gulch)	2011	2,842
Wai`anae Kai	2011	771
`Ōhikilolo	2012	1,200
Mt. Ka`ala NAR (Manuwai)	2013	3,563
Waiawa	2014	2,936
Haili to Kawaihapai	2014	2,374
Kalua`a and Wai`eli	2015	2,550

1.5 Mākua Military Reservation Ungulate Control Plan

Goal:
The overall goals of the Ungulate Control plan for Mākua Military Reservation is to reduce pig pressure in biologically sensitive areas and maintain zero tolerance for goats in the entire reservation.

Discussion:
Ungulate management activities within MMR include snaring, staff and volunteer ground hunts, transect monitoring and contract hunters from WS. There are now five ungulate-free exclosures in MMR. In November 2003, NRS completed a small exclosure encompassing a relatively large portion of the remaining *Pritchardia kaalae* in MMR. NRS feel that the goat population within MMR is nearly eradicated. Lack of incidental sign and sign along the transects combined with observations by contract and NRS hunters corroborate this assumption. NRS hope that a change in methods and increase in control efforts will eventually lead to total eradication of goats in MMR within the next year.

For fiscal year 2003-2004, WS was contracted to conduct one ground control hunt per month in either Ko`iahi or Lower Mākua. WS was also contracted to do two aerial hunts. Results of the work completed are discussed in the appropriate section dealing with the MU involved.

Total eradication of pigs from MMR is not feasible. Control of feral pigs in MMR is limited to actively managed areas (i.e. weed control, fire protection, and out-planting). Pigs generally occur in small inconspicuous groups, which makes pig control in remote areas extremely difficult. Many areas within MMR that contain pigs also contain high densities of UXO and are not actively managed (i.e. no weed control, fire protection, out-planting) by NRS. Furthermore, access to certain extremely high hazard areas within MMR will be prohibited indefinitely by the USAG-HI Safety Office, ruling out the possibility for on-the-ground management in these areas. Because pigs have a tendency to hide in thick vegetation, aerial shooting for pigs in many areas in Mākua is impractical.

On 22 July, 2003, a prescribed burn 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 ungulate fences at Kahanahāiki , Kaluakauila, and Lower `Ōhikilolo. Due to fire damage along sections of these fences NRS will need to replace them.

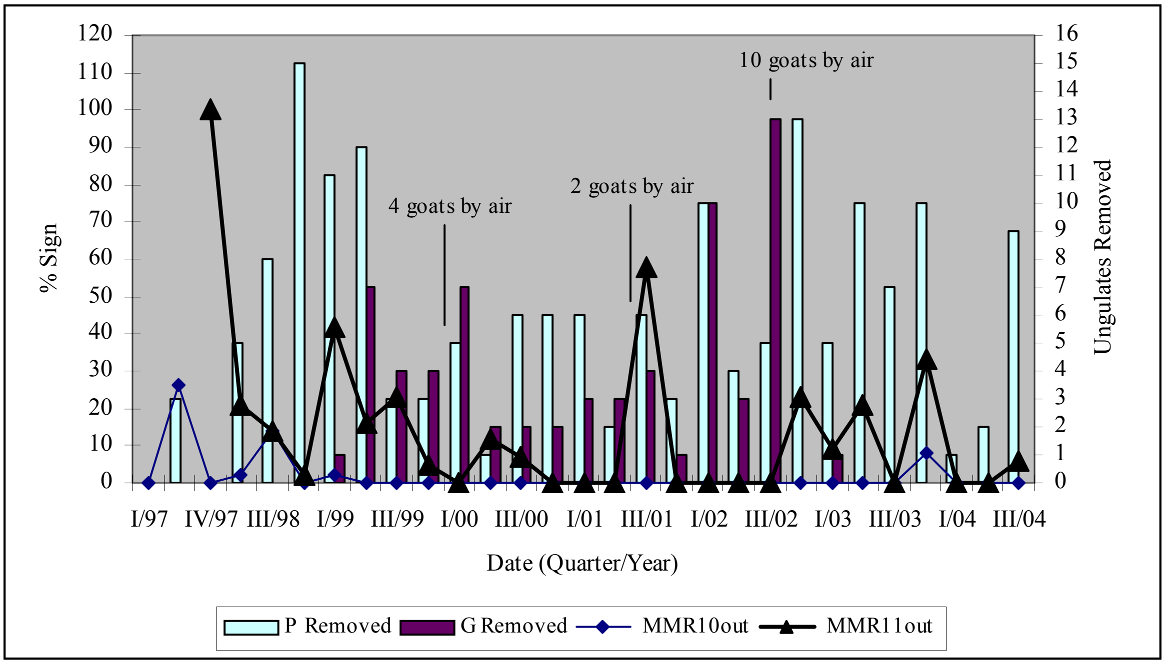
1.5.a Kahanahāiki Management Unit

Goal:
The overall goals of the ungulate program in Kahanahāiki MU are to maintain an ungulate free environment within the fenced exclosure, reduce feral pig pressure outside the exclosure, and maintain zero tolerance for goats in the entire unit.

Discussion:
An ungulate exclosure surrounding approximately 90 acres of the Kahanahāiki MU was completed in December 1996. It has been ungulate-free since April 1998. In 2003-2004, the Kahanahāiki fenced exclosure was not vandalized as it has been in the past. Regulatory and informational signs have been installed to alert and educate hunters and hikers to the importance of the resources and the management strategies practiced in the area and make it clear that there are no ungulates within it. NRS will continue to work with DLNR and local hunters to try and improve enforcement in the area.

Ungulate sign has been closely monitored with two permanent ungulate transects (MMR 10 and MMR 11) along the fence. Observations are made inside and outside the fence but for simplicity only data from outside is analyzed. Transects are monitored quarterly and any incidental observations are documented. To meet the goal of reducing pig pressure and zero goats in Kahanahāiki, a total of seven snare groups have been installed in and around the MU. These groups have been very effective, removing 234 animals (67 goats and 167 pigs) since August 1998. Since 2000, WS have removed a total of 16 goats from the unit through aerial hunting.

Figure 1-2 Kahanahāiki Ungulate Management



Initially, there appeared to be a downward trend in ungulate activity (Figure 1-2) that seemed to be associated with removal. Since the initial decline in sign, catch rates as well as sign along Transect 11 have remained constant with several spikes being observed in both. These spikes appear to be associated with both the breeding season and the Kuaokalā Game Management Area (Unit A) Mokulē`ia Public Hunting Area (Unit E) hunting season with dogs. The breeding season appears to follow the usual winter-spring rainy season when water is more abundant. During the breeding season, in this dry-dry mesic type forest, pigs move into higher ground where females will construct somewhat elaborate nests. This pattern of movement brings them into direct contact with our snare groups. The hunting units A and C open in the beginning of August to the use of dogs. Due to the close proximity of the hunting areas to our MU this hunting pressure pushes the pigs directly into our snare lines and along Transect 11.

1.5.b `Ōhikilolo Management Unit

The habitat in and around the `Ōhikilolo MU was once home to large numbers of feral goats. Observations and personal communications with people familiar with the area indicate that many goats regularly used this area for feeding and bedding down. Feral pigs have not been detected and do not appear to pose a threat to this MU, due to the steepness of the terrain.

Goal:
The overall goal for the ungulate program in `Ōhikilolo MU is to eradicate goats.

Discussion:
In 2003, NRS installed a 450m fence around the Prikaa-A (*Pritchardia kaalae)* patch to eliminate the impacts feral ungulates have had on the Prikaa seedlings. This exclosure has

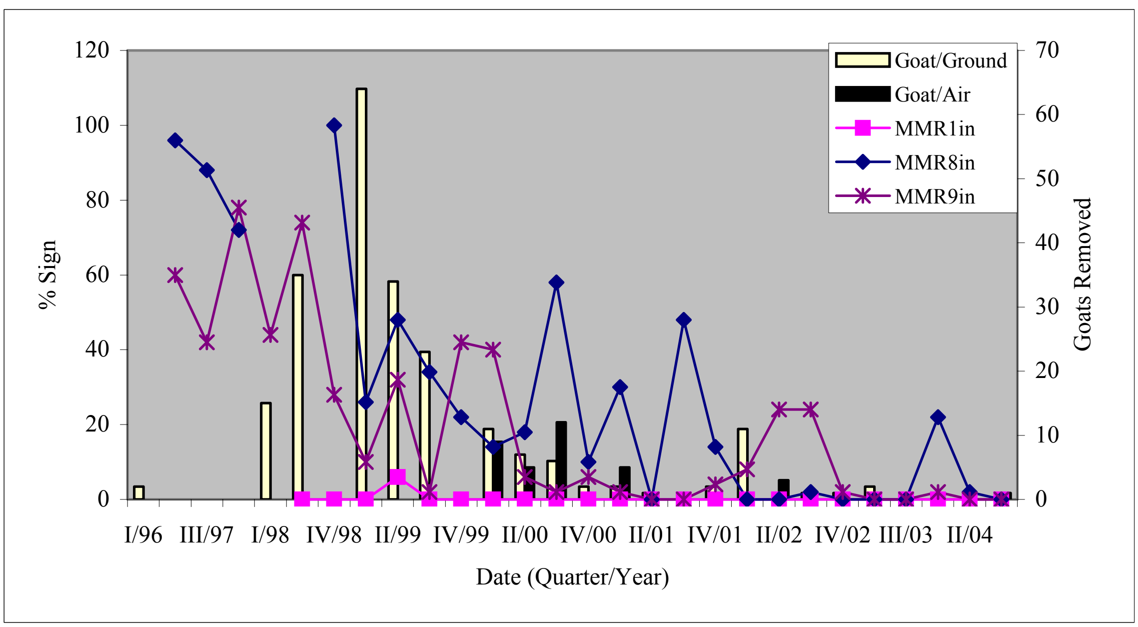
remained ungulate free and is checked on quarterly camping trips to the area. There is also a two-acre exclosure fence that surrounds a nice patch of forest that NRS monitors regularly.

As numbers dwindle and goats become more wary, fewer animals are being removed. NRS have had to make some changes in management tactics to remove the last remaining goats. Four new snare groups were installed in 2002, one in 2003 and one more in 2004 increasing the total number of groups being maintained along `Ōhikilolo ridge to twelve. These six new groups are centered around outplanting sites in order to protect new plantings from being uprooted or browsed upon. NRS also carry several snares along while hunting or scouting in case heavy sign is found.

Monitoring of ungulate activity in `Ōhikilolo MU occurs quarterly along three permanent ungulate transects (MMR01, MMR08, and MMR09). Goat censusing from helicopters has been discontinued due to the prohibitive cost and unreliable estimates of goat numbers. With such low goat densities, this method is not effective in Mākua.

Transect data (Figure 1-3) indicates a downward trend in ungulate activity. This is consistent with incidental observations as very few goats have been heard or seen in Mākua during any of the quarterly camping trips to `Ōhikilolo or Lower Mākua this year. NRS anticipate that ungulate sign will continue to drop as ungulate control continues. This is to be expected as goats become more wary and difficult to locate after intensive hunting. A breach in the fence occurred in late 2003 allowing at least three goats to cross over to Mākua from Mākaha Valley. These three goats were subsequently caught and no more sign has been observed in the area of the breach. NRS have been keeping a close eye on this area to ensure that no more goats are present. Ground hunting will continue until there is zero sign noted for one year.

Figure 1-3 `Ōhikilolo Ungulate Management



1.5.c Lower `Ōhikilolo

Goal:
The overall goal is to eliminate impacts from feral goats and pigs.

Discussion:
A strategic fence protecting an endangered population of *Lipochaeta tenuifolia was* finished in June 2002 and it appeared that no ungulates were trapped within the fence. Somehow goats breached the fence and one goat was removed from the Lower `Ōhikilolo fence during a hunt in 2002. Other goats were observed escaping at that time, three additional goats were removed from the Lower `Ōhikilolo fence during a hunt in June 2003. NRS completed the extension of the existing fence to cover the problem areas in October 2003 and have not had any breaches since.

1.5.d Kaluakauila Management Unit

Goal:
The overall goal in this MU is to eliminate impacts from feral pigs, as they are the only ungulate threat to Kaluakauila.

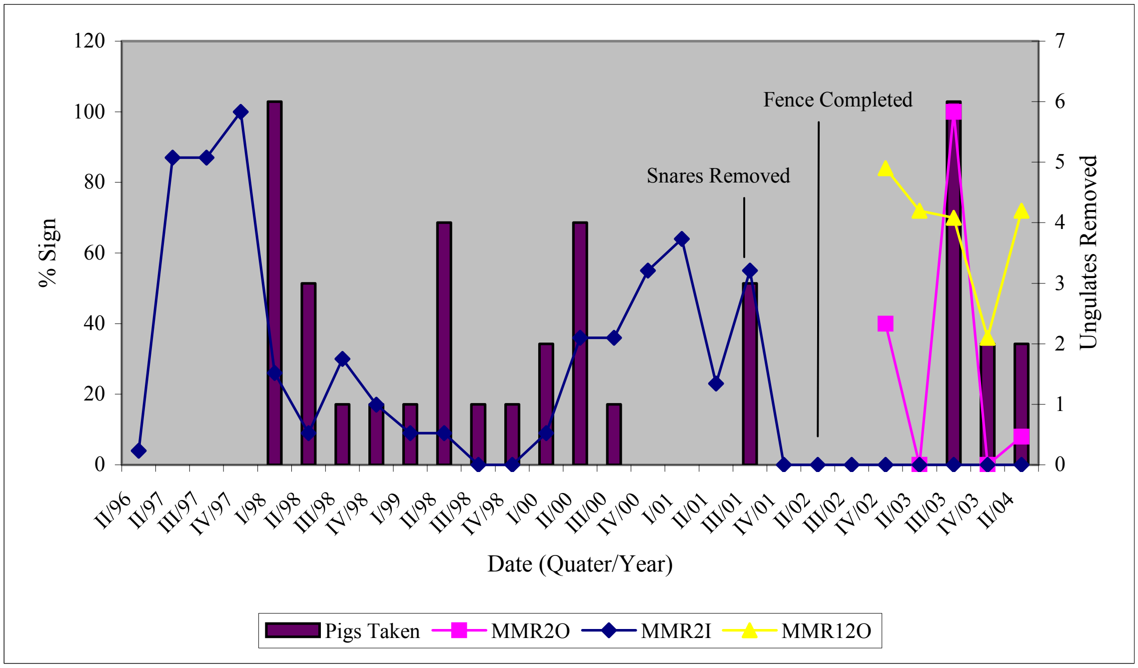
Discussion:
Monitoring for ungulate activity takes place quarterly along two permanent ungulate transect (MMR 2 and MMR 12) within Kaluakauila MU (Figure 1-4). Data is collected on sign both inside and out and is denoted as in and out respectively. Any incidental observations are also documented. There does not appear to be any correlation between pig activity and removal.

In June 2002, the Kaluakauila MU fence was completed, encompassing roughly 110 acres of dry native forest. Presently, the exclosure is pig-free. In all likelihood any feral pigs stuck inside will not survive for long, as there is no water source in the exclosure.

In November 2002 controlled hunts using dogs and volunteer hunters were conducted on four consecutive Fridays to keep heavy pig pressure off the fence. There were six pigs taken during these hunts. In 2004, NRS conducted a few more hunts around the fence perimeter removing four pigs. Three more pigs were removed with snares from this area thereby helping to keep pressure off of the fence.

The public hunting season was reopened in 2003, allowing hunters access back into this area. Unfortunately, due to fires last year in MMR, Kuaokalā Game Management Area, Wai`anae Kai, Mākaha, and Mokulē`ia the State chose to close all public hunting areas in the Wai`anaes again shutting off hunting to these areas. As a result practically the entire Dog Hunting season was lost. Fortunately, the hunting season has been opened for Units A and E in 2004.

Figure 1-4 Kaluakauila Ungulate Management



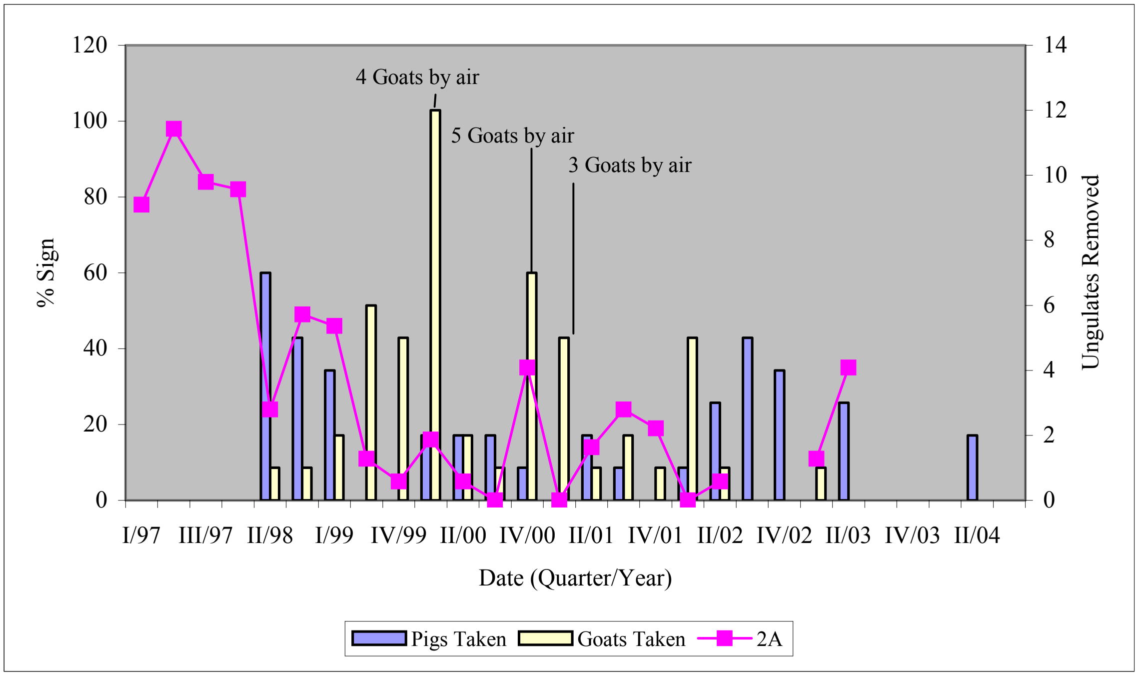
In March 2004, damage caused by falling rocks allowed pigs to breach the exclosure fence. Subsequent survey missions into the fenced area and fence perimeter have shown no signs of any pigs still caught in the fenced area after repairs were made. NRS have continued to closely monitor this area to see if any pigs may have gone undetected. NRS will try to schedule monthly monitoring trips to assess fence integrity and ungulate activity in the gulch area of this MU and hunt, repair fence as neccessary. Due to the numerous rock slides in the gulch bottom that has damaged the fence in the past, NRS will construct a deflection fence above the existing fence using stock panels which are more solid and a lot stronger than the current hog wire fencing material. NRS believes this will greatly reduce the amount of damage to the existing fence caused by rockslides.

1.5.e East Rim Ungulate Control Area

Goal:
The overall goal is to reduce impacts from feral pigs in and around biologically sensitive areas, and eradicate goats in MMR.

Discussion:
Monitoring for ungulate activity within the East Rim UCA takes place along one permanent ungulate transect (MMR02A). Due to the thick vegetation, aerial and ground hunting in this area is difficult, so most control within the UCA is done primarily with snares. There are three snare groups within the UCA. There are also two groups immediately to the west of the UCA, and another two to the southwest of it.

Figure 1-5 East Rim Ungulate Management



NRS began ungulate control in January 1998, and since then there has been a decrease in ungulate sign along transect (MMR02A) (Figure 1-5). Catch rates and ungulate activity remain low but constant with spikes of activity being observed (Figure 1-5), which is consistent with the goals of the UCA. In 2003, NRS conducted several ground surveys before and after the fire to see if any goat sign was present within this MU. If any goat sign were present, NRS would then install "spot-snares" to catch the remaining goats. No sign was observed during any of the surveys and NRS feel that the last few remaining goats in this area may have been removed. NRS will continue to monitor, survey and conduct control as needed until goat numbers are down to zero or there is no ungulate sign/activity for at least one year.

1.5.f Lower Mākua Management Unit

Because of access restrictions in areas with UXO, management of ungulates in Lower Mākua MU has been severely limited. In August 2000, NRS were granted permission to camp in Mākua Valley. This allowed NRS to expand ungulate management efforts in this unit. But due to restrictions put on NRS in 2003, camping in Lower Mākua has been stopped until further notice.

Goal:
The overall goal for the ungulate program in the Lower Mākua MU is to eradicate goats from MMR and to reduce feral pigs in and around significant biological resources.

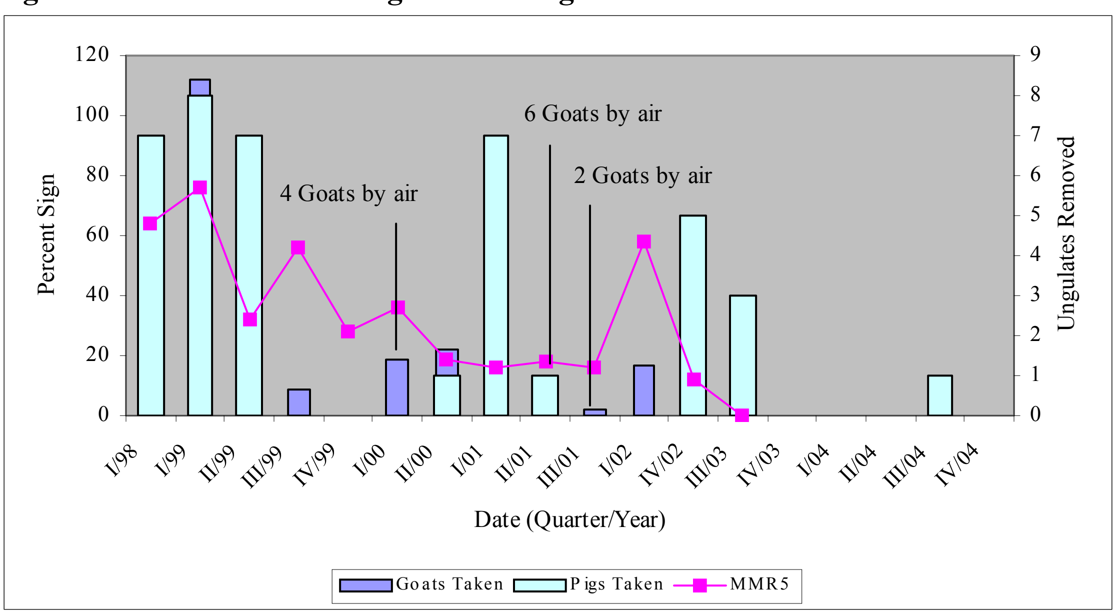
Discussion:
Presently, there is one ungulate monitoring transect (MMR05) read quarterly to assess ungulate activity in this MU.

Ungulate control programs involving Wildlife Services, staff hunters and snares are on going. Four aerial hunts were conducted in 2003, netting two goats. In addition, Wildlife Services conducted ground hunts once a month in and around this unit. In 2001, NRS installed two snare groups within the MU, netting a total of six goats and two pigs. Since that time, someone illegally accessing the area pulled one group. In 2002, two new snare groups were installed in the back of the valley, just above the MU. These two groups netted four goats and two pigs.

While most ungulate control efforts have focused on goats, NRS have been discussing strategies for managing pigs on the valley floor.

Transect (MMR05) has not been read since July 2003 but previous transect data indicates that ungulate activity declined remarkably since control was first initiated, up until the first quarter of 2002 (Figure 1-6). The subsequent spike may be the result of pig activity rather than goat activity. All of the sign recorded on the transect were old hoof tracks. It can be very hard to distinguish between old goat and pig tracks especially without any scat to provide supplementary confirmation. Figure 1-6 also indicates that there is a corresponding decline (in relation to ungulate activity) in the number of ungulates being removed. This is to be expected as there are fewer goats to be snared and those that are left become more wary and difficult to track after intensive hunting. Currently, the snares are set for goats, rather than pigs. Thus goats are being controlled more than pigs; pigs are much shorter than goats and it is not always possible to set a snare to catch both animals around the neck. Therefore, pig numbers are not reflected in the corresponding catch decline. Ground hunting will continue until no goats are removed for a period of one year. NRS and Wildlife Services personnel have noticed sign to indicate that hunters are accessing this area on foot. Hunting dogs have been seen and/or heard during trips into the area. Aerial hunts will continue for now but at less frequent intervals. The new contract requirements for Wildlife Services will be the same for this MU as is for `Ōhikilolo MU and East Rim UCA.

Figure 1-6 Lower Mākua Ungulate Management



1.5.g C-Ridge Management Unit

Goal:
The overall goal is to reduce impacts from feral pigs by reducing pig numbers in and around biologically sensitive areas and eradicating any goats that may be present.

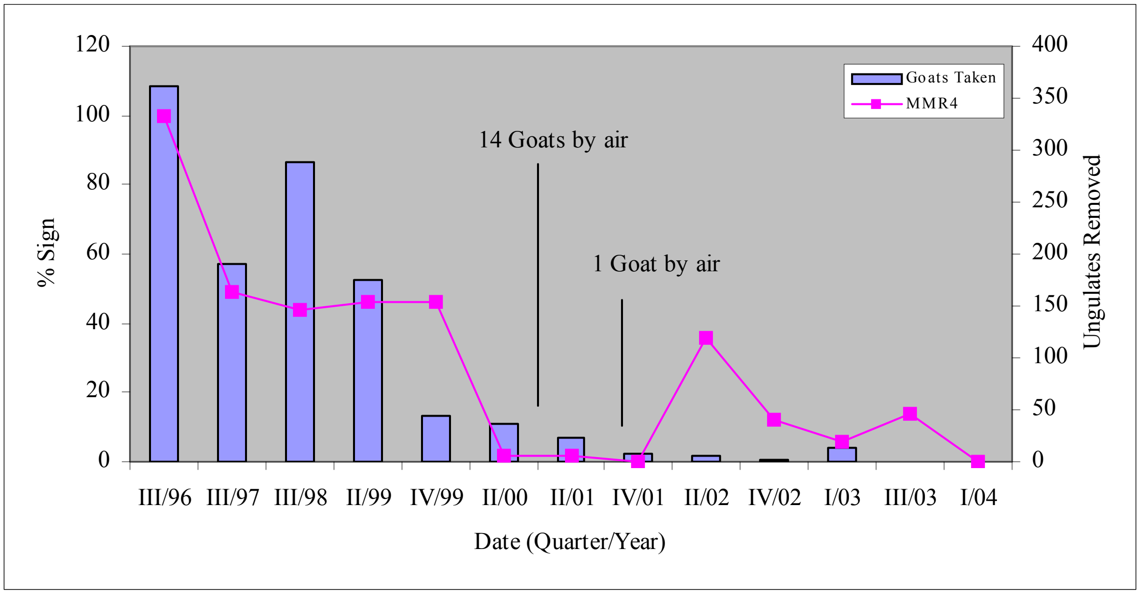
Discussion:
Rough terrain and the presence of UXO restrict access to C-Ridge MU. Active resource management is minimal in this unit as NRS only visit C-ridge twice per year. Monitoring and control are done along one transect above the MU and in several snare groups located in close proximity at Kahanahāiki MU. Aerial hunting and snaring have removed goats from areas adjacent to the MU.

1.5.h Ko`iahi Ungulate Control Area

Goal:
The overall goal for Ko`iahi is to eradicate goats from the area and reduce feral pig impacts around rare plant populations.

Discussion:
Presently, there is one ungulate monitoring transect (MMR04) used to assess ungulate activity in this MU. Goat control programs involving Wildlife Services are ongoing. There were seven aerial hunts conducted in 2002, one in 2003, and there was one aerial hunt conducted in mid August of 2004. In addition, Wildlife Services conducts ground hunts in this unit. Intensive pig control has not been deemed necessary in this area because of the lack of regular pig sign. Figure 1-7 indicates a steady drop in ungulate activity until the second quarter of 2002. This decline corresponds to control effort. The spike in activity in 2002 is most likely the result of a feral pig walking through the area and not a goat. No goats have been seen or heard in this portion of the valley by contract hunters or NRS for more than a year.

Figure 1-7 Ko`iahi Ungulate Management



1.6 Schofield Barracks Military Reservation

1.6.a Schofield Barracks West Range

Management of recources in SBW has been severely limited due to the need for unexploded ordinance escorts (UXO) and the current use of live fire training areas. In 2000 permission was granted to access all areas in SBW outside the perimeter firebreak road. These previously off-limits areas constitute the bulk of the forested lands within the training area. In addition, permission to use high-powered rifles for ungulate control was granted. Ungulate monitoring has taken place along one transect located on the summit of Mt. Ka`ala (Ka`ala MU), which is outside the UXO high-hazard area.

NRS have been controlling ungulates in SBW on a limited basis for several years. Most of the control work has focused on a population of goats that appears to be incipient in Schofield Barracks. A total of 78 goats and seven pigs have been removed since the intensive snaring effort was initiated in the Kamaohanui area. Wildlife Services was also contracted to eradicate this population of feral goats, which inhabit SBW. To date, their efforts have removed 106 goats and five pigs. The 2003-2004 contract did not call for any hunts to be conducted in SBW. Rather efforts were focused on adjacent state land, which seems to be the source of the goat population resulting in a marked decline of goats in SBW.

One small fenced exclosure and one strategic fence were built in 2004 in SBW. In April 2004, a 25-meter strategic fence was constructed above a single *Schiedea kaalae* in north Mohiākea gulch. In July 2004, an 86-meter circumference fence was constructed around a single *Stenogyne kanehoana* in south Hale`au`au gulch. Both of these fences protect just a tiny area around the endangered plants. At this time NRS are unable to do any big management projects due to the infrequent availability of the range. NRS will pursue construction of a large fence in the next year. Additionally, there is also a *Gardenia mannii* fence planned in Hale`au`au and the fenceline has already been scoped and cleared.

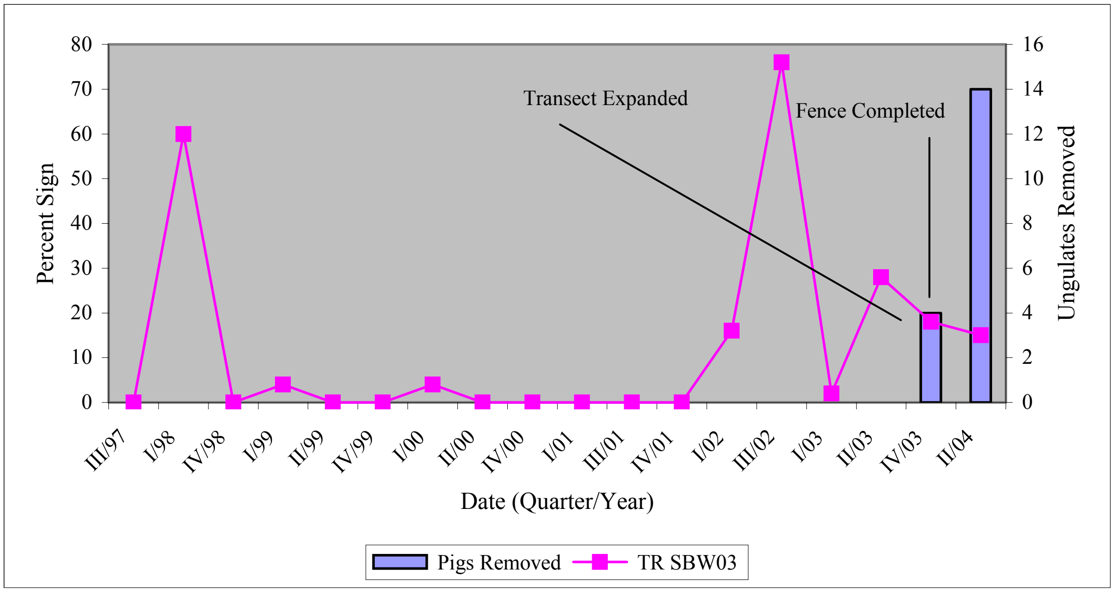
1.6.b Ka`ala Management Unit

Goal:
The goal within this MU is to eradicate ungulates from the summit region to protect the relatively intact forest located within the bog and protect rare and endangered species.

Discussion:
The one ungulate transect (SBW03) located in this MU was recently lengthened from 250m to 1,540m and is read quarterly. Concern has been expressed about incidental observations of pig sign in the area around the MU. Presently, a fence encircles one half of the bog area that is controlled by DLNR and two strategic fences on the SBW side of the bog controlled by NRS. In its current condition, the fence offers some protection from encroachment by ungulates from the SBW side but not the Lualualei, or Wai`anae sides. NRS completed the construction of two strategic fences on the Kama`ohanui and Hale`au`au sections of the summit to prevent pig ingress into the bog from these areas in November 2003. Once the fences were completed there was a spike in pig activity and sightings in the area, possibly due to the pigs usual ingress/egress points being blocked off. Upon further inspection, it was found that the pigs were also accessing the summit through a couple of other areas that the group thought were inaccessible. Due to these new findings, NRS is in the process of scoping, clearing and constructing more strategic fences to block off these areas as well hopefully stopping ungulate ingress to the summit.

In 2002, NRS and DLNR noticed an increase in pig activity. Snares were placed within the bog, netting two pigs. NRS found that snared pigs dig up large areas of forest, so this control method is not optimal for use in the Ka`ala bog due to the very soft soil. In February 2003, the snares were pulled and controlled hunts with dogs and volunteer hunters took place. Four hunts yielded four pigs. In the first two quarters of 2004 a total of seven hunts using dogs and volunteer hunters were conducted which yielded a total of fourteen pigs. These hunts were very successful due to good communication between NRS staff and volunteer hunters, and the availability of volunteer hunters to assist NRS. Because of this, the goals for this MU were met as shown in (Figure 1-8) below. Ungulate activity dropped to just about zero after these hunts took place. Controlled hunts will be scheduled in the future as the need arises. Although goat populations occur nearby, habitat within this MU may be unsuitable for goats and none have been detected in this MU. If ungulate activity levels increase dramatically around the area or if goat activity is detected inside the MU, NRS will conduct animal control. Personnel shall continue to monitor the situation and respond accordingly. There is a small population of goats that are relatively close to the summit of Ka`ala in the Wai`anae Kai Watershed Management Area. This area comes under the direction of DLNR, which plans to eliminate the herd by aerial hunting. At this writing, no word was received on the Wai`anae Kai goat population situation.

Figure 1-8 Ka`ala Ungulate Management



1.6.c Schofield Barracks South Range

Goal:
The goal within this MU is to keep feral pigs from threatening rare and endangered resources.

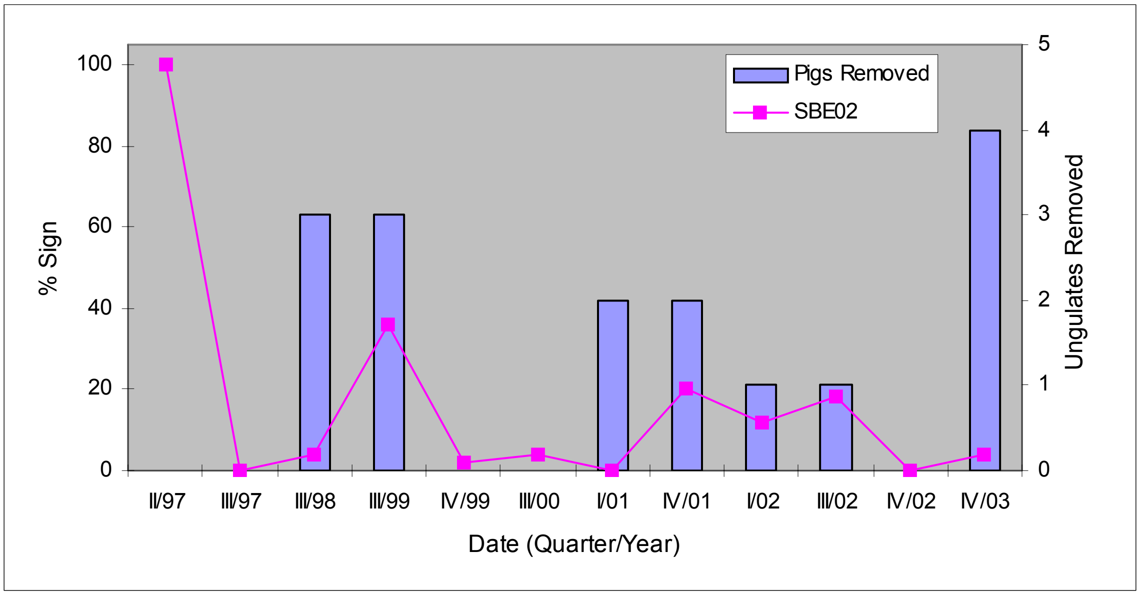
Discussion:
Resource management is limited in SBS. Most of the areas within SBS consist of heavily disturbed and altered forest. As a result, all of the management conducted by NRS in SBS focuses on single rare or endangered species and their associated habitat. At present, NRS are not monitoring any ungulate transects within SBS. Any ungulate activity observed during routine visits to the area is noted. Feral goat activity has not been observed and no goats are known from the area. In October 2003, NRS completed the construction of a fence to exclude any ungulates from a patch of `ie`ie (*Freycinetia arborea)*. This fence surrounds just over one acre and harbors two species of native land snails that are listed as a Species of Concern (SOC) by the USFWS. This is discussed in detail in the snail chapter.

NRS do not conduct any ungulate control in SBS, however this may change. NRS have contacted the federal Game Warden on Schofield and he stated that the recreational hunting program has just started back up. Due to the limited resources they have, only Schofield Barracks South Range (SBS) and Schofield Barracks East Range (SBE) are open to hunting at this time. NRS hopes to meet with the Game Warden soon to discuss opening other areas, as well as going over the rules and regulations that are in place to see if issues regarding ungulate management in these and other areas can be worked out to the benefit of the resources.

1.6.d Schofield-Waikāne Management Unit

Goal:
The goal within the Schofield-Waikāne MU is to reduce feral pigs impacts in areas that are actively managed by NRS.

Figure 1-9 Schofield-Waikāne Ungulate Management



Discussion:
This MU has one monitoring transect (SBE02) which is read twice per year (Figure 1-9). NRS do not expect ungulate activity to correlate with ungulate control as no large-scale ungulate control has been conducted. Also, transect (SBE02) has been read infrequently due to difficult weather conditions in the MU. Due to flying restrictions in 2003 and 2004 the ungulate transect was read only once. Presently, ungulate control takes place in and around areas that are being actively managed for rare species protection. Large-scale fencing projects are difficult due to the steepness of the terrain and close proximity to frequently used recreational trails. It may be possible to erect small-scale fences around biologically sensitive areas or rare plant populations. Since March 1998, two snare groups in the MU have removed 16 pigs. Figure 1-9 shows that with the given control efforts pig activity can be kept to a minimum in areas needing protection. The topography of the region lends itself to this type of management effort. Because there appear to be no resident pig populations in the MU, ungulate management is not expected to change until NRS have identified resources critically in need of increased protection (fencing, shooting, additional snaring, etc.). NRS will meet with the Federal Game Warden to see if we can facilitate hunting in this area. Currently recreational hunters cannot access military ranges with personal vehicles thus limiting the amount of control public hunters can provide. NRS will determine if it is possible to escort them onto the ranges to conduct feral ungulate hunts.

1.7 Kawailoa Training Area

Kamehameha Schools (KS), the State of Hawai`i, Dole Foods, and Attractions Hawai`i lease Kawailoa Training Area to the Army. In past years, NRS has worked on cooperative fencing projects with KS and other land managing agencies. One project enclosed Lehua Maka Noe Bog and is described in the 1999 PCSU report. In 2001, another jointly funded exclosure, encompassing roughly 150 acres, in Upper Pe`ahinā i`a was completed and is discussed in the 2000 PCSU report. In addition to these fencing projects, the Army has demonstrated its commitment to Ko`olau natural resource protection by participating in the Ko`olau Watershed Partnership. To address the impact of feral pigs in the lower elevations of Kawailoa, NRS held meetings with other members of the Ko`olau Mountains Watershed Partnership (KMWP) which proposed hiring a coordinator to facilitate public hunting in this area. This position will be funded and NRS will facilitate hunter access into this area. NRS hope that this partnership will help build support for increased ungulate control and ecosystem management within the MU, as well as throughout the entire Ko`olau Mountain range. NRS hope that this pilot project can be expanded into other lands controlled by KMWP partners as a means of protecting the watershed.

1.7.a Poamoho Management Unit

Goal:
The overall goal in this MU is to exclude feral pigs from biologically sensitive areas.

Discussion:
Presently, no ungulate control or monitoring is being conducted by NRS in the Poamoho MU. Because this unit is in close proximity to a very popular hiking trail and a public hunting area, NRS limited management in the past to rare species monitoring and weed control. Monitoring for pig sign is conducted during on-going management projects. Ungulate control and monitoring will be implemented, with the State's permission, if NRS determine that resources are in need of protection from ungulates.

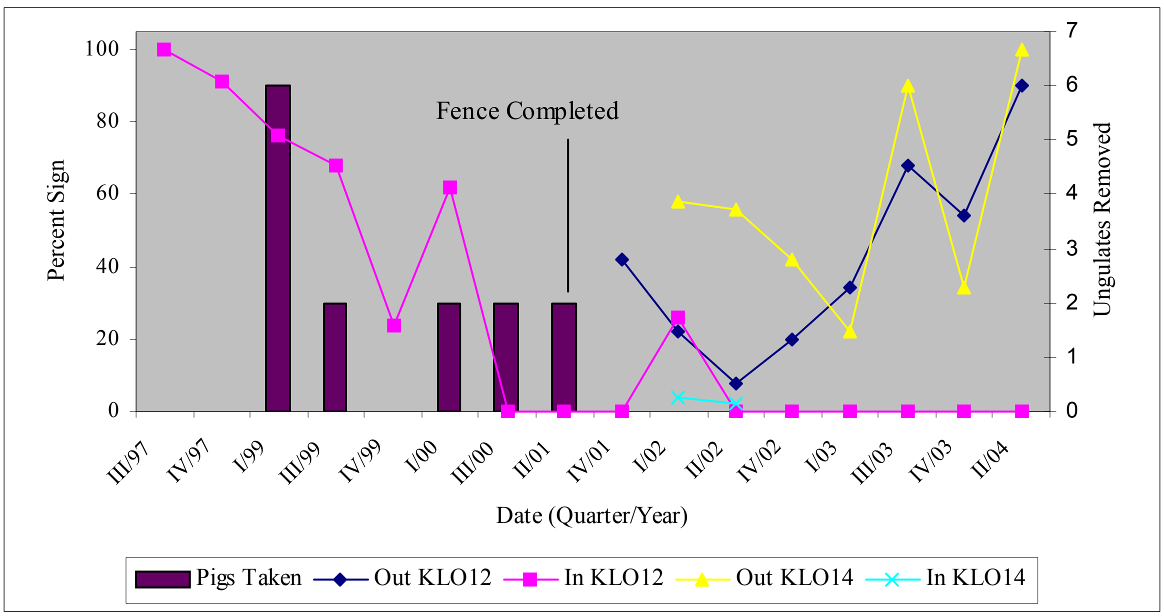
Presently, the only mechanism for ungulate control is the Division of Forestry and Wildlife's public hunting program, which is administered by the State of Hawai`i's DLNR. Portions of the Poamoho MU are located in Unit "C" of the Ewa Forest Reserve where bag limits allow for one pig of either sex to be taken per day. Unit "C" allows for year-round hunting on weekends and State holidays. The State of Hawai`i is responsible for making all management decisions in the area between the Poamoho and Schofield-Waikāne trails. Presently, Dole restricts access to the Poamoho trail due to the increase of vandalism on farming equipment and product theft. This restriction has totally closed off access to the hunting area yet some hunters still access this hunting area through various ways. NRS support DLNR 's effort to work with Dole to reopen the access to the hunting unit. NRS is also working in conjunction with the Pig Hunters Association of Oahu (PHAO) on this. Efforts to regain public access to this area are still ongoing. Just recently, the state received monies to help improve hunter access. Hopefully, this will allow the state to fund a project that would provide hunter access back into this area.

1.7.b Upper Pe`ahināi`a Management Unit

Goal:
The overall goal in this MU is to exclude feral pigs from biologically sensitive areas.

Discussion:
Monitoring of feral ungulates takes place along two permanent ungulate transects (KLOA12) and (KLOA14) which are monitored twice per year. Due to bad weather and helicopter flight restrictions, NRS trips were delayed this past year. In May 2004, the two transects were read and there was 100% sign along the two transects. Another trip conducted in July 2004, also saw a lot of pig damage surrounding the fenced area and heavy use along the fence itself. It now appears that the pigs are using the fence as trails, probably due to the fact that their normal trails were blocked off when the fence was completed. NRS have discussed the possibility of using volunteer hunters with dogs in the area as needed to help alleviate the damage to biologically sensitive areas caused by pig rooting. There needs to be a lot more discussion on this before we can implement this management tool. Other methods are also being discussed at this time to best address the situation.

Figure 1-10 Upper Pe`ahināi`a Ungulate Management



Transect data shows that there are no ungulates within the fence at this time (Figure 1-10). Transect KLOA12 is now read both inside and outside of the fence in order to have a comparison and to keep abreast of any breach. Pigs have breached the fence at stream crossings in the past. NRS recently worked on the stream crossing areas in an attempt to make them more ungulate proof. More fencing was put in place along the edge of the hypo-lon material to help it settle better in the stream after high water flooding which typically occurs after a period of hard rain. NRS would like to monitor the fence as much as reasonably possible but due to the inclement weather usually associated with the Ko`olaus, NRS knows this could be a challenge.

Opaeula Watershed Partnership Program (OWPP) is considering cooperatively funding another ungulate exclosure in the area. The Helemano drainage was selected for the site of the next fenced area. A route has been flagged, contractors have seen the proposed area and have submitted their bids for the project. NRS is in the process of finalizing and awarding the project to the winning bidder hopefully work will begin shortly. About half of the fence line has been cleared and finalized by NRS crews. The rest of the line still needs to be cleared and finalized. Hopefully that will happen this year. Unfortunately, a lawsuit against the State delayed the start of this fencing project. This delay appears to be settled and NRS expect to complete this project by the year's end. NRS plans to remove pigs from the proposed Helemano fence by combining hunting efforts during and after completion of the fence. Snaring would not be used unless NRS feels there is no better alternative to removing pigs from the area and hunting has failed to remove any pigs left within the fence.

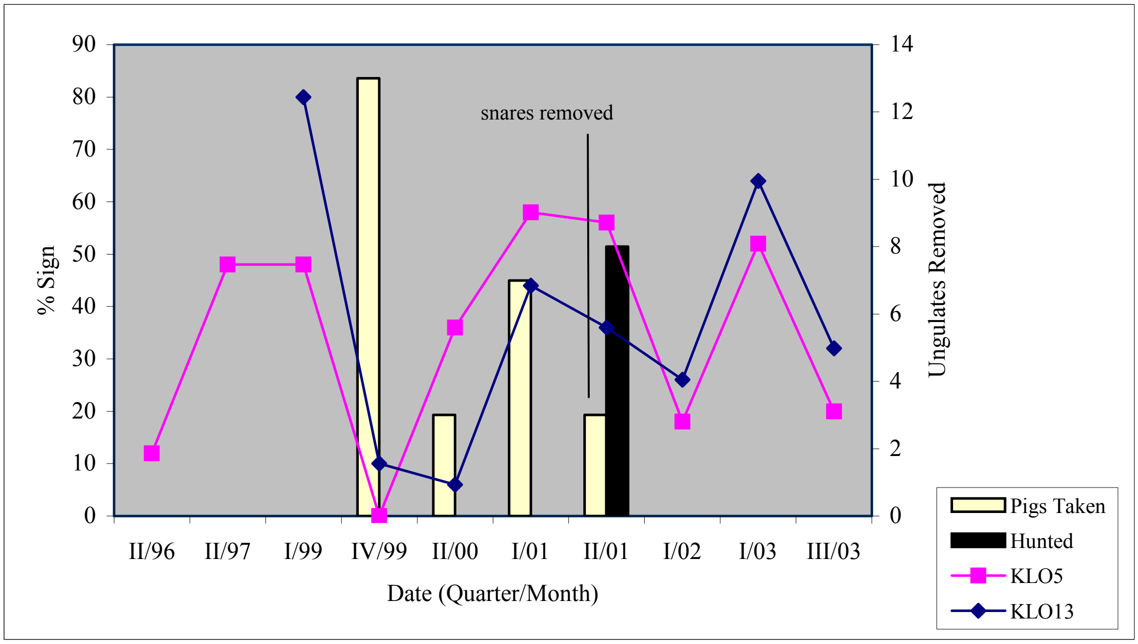
1.7.c Lower Pe`ahināi`a Management Unit

Goal:
The overall goal in this MU is to exclude feral pigs from biologically sensitive areas.

Discussion:
Ungulate management takes place only in and around areas where NRS actively conduct rare species and non-native plant management. Lower Pe`ahināi`a is a difficult place to conduct animal control and monitoring. The terrain is steep and densely vegetated which limits the areas where NRS can effectively hunt and set snares. In addition, with the lack of fences and minimal hunting pressure in the surrounding area, there is continual ingress of pigs.

This is further discussed in the 2003 PCSU Report. NRS are currently in negotiations with KS over utilizing public hunters who have proper liability insurance coverage as a way of managing pig populations in this area. NRS feel it would also be advantageous to erect strategic fences in order to stop major pig movements and protect the ridgetops and pu`u's in the area. Funding for the Lower Pe`ahinai`a fence is earmarked but an Environmental Assessment must be completed before beginning construction. Pigs may have a negative effect on weeding due to soil disturbance mainly through digging/rooting that triggers weed seed germination. NRS have set up a couple of weed plots to look at affects of weed control and possible interactions between ungulates and weed control efforts. Refer to Section 2.9.c of the Weed Chapter for more information on this. No amount of control is going to be successful at completely keeping pigs out of the area until exclosure fences are erected.

Figure 1-11 Lower Pe`ahināi`a Ungulate Management



1.7.d Castle Management Unit

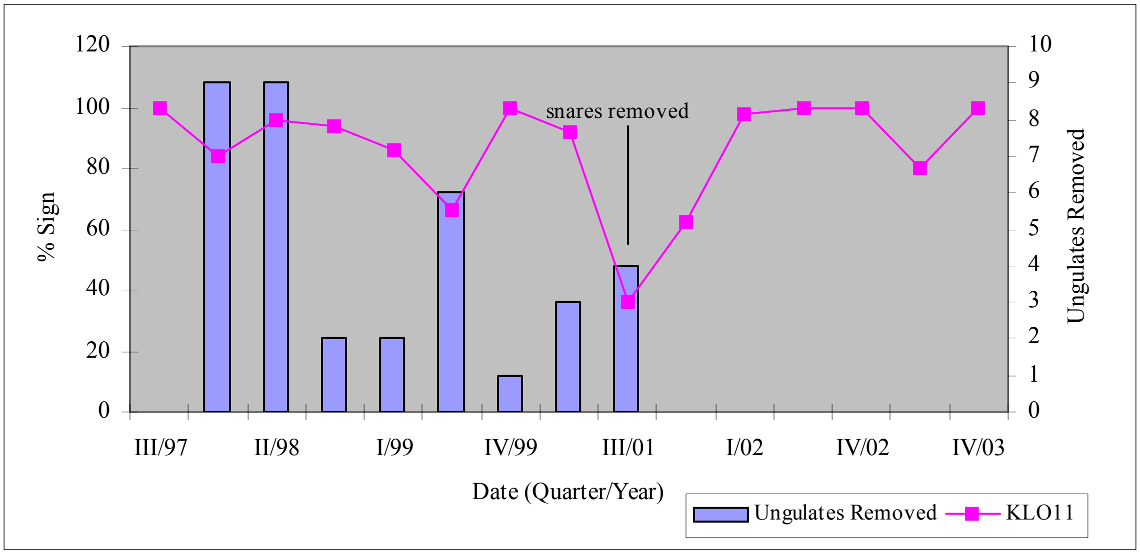
Goal:
The overall goal in this MU is to exclude feral pigs from biologically sensitive areas.

Discussion:
Monitoring for feral ungulates takes place along one permanent ungulate transect (KLO11), which is monitored twice per year.

In November 1998, NRS completed fencing Lehua Maka Noe Bog near the Ko`olau Summit/Castle Trail junction. Approximately one acre in size, Lehua Maka Noe Bog is an example of an extremely rare habitat type on O`ahu. It contains many rare species, as well as three endangered species. This project was a cooperative effort between the Army and KS. The fenced unit is monitored twice per year and remains pig free. Informational signs were installed this year explaining the purpose of the fence and importance of the area.

Data from the transect does not reflect any profound changes in ungulate activity in response to ungulate control (Figure 1-12). Ungulate activity appears to fluctuate in this area. It could be that the pigs are moving in response to food availability. In response to the lack of any profound changes in ungulate activity or catch rates, NRS removed the two snare groups in 2000. The lack of productivity of these groups did not warrant the effort required in maintaining them or the degradation of the native forest (snared pigs digging up area). It seemed that these groups were acting as an ungulate "sink" for the area as a whole without actively reducing overall numbers. Without a fence to effectively exclude pigs from the area, any ungulate management actions imposed would be unproductive. NRS hopes to work with Ko`olau Watershed Partnership members to possibly open access to this area to allow hunting.

Figure 1-12 Castle Ungulate Management



1.7.e Kahuku Cabin Management Unit

Goal:
The overall goal in this MU is to reduce feral pig impacts to rare and endangered species by reducing pig numbers as the need arises.

Discussion:
Resource management in this unit is centered on rare plant and snail species. Ungulate transects KLO01, KLO02 and KLO10 were removed in 2000 as no ungulate control or intensive rare plant management actions are taking place in these areas. Incidental observations of pig activity are made when NRS conduct quarterly fieldwork. One snare group had been established in this management unit. Five pigs were snared. However, the snare group has been removed because it was in a very remote area and has not been particularly productive. NRS may consider fencing portions of this area since it contains a high density of rare species and has topography that is relatively easy to fence. Hawai`i Reserves, Inc., the management company for the Church of Jesus Christ of Later Day Saints, has been contacted. They accompanied NRS on a trip to Kahuku Cabin in 2001. The representatives seemed very receptive to the work being done and to the potential for large fencing projects in the future. NRS will continue to work with the representatives from Hawai`i Reserves, Inc. to encourage fencing projects and hunter access to this area to meet the overall goals for this MU in the future.

1.8 Kahuku Training Area

Goal:
The overall goal in this MU is to exclude feral pigs from biologically sensitive areas.

Discussion:
Management in KTA is centered around rare species populations. Presently, there are no ungulate monitoring transects in KTA. Ungulate sign and specific threats are noted whenever they are observed.

In 2003, NRS identified a patch of diverse native forest as a possible MU. NRS are still in the process of surveying KTA but plan to erect three small-scale fences around populations of *Eugenia koolauensis*.

Currently, the only mechanism underway for ungulate control is the Division of Forestry and Wildlife's public hunting program, which is administered by the State of Hawai`i's DLNR. Portions of KTA are in close proximity to Unit C in the Pūpūkea Paumalū Forest Reserve where bag limits allow for one pig of either sex to be taken per day. Hunting in Unit C is permissible on weekends and State holidays year-round. NRS support other areas of KTA being opened for public hunting. NRS will look into the Army's recreational hunting program, which would allow hunting in certain areas in KTA. NRS staff hunts are also a possibility if the need arises.

1.9 Dillingham Military Reservation

Resource management in DMR occurs only around rare species and in relatively intact stands of lonomea (*Sapindus oahuensis*) forest. Although pig sign has been observed, feral ungulates have not been identified as a major threat to resources within DMR. The native environment has been seriously altered through previous human use of the area and the invasion of weedy plant species. Most of the remaining native resources occur on rock talus or steep slopes, which are inaccessible to pigs. There are no permanent ungulate transects in DMR. Monitoring is limited to incidental observations of pig activity. NRS regularly observe ungulate sign in the area. Surveys earlier this year noted increased pig sign along a small stream that borders an area of native forest. Staff and volunteer hunters will most likely be used to address this problem in the future.

1.10 Offsite Ungulate Control Areas

Goal:
The overall goal for all of the offsite management areas is to reduce impacts from feral pigs in and around rare plant populations. As the need arises, lethal ungulate control measures will be administered around the rare plant species that are being impacted but non-lethal techniques will predominantly be used. This will be accomplished by erecting small fences around populations until large-scale fences can be erected.

1.10.a State of Hawai`i Department of Land and Natural Resources Lands

1.10.a.1 West Makaleha

NRS, in cooperation with DLNR, initiated pig control in an area within Mokulē`ia Forest Reserve exhibiting extremely high pig activity and damage. This area is on State land, just outside the southeast rim of Mākua Valley in West Makaleha and is referred to as Three Points. The damage in 2000 was amongst the worst ever observed in a natural area by NRS. Huge areas were rooted and devoid of any ground cover. Aggressive weedy species, including *Rubus argutus* (blackberry) and *Melinis minutiflora* (molasses grass) were quickly becoming established. In addition, the Mākua Rim fence was being undermined in many places and it was necessary to reinforce it with horizontal fence aprons. It was speculated that this high level of localized activity could be due, in part, to the fences that NRS have erected around Mākua Valley. The fences may have funneled animals into the area or changed pig movement and distribution patterns. Other possible reasons include the flat topography of the area in comparison to surrounding areas. Pig control was begun shortly after the discovery of a new population of *Cyanea grimesiana* ssp. *obatae*. This population and another of *Alsinidendron obovatum*, both extremely rare species, were in close proximity to the heavily damaged area. In January 2000, DLNR and NRS installed snare groups throughout the Three Points area. Pig catches were among the highest observed from any area where NRS conducts animal control. A total of 44 pigs were removed before October 2000, when all the snares were removed in preparation for the installation of the fenced exclosure. In April 2001, reconnaissance of the fence line began, and by July, approximately six acres of forest encompassing the *C. grimesiana* ssp. *obatae* were fenced. A large-scale exclosure may be constructed in the near future that will protect the *Alsinidendron obovatum* and provide more habitat for restoration and reintroduction.

NRS will work with DLNR to coordinate access to areas that are bounded by private landowners. Since the opening of the Mokule`ia Forest Reserve hunting area, hunters have been accessing this area through the Mokule`ia trail, and as of September 2003, 15 catches have been reported from this area. NRS will continue to work with the hunting community to get catch reports from this area.

In February 2004, another fence was constructed in West Makaleha. This new exclosure encompasses roughly one acre and adjoins the proposed Kapuna gulch fence. This fence protects 73 individuals of a recently discovered population of *Alsinidendron obovatum.*

1.10.a.2 Lower Ka`ala Natural Area Reserve

NRS contracted WS to participate in multi agency hunting operations for the 2004 fiscal year. The goal of these operations is to reduce goat numbers in Lower Ka`ala NAR, where the source of the goat population in SBW is located. Partners in this venture include NRS, DLNR, The Nature Conservancy of Hawai`i and numerous private volunteers. The 2003-2004 contract stipulated three hunts for the contract period. The first feral goat control effort initiated by NRS in Mt. Ka`ala Natural Area Reserve was conducted in June 2002. A total of 48 animals were removed over a two-day hunt. Another hunt was conducted in February 2003. A total of 19 animals were removed over the two-day effort. A two-day hunt in September 2003 removed 25 animals. Two two-day hunts in June and August 2004 netted 37 animals. One more hunt is slated for September 2004.

Presently, NRS is working out details with the State on how to proceed with a partnership to fence a portion of Ka`ala NAR. Once the Mākua Implementation Plan is signed and implementation begins, moneys will be made available for the construction of these much needed fences. In September 2000, a 50 m^2 diameter fence was constructed around a single *Cyanea grimesiana* subsp. *grimesiana* in Palikea gulch.

1.10.a.3 Pahole Natural Area Reserve

In December 1996, roughly 88ha of Pahole gulch was fenced, effectively protecting 15 endangered species from feral ungulates. In February 2004, two small fenced exclosures (350 m^2 and 150 m^2) were built to protect outplanted individuals of *Phyllostegia kaalaensis* in Keawapilau gulch. There are two more proposed large scale fences slated for both Keawapilau and Kapuna gulches.

1.10.b The Nature Conservancy of Hawai`i Honouliuli Preserve

1.10.b.1 `Ēkahanui Management Unit

Since 2001, roughly 25 ha of `Ēkahanui gulch has been fenced. In May 2004, four small fences were erected to protect two separate populations of two species of plants. The first two fences are 68 m^2 and 53 m^2 and protecting one single and a pair of *Schiedea kaalae* respectively. The second two fences are 40 m^2 and 144 m^2 and protecting one single and a trio of *Delissea subcordata* respectively. More large-scale fences are scheduled for construction.

1.10.b.2 Kalua`a Management Unit

Since 1999, roughly about 17 ha of Kalua`a gulch has been fenced. In May 2004, a small 25 $m^2$ fence was constructed around a single *Cyanea grimesiana* subsp. *obatae* along the stream bank of Kalua`a gulch.

1.10.b.3 Palikea Management Unit

Several small-scale fences were built in Palawai gulch in 2003-2004. In November 2003, three of the fences were erected around populations of two *Delissea subcordata*, seven *Hesperomannia arbuscula*, and one *Schiedea kaalae*. The sizes of the fences were 157 m^2, 421 m^2, and 14 m^2 respectively. In January 2004, a 1057 m^2 fence was constructed around another population of three *Delissea subcordata*.

1.10.c The Honolulu Board of Water Supply

1.10.c.1 Mākaha Management Unit

In an effort to protect a large portion of the 21 threatened and endangered species in Mākaha Valley a large-scale fence has been proposed. To date, the proposed fenceline has been scoped and will encompass roughly about 41 ha. The line has also been surveyed for any possible cultural resources. The whole proposal package has been submitted for an Environmental Assessment. NRS hope to start clearing the line and assign the contract for construction by the summer of 2005.

There are also four small-scale fences that have been proposed to be erected around three endangered plant species. Two of the fences will enclose separate populations of *Sanicula mariversa* on Kamaile`unu ridge. The two fences are 176 m^2 and 2025 m^2 respectively. The third proposed fence will encompass a population of *Hesperomannia arbuscula* and will be 400 m^2. The fourth proposed fence will encompass a population of *Cyanea longiflora* and will be 5625 m^2.

1.10.d Kualoa Ranch

In the fall of 2003 NRS with a Genetic Safety Net employee and a volunteer constructed a 241 m^2 fence around a population of two *Schiedea kaalae* in Maka`ua Gulch. This gulch is located on Kualoa Ranch and the officials there were gracious enough to give permission for this project.

CHAPTER 2 WEED MANAGEMENT

2.1 Introduction to 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 are therefore one of the primary focuses of all natural resource programs in Hawai`i. NRS have been conducting weed control on Army lands for nine years. Management objectives have been developed following a four-step approach: surveying, prioritizing, controlling, and monitoring. Using these four steps, NRS have tailored weed control efforts to individual sites. 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 Hawaii. This year, NRS maintained a high level of attention to the weed management program.

2.2 Weed Surveys

Surveys are conducted to assess, detect and prioritize weed problems across training areas. These surveys allow NRS to study their distribution and track their spread over time. In this way, NRS can respond to weeds dispersed by Army training.

NRS conduct road and landing zone surveys annually at locations that have a high potential for invasive introduction of weeds from military activities. NRS also conduct weed surveys along ungulate transects; ungulates are important alien species vectors. NRS use a Weed Survey Form (Appendix 2-H) for road surveys and keep updated weed lists for surveys on LZs and ungulate transects. Survey routes and results are presented within the discussion for each Training Area. In addition, incidental notes are taken of incipient or problematic weeds when they are observed anywhere on training areas during other field operations. New or unknown species are collected and sent to Bishop Museum for identification. For 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 individuals. These maps direct plant removal on the ground and greatly facilitate navigation to outlying targets.

2.3 Weed Prioritization

Weeds are widespread throughout Army training lands and therefore NRS must prioritize weed control projects to ensure the most efficient and effective use of time. Factors important in determining weed control prioritization include invasiveness, distribution (incipient/widespread), and proximity to native forest.

Weed species vary in level of invasiveness and potential to dominate native areas. These inherent traits are taken into account when NRS prioritize weed projects. NRS rely on the cumulative knowledge of the conservation community in Hawai`i to determine the invasiveness of species for which staff do not have personal experience. The species most successful at invading and dominating native ecosystems become the highest priorities for control.

Weeds are also classified as either incipient or widespread, based on abundance in a given area. Incipient weeds exist in a very small area and may not yet be established. These populations are high priorities because of their high potential for eradication. Widespread weeds are found in high densities in many areas and controlled only in areas where native forest is relatively intact.

The proximity of a weed to native forest is also used as a determinant in setting weed control project priorities. Incipient weeds in close proximity to intact native forest are a higher priority for control than those located far from intact forest. All of the above factors, as well as accessibility and available management tools, are used in combination to determine which weed control projects are worth tackling.

2.4 Weed Control

Weed control aims to eliminate, either in one or repeated treatments, target weed species from a native forest area. The primary approaches and techniques used in weed control are described in the following sections. Whenever possible, volunteer help is used. Weeding, as a general rule, requires a lot of labor. NRS hope to expand volunteer efforts in the future. In the past year, NRS have started to generate a list of projects appropriate for large groups of inexperienced volunteers; this will allow NRS to take advantage of last minute opportunities and to accommodate the limited schedules of such groups.

2.4.a. Weed Control Approaches

Since NRS work in different types of areas, a variety of approaches are taken to weed control. General approaches used by NRS include gradual restoration, active restoration, fenceline weeding, and firebreak construction. Evaluating weed composition and abundance, as well as location with respect to native plants, are also important considerations in assessing weed control projects.

Gradual (passive) restoration is the approach most often taken by NRS. Passive restoration involves sweeping through an area and removing no more than 20% of the alien canopy at a time. The key to passive weed control is slowly removing undesirable elements, while maintaining vital site characteristics, like light level, temperature, and humidity. Due to resource constraints, NRS focus efforts on predominantly native forest. This approach is well suited for predominantly native areas, since it is efficient in time and effort. In areas with 80% or greater native cover, NRS work to eliminate alien species with as few treatments as possible. In more mixed forests with about 60% native cover and larger numbers of aliens, no more than 20% of the canopy is removed or opened during a treatment. Removing canopy trees at a higher rate can change the light regime of the forest to a point where invasive understory species are favored. However, in some more open areas, such as Maile Flats in Kahanahāiki, it may be appropriate to remove more than 20% of the canopy, since the area is already adjusted to high light levels. The gradual approach is most useful for treating canopy weeds in areas sensitive to significant alterations in light regime. Unlike canopy weed control, understory weed control, whether or not the site is 80% native, is generally conducted to eliminate target weeds with a single treatment.

In the large patches of native forest, NRS control weeds by sweeping through the forest in phalanxes. Staff line up along the edge of the area to be weeded, and sweep across it in an – ideally – unbroken line, see Table 2-1. This method provides good, easily trackable coverage of large areas. It is effective in treating scattered weeds in large areas.

Table 2-1: Weed Sweep Guidelines

SWEEP GUIDELINES
►This method is easiest with groups of 5-7 people. This allows for good coverage, while reducing the number of sweeps. Smaller groups result in narrower swaths, more confusion, and duplication of effort on edges of neighboring swaths. Larger groups are much harder to keep in line.
►Stay in line, so coverage between sweepers is maintained. Go as fast as the slowest person.
►When lining up, keep sweepers close enough together to maintain visibility. In Maile flats there are many areas with low visibility and thick underbrush; sweepers should be only a few meters apart.
►Always start on one end of a quadrant (not in the middle).
►Use the trails as guides.
►Always use compasses, and always sweep on east/west bearing (or its converse, north/south bearing). The trails and fence run roughly north/south and east/west; following these bearings insures that workers are always parallel to a trail or fence.
►Use hip chain and/or white flagging to denote 'new' edge of swath, so it can be easily followed on next sweep. Never use pink/orange/blue flagging, which could be confused with a trail.
►Use GPS track to record coverage, and GPS the corners of the weeding swath.
►Useful tools: handsaw, clippers, hatchet. Loppers, machete unwieldy while hiking.
►Fill out a WCEF and make a readable map so the next group can efficiently cover new areas.
►Once a quadrant has been completely swept, next set of sweeps in that quadrant should be perpendicular to the previous sweep. For example, NRS have swept the entire SW corner on an east/west bearing. The next time this quadrant is treated, it should be swept on a north/south bearing.
►Weeds tend to be thickest along the fenceline. Either allow extra time to treat this area, or note it on a WCEF and leave it for another crew.
►Map particularly large weedy areas. Use GPS if possible. Target them with another control technique during another visit.

Active restoration is not used as often, since it is much more labor intensive and has the potential to change site microclimate drastically. This approach is primarily used in very weedy, problematic areas, or when complete eradication of a locally incipient weed population is desired. Active restoration involves the removal of greater than 20% of the canopy and the creation of an open gap, susceptible to weedy invasion. Common native species are often outplanted into the sites. In some cases, removal of large amounts of canopy is desirable; eliminating *Psidium cattleianum* stands may actually reduce *P. cattleianum* recruitment, as described in the Kahanahāiki MU monitoring discussion.

Two types of weed areas, each requiring a different control approach, can be identified: mixed alien species areas, and *P. cattleianum* monocultures. *P. cattleianum* monocultures may require more drastic methods of control. Mixed alien species areas may respond to more gradual treatments. The size of the patches and the type of surrounding vegetation may also affect control. A preliminary list of weedy area types includes: small (10x10m²) mixed alien weed patch surrounded by native vegetation, large (100x100m²) mixed alien weed patch surrounded by native vegetation, small *P. cattleianum* monoculture surrounded by native vegetation, large *P. cattleianum* monoculture surrounded by native vegetation, and small or large *P. cattleianum* monoculture surrounded by mixed alien species. However, no matter how one tries to create a list of categories that encompasses all possible types of weedy area, weed control will work best if tailored to the specific area, to take advantage of unique features. The broad categories listed above and described below are meant to be a starting point for developing a restoration plan for a particular area. In addition to these broad categories, fencelines, which tend to act as weed corridors, are often treated as separate projects.

1. Small mixed alien patches surrounded by native vegetation are excellent candidates for active restoration. NRS control the entirety of such patches of alien plants in one treatment during regular weeding sweeps. NRS use this aggressive approach expecting that regeneration from the surrounding native forest will occur naturally. NRS have not observed any detrimental impacts from this approach and will continue to control small mixed alien patches in this manner.

2. Large mixed alien patches surrounded by native vegetation are more problematic than small patches. In large mixed alien patches, natural regeneration may not occur as quickly or successfully since the ecosystem has been so severely altered and the surrounding seed supply is limited. Therefore, NRS do not take an aggressive control approach to these areas but instead sweep through the area and remove weeds selectively. In some cases weeding efforts may focus on the perimeter of the patch, allowing natives to invade the edges of the weedy patch. NRS will continue to conduct control in these areas in this manner.

3. *P. cattleianum* monocultures, of any size, are difficult to control. For the most part monocultures are clones of one or a few individual plants. Other species do not appear to thrive beneath a *P. cattleianum* canopy, perhaps due to allelopathic complications. If only part of a monoculture is treated, control can be ineffective and treated areas may grow back. For small stands surrounded by native vegetation, NRS control the entire stand and outplant common natives if necessary. (See section 2.7.a for details of *P. cattleianum* monotypic stand treatment).

4. Other regions that deserve separate consideration are fencelines. Small shrubby weeds thrive in the open light corridor provided by a fenceline. In many areas for example, *Stachytarpheta dichotoma* forms thick stands and *M. minutiflora* grows into large banks in sunny areas. While most of the weeds along the fenceline do not compete well in the shaded understory of the nearby forest, the fenceline can act as an invasion corridor. During weed sweeps that take place perpendicular to fences, workers often cannot keep up with the rest of the sweep due to the large amount of weeds needing treatment along the

fenceline. Therefore, weeders keep about 1 to 2 meters in from the fence during sweeps, and treat the fenceline weeds as a separate project. Fencelines lend themselves well to the use of volunteers and can benefit greatly from common outplantings that shade out sun loving weeds.

5. Firebreak construction is done to reduce the fire risk to native forest patches and endangered species. The goal of firebreak construction is not necessarily restoration but protection of existing resources. The majority of firebreak construction performed thus far has been in grass-dominated areas. While returning less-fire prone natives to the area is desired, fuel removal is a higher priority. Thus, firebreak construction often results in the creation of very large, open areas.

Last year several firebreaks were put to the test during a number of fires in Makua Valley. The efficacy of the firebreak at Kaluakauila was questionable, and firebreak maintenance there has been put on hold until the Kaluakauila Fire Management plan has been finalized (details in sec 2.7). However, the firebreaks in Lower Ohikilolo were effective and are currently being maintained.

2.4.b. Weed Control Techniques

Control of weeds is conducted using a number of techniques, including manual, chemical and biological control. The method of control depends on the growth form of the target species (grass versus shrub versus tree), and the type of weeding project (active restoration versus gradual restoration versus firebreak). Manual and chemical control are often combined. Manual control includes all types of weeding done without the use of herbicide, for example, hand-pulling, grass-cutting, girdling, clipping, and felling. Manual control sometimes involves the use of chainsaws; all NRS take a chainsaw training class prior to use of a chainsaw in the field. In addition, all NRS undergo state certification for application of restricted use pesticides, although no restricted use pesticides or pesticides with a stronger signal word than Caution are used in management. As a rule, NRS strive to use the most effective combination of control techniques to achieve optimum weed control with minimal secondary effects on native plant species. In general, control of canopy weeds is done using a basal bark application of 20% Garlon 4 in Forestry Crop Oil. The following are definitions of the most common control techniques used by NRS:

- Girdle—wound cut into the cambium layer of a tree trunk or shrub encircling its base with a chainsaw or treesaw; herbicide is usually but not always applied to the cut.
- Cut-stump (Flush Cut)—tree or shrub trunk severed near the base; herbicide is usually then applied to the stump.
- Frill-cut—wound cut with a hatchet or machete into the cambium of a tree trunk or shrub encircling the base, leaving the removed bark attached at the base to act as a trough for herbicide if applied.
- Foliar spray—herbicide sprayed on the leaves of a plant.
- Basal bark/Thin line—herbicide is squirted in a ring around the base of a weed trunk or stem.
- Clip and drip—small stemmed weeds cut with pruners or loppers; herbicide is applied to the cut surface.

- Weedwhacking—for grassy species; grass cut low to ground, herbicide is usually applied to new growth.
- Handpulling—for young woody species or herbaceous species; entire plants are pulled from ground, including majority of roots.
- EZJECT—.22 caliber shells filled with water-soluble systemic herbicide (either Garlon or Round-up) are injected directly into stems or rhizomes; shells pushed into plants using EZJECT injection equipment, hammer, or hand pressure.

NRS have relied on other natural area managers' experience or their own set of efficacy control plots to determine products used to kill introduced plant species. Products used by NRS include:

- Garlon 3A—a systemic herbicide diluted with water; applied as either a foliar spray or using a girdle, frill or cut stump method. Active ingredient: 44.4% triclopyr.
- Garlon 4—a systemic herbicide diluted in FCO; applied generally as a basal bark treatment. Active ingredient: 61.6% triclopyr
- Forestry Crop Oil (FCO) —an oil-based carrier used in thin line treatments with Garlon 4 to improve penetration through bark and other plant tissue.
- Glypro Plus—a non-specific, systemic herbicide diluted in water; applied generally in low concentrations. The patent on Round-up recently expired; Glypro Plus is a replacement for Round-up, and functions in much the same way. Active Ingredient: 41.0% glyphosate.
- Fusilade II—a grass specific herbicide diluted in water; most frequently applied as a foliar spray. Active ingredient: 24.5% fluazifor-P-butyl.
- Escort—a systemic herbicide diluted in water; sprayed on the rhizomes of ginger. Active ingredient: 60% metsulfuron methyl.

Essential to large spraying efforts is availability of water. Filling jugs of water at the baseyard and transporting them to specific sites is often time consuming, and moving heavy jugs of water to desired spraying areas is often difficult. This year, NRS experienced frustration at having to rely on weather and permission dependent helicopter operations to transport water to specific sites. NRS therefore are installing water catchments where ongoing spraying efforts are expected. Dan Tanji, a part-time NRS, has designed a structure that catches rainwater and fills a 125-gallon tank. So far catchments have been built at Lower `Ōhikilolo, Kahanahāiki, Three-Points (Mokulēi`a Forest Reserve). Plans for future catchments are described in individual management sections.

While control methodologies have been developed for most problem weeds, NRS are continually experimenting with techniques for effectively treating problematic species. Discussions of the results of these trials are included in the control sections for the management units in which they are held.

2.4.c. Weed Control Effort Form

NRS use a Weed Control Effort form to provide a written record of weed management (Appendix 2B). It tracks species treated, effort in person hours, area treated, and pesticide use. It helps determine efficacy of different control techniques and guides scheduling, prepping, and packing for future trips. It is an important tool in making the weed management program more cohesive.

2.4.d. The Human Effect – Sanitation Policies

Working in weedy areas, there is always the potential for NRS personnel to act as dispersal vectors. In order to reduce this potential, 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 unforeseen consequences.

- *Vehicles.* All vehicles are washed at the end of the week. If a vehicle goes to a site known to have particular invasive weeds, it is washed at the end of the day. Examples of such sites are KTA and OP Halo on SBS. KTA, which receives heavy military use, is home to a number of invasive weeds, including *Pennisetum setaceum, Melochia umbellata*, and *Acacia mangium*. OP Halo is the site of a prolific incipient weed, *Senecio madagascariensis*.
- *Footwear.* NRS footwear is washed at the end of each work day. Each NRS has two sets of tabis, one solely for use in the Wai`anae Mountain Range, and the other solely for use in the Ko`olau Mountain Range.
- *Fencing*. Fencing gear, including panels, posts, and fence rolls, is stored in a sterile place until it is needed. Currently, NRS store all fencing material in storage rooms at the NIKE site or on paved/graveled areas at the baseyard. Fencing material is not recycled.
- *Sling nets* and *Straps*. Helicopter equipment such as sling nets and straps are washed whenever they appear dirty. NRS evaluate each LZ based on the LZ weed list, and have identified LZs with weeds of concern. They are `Ōhikilolo (*Triumfetta semitriloba, Cirsium vulgare*) and Ka`ala (*Rubus argutus*). After use at either of these sites, sling nets are washed.
- *Rat bait*. Every year, approximately 1,225.5 lbs of rat bait are used in the field on Army lands. NRS use Ramik, rat bait that is not formulated with seeds, but rather with cracked corn, milled grain, and wax. A trial described in 2003 PCSU report determined that none of these components are a potential source of weeds.

2.5 Weed Monitoring

Weed monitoring plots are used by NRS to assess the effectiveness of weed control in restoring and improving native ecosystems. In order to obtain reliable data, the plots must be monitored over long periods of time. Trends may be slow to surface due to the slow growth rates of native species. Appendix 2A, Weed Plot Methodology, describes the detailed scheme employed for basic monitoring and contains samples of field forms used to facilitate data collection. Sometimes this methodology is applied in its entirety and sometimes only certain parts of it are used, depending on plot purpose and available monitoring sites. Weed plot data indicate patterns or trends related to the treatment employed in a given plot. However, data may always be influenced by factors unrelated to the treatment, including seasonal fluctuations, observer bias, trampling, and natural occurrences such as wind or senescence.

In addition to tracking vegetation change over long time periods, NRS use plots to test the efficacy of control methods. These plots are generally monitored over shorter time periods –

months, rather than years. The same protocols and forms referenced above are used in these trials. This year an Informal Weed Plot Form was also created to allow for easier establishment of weed control plots, and to draw quicker conclusions about weed control from general observations about those techniques. Control plots have been established in many of the MUs.

Monitoring data and discussion are presented within each Training Area section. Additional data plots have been analyzed in the 1998 through 2003 PCSU Reports and will not be included in this report.

2.6 Interagency Cooperation

Weeds know no boundaries! In order to better combat certain weed species, NRS collaborate with other agencies to target incipient and established species, share control methods, and compare management results. This year, NRS worked with a number of agencies on weed-control projects. These agencies include the O`ahu Invasive Species Committee (OISC), The Nature Conservancy of Hawai`i (TNCH), the Hawai`i Rare Plant Restoration Group (HRPRG), the State Natural Areas Reserve System (NARS), the Department of Agriculture (DOA) and the University of Hawai`i (UH). With TNCH, HRPRG, and NARS, much of this collaboration involves weeding around specific populations of endangered plants, or reintroductions. This facilitates sharing information and discussing weed control projects. These projects are discussed in detail in section 2.12, Offsite Management Areas. With DOA and OISC, NRS recently began coordinating joint control of *S. madagascariensis* in SBS. These efforts are described in section 2.8.b.

2.6.a. O`ahu Invasive Species Committee (OISC)

As part of the statewide Invasive Species Committee system, OISC works to prevent new invasive alien species from becoming established on O`ahu. OISC is comprised of State, Federal, and private agencies, as well as interested individuals. As the main point of entry to the state, O`ahu is under direct threat from new invasive species. Since its establishment, OISC has been able to effectively control many incipient weed populations.

Since the military controls a significant portion of the forest on O`ahu, NRS participation in OISC is vital to its effectiveness. The Army also moves large quantities of personnel and machinery to and from the State of Hawai`i; these transports are an important potential vector for the introduction of new alien species. If the establishment of a weed species can be prevented through OISC's pro-active approach, the costs of future control are avoided.

OISC is divided into sub-groups that focus on detection of incipient alien species, control of these species, restoration of weed control areas, and invasive species policy and legislation. NRS participate primarily in the control sub-group. The control group, which meets annually, addresses the control status of target invasive species and develops action plans for each species. NRS also present new and/or unfamiliar weed species detected during annual weed surveys to OISC to begin a dialogue about possible control.

In addition, NRS contribute by coordinating and volunteering for weed control projects and supporting OISC field staff whenever possible. In the past year, NRS and OISC have combined efforts to control *A. semibaccata* at Ka`ena Point, *S. madagascariensis* at SBE, *Tibouchina urvilleana* and *Ilex cassine* at Whitmore Village, and *Hedychium gardnerianum*, *R. argutus*, *L. scoparium*, and *P. cattleianum* on Mt. Ka`ala. These projects are discussed in more detail in the training range and MU sections below. NRS also aided in OISC efforts in controlling a large population of *L. scoparium* on Waimano ridge, off Army land. This very successful effort helped to reduce the population of this locally incipient weed in the Ko`olau Mountains. NRS have also spent many nights aiding in the control of *Eleutherodactylus coqui*, the coqui frog. Whenever possible, OISC and NRS have coordinated helicopter trips to save costs. NRS will continue their involvement in the control sub-group, and their support of OISC projects.

2.7 Makua Military Reservation

Fire is a risk to many Special Ecological Areas (SEAs) in MMR. Past fires in MMR, caused by training and arson, have been observed to facilitate weed spread and erode native forest boundaries. As a result, NRS conduct fuel-load reduction and firebreak construction in high fire risk areas, particularly the Kaluakauila and Lower `Ōhikilolo Management Units. However, last year, a prescribed burn escaped burn perimeters and negatively impacted every MU in MMR except `Ōhikilolo. The MUs most intensely affected were Kaluakauila and C-Ridge. Fortunately, the firebreaks in Lower `Ōhikilolo were successful in preventing major damage to the MU. While the majority of the burned habitat was grassland, the fire did affect both common and rare native species. Reclaiming burned forest perimeters is very difficult; as a result of the fire, weedy grasses will push further into the boundaries of the MUs, heightening the risk of future fires, increasing weedy cover, and limiting native recruitment. As a result of this fire, NRS are reassessing firebreaks in Kaluakauila and are considering how to protect other affected MUs in the future.

Surveys

In 2002-2003, while NRS were conducting two road surveys in Mākua, one new potential incipient invasive weed was detected, *Caesalpinia decapetala*. The plants were found growing in and around a pile of rubble; it appears that *C. decapetala* was a contaminant in the rubble. Control is discussed in the Lower `Ōhikilolo MU section below. No new weeds were discovered this year. Landing zone surveys have shown a stable set of weeds (See Appendix 2-C, Weed Surveys Roads and Landing Zones, MMR).

It was brought to the attention of NRS by Rick Warshauer (Volcanoes National Park) that *Pennisetum setaceum*, fountain grass, had been reported from Mākua by John Obata and Rick Warshauer in 1977. Two years ago, NRS extensively surveyed this entire area inside the firebreak road and found no fountain grass plants. Since no plants were present two years ago, and the original sighting occurred in 1977, it does not seem likely that the population has persisted. However, NRS will continue to survey inside the firebreak road annually to be sure no plants still exist.

Control

In Mākua, NRS have spent 2,215 hours controlling established weeds over 269 acres of land. Acreage detailed in this report does not account for areas that are treated repeatedly in the year. For example, weed control efforts may have taken place several times in the same area (for retreatment purposes) in one year, however, the amount of area controlled will be reported as a sum of the area treated each time. New types of projects, including *Panicum maximum* control, *P. cattleianum* monoculture management, and the development of a weed control plan for Kahanahāiki show increased sophistication in NRS' approach to weed management.

Weed management efforts are focused within the various MUs detailed below. There is only one weeding site outside of any MU. Last year, NRS discovered *Desmodium intortum*, an invasive weed, in the East Rim Ungulate Control Area, along the fenceline. *D. intortum*, a twining weed covered with sticky hairs, fruits prolifically, grows rapidly, and is very easily dispersed via its sticky seeds. On MMR, it is also known from the Mokulēi`a Trail, and NRS would like to prevent it from spreading into any Army MUs. NRS spent no time controlling *D. intortum* this year, however NRS will continue to monitor and treat this species in the coming year.

Monitoring

Descriptions of monitoring plots are discussed in the MU section in which they are installed.

2.7.a Kahanahāiki MU

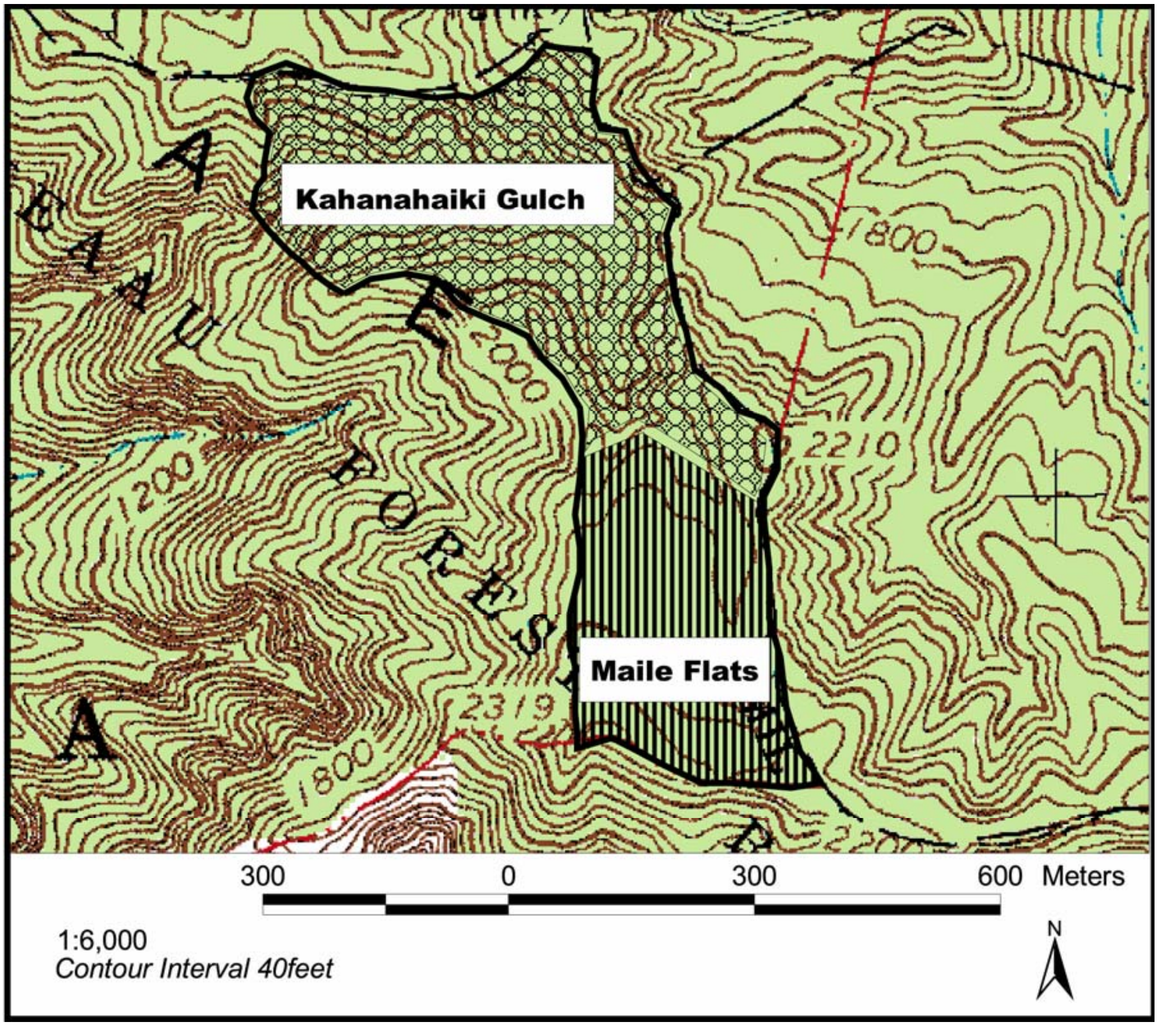
Surveys

There are two ungulate transects in the Kahanahāiki MU, Transects 10 and 11. One isolated *Triumfetta semitriloba* plant was observed along Transect 10 in October 2002. The plant was pulled and no plants have been seen on Transect 10 since. This year, *T. semitriloba* was found along Transect 11. NRS have been conducting control along Transect 11, and are continuing to monitor Transect 10. Control is discussed below.

Control

Approximately 686 person hours have been spent controlling weeds over 21 acres of Kahanahāiki MU. Management in the Kahanahāiki MU focuses on the fenced, 90 acre exclosure. The exclosure includes Kahanahāiki Gulch and a relatively flat area above the gulch nicknamed 'Maile Flats' (see Figure 2-1). NRS have developed a working weed control plan for the Kahanahāiki exclosure. The discussion of control done in the past year will be incorporated into the Kahanahāiki Weed Control Plan below. The Weed Control Plan discusses Maile Flats and Kahanahāiki Gulch separately; the areas differ in topography, vegetation communities, and weed threats. NRS chose to focus on Kahanahāiki because it encompasses a range of habitat types and vegetation communities, is easily accessible, and provides an ideal location to experiment with different approaches to weed management. NRS hope to apply the lessons learned in Kahanahāiki to other MUs, in particular, Lower Mākua, Kaluakauila, and `Ōhikilolo Ridge.

Figure 2-1. Kahanahāiki Exclosure: Maile Flats and Kahanahāiki Gulch.



<u>*Kahanahāiki Weed Control Plan*</u>

Long Term Objective

The long-term objective of weed management in the Kahanahāiki exclosure is to restore the area to predominantly native forest, which can be defined as forest with 80% or greater native species composition. Complete eradication of all alien invasive species is unrealistic at the present time, given that some weed species have been well established in Kahanahāiki for many years. To achieve a predominantly native forest, we will work towards the following sub-goals:

- 100% native cover in areas around significant resources and in areas that currently have 80% native cover. These areas are the highest priority for management. Canopy weeds will be removed gradually, maintaining site characteristics.
- Conversion of areas with predominantly weedy canopy (50% or less native canopy) to predominantly native canopy. Complete restoration of areas with 50% or less native cover is

very difficult and involves massive changes in site characteristics, as well as massive amounts of work. In some areas, total elimination of all weedy trees may not be possible or even desirable; in particular, the removal of Kukui from gulch habitats may significantly alter gulch microclimates and have a negative impact on native understory plants. Management of any particular site will be customized, based on the weed and native species present, and directed towards increasing native cover using gradual and active approaches.

- 80% native understory. Weeds will be controlled before they reach maturity and reproduce, if possible. Understory weed control will focus on immature weedy trees and particularly invasive shrubby and herbaceous species. Non-ecosystem altering weeds will not necessarily be control targets.

Short Term Objectives and Discussions

Restoration to predominantly native forest will take many years. In order to work towards this goal, NRS will maintain an adaptive list of short-term objectives. This list will guide current management efforts.

1. Prevent incipient invasive aliens from becoming established in the area.

a) ***Achyranthes aspera.*** *A. aspera* was discovered in Kahanahāiki Gulch two years ago. NRS have since monitored for seedling germination and any re-growth of treated plants. A total of 4.5 people hours were expended on this effort in the last year. Since the initial treatment of all mature plants, NRS have treated only juvenile and seedling plants within the exclosure. The number found on each trip has continually decreased. However, a mature plant was found about 4 meters outside of the exclosure, and NRS will monitor this site for seedlings. This species is abundant in nearby Pahole. Its barbed fruit are adapted for dispersal via hitchhiking. Preventing it from becoming established in Kahanahāiki will be a management priority. Given that the exclosure is pig free, NRS feel that weed control will be effective in doing this.

b) ***Ehrharta stipoides.*** *E. stipoides* was discovered in the NARS's snail exclosure in Pahole, a few meters from the Kahanahāiki fence. NARS staff, with help from NRS, continue to monitor for any seedlings in order to eradicate the small population. NRS are concerned about this species, which thrives in shaded areas with low light levels, and is a problem on the island of Hawai`i. *E. stipoides* was collected once inside the Kahanahāiki exclosure. This year, NRS spent 2.5 hours pulling, bagging and monitoring the *E. stipoides* in the snail exclosure. NRS visitation has been sporadic over the last two years and thus control time spent each trip has not decreased. Based on this observation, NRS should visit twice per quarter in order to ensure that seedlings are controlled prior to maturation and the amount of effort expended each trip should begin to decrease.

c) ***Triumfetta semitriloba.*** *T. semitriloba*, a noxious weed that is a major problem on Kauai, was discovered in the region above C-Ridge at Kahanahāiki. In June 2003, another population of *T. semitriloba* was discovered along the Orange Trail in the Maile Flats region of Kahanahāiki. *T. semitriloba* is established in the bottom of Mākua Valley, and this is thought to be the source of the Kahanahāiki population. This year, NRS spent 8 hours in the

C-ridge vicinity and 16 hours in the Maile Flats Orange Trail area monitoring and treating seedling germination and any re-growth of treated plants. Considering that the fruit of this taxon is hooked and designed for dispersal by hairy/feathered animals, NRS may frequently be addressing new infestations within the MU. A primary disperser of *T. semitriloba* fruit into the Kahanahāiki exclosure could be Erckel's Francolins (*Francolinus erckelli*). Therefore, NRS continue to survey for this species at all times while in the MU. NRS will continue to monitor for outliers and re-treat all populations every time NRS are in the vicinity of *T. semitriloba* sites.

d) ***Rubus argutus*, Blackberry.** NRS are making progress controlling the small population of *R. argutus* present in the southeast portion of the exclosure. The number of plants treated on each visit is decreasing. In July 2002, NRS treated approximately 50 plants, including some as tall as half a meter. In the last year, no more than five re-sprouts less than 20 centimeters tall were treated on any visit. All of the plants discovered were found in the "core" area of the population. The numbers and size of re-sprouts are so small that it is difficult for NRS who have never monitored the site to conduct effective control. NRS recommend that the personnel most familiar with the population conduct the control and that herbicide always be used to treat re-sprouts. Hand-pulling is not an effective control technique as the rhizome associated with a very small re-sprout can be large. NRS should consider digging up the rhizome of each re-sprout to determine how extensive the underground system is.

A second *R. argutus* population was discovered at the Black Wattle Site, close to the Nike Site. NRS initially sprayed the population with a mix of herbicides shown to effectively kill the weed. This year NRS spent one hour monitoring and controlling seedling and regrowth of this population. NRS believe that both of the *R. argutus* populations in Kahanahāiki began via bird-dispersed fruit from nearby West Makaleha. The distance between the perimeter of this large, established population and Kahanahāiki is about five kilometers. NRS will continue to control plants at this site quarterly, using the same approach employed at the Maile Flats population.

e) ***Acacia mearnsii*, Black wattle.** Over the past four years, NRS have worked with volunteer groups to eradicate a locally incipient population of black wattle inside and just outside of the Kahanahāiki exclosure. Control efforts in the exclosure have included chainsawing all large trees leaving much of the site open and denuded. NRS have since outplanted a variety of common native species into the site. See the 2001 through 2003 PCSU reports for a full description of these efforts. This year, NRS spent fifty-three hours controlling *A. mearnsii* as well as controlling grass and other invasive weeds that have since thrived in the open area. This species is well established along the Kuaokala Road west of Kahanahāiki, and over time it is possible that the road population could encroach upon the MU. This year NRS surveyed for *A. mearnsii* elsewhere in the exclosure, as well as along a slope of Pahole Natural Area reserve that neighbors the Black Wattle site in Kahanahāiki. This year NRS will continue to pull seedlings, treat grass and restore the Black Wattle site.

f) ***Montanoa hibiscifolia*, Tree daisy.** Another locally incipient weed in Kahanahāiki is *Montanoa hibiscifolia*. NRS have been aware of *M. hibiscifolia* on the back wall of Mākua for some time. So far, *M. hibiscifolia* has spread into the Kahanahāiki, Kaluakauila, and Lower Makua MUs. NRS have noted an increasing number of individuals in the southern end of Maile Flats and plan to target these plants this year before they flower.

2. Target established weed species with relatively small populations and high levels of invasiveness to prevent further spread and ecosystem altering effects.

While there are many species of weeds throughout Kahanahāiki, NRS target weeds that are particularly invasive and have the potential to affect native ecosystems. These species are always targeted on weed sweeps (or during spraying efforts) by NRS and are often treated as the target weed for the day with volunteer groups. Often these weeds are somewhat localized and an entire patch can be controlled in an area. However, revisiting these sites of initial eradication is crucial in preventing further spread and controlling, if not eradicating, these localized populations. The following are such weeds.

a) ***Rubus rosifolius*, Thimbleberry.** *R. rosifolius* is found throughout the Kahanahāiki exclosure. Complete eradication of this species is not feasible at this time. However, since thimbleberry grows quickly, produces lots of bird-dispersed fruit, is thorny, and is easily controlled, NRS feel that it warrants attention. It is difficult to determine exactly how much time was spent specifically *R. rosifolius*. *R. rosifolius* is dispersed sporadically throughout Maile Flats and is always treated during sweeps through this area. In Kahanahāiki Gulch however, *R. rosifolius* grows in large patches in light gaps in the Gulch. In the coming year NRS hope to target some of these thicker patches reducing the source population of this weed.

b) ***Clidemia hirta*, Koster's Curse.** While *C. hirta* is a very widespread weed, it has a patchy distribution in Kahanahāiki. However, NRS are concerned, as there is an apparent increase in mature *C. hirta* plants in Maile Flats this year. Previous weed sweeps in the Flats have opened up the overstory and might explain this increase. NRS will control *C. hirta* in the Flats this year before mature seeds are released into the seed bank. This weed also is much more abundant in Kahanahāiki Gulch. NRS would like to prevent it from becoming more widely established, and this year will investigate hot spots for increased effort.

c) ***Casuarina glauca*, Ironwood.** On the Mākua rim just outside of the Kahanahāiki exclosure, there is a population of ironwood, larger than NRS previously believed. Very few species other than ironwood recruit beneath its dense canopy. This species exhibits allelopathy. NRS are concerned with this population not only because of this quality, but also because ironwood carries fire well. This population represents a finger of fire-prone vegetation, which, if uncontrolled, could carry fire from bordering grasslands into the heart of Kahanahāiki Gulch. The July 2003 fire burned to within 50 meters of this ironwood patch. NRS want to eventually eliminate *C. glauca* from the Kahanahāiki MU. To begin this process, NRS have controlled large trees adjacent to the fence, and will continue to push the population further and further away from the fence until all mature plants have been completely eradicated. Monitoring and control of regrowth and seedlings will likely follow. Koa has also been outplanted in the site next to the fence to restore the canopy. This year

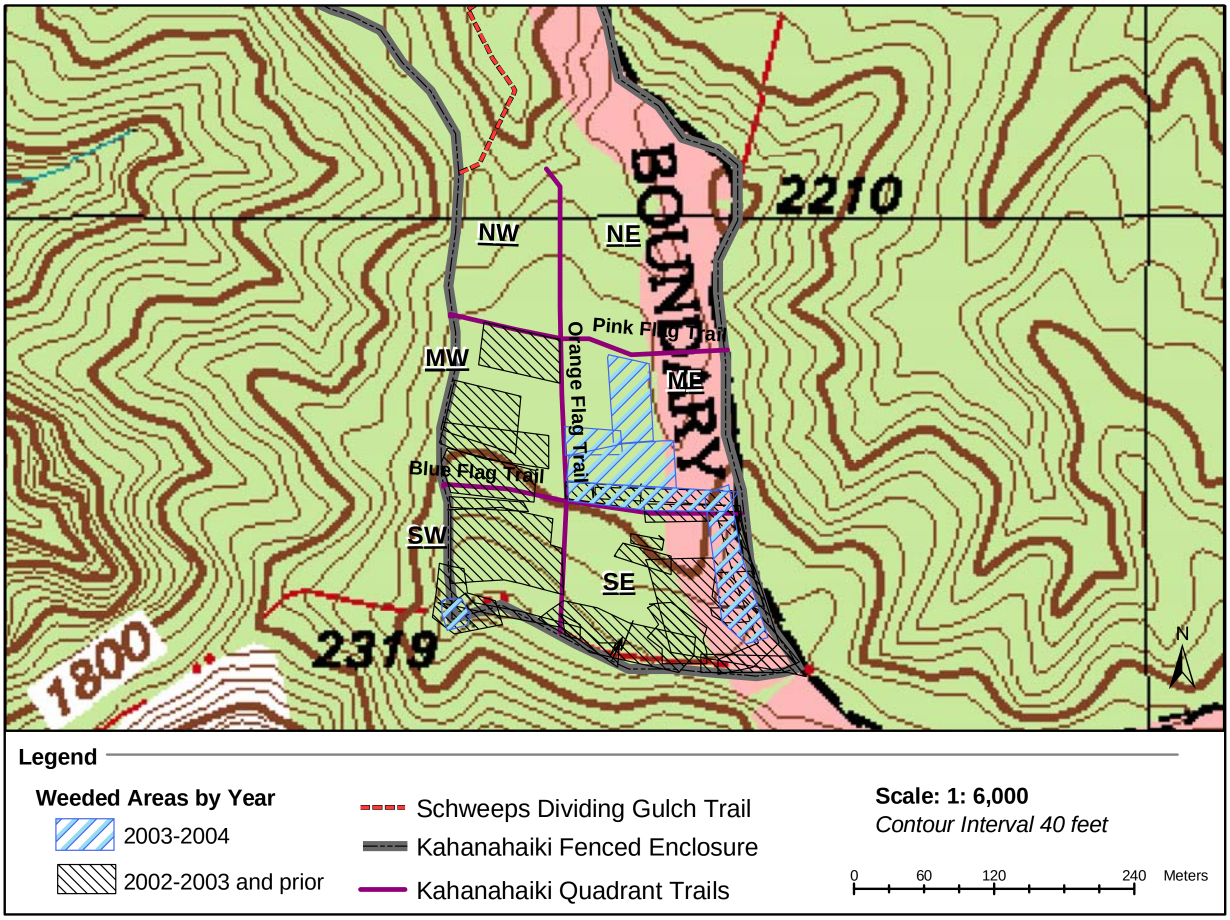
NRS will continue to treat larger trees outside the exclosure as well as resprouts and seedlings within the exclosure

d) ***Melinis minutiflora*, Molasses grass.** *M. minutiflora* is abundant in certain sections of the Kahanahāiki exclosure. While it is not feasible to eradicate all the molasses grass from the exclosure, it is feasible to control it in the predominantly native Maile Flats region where it is most abundant. *M. minutiflora* has been observed to invade areas that have been previously weeded, especially where a significant light gap has been created. NRS have taken note of this and plan to schedule follow up spraying efforts several months after canopy weeding has been done. In the coming year, NRS aim to identify areas for treatment and spray molasses grass areas throughout Maile Flats. The installation of a water catchment in the Flats will help facilitate these efforts. As native trees and shrubs colonize treated areas, these sites will no longer be favorable for molasses grass.

3. Outline an approach to Maile Flats.

NRS are focusing on implementing the Maile Flats portion of the plan first. Lessons learned are being applied to the Kahanahāiki Gulch portion of the plan. The Maile Flats area includes patches of 80% native canopy, areas of mixed weed species, and large monocultures of *Psidium cattleianum*. Maile Flats slopes downward, north, from the Mākua Overlook and C-Ridge junction, towards Kahanahāiki gulch. The area ends somewhat abruptly as the downward slope steepens into a waterfall, which leads into Kahanahāiki Gulch. As the name suggests, the area is fairly flat, but two small gulches running roughly parallel to the Mākua and Pahole rims cut through it. The quality of forest also declines towards the north. The Southwest Quadrant has some weedy areas, but has large patches of predominantly native forest. As one moves north, the native patches become smaller, the weedy areas expand, and strawberry guava stands become larger and more numerous. There are five outplantings of endangered species in Maile Flats, including *Cyanea superba*, *Alsinidendron obovatum*, *Schiedea nuttallii*, and two sites with *Cenchrus agrimonioides*. There is also one wild population of *C. agrimonioides*. All but one of these endangered species populations are on the northern end of Maile Flats. The endangered tree snail *Achatinella mustelina* is concentrated in the Middlewest, Southwest, and Southeast Quadrants. Since this area is very accessible to NRS as well as volunteer groups, and contains a patchwork of native and alien forest, it is a good place to experiment with weed control techniques for use in other high priority regions.

Figure 2-2: Kahanahāiki: Maile Flats Weeded Areas



a) Map weedy and non-weedy areas.
In order to facilitate management of the Maile Flats area, three trails were installed. These trails divide the Maile Flats area into six quadrants seen in Figure 2-2. Using these trails, NRS have done preliminary surveys of the area and gained a general sense of the vegetation communities. NRS have found that sketch maps are more useful in navigating in the featureless flats than GPS maps. NRS have used sketch maps to guide weed control efforts in several of the Maile Flats quadrants.

b) Identify and target areas with 80% native cover. Work towards 100% native canopy in these areas.

Management in the Maile Flats area includes surveys in each quadrant at least once every two quarters to assess which quadrants are in the most need of concentrated management activity. Areas exposed to significant changes in light regime may require more frequent monitoring, as they are more susceptible to weedy grass infestations such as *M. minutiflora*. Since Garlon 4 takes a couple months to kill trees, work days scheduled in a specific quadrant may be spread out over one or more quarters. NRS most frequently use weed sweeps in Maile Flats. For a description of the established weed sweep guidelines please refer to Table 2-1 in section 2.4.a.

A total of 382 person hours were spent conducting weed control in the Maile Flats region between August 2003 and August 2004. Figure 2-2 shows the coverage of weed control efforts by quadrant for the last year. Table 2-2 below indicates the amount of time spent weeding in the last year by quadrant. Weed control was most concentrated in the Middle East quadrant.

The two most common canopy weeds in Maile flats are *P. cattleianum* and *S. terebinthifolius*. The most commonly controlled understory weeds are *C. hirta* and *Lantana camara*.

Table 2-2. Hours of Weed Control by Quadrant, 2003

Quadrant	Number of Person Hours	Current Status
SE	0	All native area swept in 2003.
SW	0	Entire area swept in 2002.
ME	239.5	In progress; area not all treated.
MW	23.5	Expanded control into weedier areas.
NE	40	Preliminary control began.
NW	79	In progress; area not all treated.

In some weedier quadrants the sweep method isn’t entirely appropriate. Frequently, large stands of *P. cattleianum* or other weeds stymie efforts to achieve complete coverage. NRS have modified their approach to weedy quadrants. Preliminary surveys are conducted first to identify native patches and weedy patches. The native patches are then swept. The *P. cattleianum* stands are skipped and noted for future volunteer projects and more intensive efforts. The mixed weedy areas are swept and controlled weeds are controlled selectively, in a more gradual approach.

c) **Focus around wild endangered plant populations and outplantings.**
In the last year endangered plant populations were targeted specifically for weed control efforts. NRS spent 25.5 hours of weed control around a reintroduced population of *Cyanea superba* ssp. *superba* near the western border of the Middle West and Northwest quadrants, and a reintroduced population of *Cenchrus agrimonioides* var. *agrimonioides* near the ironwoods. In the coming year, NRS will target other outplantings in the Maile Flats region and monitor them for weed recruitment two times a quarter, or during regularly scheduled data collection visits. Table 2-2 lists these sites and includes suggestions for weeding around these populations in the future. In the coming year a reintroduced population of *Alsinidendron obovatum/ Schiedea nuttalii* in the ME quadrant will be targeted for weed control.

Table 2-3. Wild and Reintroduced Rare Plant Populations in Maile Flats

Species/Population Code	Type	Site Nickname	Hours Weeded	Comments/weed actions 2004/2005
Cyanea superba var. *superba* MMR-G	Reintroduction	Maile Gulch	22.5	Revisit to check weed recruitment in '05.
Alsinidendron obovatum MMR-F & *Schiedea nuttalii* MMR-C	Reintroduction	Lower Maile Gulch	0	Check and weed around if necessary in '05.
Cenchrus agrimonioides var. *agrimonioides* MMR-C	Rare plant	Lower Maile Flats	0	Selectively weed around population in '05.
Cenchrus agrimonioides var. *agrimonioides* MMR-D	Reintroduction	Upper Maile Flats	0	Weed as part of Maile Flats Sweeps
Cenchrus agrimonioides var. *agrimonioides* MMR-E	Reintroduction	Ironwoods	3	Weeded Casequ around plants on 5/26/04.

d) Develop a restoration plan for predominantly weedy areas. Develop a method for categorizing weedy areas according to percent native composition. Determine which actions are most useful in each category.

See the monitoring section for a discussion of *P. cattleianum* monoculture weed techniques.

4. **Outline an approach to Kahanahāiki Gulch and the rest of the exclosure. Sub-divide this area as needed. Apply the lessons learned managing Maile Flats to the gulch. Outline an approach to Maile Flats.**

The gulch region encompasses a larger portion of the exclosure than Maile Flats. It includes a range of forest types, from very weedy, to predominantly native. Many side-gulches feed into the main Kahanahāiki Gulch. Much of this area is steep, making it difficult to manage. There are many outplantings in this region, as well as populations of wild endangered plants. Just as in Maile Flats, a variety of weed control programs will need to be implemented to achieve native forest restoration.

a) **Create a detailed map of weedy and non-weedy areas.**
In 2002, a vegetation map detailing high priority weeding sites in Kahanahāiki Gulch was created. NRS installed three management trails to guide planning and allow easy navigation through this portion of the gulch. This coming year NRS plan to continue detailing vegetation in the Gulch as well as dividing the area into smaller management areas for easier tracking of weeding efforts as done in Maile Flats.

b) **Identify and target areas with 80% native cover. Work towards 100% native canopy.**
This year NRS focused weeding efforts in an area at the makai end of the exclosure. This area includes an outplanting site of several different endangered species adjacent to an area identified as having greater than 80% native cover. 14 hours were spent weeding through Pteralyxia Gulch. Canopy and understory weeds were treated, as well as the expanding population of *Oplismenus hirtellus* (Basket Grass) growing throughout the area. A water

catchment was built this year to facilitate insecticide treatments for the outplanted plants. This water will be helpful for future grass spraying efforts in the area. NRS plan to expand weeding efforts from Pteralyxia Gulch along the blue flagged trail up-gulch. This blue trail passes through various outplanting sites as well as native forest patches. NRS hope to connect these fragments along the trail creating a more continuous native canopy.

Another area with greater than 80% native diverse forest cover is located near a *D. subcordata* and *C. superba* outplanting (Auntie Barbs'). 18 hours were spent weeding at this site this year. This coming year NRS will re-sweep the area and work in adjacent areas, thus creating a larger patch of mostly native cover.

c) **Focus around wild endangered plant populations and outplantings.**
There are thirteen wild and outplanted endangered species sites in the gulch. A total of 10 hours were spent this year specifically weeding around wild and outplanted endangered species. In addition, the 80% native cover areas discussed in section b above overlap with some rare plant sites, providing additional coverage. All of these sites are priority weeding areas since the success of the outplantings are crucial to achieving requirements set in the Makua Implementation Plan. Some, like the 'Delsub' site, are located in greater than 80% native forest, and others are in slightly more degraded forest. Table 2-4 below describes the wild and reintroduced endangered plant populations, their site nicknames, hours spent weeding at the site, and comments about future weeding projects. This coming year NRS plan to increase their focus around these sites and aim to visit all wild and outplanted endangered plant sites to ensure stability of these populations.

d) **Develop a restoration plan for predominantly weedy areas. Develop a method for categorizing weedy areas. Determine which actions are most useful in each category.**
The approaches and techniques developed in Maile Flats will be implemented in the gulch region. Preliminary surveys indicate that there are many *P. cattleianum* stands appropriate for active restoration. The gulch also contains monocultures of other weedy trees, including *A. moluccana* and *S. terebinthifolius*. The restoration potential of these sites will be evaluated and test plots may be installed. While NRS have gathered information about successfully treating *P. cattleianum* in Maile Flats, treatment of this invasive species in a Gulch setting may be quite different given the different associate species and topography of the landscape. NRS have set up an informal Basal trail with Waianae High School students in January of this year and will revisit the site to evaluate efficacy, recruitment of natives, and recruitment of *P. cattleianum* seedlings. NRS will continue to establish *P. cattleianum* trial plots to identify means of treating monotypic stands in the Gulch.

Table 2-4. Wild and Reintroduced Rare Plant Populations in the Gulch Area

Species/ Population code	Type	Site Nickname	Hours weeded	Comments/weed actions for 2004/2005
Alsinidendron obovatum MMR-D	Reintroduction	Schwepps Trail	0	Sweep slope above Schwepps Trail
Schiedea nuttallii MMR-B	Rare Plant	Schnut B	0	Weed around patch
Cenchrus agrimonioides var. *agrimonioides* MMR-F	Rare Plant	Near Schnut in Gulch	0	Isolated plant in patch of *P. cattleianum*; weed *P. cattleianum* around plant
Cenchrus agrimonioides var. *agrimonioides* MMR-A	Rare Plant	Above Delsub reintro	0	Spray *M. minutiflora* around population and sweep overstory weeds
Crytandra dentata MMR-A	Rare plant	Kahanahāiki Gulch	2	Sweep gulch from waterfall down gulch to improve habitat
Cyanea superba var. *superba* MMR-H	Reintroduction			
Cyanea superba var. *superba* MMR-B	Reintroduction	Auntie Barbara's/ Delsub	0	Sweep area for overstory and understory weeds where greater than 80% native
Cyanea superba var. *superba* MMR-D				
Delissea subcordata MMR-A				
Delissea subcordata MMR-B	Rare Plant	Near Fluneo	0	Weed area around plants
Nototrichium humile MMR-F	Rare Plant	Lower Kahanahāiki Gulch	0	Weed immediate area around plants
Alectryon macrococcus MMR-G	Reintroduction	Pteralyxia Gulch	8	Continue to monitor area, re-sweep as necessary
Flueggea neowawraea MMR-F	Reintroduction			

5. Evaluate the potential, drawbacks, and regional applicability of common native species for outplanting.

Over the last few years, young koa plants grown in the NRS nursery were outplanted in a variety of sites, including the ironwood site, the black wattle site, the wild population of *Schiedea nuttallii*, and the snail exclosure. All four areas are open and sunny; these trees appear to be growing well. NRS continue to collect koa seeds in anticipation of future restoration outplanting projects.

In past years, NRS have outplanted several understory species. Since these species are slow growing and since the sites into which they were planted were highly degraded, it does not appear as if these outplantings have been as successful as recent koa plantings. In the future, NRS will evaluate understory species outplantings and decide whether or not the effort put into such outplantings is justified by the gain to ecosystem recovery. NRS will also experiment with some new sun-loving species, such as *Gahnia beecheyi*, to determine whether they can act as open gap colonizers, thus minimizing the potential for invasive species to take hold in recently cleared gaps. NRS will keep in mind that common outplanting time may be more efficiently spent conducting weed control; there is a trade-off between the two.

6. Use volunteer labor for large-scale projects. Expand volunteer program.

NRS have used volunteer labor extensively to sweep through forest patches and to set up experimental plots in *P. cattleianum* stands in Maile flats. Several large volunteer groups, including students from the UH Ethnic Studies class, Wai`anae High school Hawaiian Studies Program, the Youth Conservation Corps, and Halau Mohala Ilima helped to treat large areas; these groups volunteer once or twice a year. In addition, NRS have recruited many experienced, repeat volunteers. These volunteers have been particularly helpful, since they require less direction, and are familiar with existing programs.

NRS hope to bring some of these repeat volunteers into a more cohesive group and expand the volunteer program by setting up a regular volunteering schedule.

Monitoring

Psidium cattleianum monotypic stand treatment

In order to determine the best methods for treating monotypic *P. cattleianum* stands, plots were installed in the Maile Flats area in 2003. See Table 2-5 for a summary of treatment techniques employed. This project is described in detail in the 2003 PCSU report.

Table 2-5. Summary of Large Monoculture *Psidium cattleianum* Control Plots

Plot	Date Installed	Treatment
Clearcut	5/9/2002	All non-natives cut down and treated with Garlon 4. Only natives left standing.
Selective Clearcut	10/21/2002	Some non-native trees selected and treated with basal application of Garlon 4. Remaining non-native trees all cut down.
Basal	4/13/2002	All non-natives left standing and treated with a basal bark application of Garlon 4.
Selective Basal	4/13/2002	All non-natives left standing. Most treated with a basal bark application of Garlon, but some selected to remain untreated and provide a canopy.
Stripes	8/20/2002	Narrow rows of native and weedy trees alternating with wider rows of clearcut non-native trees.
Koa Canopy/ Clearcut	4/8/2002	All non-natives cut down and treated with Garlon 4. Only natives left standing.
Chipper	3/6/03	All non-natives cut down and treated with Garlon 4. Slash chipped up and left in piles.

The plots were installed at different times, as scheduling required. Comparison of the plots must take this into consideration. Most plots have also received some sort of weed control since installation (seedlings sprayed, regrowth treated, colonizing weeds controlled…etc.). All of this weed control has been recorded. NRS were interested in several questions. Is slow removal via basal herbicide application more effective than clearcutting? Does a canopy need to be maintained to promote native seed germination? Does canopy removal trigger *P. cattleianum* seedling growth? Or does this weed germinate best when shaded by other large *P. cattleianum*? Which control method is most successful and least time-intensive?

Results of these plots are fairly definitive, however plots will be left and read for a few years to observe long term affects of these treatments. The plots with the most promising results were the Clearcut, Basal, and Chipper Plots. Much *Acacia koa* regeneration has been observed in these plots. These are the three plots where the *P. cattleianum* canopy has been completely eliminated, and where the microclimate has been most altered. Most of the koa regeneration appears to be from seed, rather than root suckers, indicating that koa regeneration prefers the creation of such a light gap. These plots are also promising because they had the least recruitment of *P. cattleianum*. It appears as though *P. cattleianum* recruitment does not favor such drastic exposure to light and heat, a likely explanation for the extensive seedling beds that are found in dense monotypic stands of the weed. The effectiveness of these control techniques is exciting because it provides NRS with several options for treating an area. For example, in steep areas, where chainsaw clearcutting work is not ideal, basal treatment can be used.

In contrast, little germination of native seedlings and quick development of *P. cattleianum* seedling beds have been observed in the other plots where some *P. cattleianum* canopy has been maintained. The chipper plot has also proved to be a promising alternative to clearcuting where a huge pile of slash is created. The few existing native species in the area have managed to handle the heat and light after nearly the entire canopy in the area was removed. Many new koa seedlings and other native sun-loving species such as *Bidens torta, Alyxia oliviformus,* and *Cocculus trilobus* are observed, mostly close to mature source trees. NRS believe that having mature source trees such as koa and other quick germinating species nearby is crucial to this type of active restoration. With a close source of native seedlings, the area requires less time and effort from NRS in the way of supplementing the site via outplanting common natives, and fosters a more natural form of forest regeneration. At the chipper site, NRS are still investigating the response of native seedlings in the area to *P. cattleianum* chips spread out over the ground for experimental purposes. In all plots where *P. cattleianum* has been treated with a chainsaw, there are several stumps with resprouts. It is likely that these stumps were unseen and missed treatment with herbicide. NRS aim to be more vigilant about treating all stumps during initial elimination to reduce future maintenance at these sites.

P. cattleianum monoculture control will be time-intensive, no matter what methods are used. Doing any kind of aggressive weeding requires constant site follow-up and maintenance. By creating such large light gaps, sun-loving weed germination will also be encouraged. Whether or not there is time to do regular maintenance should be a deciding factor in whether or not such an aggressive approach is taken.

These plots will also be used to test control methods and to approximate a general restoration timeline. A potential timeline could be: control in spring, decomposition over summer, control establishing weeds, outplant first or second winter depending the quality of the area. Outplanting may or may not be necessary depending on how quickly native species colonize the cleared areas.

Psidium cattleianum seedling bed treatments

Maile Flats contains large seedling beds of *P. cattleianum*, as well as older *P. cattleianum* monocultures. Some of these seedling beds are quite large, up to 30m by 30m. Individually treating each seedling is extremely time consuming. In response to this dilemma, NRS conducted experiments to test the effectiveness of a foliar Garlon spray. See PCSU Final Report 2003 for details of these experiments. Results from these experiments found the various methods tested to be ineffective. As a consequence of these negative results NRS tried a different spray solution of 10 % Garlon 3A mixed in water. This spray solution was applied to *P. cattleianum* seedling beds existing in the *P. cattleianum* plots. After several check-up visits spanning four months all of the treated *P. cattleianum* remains dead. For now, the method looks successful enough to begin implementing. NRS will continue to implement this method in monoculture areas and monitor its effectiveness. Based on the results of these trials, NRS may explore the potential of new treatment methods, in particular, drizzlers and paint rollers.

2.7.b `Ōhikilolo MU

The `Ōhikilolo MU is visited at least once per quarter. All management usually takes place during these regularly spaced trips. This year, due to a halt of helicopter operations, NRS were unable to visit the MU as often as planned.

Surveys

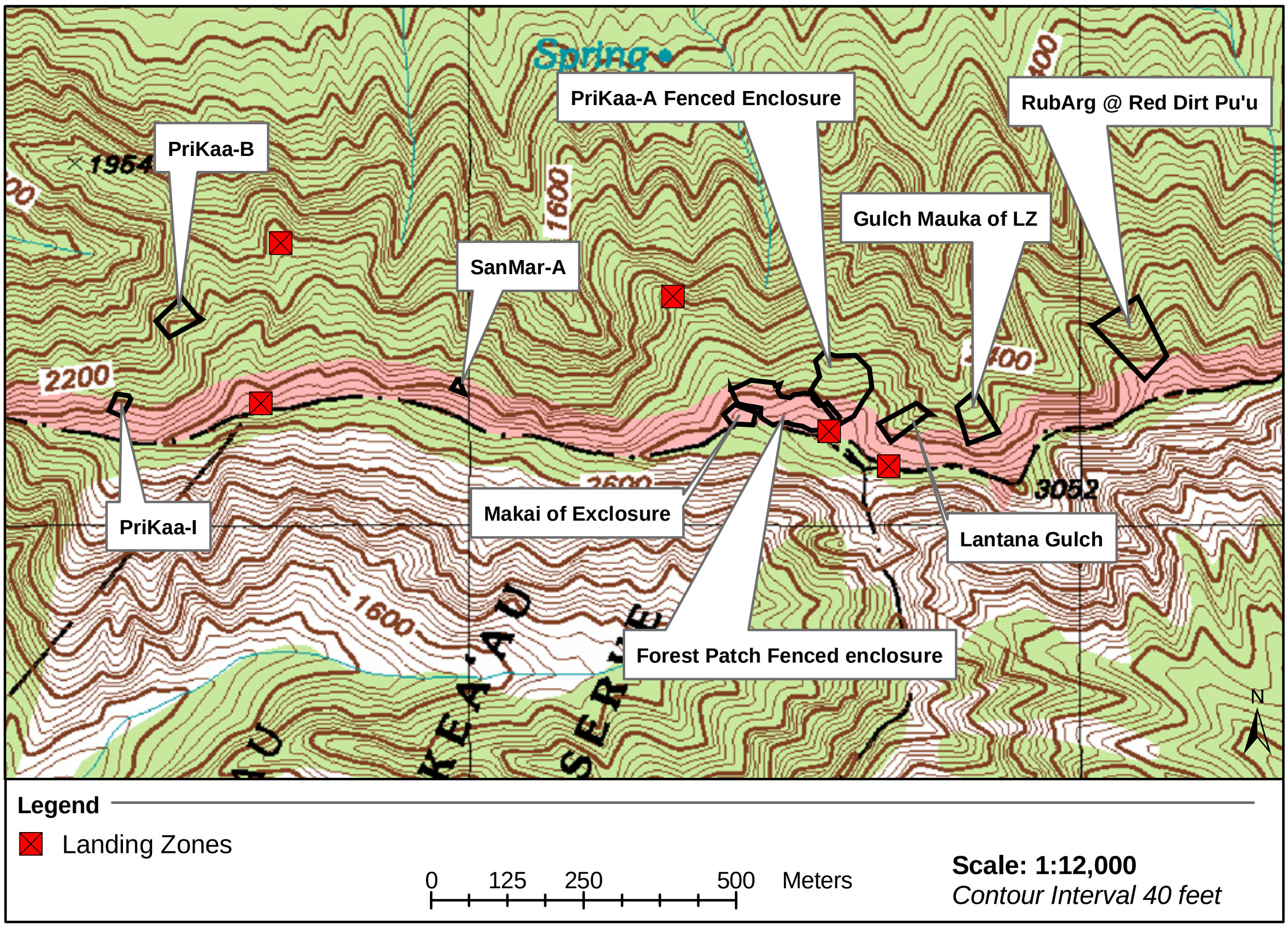
Quarterly weed surveys are conducted along three ungulate transects and on the primary natural resources LZ. No new incipient invasive weeds were discovered in any of these weed surveys. However, NRS did note *T. semitriloba* in increased abundance on the LZ. To reduce the potential of NRS unwittingly acting as vectors and transporting this weed into areas of native forest, *T. semitriloba* will be controlled on the LZ and other well-traveled areas.

Control

While most of the `Ōhikilolo MU is made up of extremely steep and rocky terrain, it also includes small patches of moderately-sloped mesic forest. Weed management done in the MU focuses mostly around these forest patches. In particular, NRS focus on a two and a half acre ungulate-free exclosure near the primary LZ. The steep `Ōhikilolo ridge widens out in this area, creating a small island of relatively flat land. This is where the primary LZ is located. Vegetation in the `Ōhikilolo MU ranges from close to 100% native to 100% alien. The long term objective of weed management at `Ōhikilolo is to restore the small mesic forest areas to greater than 80% native cover and prevent new incipient weeds from becoming established. Because the area is an island – remote, pig-free, nearly goat-free – NRS feel that there is great restoration potential for the degraded areas in the MU, and great survival value in the predominantly native areas.

Approximately 55 person hours over three 3-day camping trips were spent controlling weeds in the `Ōhikilolo MU by NRS and volunteers this year. This is 80% less time spent weeding than last year. With helicopter operations on hold, NRS spent the longest span of time away from the MU since management began there. Therefore, the work done during the first trips back to `Ōhikilolo after this long break focused on priority issues such as rare plant monitoring, collecting, outplanting, and rat baiting. This coming year NRS hope to return to a regular weeding schedule. In addition, NRS will seek the assistance of volunteers to aid in overdue weed projects.

Figure 2-3. `Ōhikilolo Weed Control Sites



<u>*Short Term Objectives and Discussions*</u>

NRS will maintain an adaptive list of short-term goals to help direct management efforts.

1. Prevent new invasive alien species from becoming established

a) ***Rubus argutus.*** An incipient population of *R. argutus* was discovered near a population of endangered *Hedyotis parvula* two years ago. The population does not appear to be thriving; perhaps the site is drier than *R. argutus* usually prefers. This year NRS visited the site twice and spent a total of 2.5 hours sweeping for and controlling *R. argutus* in a 3000m² area. In December 2002, 165 plants were treated. In July 2003, 103 immature and 4 reproductive plants were found. However on the first visit this year, 4 seedlings and about 8 resprouts from previously treated plants were found. On the second visit, no plants were found. NRS will continue to monitor the population quarterly for resprouts and seedlings with the hope that complete eradication from that site can be achieved.

b) ***Cirsium vulgare*.** Around the LZ, just below the LZ in the exclosure, and in nearby Lantana Gulch, there is a population of *C. vulgare*, Scottish Thistle. *C. vulgare* appears to thrive primarily in open sunny areas, although NRS have seen it growing in forest understory. NRS have treated this population repeatedly; however, *C. vulgare* appears to have become established in the seed bank. While NRS have previously been diligent at sweeping for this weed on most work trips, *C. vulgare* was swept for only once this year. Thirty immature plants were found in Lantana Gulch. No sweeps were made in other areas where it has previously been seen. NRS plan to revisit all sites where mature plants are known from.

c) ***Araucaria columnaris*, Norfolk Pine.** One of the unique landmarks of the `Ōhikilolo LZ was a very tall Norfolk pine tree that is the source for the hundreds of seedlings in the area. The tree has been killed, and in December 2001, NRS began to control the many seedlings in the area. Most of the seedlings are concentrated around the LZ, but outliers have been found in forest patches mauka and makai of the LZ. Without a source of new seed, NRS will have to sweep the area and remove plants before they reach maturity until the seedbank is exhausted. NRS will continue to focus on removing seedlings from the MU during quarterly management trips.

2. Target particularly invasive species with small populations for increased control effort. Create a High Priority List

a) ***Erigeron karvinskianus*.** *E. karvinskianus* thrives in steep, open areas, where it can be very destructive and poses a significant risk to ecosystem quality. It does well in open gaps within forested areas. This creeping plant grows quickly and forms large mats. Trials established that *E. karvinskianus* responded well to Garlon 3A foliar spray. However, native plants are also susceptible to the foliar spray. Care must be taken to reduce secondary kill. This year NRS spent 5 hours treating *E. karvinskianus* patches in the gulches mauka of the LZ. Sweeps in this area and in the Forest Patch Exclosure will continue with caution around sensitive resources.

b) ***Melinus minutiflora*.** *M. minutiflora* colonizes open sunny gaps. It forms thick mats and crowds out native species. While it is widespread throughout the `Ōhikilolo MU, NRS have targeted it for eradication in the Forest Patch Exclosure and around various rare plant sites. No spraying took place in the forest patch exclosure this year. *M. minutiflora* was controlled with handsprayers around a wild population of *Pritchardia kaalae* and a population of *Sanicula mariversa* for a total of 4 hours. Both areas were previously sprayed, however follow-up spraying was minimal. Next year, NRS want to expand grass control to the 'Makai of Exclosure' area (see section 4.b) below), and will continue control in the gulch mauka of the LZ.

c) ***Rubus rosifolius.*** *R. rosifolius*, like *E. karvinskianus*, is locally abundant in the `Ōhikilolo MU. There is a particularly large patch of *R. rosifolius* in the gulch mauka of the LZ. NRS have treated this population in the past. NRS treated this population once in the past year. However, *R. rosifolius* is fast-growing, and quickly reestablishes itself. Further and consistent control is needed. NRS will check and control this population quarterly. *R. rosifolius* is also found scattered in the Forest Patch Exclosure. Almost all of the exclosure was swept once over the past year; during these sweeps, NRS treated *R. rosifolius*.

d) ***Triumfetta semitriloba.*** *T. semitriloba* is widespread throughout the `Ōhikilolo MU. While targeting this species for eradication in the MU is not feasible, NRS hope to control its spread by removing it from well-traveled areas, including the fenceline and the `Ōhikilolo LZ. NRS do not want to inadvertently track it into predominantly native areas. There are large patches along the fenceline by the Forest Patch Exclosure, on the LZ itself, and on the fenceline mauka of the LZ. It is likely that goats on the Kea`au side of the fence are in part responsible for the spread of this weed. This year, NRS spent no time treating these areas. Next year, NRS will use more aggressive tactics to control the spread of this weed. *T. semitriloba* is susceptible to Glypro+ foliar spray.

3. Identify forest patches of 80% native composition. Work on them as specific projects. Direct control efforts to achieve 100% native composition.

a) **Forest Patch Exclosure.** The Forest Patch Exclosure encloses a mostly native forest patch, an eroded scar, and an open weedy area. This weedy area below the LZ is discussed in section 4.a. The forest patch is home to a candidate for endangered status plant, *Melicope makahae*, an endangered snail, *Achatinella mustelina*, and reintroductions of two endangered plants, *Pritchardia kaalae*, and *Sanicula mariversa*. NRS have expended extensive effort over the past four years to convert the forest patch section into a pristine native area. At the outset of the program, extensive work was performed to remove established weed populations. However, in recent years it has become increasingly easy to maintain the forest patch as a weed-free area because follow-up is done regularly and invasive plants do not have the opportunity to become established. The entire exclosure area, except the weedy portion below the LZ, was swept once this year. NRS believe the exclosure need only be swept once a year, with attention focused on weedier areas and persistent weeds such as *E. karvinskians*. Weedy areas included the *S. mariversa* outplanting, '*Stachytarpheta* flats', and the fenceline. In the future, the fencelines may be weeded in a separate effort, rather than as part of the exclosure sweeps. NRS observed *Metrosideros tremuloides* colonizing the eroded scar. This bodes well for the recovery of the area.

b) **Gulch mauka of LZ.** Just mauka of the LZ there is a large gulch which hosts a variety of resources, including the rare tree *P. macrocarpa*, the endangered snail *A. mustelina*, and an outplanting of the endangered palm *P. kaalae* (MMR-H). In addition, the area has experienced regrowth of native species, such as `ie`ie (*Freycinetia arborea*), since goats have been controlled in the region. NRS spent 7 person hours controlling *S. terebinthifolius*, *L. camara*, *S. dichotoma*, *A. riparia*, *R. rosifolius*, and *E. karvinskianus* in and around this gulch. Much of this area has been swept in previous years and only requires regular monitoring to prevent the re-establishment of large weedy populations. *R. rosifolius* and *E. karvinskianus* appear to be the most resilient weeds. NRS will continue to monitor this area and will expand the area treated to fully encompass the area of the *P. kaalae* reintroduction. NRS will also continue to slowly remove large *S. terebinthifolius* and target the expanding patches of *M. minutiflora* in the surrounding area. NRS will also consider outplanting common natives.

c) ***Sanicula mariversa* MMR-A.** On the makai section of the `Ōhikilolo MU, there is a population of endangered *S. mariversa*. This species thrives in exposed, steep, sunny habitat. The site is primarily made up of native vegetation; however, *M. minutiflora* was beginning to invade it. Treating *M. minutiflora*, which interferes with *S. mariversa* growth, must be balanced by the need to maintain ground cover and reduce erosion. Although the area is steep, most of the patch is vegetated with native grasses and sedges. This year, NRS did not treat the area because *M. minutiflora* was not regrowing into the endangered plant population. The area had been treated using Fusilade II with hand sprayers the previous year. NRS will continue to monitor the site and will retreat the grass patches as needed.

4. Identify weedy patches and evaluate their restoration potential. Work on them as specific projects. Direct control efforts to increase the proportion of native species.

a) **Exclosure, Below LZ.** The Forest Patch Exclosure consists primarily of 90% native mesic forest; however, one end of the exclosure juts mauka, below the LZ. This triangular area is very weedy. No time was spent treating this area. This area has been weeded multiple times before; however, because it is so open, weeds continue to thrive. Last year, NRS directed effort towards outplanting native species in order to reduce the regeneration of weedy species and promote more rapid native invasion. Almost 100 *A. koa* were outplanted. NRS have observed improvement; there are new patches of *Sphenomeris chinensis* (pala`a), as well as other scattered natives. Next year, NRS will continue weed control.

b) **Makai of Exclosure.** The area just makai of the Forest Patch Exclosure is around 50% native cover. NRS spent no time removing weeds from the area. This area borders a patch of 80% native forest; NRS hope to promote the expansion of native forest into this site. Since much of the canopy consists of *S. terebinthifolius*, weeding must be selective to prevent the creation of open gaps. *M. minutiflora* is invading the site; in the coming year these patches will be treated.

c) ***Pritchardia kaalae* MMR-A.** Just below the Forest Patch Exclosure is the largest known wild population of *P. kaalae* (MMR-A). Last year, NRS constructed a fence around the *P. kaalae* population to protect it from goats. The area immediately around the *P. kaalae* is 50% native mesic forest. In the interests of improving habitat quality for this endangered species and in the course of fenceline clearing, NRS controlled *S. terebinthifolius*, *A. riparia*, *A. adenophora*, *S. dichotoma, M. minutiflora*, and *P. conjugatum*. This site is especially sensitive; NRS have observed huge numbers of slow-growing *P. kaalae* seedlings; NRS must balance weed control against the potential to trample delicate seedlings. In addition, NRS do not want to significantly alter light levels present at the site; this may have an adverse effect on seedling germination and growth. NRS will continue to manage the site, taking a gradual approach to removing canopy weeds, and focusing primarily on understory weeds.

d) ***Lantana camara* Patch.** Between the LZ and the gulch mauka of the LZ lies a bowl formerly infested with *L. camara* surrounded by 80% native canopy forest. In September 2002, the entire *L. camara* patch was treated. A large open area was created by this effort. Since then, NRS have controlled other weeds present in the area to prevent the formation of another weed patch. This year several *A. koa* were outplanted in the area with hopes that they will serve to provide additional shade to suppress these weeds. If this trial outplanting is successful, NRS will consider outplanting more koa and other native species as well. Minimal time was spent weeding *E. karivinskianus* in the area this year. In the coming year, NRS will monitor and treat weeds, as well as investigate outplanting other common native species into the site.

e) ***Pritchardia kaalae* MMR-B, Ko`iahi.** On the makai section of `Ōhikilolo ridge, above Ko`iahi, there is a wild population of *P. kaalae*, MMR-B. This small population is located in weedy, open habitat. NRS identified *M. minutiflora* as a potential threat to seedling germination at the site. To combat this, NRS have used a combination of hand pulling, cutting, and spraying with Fusilade II. This year, 1.5 hours were spent spraying *M. minutiflora* in the immediate area around the mature *P. kaalae* and the installed seedling catchments. NRS were concerned about removing a lot of grass and causing erosion; however, many of the other grasses present in the area are not susceptible to Fusilade II, so this was not a danger. Since the site is open and weedy, and there is *M. minutiflora* throughout the surrounding area, completely eradicating it is not a priority.

f) ***Pritchardia kaalae* MMR-I, Ko`iahi.** Further south of the *P. kaalae* MMR-B site is a large outplanting of *P. kaalae* (MMR-I). In addition to being a reintroduction site, endangered *A. mustelina* snails have been observed in the area. Approximately 20% of the canopy consists of *S. terebinthifolius*. This year, NRS spent 3 person hours weeding *S. terebinthifolius* and *L. camara* from 900m^2. Since the area is weedy, control focused around native trees in the patch. In the coming year, NRS plan to continue this selective weeding and improve habitat quality.

5. Erosion control. Identify areas that would benefit from more active management. Use mats, or other techniques, to reduce erosion, and increase the rate of revegetation.

a) **LZ.** On 7 March 2002, major erosion control work was conducted on the primary LZ, which also serves as the NRS campground. Since this preliminary erosion control, NRS have observed promising results: a significant reduction in dust, and 80% vegetative cover on the LZ. Most of the plants colonizing the LZ are weeds. This year NRS covered the entire LZ/campsite area with jute secured to the ground. This erosion control work has been very successful. NRS will use jute mats to help rehabilitate other eroded areas in the `Ōhikilolo MU, including eroded scars directly bordering the LZ. At these other sites NRS would like to promote growth of native colonizing species; however, since erosion control and revegetation are the goals of these efforts, colonization by weedy species would also be acceptable.

b) ***Pritchardia kaalae* A fence.** NRS installed jute matting, covered with fence skirting along the new *P. kaalae* fence that crosses over some steep dirt slopes. This erosion control already appears to be fostering vegetation recruitment in previously bare areas, as well as slowing erosion in some areas.

c) **Region west of *Sanicula mariversa*.** The fence which runs along `Ōhikilolo ridge is Mākua's primary defense against goats. Some areas of the fenceline are severely eroded, in particular, a 75m long area just makai of a population of *S. mariversa*. In this spot, soil is eroding out from under the fence, creating a gap between the bottom of the fence and the ground. In March 2002, NRS installed fence skirting and coconut mat at these gaps to slow erosion and prevent ungulate ingress. While the coconut did appear to slow erosion at first, it was not colonized by plants and eventually degraded. The effort was unsuccessful. In April 2004, NRS used a post pounder to sink the fence flush with the ground once again, however this method does nothing to prevent further erosion, and at some point, the fence will not be able to stretch closer to the ground. NRS have begun investigating alternative erosion control techniques, including jute matting, coconut fiber logs, and photodegradable matting. Next year, NRS hope to test some of these materials.

Monitoring

There are no active weed-control monitoring plots on `Ōhikilolo ridge. This year, a trial plot was installed to monitor the effectiveness of treatments for the invasive fern *Blechnum appendiculatum*. *B. appendiculatum* is the last remaining habitat altering invasive in the `Ōhikilolo MU for which NRS do not have an effective control strategy. While treatments for *B. appendiculatum* have been investigated for the last several years, no treatment has been effective at reducing *B. appendiculatum* cover without impacting native cover. In talks with Mike Matsukawa at the Dept. of Agriculture, NRS found that there are no fern-specific herbicides available for use in Hawaii. NRS are not sure if any even exist. NRS consulted Dan Palmer, author of *Hawai`i's Ferns and Fern Allies*, and learned that *B. appendiculatum* spreads via stolons. A large patch of this weedy fern may actually be one plant. This explains why in previous trials, Garlon 3A sprayed at 2% created an initial dieback in *B. appendiculatum*, but over time, the fern cover returned. Therefore, the trial this year involved installing 1 meter by 1 meter plots by cutting the stolons around the patch of fern, thus isolating a patch to spray with Garlon 3A at 2%. It only took one return visit to see that this treatment was ineffective.

While NRS continue to search for treatments for large patches of *B. appendiculatum*, an informal weeding trial was installed to investigate whether or not isolated patches can be treated basally with Garlon 4 at 20% concentration. If this treatment proves effective, isolated patches of *B. appendiculatum* can be treated during sweeps for other weeds. Initial observations suggest that Garlon 4 is effective, but further trials will be conducted in the coming year.

A few years ago, the results of several other weed control monitoring plots were deemed conclusive (see PCSU report 2001). NRS have been using the results of these plots to direct future management. Both *E. karvinskianus* and *K. pinnata* responded well to a 3% Garlon 3A spray. *Christella parasitica* was killed by basal treatment with Garlon 4. Over the past year, NRS have increased their efforts in controlling these weedy species.

2.7.c Lower `Ōhikilolo MU

Surveys

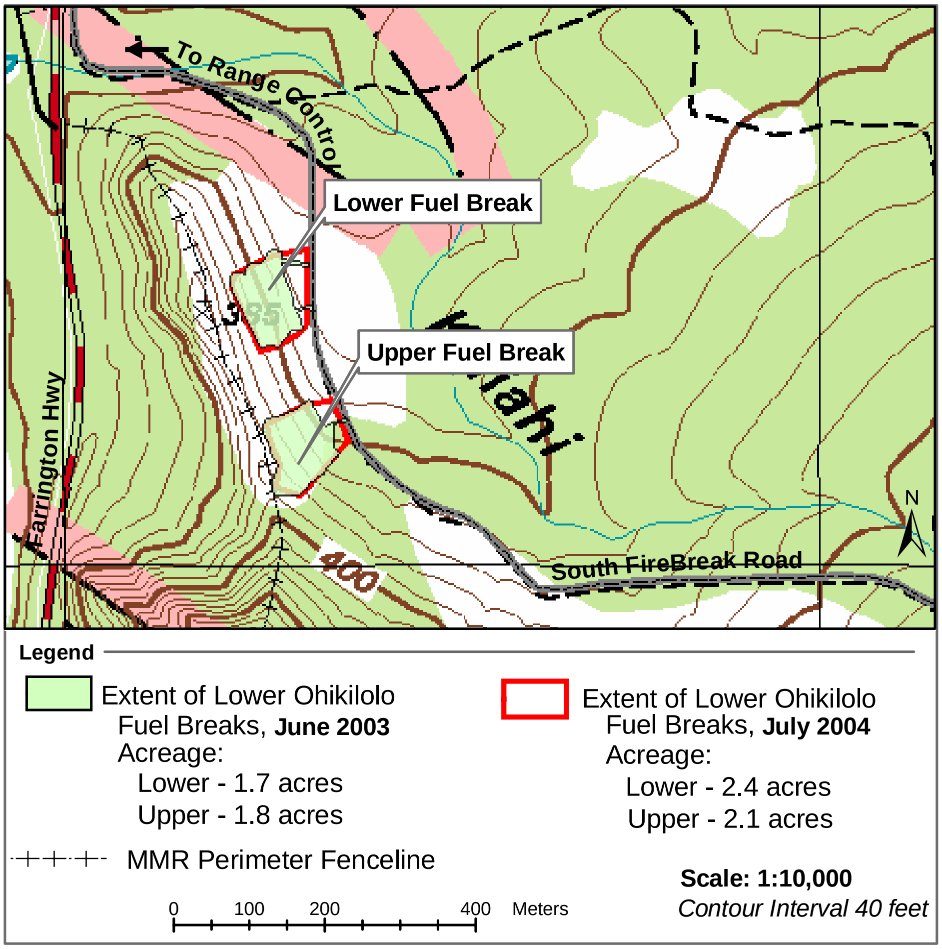
The Mākua firebreak road cuts directly below the Lower `Ōhikilolo MU. One incipient invasive species was identified during the annual road survey, *Caesalpinia decapetala*. It appears that this species was a contaminant in rubble deposited along the road for future road repairs. NRS has continued to conduct routine surveys in this area, and it appears this species has been successfully controlled. NRS will monitor the population and retreat as necessary.

Control

Management in the Lower `Ōhikilolo MU is unique among the many weed control projects performed by NRS because it is focused primarily on firebreak construction and maintenance and secondarily on native habitat management. There are three endangered species, *Chamaesyce celastroides* ssp. *kaenana*, *Hibiscus brackenridgei* subsp. *mokuleianus*, and *Spermolepis hawaiiensis* in the MU. Management is focused around the two *C. celastroides* patches and one *H. brackenridgei* population. A sea of the invasive grass, *P. maximum*, and the invasive tree, *L. leucocephala* surrounds all populations. The *H. brackenridgei* population is approximately 150m from the south firebreak road, and both the upper and lower groups of the *C. celastroides* population are only 15m from the road (See figure 2-4).

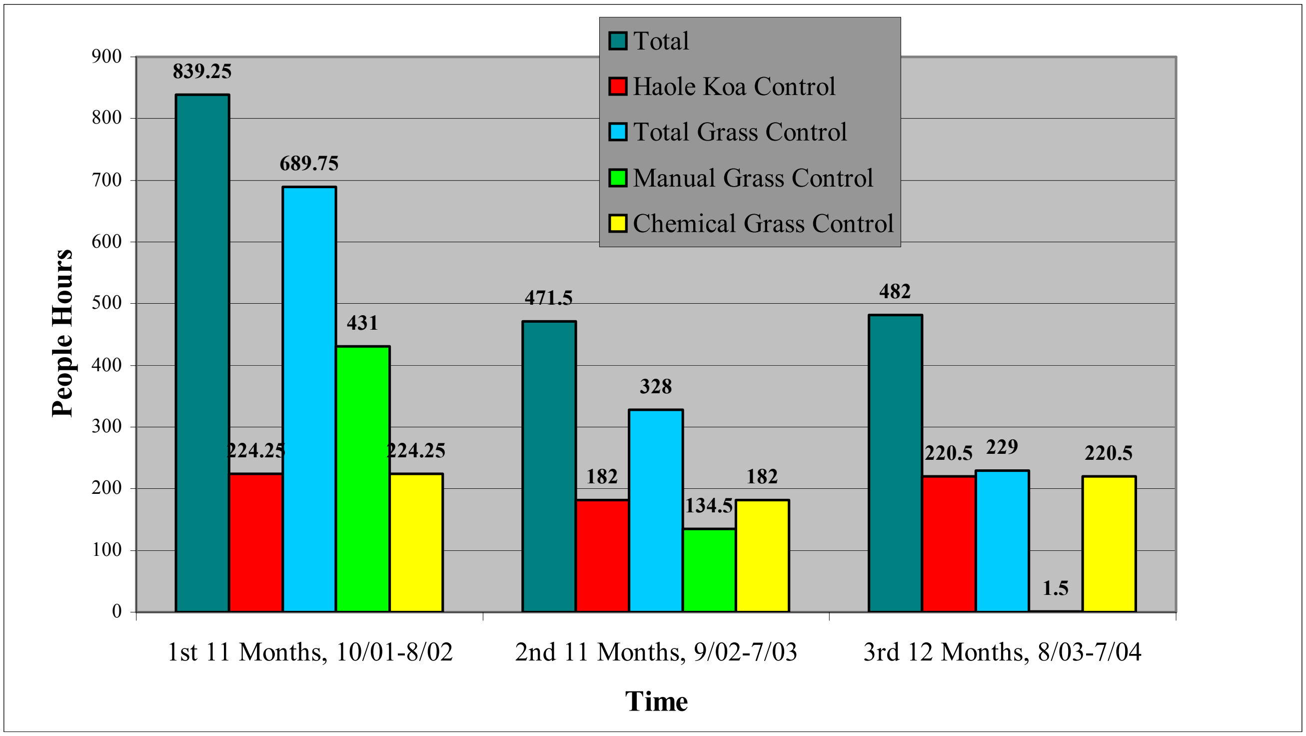
Range Control has adopted a new fire-reduction policy that limits live-fire training when weather conditions are favorable for fire; hot, dry, and windy conditions are avoided. In addition, Range Control is responsible for maintaining a 30m clear-cut and chemically controlled firebreak inside the firebreak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

Figure 2-4. Increase of Lower `Ōhikilolo *C. celastroides* Fire Breaks



Despite these measures, *C. celastroides* and *H. brackenridgei* still face a high threat from range fire from training and other range activities. In order to reduce this risk, NRS constructed 30m firebreaks around the three populations. This resulted in the creation of a 3.5 acre fuel break around the *Hibiscus* population, a 1.8 acre fuel break around the Upper *Chamaesyce* Patch, and a 1.7 acre break around the Lower *Chamaesyce* Patch. In the last year, NRS spent 482 hours maintaining and extending the fuel breaks on these 7 acres. In Figure 2-5, time spent conducting different types of control is summed for all three Lower `Ōhikilolo sites. In the first 11 months of fuel break installation, effort was very high. During this time, work on the *Chamaesyce* fuel breaks did not even begin until 6 or 7 months into the period, and all work focused on grass control. In the second 11 months of control, total effort dropped by almost half, and grass control effort dropped by more than half. In the 3rd year of control, total effort stayed relatively constant, but grass control effort dropped by 100 person hours. NRS were able to spend increased effort on haole koa in this period. This generally decreasing trend in effort needed to maintain the fuelbreak is very encouraging, given the huge time investment this large project initially required. It signifies the success of sustained control efforts as an effective means to control and reduce weed populations. NRS foresee that in the future, haole koa control should take less and less effort, as the sites are slowly rid of mature trees, and effort shifts to seedling control. The time spent on manual control of grass has steadily dropped and will end altogether, while time spent on chemical control of grass has remained constant. Since grass growth is in part dependant on rainfall, this effort will probably fluctuate from year to year, and may remain in the 200 person hour range. As grass seeds do not disperse far, we may be able to exhaust the seed bank within the fire brake. If so, effort within the fire brakes may drop substantially. The reduction of weed populations within the fuel breaks also encourages the regeneration of native dry shrubland species, such as *D. viscosa*, *Sida fallax*, *Abutilon incanum*, *Heteropogon contortus*, *E. sandwicensis*, and *Waltheria indica*.

Figure 2-5. Lower `Ōhikilolo: Change in Effort Over Time



NRS made a concerted effort this year to reduce the population of *Acacia farnesiana*, and *L. leucocephala* inside the three fuel breaks. Removal of these species eliminates habitat beneficial to grass propagation and facilitates native plant recruitment. In the Upper *Chamaesyce* patch about a four fifths of the existing population of these species was removed. A part of the area cleared included what was formerly a large swath extending from the lower road-facing perimeter to the road itself. A similar section was cleared in the Lower *Chamaesyce* patch as another means to extend the perimeter and effectiveness of the fuel break around the native plant population. A significant portion of the all the work done in controlling *Acacia farnesiana*, and *L. leucocephala* is due to the hard work of volunteer staff. NRS have found this area to be a particularly good area to bring volunteers as it is easily accessible, and these weeds are easy to identify and target. Volunteer trips will continue to be scheduled to eradicate these species.

Control techniques established as effective in 2003 for target weed species have remained largely the same. Control of grass species, namely *P. maximum* is done so with the use of back pack sprayers and one of two herbicides. The larger portion of the patches are sprayed with Round-up, in a 1% mix with water. The smaller portions, around sensitive native plant populations, are sprayed with the grass-specific herbicide Fusilade, in a 0.6% mix with water. As a means to aid this work, water catchment systems were created in each of the plots. Two catchments were constructed in the *Hibiscus* patch, and one in each of the *Chamaesyce* patches. NRS will monitor and maintain catchments as necessary during scheduled visits. Control of woody species, such as *Acacia farnesiana*, and *L. leucocephala* is done hatchets, loppers, and handsaw. Each weed is cut low to the ground creating a stump, which is then split with a hatchet scarring the taproot. Scarified taproots are then treated with a 40% Garlon 4. Moving forward NRS will continue control in these patches employing techniques proven successful in the past, as well as look for new strategies to improve our efficiency and effectiveness in this area.

Monitoring

Photopoints were taken at each site to track the changes in vegetation that have occurred with management (Figure 2-6)

Figure 2-6. Upper *Chamaesyce* Photopoint Series

July 2002

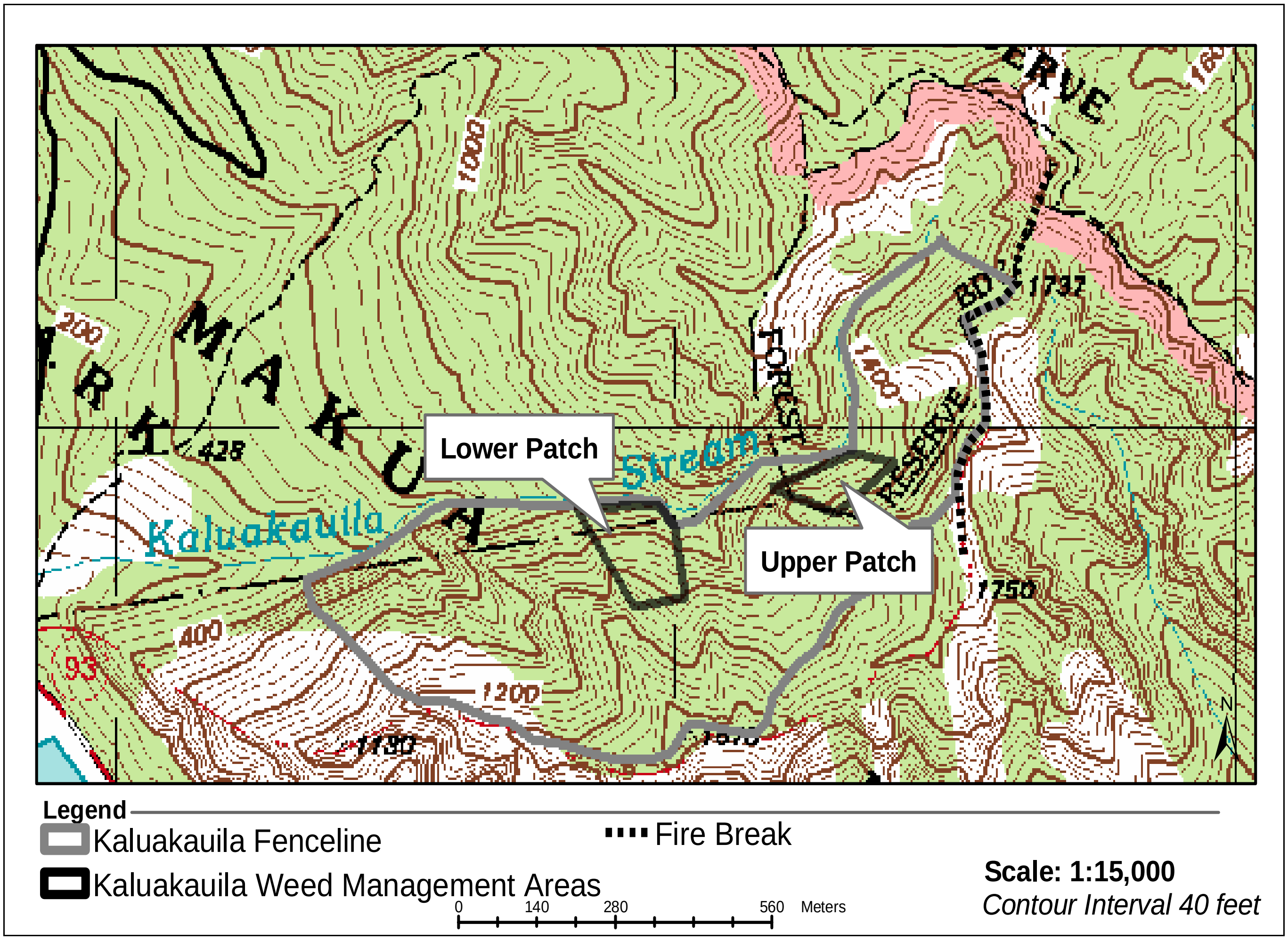
July 2003

2.7.d Kaluakauila MU

Surveys

There are two weed and ungulate transects in Kaluakauila. After the completion of the new exclosure, NRS moved one transect from inside the fence to the fenceline, and installed a new transect along another section of fenceline. No incipient invasive weeds were observed along either transect.

Figure 2-7: Kaluakauila Weed Control Sites



Control

Located in Keawa`ula, in Kaluakauila gulch, bordering on the northern flank of Mākua Valley, the Kaluakauila MU encompasses unique dry forest habitat (Figure 2-7). Surrounded by tall grass, it faces a high risk of fire. This year, Kaluakauila sustained significant damage from the July 2003 fire (see Appendix 7 MMR Natural Resource Post Fire Assessment). Endangered species were affected and native forest patch perimeters eroded. The fire damage has since exacerbated the grass problem in the MU. Most of the weeds in the MU are canopy weeds such as *P. cattleianum, S. terebinthifolius, A. moluccana, G. robusta, M. azedararch*, and *L. leucocephala*. There are few serious understory weeds in the MU, except *Rivinia humilis, Hyptis pectinata*, and fire-prone *P. maximum*.

Two years ago, an ungulate fence was constructed around the MU. Weed control in the MU has focused along the firebreak, which includes the uppermost portion of the fence, around two groups of *Euphorbia haeleeleana*, referred to as the Upper and Lower *Euphorbia* patches, and around a *Hibiscus brackenridgei* ssp. *mokuleianus* reintroduction. Several camping trips and numerous day trips were spent in the MU. NRS spent 101 hours treating approximately 56 acres throughout the Kaluakauila MU. Nearly 60% of this time was spent controlling grass. NRS faced major hurdles accessing the site due to poor weather conditions.

1. **Firebreak.** The firebreak installed and maintained by NRS stretches along the ridgeline from the junction of the Kuaokalā trail, along the fenceline for a distance, to a prominent ironwood tree where the fenceline leaves the ridge and cuts down into the forest patch. At this point, the 10ft wide firebreak ends. Beyond the ironwood, the ridgeline vegetation is much more sparse. During the July 2003 fire, this firebreak was put to the test and failed. NRS have since received a draft analysis of fire management concerns in the Kaluakauila management unit written by an Army fire expert consultant, Andrew Beavers (Appendix 6). A finalized report of these concerns and a Kaluakauila Fire Management Plan will be produced in the coming year. In this preliminary report Mr. Beavers proposed changes to the current firebreak. In addition to extending the firebreak up and down the ridge, Mr. Beavers also suggested that the break, as maintained by NRS, was not wide enough or bare enough to act as a true firebreak. NRS were leaving sparse native vegetation on the ridge and not maintaining 100% bare earth. In many places the ridge is too narrow to stop a high intensity fire. Therefore Mr. Beavers believes that this ridgetop break will be more useful as a fixed line from which to backburn. If the ridge is used as a fireline, there are requirements for creating such a line that are different than those of creating a firebreak. For one, a fire line must include 'safety zones' along the line where firefighters are safe from fire. Mr. Beavers has stated that there are no ideal locations for safety zones anywhere along the ridge. It is therefore still unclear whether or not considered effective backburn line can be created. Other fire management strategies are being brainstormed. NRS are waiting for a final analysis and a completed fire plan for the areas before investing time and effort into further firebreak maintenance and installation. NRS will work with the Army/Range Control/Range Safety, who are the primary responders to range fires, to develop a coherent and realistic fire response plan.

2. **Fenceline.** A portion of the exclosure fenceline runs from the firebreak at the ridge top, through a grassy bowl to a forest patch. NRS decided not to maintain the fenceline as a secondary firebreak, since it is sandwiched by large grassy areas. However, a five-meter strip along the fence has been maintained. This year, 2 person hours were spent spraying 300m of fenceline.

3. ***Hibiscus* Outplanting.** This outplanting area consists of two sites a couple hundred meters apart on the makai end of the exclosure. The habitat consists of scrubby forest, including *P. odoratum*, *D. viscosa* and patches of *Erythrina sandwicensis*. NRS spent no time this year weeding around the outplanting. Since the July 2003 burn, *P. maximum* is flourishing around the outplanting. While grass control around the two *Hibiscus* outplanting areas would greatly improve habitat and foster optimal *Hibiscus* growth, this small-scale control seems to be pointless if the overall biomass of *P. maximum* throughout the greater area poses such a larger threat of fire. This year NRS will weigh whether or not a firebreak on this makai end of the exclosure is feasible, and whether or not grass control around this outplanting is an efficient use of time if a firebreak cannot be established.

4. **Upper *Euphorbia* Patch.** The Upper *Euphorbia* Patch encompasses a group of 21 *E. haeleeleana* trees, which are spread out over 1.3 acres. The population is bordered on the mauka

side by areas of predominantly native forest. Last year, weed control in the patch centered on a patch of *Leucaena leucocephala*. NRS also swept a great deal of area within the bait grid for canopy weeds such as *S. terebinthifolius, L. leucocephala, G. robusta, P. cattleianum, P. guajava* and understory weeds, including *L. camara, H. pectinata, C. hirta, R. humilis*, and *Chenopodium murale*. This sweep was very effective, and future efforts should require minimal control. A rather large patch of *P. maximum* was also observed along the B-line ridge around a *Hibiscus* and *Neraudia angulata* outplanting as well as in open cliff areas on the makai end of the Upper *Euphorbia* Patch. A water catchment site was scoped in this area and when it is constructed water will be permanently available for future spraying efforts. NRS plan to control the *P. maximum* in the Upper Patch this year.

This year, time was also spent weeding *L. leucocephala* around a wild population of *N. humile* in the gulch bottom below the Upper *Euphorbia* Patch. Two main areas of *N. humile* were treated. Continued effort is required in the coming year.

5. **Lower *Euphorbia* Patch.** The Lower *Euphorbia* Patch encompasses a group of 170+ plants spread out over 4.5 acres. The patch is crisscrossed with a grid of rat bait stations. NRS spent 5 person hours treating canopy weeds along the rat bait transects and also in areas of greater than 80% native forest. In the future, NRS will continue weeding canopy weeds in the mostly native forest patch areas as well as the *L. leucocephala* along bait trails.

This year extensive efforts were made to control *P. maximum* in the patch. NRS feel that *P. maximum* poses a severe threat, both as a fire-hazard and as a quick-growing sunny gap colonizer. NRS use a combination of mechanical control with weedwhackers followed by an herbicide treatment to control this grass. Due to the sensitivity and prevalence of native seedlings throughout the area NRS choose to work with the grass specific herbicide, Fusilade II, rather than the more general, but more effective Round-up Pro. NRS have found that this herbicide is most effective at treating *P. maximum* about 6-8 weeks after it has been cut (the grass must be actively growing for Fusilade II to be effective). After a first round of 28 hours worth of weedwhacking this year, NRS were unable to return to the site for a follow up spraying operation because water could not be flown in due to helicopter restrictions. Grass grew back to levels unable to be treated with Fusilade II, and NRS spent 21.5 more hours weedwhacking. Efforts to follow this second cutting with a spray also failed because of helicopter issues. Since water is the limiting factor in spraying, and weather conditions often prevent helicopter deliveries of water, NRS plan to build water catchments this year. With water permanently stationed in the patch, spraying can be done at any time. This coming year NRS plan to control *P. maximum* with a weedwhacking and follow up spray effort. Since weedwhacking is a rather invasive control method, NRS hope that *P. maximum* can be set back so that future control of the grass will only require spraying.

One gulch over from the Lower *Euphorbia* Patch, *Rivinia humilis* forms an almost unbroken carpet through the understory. *R. humilis* plants have been found in the *Euphorbia* Patch. More needs to be learned about this weed. For now, NRS are manually removing it in the course of regular weeding efforts and are considering the feasibility of spraying it with Glypro+.

In the course of regular management work, NRS observed an unusual proliferation of a weedy annual mint, *H. pectinata*, in the Lower *Euphorbia* Patch. *H. pectinata* choked the understory of the normally open dry forest. NRS feel that it is spreading and may be a future problem. NRS will continue to monitor this weed, and may have to consider treatment methods for *H. pectinata*.

Monitoring

There are two long-term weed plots in Kaluakauila. One is near the Upper *Euphorbia* Patch, and the other is above the Lower *Euphorbia* Patch. This year, NRS re-staked and read the lower plot. Data collected from these plots is kept on file at the Natural Resource Center.

2.7.e Lower Mākua MU

Surveys

There is one ungulate transect and two natural resources landing zones in the Lower Mākua MU and another transect in the neighboring Ko`iahi Ungulate Control Area. Due to a review of our safety protocols and procedures by the military safety office, access to the landing zone in this MU has been temporarily denied. As a logistical consequence, no new data has been collected along the transects or LZ this year. However, without ingress of NRS or helicopter, no new incipient weeds have spread to the LZ.

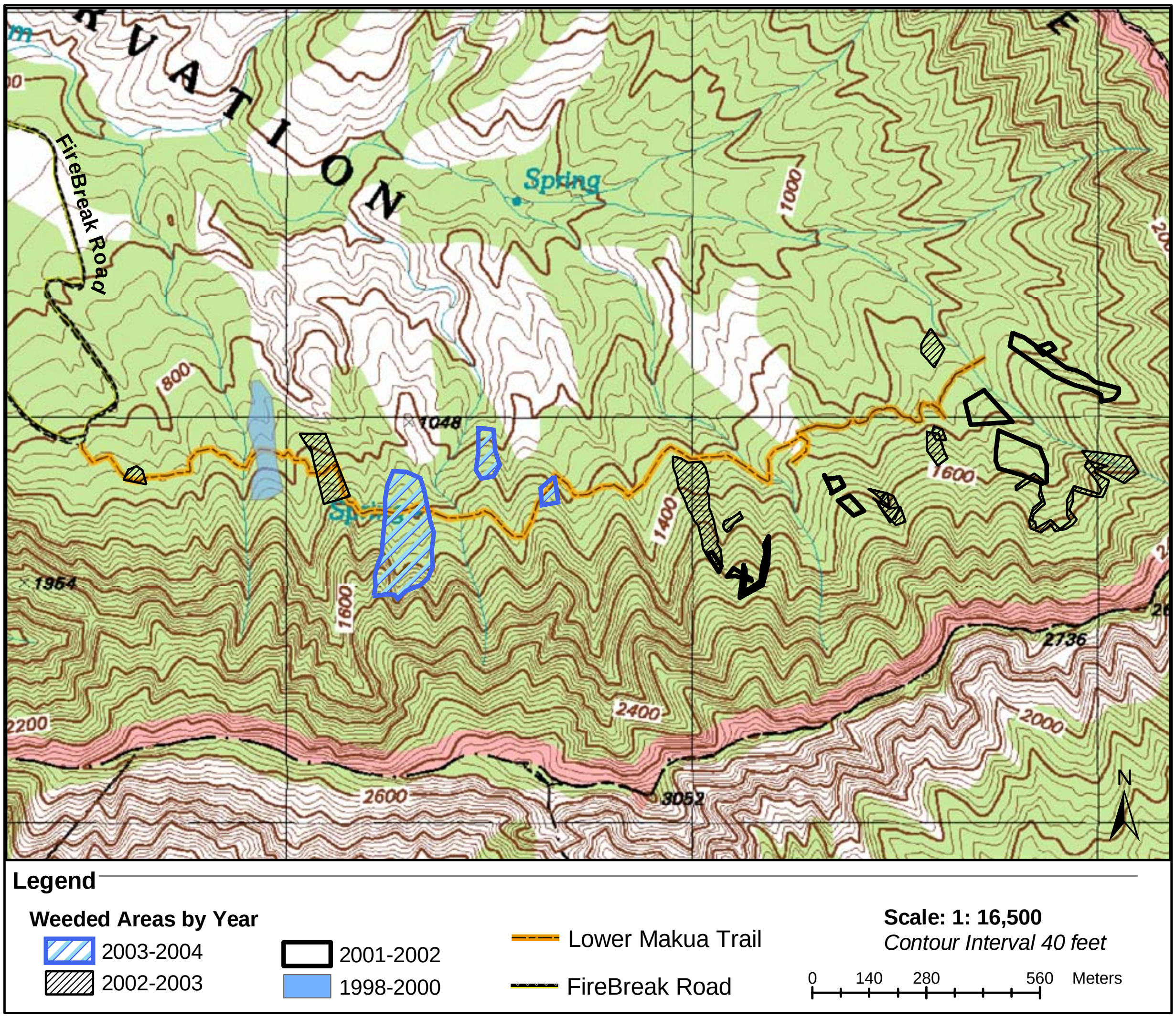
Control

The lower slopes of Mākua Valley contain some of the most intact stands of dry and mesic forest remaining on the island of O`ahu. The floor of the valley, in contrast, has been highly degraded by military training and fires, including the July 2003 fire. Parts of it are eroded and the rest is covered with thick grass. Dry forest once covered much of the valley floor, and NRS are eager to preserve the forest that remains. Most of the weeds in this forest are canopy weeds. UXO left by past training hinders management in the dry forest. Access is only allowed with EOD escort. Four day-trips were taken by NRS last year. NRS spent 134 hours weeding more than 22 acres during these trips. NRS focused on areas with 80% or greater native canopy. A large proportion of the managed areas described below have relatively few weeds and are returned to a near-pristine state after one treatment. To track the areas weeded, NRS used GPS units, sketch maps, and contour maps. NRS will revisit weeded areas once every two years for follow up.

This past year weed control activities were focused on closer to the firebreak road. Due to logistical concerns, locations requiring a long hiking time, or heavy gear were avoided as being ineffective without the use of helicopters. As a result, the scope of control activities has been temporarily reduced until such time that helicopter support resumes. Figure 2-8 details the areas covered this year by NRS.

In order to better track and direct management effort, NRS will create a map delineating broad areas with different vegetation types, including 80% native canopy, 50% native canopy, 80% alien canopy, and *P. cattleianum* monoculture. NRS will also establish permanent reference points using T-post markers to identify prominent landmarks. These different vegetation types require different management approaches. NRS are experimenting with approaches to weedy areas in Kahanahāiki (See Chpt. 2.7.a, pg. 20). These approaches, especially towards *P. cattleianum* monocultures, will be used in the Lower Mākua MU where applicable. However, NRS will first focus on the areas with the most native cover.

Figure 2-8. Lower Mākua Weed Control Areas



Monitoring

Areas in Mākua Valley that have burned in the past are dominated by alien grass. These grasses grow in thick patches and prevent the germination of the native woody species that dominated the area before it was burned. NRS hypothesized that these areas retain a rich seed bank built over the years when the area was dominated by native dry forest. If the alien grasses were removed, germination from the seed bank would begin the slow process of regenerating native forest. This was observed in areas on Haleakalā, Maui where invasive kikuyu was removed (Bill House, pers. comm.).

If a seed bank still remains in the area, it probably is dominated by species that do not grow in open areas. These species were part of a forest that favored germination in typical forest understory conditions. To begin the process of restoration, light-loving pioneer species are needed. At the moment, it seems that more aggressive measures, like intensive outplantings or seeding of pioneer species, are needed to reclaim these grassy slopes. NRS will consider this option and investigate future locations for intensive alien grass removal.

2.7.f C-ridge MU

Surveys

There are no weed transects set up in the C-ridge MU.

Control

NRS visit this MU twice a year for management work, including weed control. Understory weeds are not a significant problem in this MU; they include *L. leucocephala* and *L. camara*. Most of the weeds are canopy species, including *S. terebinthifolius, P. cattleianum, P. guajava, S. cumini, M. azedarach, G. robusta, M. hibiscifolia, L. leucocephala* and *A. moluccana*. The goal of weed management in the MU is ecosystem-scale control.

NRS work in C-Ridge was stymied this year due to the discovery of a thousand pound bomb just off the fire break road. The obvious threat to the safety of NRS due to the presence of the bomb impeded all weeding activities in the area. Just recently the bomb was detonated removing this threat. This winter, NRS with the help of RoundUp Pro® will control the dense *P. maximum* currently choking the C-Ridge road preventing safe access. As well, NRS will continue to work to control grass patches within the forest in order to slow the spread of this weed into the native understory.

Monitoring

There are no weed plots being actively monitored in the C-ridge MU.

2.8 Schofield Barracks Military Reservation

Schofield Barracks is comprised of three separate ranges: West (SBW), South (SBS), and East (SBE). These ranges will be discussed separately in each sub-heading. There are three MU's in Schofield Barracks; they are Ka`ala MU (SBW), Pu`u Hāpapa MU (SBS), and Schofield-Waikāne MU (SBE).

Surveys

See Appendix 2-D, Weed Survey Roads and Landing Zones, Schofield Barracks Military Reservation, for the exact locations of survey routes and LZs.

2.8.a West Range

Surveys

In past road surveys, NRS have targeted several weed species because of their especially invasive characteristics. Please reference RCUH Final Report 2003 for a discussion of these weeds. However, this year follow up tracking of these weeds, as well as surveying of the fire-break road has not been permissible due to lack of access during regularly scheduled road survey times (winter). Access in this area is often limited due to the presence of UXO and its high-use as a live fire range. NRS will increase their flexibility with road survey scheduling so as to ensure road surveys take place at least sometime during the year, even if later than planned.

Control

In SBW, the majority of weed control effort is performed at Mt. Ka`ala. These actions are described in the Ka`ala MU discussion below.

Monitoring

See the appropriate MU section for detailed discussions of trials.

2.8.b Ka`ala MU

Surveys

There is one ungulate transect weed survey in the Ka`ala MU. No new habitat-altering weeds were identified along it this year.

Control

Mt. Ka`ala is home to some of the most pristine and unique forest in the Wai`anae Mountains; much of it is an immature bog. There are few weeds in Ka`ala, but they have the potential to completely alter the habitat of the bog, these weeds are: *P. cattleianum* (strawberry guava), *Hedychium gardnerianum* (Kahili ginger), *Hedychium coronarium* (white ginger), *R. argutus* (blackberry), and *Sphagnum* moss. Other weeds, including *Leptospermum scoparium* (manuka), and *C. hirta* (Koster's curse), have also been observed in the bog. NRS spent 495 person hours controlling weeds across the MU this year. In order to better direct management efforts, NRS developed a weed control plan for the bog flats area. The discussion of control done in the past year is incorporated into the Ka`ala Bog Flats Weed Control Plan below.

<u>Ka`ala Bog Flats Weed Control Plan</u>

Long Term Objective

The long term objective of weed management for the Mt. Ka`ala bog is to maintain the area as a predominantly native forest. Complete eradication of all alien invasive species is unrealistic at the present time, given that some weed species, like *Rubus argutus*, have been well established at Ka`ala for many years. To achieve a predominantly native forest, NRS will work towards two sub-goals across the area defined in the attached map *Ka`ala Weed Control Areas* Figure 2-9:

- 100% native canopy cover.
- 95% native understory.

Ideally, weeds will be controlled before they reach maturity and reproduce. Understory weed control will focus on immature weedy trees and particularly invasive shrubby and herbaceous species. Non-ecosystem altering weeds will not necessarily be control targets.

Currently, the Ka`ala weed control area is defined as the flat portion of the bog and select native gulches and ridges. Based on knowledge gained during future surveys and work trips, the exact delineation of the Ka`ala weed control area will evolve as knowledge of weed threats, potential treatment methods, and weed distribution evolves. The bog stretches beyond Army lands. Weed control needs to occur across the entire bog for removal efforts to be effective in the long term. NRS will establish a partnership with the other bog landowners, including the State of Hawaii and the Board of Water Supply, and will clearly establish the responsibilities of each party relative to weed management.

Short Term Objectives and Discussions

Restoration to predominantly native forest will take many years. In order to work towards this goal, NRS will maintain an adaptive list of short-term objectives. This list will guide current management efforts.

1. Prevent incipient invasive aliens from becoming established in the area.

a) ***Leptospermum scoparium* (manuka).** A sizeable population of *L. scoparium* exists below the Mt. Ka`ala bog on Kūmaipō Ridge. Seed from this population has been dispersed primarily via wind onto the bog flats. The distribution of *L. scoparium* throughout the bog is believed to be minimal but surveys are needed to better clarify its range. Two years ago, NRS found five *L. scoparium* in the bog flats. This year, NRS discovered two more plants on the FAA side of the radio tower road. As these plants are on the State side of the bog we will continue our efforts to facilitate removal with them. The following series of actions is recommended for this species:

1. Conduct aerial surveys to better define the extent of the core *L. scoparium* population on Kūmaipō Ridge and to GPS locations of *L. scoparium* within the Ka`ala bog.
2. Re-assess the feasibility of complete eradication of population. Define control goals for bog flats and core population separately.
3. Conduct control in Ka`ala bog in conjunction with widespread sweeps for *H. gardnerianum* and *P. cattleianum*.

4. If deemed feasible, control core population. Coordinate efforts with OISC.

b) ***Hedychium gardnerianum* (Kahili Ginger).** The point of origin of this *H. gardnerianum* population is suspected to be ornamental plantings along the walkway on the west of the FAA compound. Control of the area surrounding the original population is conducted on a yearly basis. This year NRS spent 335.25 person hours controlling ginger around the core population and in outlying areas swept on surveys. While the population extends into the bog flats area, the plants are scattered and sparse in this control area. The distribution of *H. gardnerianum* is fairly well known on the Army side of the boardwalk, but knowledge of the extent of the population on the State side of the boardwalk is limited to a small section swept by the *Oahu Invasive Species Committee*. NRS are finding significantly less *H. gardnerianum* now than when control began. However, in the core area, as NRS search a wider and wider area, satellite patches continue to be found. These sweeps have focused on the southeastern and eastern sides of the FAA station. More surveys from transect marker 590 are needed to clarify distribution past this point. Based on problems with control efficacy, last year NRS conducted trials in order to determine the most effective control method. (Details of these trials are outlined in the 2003 report.) The results are described in section 3. The following is a series of actions and the current response to these actions for this species:

1. Continue to monitor and conduct *H. gardnerianum* control in Ka`ala bog via widespread sweeps across the bog flats and outlying areas. Widespread sweeps have been successful in discovering outlying populations of *H. gardnerianum*, and useful in determining where to conduct sweeps and surveys in the future.
2. Determine the extent of the *H. gardnerianum* core population to the west of the bog. Conduct aerial surveys during summer flowering season across State and BWS land, as well as Army land. Aerial surveys though proven useful, have not been conducted this year due to scheduling challenges oriented around new safety protocols.
3. Reassess feasibility of complete eradication of population. Define control goals for bog flats and core population. NRS will continue to work towards complete eradication of *H. gardnerianum,* even though the feasibility of this goal is negotiable based on its wide distribution. Sweeps, surveys and control activities for *H. gardnerianum* will continue in the bog flats and core population, with the hope that these activities will slow at a pace commensurate to this weeds decline.
4. Keep in contact with Rob Anderson, U.H. Mānoa PCSU research assistant, regarding feasibility of *H. gardnerianum* biocontrol. Contact with Rob Anderson was reestablished during the 2004 Conservation Conference.

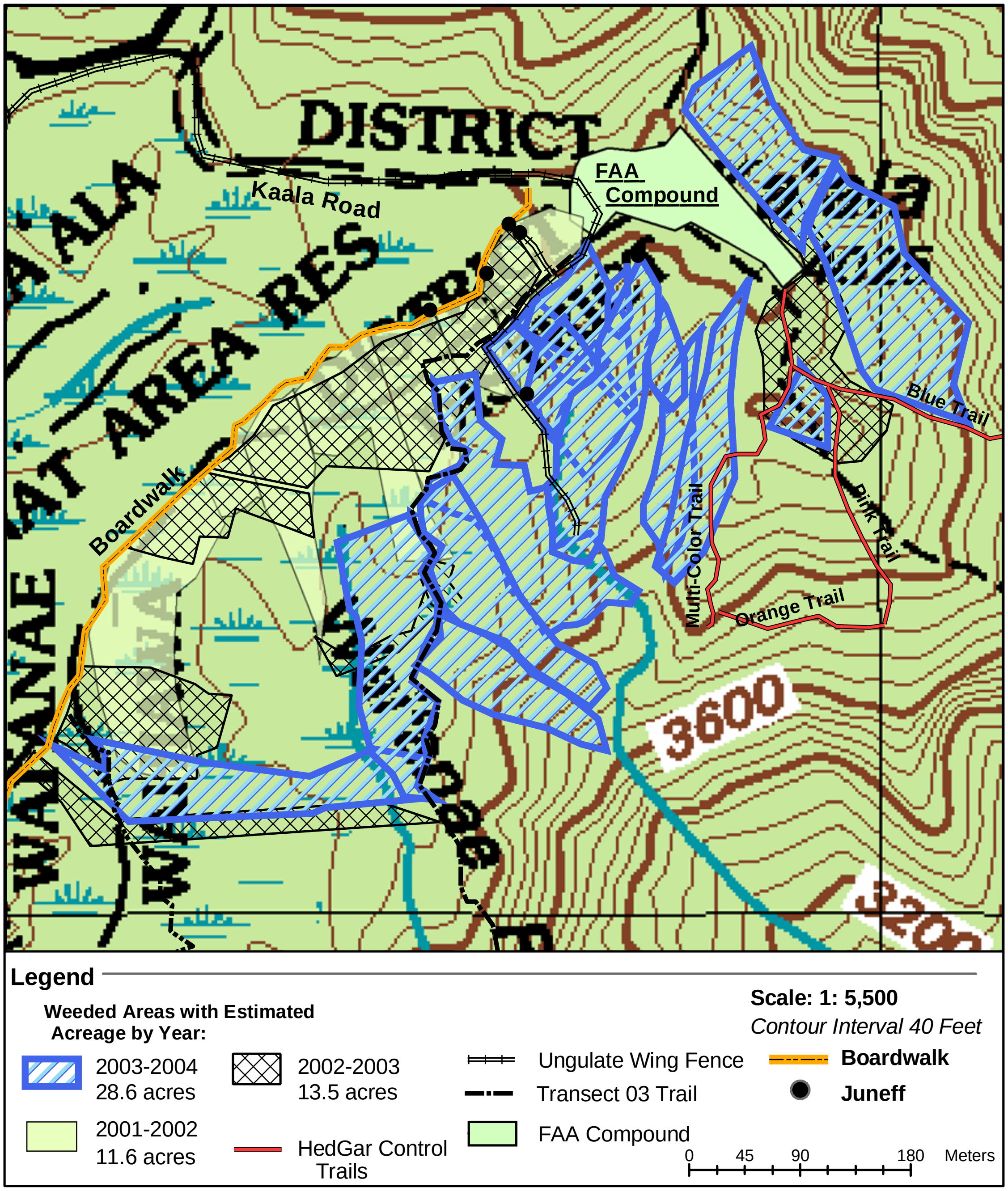
c) ***Elaeocarpus grandis* (Blue Marble).** A single *E. grandis* was known from the area around an old bunker just outside the FAA exclosure. This tree may have been part of an ornamental planting. NRS treated the lone tree with herbicide in September 2002, and retreated it in May of this year. No *E. grandis* have been found within the Ka`ala bog flats. The following series of actions is recommended for this species:

1. Re-visit location of single tree and continue to retreat tree as necessary to insure its demise.
2. Conduct surveys for other *E. grandis* via widespread sweeps for *H. gardnerianum* and *P. cattleianum* and destroy any plants discovered.

d) ***Juncus effusus* (Japanese mat rush).** The distribution of *J. effusus* in the Mt. Ka`ala bog is limited by appropriate habitat. Continued surveys are needed to determine the full extent of this weed throughout the bog flats. Two new populations were discovered this year outside of where it is known from the north end of the boardwalk. See Figure 2-9 State NARS Biologist Talbert Takahama observed *J. effusus* along trails on the State-owned portion of the bog. This species is a documented pest in other natural areas, including Hakalau Forest National Wildlife Refuge. NRS believe that *J. effusus* has the potential to spread beyond its current distribution within the bog, although its spread may be limited by appropriate habitat. The following series of actions is recommended for this species:

1. Determine the extent of the *J. effusus* population in the Mt. Ka`ala vicinity by conducting ground surveys and interviewing the NARS Biologist.
2. Research control techniques for this taxon. Reference control work conducted elsewhere in Hawaii. Conduct control trials.
3. Assess the feasibility of complete eradication of population and define control goals for bog flats.

Figure 2-9. Ka`ala Weed Control Areas



e) ***Setaria palmifolia* (palm grass).** *Setaria palmifolia* has been reported from the bog flats. The following actions are recommended for this species:

1. Search for *Setaria palmifolia* while conducting sweeps and surveys for other incipient weeds and interview NARS Biologist.

f) ***Festuca arundinacea* (grass).** Last year, NRS discovered *F. arundinacea* along a roadside portion of the Ka`ala fenceline. The population extends along the uppermost part of the road to the FAA exclosure as well as along the road to the radio towers. This is a new island record for this species. According to The Nature Conservancy's Element Stewardship Abstract on the taxon, *F. arundinacea* prefers open habitats, is tolerant of water-saturated soils, and thrives in a variety of habitats. It produces allelopathic compounds which inhibit woody plant growth. It is a long-lived and strong competitor. It is unclear how much of a threat it poses to the forested bog; given available information, NRS feel the more conservative approach is to begin control now. The following series of actions is recommended for this species:

1. Determine the extent of the *F. arundinacea* population in the Mt. Ka`ala vicinity while conducting ground surveys for other insipient weeds and interviewing NARS Biologist.
2. Control population with RoundUp and observe effectiveness of control.

2. Target established weed species with relatively small populations for complete eradication. Create a Zero Tolerance weed list to guide effort.

a) ***Clidemia hirta* (Koster's curse).** While *C. hirta* is very widespread throughout the Wai`anae Mountains, it has a patchy distribution in the Ka`ala bog flats. NRS will maintain a zero tolerance policy for it in the control area. *C. hirta* is mainly dispersed by pigs and frugivorous birds. Pig dispersal will be eliminated once the ungulate fence is complete and any pigs within the exclosure are removed. Re-invasion via birds is inevitable, therefore control must continue on a regular basis to reach the short term goal for this species. The following series of actions is recommended for this species:

1. Conduct *C. hirta* control in conjunction with widespread sweeps for *H. gardnerianum* and *P. cattleianum*.

b) ***Sphagnum* Moss.** Although it has a limited distribution, *Sphagnum* is considered established in the bog flats. There are two core *Sphagnum* populations. One population is spread along the boardwalk, from the 120m tag to the 500m tag. The second population is located along the upper reaches of the Makaha stream. The Makaha population stretches from approximately 4,000 ft. elevation to 3,800 ft. Besides these core sites, NRS know of one outlying site along the old boardwalk, and the NARS Biologist, Talbert Takahama, knows of other satellite populations. Preliminary results using hydrated-lime (Calcium hydroxide CaOH), an experimental moss control substance have had positive results. These experiments have been conducted by staff horticulturalist Dave Palumbo, and are discussed in section 3. At this point in time, a control technique has yet to be identified for *Sphagnum* moss. Some manual and chemical control plots have been established; they are ongoing. See section 3 below for details. A large portion of the Makaha population is in standing water and thus may require special control techniques. Control goals will be established once NRS have defined control techniques. Where possible, NRS will coordinate volunteer help for this project. The following series of actions is recommended for this species:

1. Institute a formal *Sphagnum* sanitation protocol to prevent NRS from tracking it to new locations. Ensure that volunteers are educated about the threat of human-dispersal of *Sphagnum*.

2. Continue to investigate control of *Sphagnum* using hydrated-lime.
3. Determine the feasibility of controlling any satellite populations. Assess the extent of *Sphagnum* within the bog outside the two core populations and map with GPS. Interview the State NARS Biologist and conduct ground surveys as needed.
4. Determine the feasibility of controlling the *Sphagnum* core populations once a control technique is developed.
5. Control satellite and core populations with new control technique if proven successful. If technique is proven successful, approach State NARS Biologist about applying technique on the State side of the bog.

c) ***Psidium cattleianum* (strawberry guava).** While *P. cattleianum* is a very widespread weed on the slopes below the Mt. Ka`ala bog, it has a patchy distribution in the bog flats. NRS will maintain a zero tolerance policy for it in the control area. *P. cattleianum* is primarily dispersed by pigs and frugivorous birds. Pig dispersal will be eliminated once the ungulate fence is complete and any pigs within the exclosure are removed. Re-invasion via birds is inevitable, therefore control must continue on a regular basis to reach the short term goal for this species. It is very difficult to see and identify *P. cattleianum* amongst the thick native forest of the bog. Only experienced volunteers should be enlisted for sweeps or control may be ineffective. This year, NRS spent 174 person hours surveying 8 acres. Control efforts have been limited somewhat by weather conditions; herbicides cannot be applied in the rainy conditions characteristic of Ka`ala. To effectively cover large areas, NRS use the sweep method, described in the Kahanahāiki MU discussion above. Compasses are vital for maintaining bearings, and a GPS unit is vital for tracking management. NRS installed metal tags every 20m on the boardwalk. These tags serve as markers. The sweep method has proven very effective at locating various, sometimes unexpected, alien weeds, treating them, and giving NRS a better idea of conditions in Ka`ala bog. The following series of actions is recommended for this species:

1. Determine best method for defining and designating control areas on a yearly basis.
2. Conduct *P. cattleianum* control via new method.

d) ***Rubus argutus* (blackberry).** *R. argutus* is very widespread on the slopes surrounding the Ka`ala summit, as well as on the bog flats. In the bog flats, most of the plants are scattered, but there are occasional small thick patches of *R. argutus*. NRS will work towards a zero tolerance policy for it in the bog flats control area. Achieving this goal may take longer than for other species because of its extensive distribution. *R. argutus* is mainly dispersed by frugivorous birds. Re-invasion via birds is inevitable, therefore sweeps must continue on a regular basis to reach the short term goal for this species. The following series of actions is recommended for this species:

1. Conduct *R. argutus* control using methods detailed in section 3 via widespread sweeps across the bog flats.
2. Identify focus areas to target with volunteer groups.

3. Support biological control development. Contact Dr. Don Gardner and other researchers to determine the best approach for acquiring a successful biological control for *R. argutus*.

3. Develop protocols to treat species which NRS don't currently have a means of controlling.

b) ***Sphagnum* Moss.** Plots testing the efficacy of three non-chemical control techniques were established along the Mt Ka`ala bog boardwalk in January of 2003. Treatment using a hydrated-lime compound was added in November of the same year. Eight non-chemical one-meter plots were installed; two for each treatment method, and two control plots. The newer hydrated-lime plots were installed further down the boardwalk at a separate *Sphagnum* population. They consist of five one by four meters plots, each plot testing five different concentrations of hydrated-lime. The test treatments are:

1. Hand removal.
2. Smothering all *Sphagnum* with a layer of sawdust.
3. A combination of the above methods; pulling the green layer of moss and then coating with sawdust.
4. Spraying with a hydrated-lime compound solution.

While only two trials of each treatment will not give enough data for statistical analysis, at this stage NRS are mainly interested in a simple yes or no—does the treatment clearly and effectively work? Or not? Observations indicate the original three treatments are effective in reducing *Sphagnum* cover to varying degrees in the short term. However, the treatments' effectiveness in the long run, determined by the number of revisits necessary to eradicate a population, is poor. NRS observed regrowth at all plots. The fourth trial using the Hydrated Lime has shown very promising preliminary results after two treatments. Responses varied in effectiveness based both on precipitation levels during treatment, and percentage of the compound mixed per five-gallon backpack sprayer. Each of the test plots one through five make an incremental increase in concentration. Results show a corollary relationship between the concentration of Hydrated Lime per plot and reduction in *Sphagnum.* NRS also monitored these treatments for their impact on native plants inside the test plots, and took soil samples that were submitted to the *University of Hawaii's College of Tropical Agriculture Diagnostic Service Center* in order to test their pH levels. Test results from the soil samples showed an initial minimal pH fluctuation, follow up testing showed levels returned to normal. Monitoring of native vegetation within the treatment areas indicated no negative impact. Plots with the highest concentration of CaOH (plot 5) displayed the greatest degree of success. Also, within this plot, native seedling (*Metrosideros*) recruitment was noted on dead/dying *Sphagnum*. Widespread use of hydrated-lime as a *Sphagnum* control is pending further study and collaboration with the Department of Agriculture. NRS will continue to monitor the plots, noting effectiveness in long-term eradication of *Sphagnum*, and watching for any impact on native vegetation.

c) ***Juncus effusus.*** Research will be conducted to determine what methods other managers use to control *J. effusus*. Two informal plots were installed on 6/25/2003 to test the response of *J. effusus* to two different herbicide applications: 2% Glypro+, and a mixture of 2% Glypro+ and 2% Garlon 3A. The plots were monitored 7/14/2003 and 11/18/03. Plants treated with the 2% Glypro+ died. Plants treated with the mixture were mostly dead, however some retained color towards the center of the blade. Although the mixture treatment may work, it appears the 2% Glypro+ method is more effective. NRS will conduct another round of tests to insure the effectiveness of this application.

d) ***Rubus argutus.*** The Nature Conservancy's Element Stewardship Abstract for *R. argutus* calls for a more complete study of control techniques for this taxon. Control methods discussed in the Abstract had low efficacy. Foliar sprays of 2% Round-up and Escort (28g/L) resulted in 50% mortality of *R. argutus*. No well-monitored trials of cut stump treatments had been performed. OISC has achieved 80% kill with a 2% spray of Round-up Pro on related *Rubus discolor*. To gain more information, NRS installed 4 small trials on 6/25/2003 and another on 1/07/04. The trial treatments are:

1. R1: Cut stump treated with 20% Garlon 4 in FCO.
2. R2: Foliar spray of 2% Glypro+.
3. R3: Foliar spray of 2% Glypro+ and 2% Garlon 3A mix.
4. R4: Foliar spray of 2% Garlon 3A.
5. R5: Foliar spray of 2% Round-up Pro

The plots were continuously monitored until 3/18/04. The R1 plants did not show any resprouts. The R2 plants had seven stems with new leaf buds. The R3 and R4 plants were both dead. The R5 plants seemed virtually unaffected by the treatment, except for some yellowing of the leaves. Based on these results, treatment methods R1, R3, and R4 appear the most viable means of control. NRS will conduct another round of tests to insure the effectiveness of this application.

e) ***Hedychium gardnerianum.*** Last year NRS set up six trial treatment methods. See RCUH Final Report 2003. Conclusions from these treatments indicate the most effective treatment of *Hedychium gardnerianum* is to cut stalks, clear and then slash rhizomes and spray with 1.5g/L Escort.

Monitoring

Current monitoring efforts are described above in section 3. Past monitoring efforts centered on the development of a *H. gardnerianum* biocontrol. NRS are particularly concerned about the ginger invasion of Mt. Ka`ala. NRS have worked with Rob Anderson (a research assistant in PCSU at the University of Hawaii), who developed a ginger-specific bacteria. This control technique would be ideal; it is completely non-toxic, and affects only ginger. In theory, it infests the ginger clone to which it is applied, eventually killing its host. Unfortunately the treatment has had disappointing results at Ka`ala. See PCSU report 2002 for a discussion of Mr. Anderson's work. However, based on recent discussions with Mr. Anderson regarding the improved efficacy of his work with ginger, we would like to renew control efforts along these lines.

2.8.c South Range MU

Surveys

No new weeds were found along military training roads in South Range this year.

Control

In SBS, control centered on *Senecio madagascariensis*, a newly discovered weed, and two areas of native forest that are home to several endangered snail species. One of these patches was fenced this year, warranting the increase of weed control effort. 20 person hours were focused within the more native areas of this exclosure to improve the habitat for the endangered snails found there. NRS make regular collections of two common species, *Urera glabra*, and *Pipturus albidus*, for future outplanting in the large, weedy, open area within the exclosure to compliment weeding efforts. Much else of SBS is a patchwork of weeds and native areas, and does not merit weed control at this time.

Native to South Africa and Madagascar, *S. madagascariensis* is a huge problem in Australia, where it poses serious threats to the livestock industry. In the state of Hawaii, it is found on the Big Island, Maui, Kauai, and Oahu. *Senecio madagascariensis* contains pyrrolizidine alkaloids which are toxic to livestock. It spreads quickly, the seeds persist in the soil, and thus it is difficult to eradicate. *Senecio madagascariensis* was first identified as a problem at Parker Ranch in the 1980s and has since spread to Waimea, North Kona, Ka`u, and along the Saddle Road. NRS suspect that *S. madagascariensis* entered SBS by either an Army vehicle contaminated with seed from Pohakuloa Training Area on the Big Island, or as seed that was part of a seed mix used in erosion control efforts at the site by the Integrated Training Area Management (ITAM) program. NRS are following up with ITAM to see if the seed mix was used at any other locations. The infestation covers approximately 1.5 acres.

Due to the fact that this weed is an agricultural pest and not a threat to natural resources, NRS decided to hand the project over to ITAM, who will take the lead in regular control efforts to eradicate *S. madagascariensis.* NRS have however agreed to assist in large spraying efforts; NRS spent 15 person hours this year handpulling and spraying the site.

Monitoring

No weed monitoring plots have been established in South Range

2.8.d Pu`u Hāpapa MU

Surveys

No new incipient weeds were observed on NRS' Pu`u Hāpapa LZ.

Control

In the snail site just below the ridge crest of Pu`u Hāpapa 5 hours were spent this year weeding in a weedy snail 'hotspot'. Several rare and endangered plants are also found in this mostly native area. NRS plan to increase weeding efforts here in the coming year.

Monitoring

No weed monitoring plots have been established on Pu`u Hāpapa.

2.8.e East Range MU

Surveys

No new weeds were found during surveys conducted this year. The weed population in the region has been stable in past years (See Appendix 2-D Weed Surveys Roads and Landing Zones, Schofield Barracks Military Reservation).

Control

All control efforts are discussed in the Schofield-Waikāne MU section below.

Monitoring

No weed monitoring plots have been established in East Range.

2.8 f Schofield-Waikāne MU

Surveys

There are two LZs and one ungulate transect in the MU. Due to helicopter restrictions, only one landing zone survey was conducted within the MU at Puu Ka'aumakua West. No new incipient weeds were discovered on this survey or on the ungulate transect. Several years ago NRS discovered a moss suspected to be Sphagnum, however, this moss has not been sighted in the last few years. NRS will remain vigilant in their efforts to locate this moss, if it exists in the area.

Control

There are two known incipient populations and a third possible population of seeding white ginger (*Hedychium coronarium*) in the Schofield-Waikāne MU. The two known populations are located at the summit of the Schofield-Waikāne trail and Pu`u Ka'aumakua. The possible third population is north of Pu`u Pauao. Control has been focused on the trail population. The presence of the third population has yet to be confirmed; NRS plan to survey north of Pu`u Pauao to investigate an area which was reported to have ginger in the past. Helicopter restrictions limited control work this year.

NRS will continue with efforts to contain the population of *Hedychium coronarium* that appears to be spreading up from the back of Kahana Valley where the species is widespread. In 1999, NRS adopted a zero tolerance policy for ginger on the leeward side of the summit. This year, NRS discovered and pulled one plant on the upper windward side of Haku Lei Ridge. With the resumption of helicopter use in the area NRS will continue the use of aerial and ground surveys, which have resulted in the discovery of satellite populations in the past.

Monitoring

No monitoring projects are being conducted in the area at this time.

2.9 Kawailoa Training Area

Surveys

No new weeds were discovered during road surveys for KLOA-1 through KLOA-6, with the exception of *A. ciliatum* in KLOA-4. As KLOA-3 is no longer used for training, the road is no longer drivable past the top section of the upper pasture. NRS will discuss the discontinuation of surveys in this area. Last year NRS decided to add another road survey running from the junction of Kawailoa and Drum Roads, through Ashley and McCormick gates, to the intersection of Pupukea Road. As this year was the first NRS surveyed what is now referred to as KLOA-7, all weeds documented will serve as the basis to which future weed observation will be compared. With the projected increase in traffic for this area, the potential for dispersal of new incipients is high. NRS will watch this area closely.

There are eight military LZs surveyed in this MU (Appendix 2-E). These LZs are surveyed every year. No new incipient weeds were discovered on any of the military LZs.

Weed surveys along ungulate transects, and remaining LZ weed lists will be discussed in the appropriate MU section.

Control

Weed control in KLOA is focused on MUs, *A. ciliatum* along the Poamoho Road (KLOA-4 & KLOA-5), and the *Tibouchina urvilleana* infestation at Whitmore village. NRS spent 197 hours treating 22 acres in Kawailoa. This is significantly less than last year. Overall, management efforts in KLOA suffered severely from the suspensions of helicopter operations imposed by the Range Safety Office. Operations were suspended from December 2003 through early 2004, following a helicopter accident, until safety concerns by the military safety office were addressed. Much of the area is only accessible via helicopter, and without this support, trips to many areas within the MUs were severely limited. This year marked the inception of another MU, Helemano, located directly south of the Upper Pe`ahinai`a MU. Management of all the MUs, will be described in the MU sections below. Southwest of Pu'u Kainapua'a, there is a large, distinct population of *L. scoparium*. NRS will coordinate with OISC to scope the population and determine whether control is feasible at this site.

1. *Arthrostemma ciliatum*, Poamoho Road, Lychee Field Road. *A. ciliatum* was first detected in 1998 along the Poamoho Road, KLOA-5. It appears the *A. ciliatum* may be widespread in gulches in the area. Rather than completely eliminating the species from the area, NRS hope to keep it off the road, and thus prevent its spread via road traffic to native areas; if it were tracked to the Poamoho Trail at the end of the road, it could be tracked by hikers all the way to the summit. NRS also discovered *A. ciliatum* this year off the road, past the lychee field towards the bottom of a gulch along KLOA-4. All locations were sprayed with a mixture of Garlon 3A and

Round-up. Pest control has appeared to be very effective. No live, treated plants were found at previous known sites this year. These populations will be monitored and controlled quarterly in the coming year.

***2. Tibouchina urvilleana* and *Ilex cassine,* Whitmore Village.** Just above Whitmore Village, at the site of a former nursery, there is a population of *T. urvilleana*. This is the only known naturalizes site of this taxon on O`ahu. *Tibouchina urvilleana* is a major pest on the Big Island, and NRS are eager to prevent its establishment on O`ahu. Previous control efforts have completely rid the site of reproductive plants. The number of seedlings found on each trip is declining. This year, the area was visited two times and six hours were spent surveying the seven-acre site. In January 2004, two new sprouts were found, extracted and treated with Garlon 4. These sprouts on close inspection appeared to have grown from minute lateral fragments of former plants. NRS will continue to survey the site twice a year and remove any plants found.

There is also a population of *Ilex cassine* at the Whitmore site. Two years ago, this population was mapped and determined feasible to control. Based on information collected from trials, NRS has decided to eradicate this population. NRS will employ basal and girdle applications of 20% Garlon 4. After the initial eradication has been conducted, subsequent trips to the population will occur twice a year to monitor and retreat the population as necessary.

Monitoring

The plots described in Table 2-6 below are being monitored in KLOA. Plot analyses are included in MU discussions.

Table 2-6: Weed Plot Summary Kawailoa Training Area

Area/Plot	Purpose	Treatment	Results
ITAM plots Upper Pe`ahināi`a MU,	Long term vegetation monitoring to determine trends and direct management	None	Ongoing.
Pe`ahināi`a Castle MU,	Determine the effect of pig removal on *Pterolepis glomerata* and native species	Fencing and pig removal from within the fence	Inconclusive See 2.9.b.
Clidemia Plots Lower Pe`ahināi`a MU	Determine effect of removing climax *Clidemia hirta* on native vegetation with respect to level of ungulate control. Investigate potential of *C. hirta* to recolonize.	Removal of *C. hirta* from plot area using clip and drip method with 20% Garlon 4.	Installed February 2003. Ongoing.
Psidium Plots Lower Pe`ahināi`a MU	Determine most efficient and effective concentration of Garlon 4 on *Psidium cattleianum* in wet environment.	5 different concentrations of Garlon 4 used to treat dense *P. cattleianum* stands: 20%, 30%, 40%, 50%, and 60%. Treatment methods used include cut stump, girdle, and basal application.	Installed February 2003. Ongoing.

2.9.a Poamoho MU

Surveys

No weed surveys are conducted in this MU.

Control

The Poamoho MU encompasses wet summit forest and is accessible by the Poamoho Trail. Weed management in the MU is focused on an isolated population of *L. scoparium* (manuka). In 1995 this canopy tree was well established along the Poamoho Trail, stretching from the summit two miles down the trail, and extending into the drainages on either side. NRS began control in 1996. Manuka is effectively controlled without herbicides; pulling up small plants and cutting down large plants is effective. Most of the mature trees in the mauka portion of the range have been removed, although seedlings remain, especially around old flowering trees. This year, NRS spent no time controlling the manuka population at Poamoho.

In the past, work has focused on treating outlying plants located during aerial surveys. NRS use GPS to navigate to these outliers. Controlling these last widespread remnants of the population is time-consuming and intensive. In the coming year, NRS will visit the area, resurvey previously treated areas for seedlings and will re-take the photo point at the original core of the population to document progress. In addition, NRS will develop a monitoring schedule for revisiting treated areas and resurveying the area via helicopter. Manuka can flower when it is less than a meter tall and the seeds are wind-dispersed. Treated areas, both outlier and core, will be monitored every five years, and aerial surveys will be conducted every five years as well. Control of the Poamoho population will now primarily focus on monitoring and intermittent maintenance.

Monitoring

No plots have been established in the Poamoho MU.

2.9.b Upper Pe`ahināi`a MU

Surveys

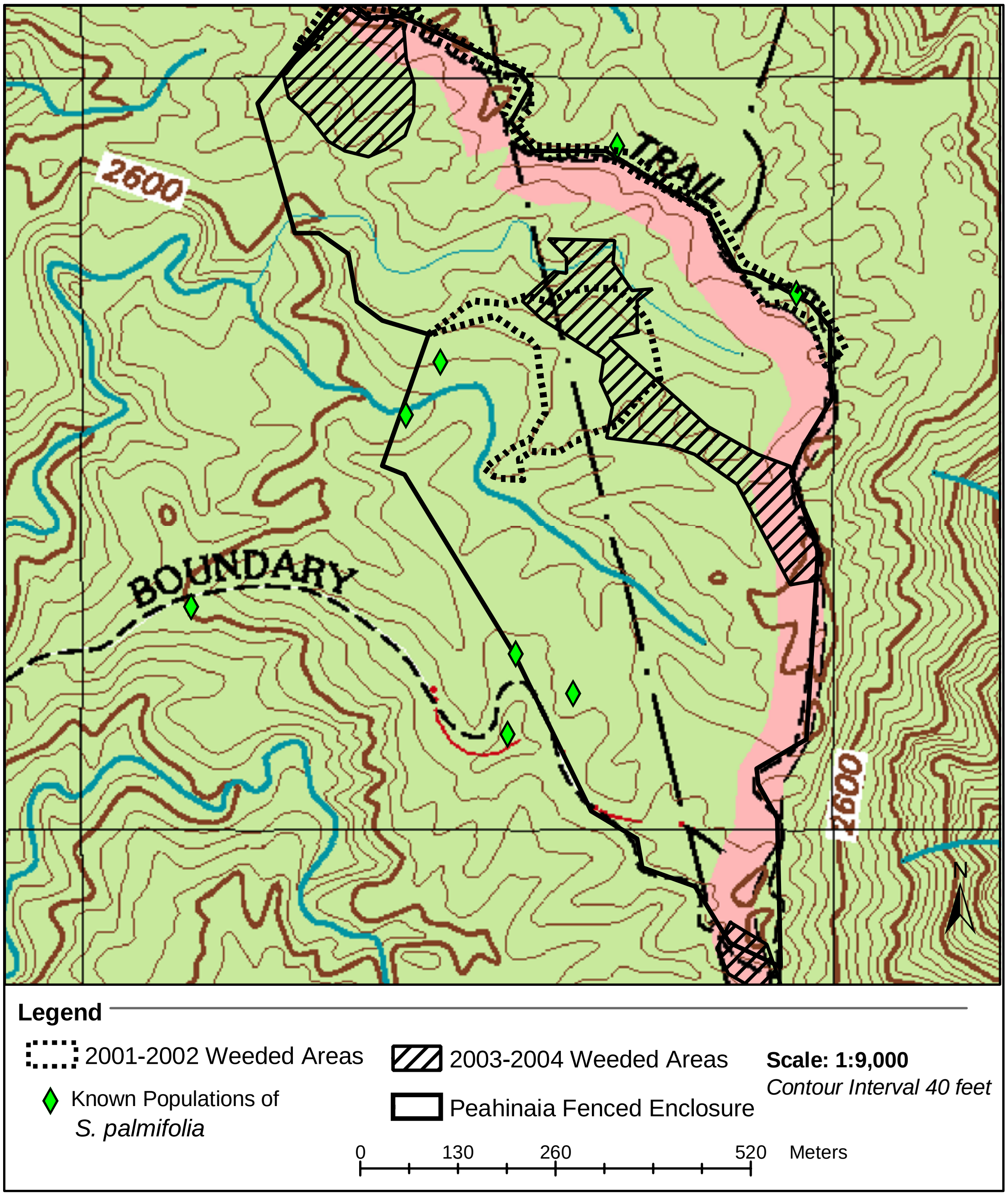
No new incipient invasive weeds were detected at the Pe`ahināi`a summit or Weatherport LZs or along ungulate transects KLO-12 or 14 this year.

Control

In May 2001, the `Ōpae`ula exclosure was completed. It is the first ecosystem-level exclosure in the Ko`olau Mountains. NRS weed management efforts in the area focus on the only widespread canopy weed, *P. cattleianum*, and on several sites where *S. palmifolia* (palm grass) grows. NRS spent 93 hours controlling these species this year. Additional problematic species in the area include *Axonopus fissifolius* and *Pterolepis glomerata*. These are opportunistic species that thrive in pig-disturbed areas. *Axonopus fissifolius* is considered the worst of the two because it produces a dense carpet which completely inhibits the germination of native species. Plots have been installed to determine control options for this species. *P. glomerata* presents a greater challenge to control because it is often tangled in native vegetation and therefore is difficult to control by spraying with herbicides. NRS are hopeful, now that pigs have been excluded from the area, that native species will be able to reclaim areas dominated by *P. glomerata*. Control efforts were severely limited by a halt on helicopter operations imposed by the Range Safety Office.

NRS have been slowly killing *P. cattleianum* in Upper Pe`ahināi`a since management has begun in this unit, however, documentation and planning of these efforts has been more easily facilitated since the `Ōpae`ula exclosure has been built. NRS spent 75.5 hours treating *P. cattleianum* in the exclosure this year. At lower elevations, *P. cattleianum* is typically a tree that produces abundant fruit and forms large groves. However in the summit environment, it forms short-statured, dense clumps, and produces few fruit. *P. cattleianum* clumps were treated either with a basal application of 20% Garlon 4, or the cut-stump method. NRS have observed slash from earlier treatments resprouting in the wet environment, therefore, if the cut-stump method is used, both the stump and the slash are treated with Garlon 4, and the slash is propped above the ground. Heavy rains seem to affect efficacy, so NRS try to perform weed control only in dry weather. Since dry weather is rare in the Ko`olaus, weed control is limited. To effectively track treatment, NRS and volunteers frequently use a GPS to mark the area treated. In the past, special attention has been paid to the summit trail, where pigs, one of the primary dispersers of *P. cattleianum*, typically run. In the future, NRS plan to conduct and map results of aerial surveys to better plan where to focus weeding efforts, as well as to use the 2 streams and gulches in the exclosure as boundaries to track weeding. This year no time was spent treating *P. cattleianum* along the summit trail, however NRS plan to treat this area in the coming year.

Figure 2.10. Upper Pe`ahināi`a Weed Control Sites



There are six known small populations of *S. palmifolia* within the exclosure and two sites outside the exclosure. Seventeen hours have been spent controlling *S. palmifolia* at these sites last year. Last year NRS also discovered a very large *S. palmifolia* population in the South Helemano drainage, within the neighboring proposed Helemano exclosure. This site is only about 30 meters away from the fence, closer to the exclosure than the Pe`ahināi`a trail population that has been treated for several years. Since this find, NRS are reevaluating the true extent of this weed. NRS hope that eradication of *S. palmifolia* within the exclosure is still feasible with consistent control and monitoring at known sites. However, NRS may no longer treat nearby populations outside of the fence as incipient populations, which would necessitate eradication wherever found. Until a decision is made about how to address this large population, NRS will continue to visit smaller known populations on a regular basis. The plants are pulled, bagged, and flown out. It is difficult to locate the plants in the thick vegetation; consistent monitoring is necessary to ensure good coverage. Control efforts are summarized in Table 2-7.

Table 2-7. Summary of *Setaria palmifolia* Control, Upper Pe`ahināi`a.

Site	Plants Treated October 2002	Plants Treated January 2003	Plants Treated August & October 2003	Plants Treated May 2004	Comments
Tr. 12-260	15 mature, 65 immature	2 mature	9 mature	2 mature, 1 immature	Population slowly shrinking. Continue monitoring.
Tr. 12-370	0	0	0	1 mature	Needs continual monitoring.
Hypalon		First control at site. 1 immature	0	0 plants found	Possible that removal of one and only plant found at this site effective eradication. Will continue to monitor this year.
Goosehead Ridge	10 mature, 20 immature	0	0	1 mature, 1 immature	Population shrinking.
Pe`ahināi`a trail	90 mature, 42 immature	Many immature	25 mature, 110 immature	1 mature, 1 immature	This was the largest of the five sites; the population has shrunk significantly.
Tr. 14- 290	3 mature	Not visited	0	5 immature	Population shrinking. Continue monitoring.
Shaka		First control at site. 1 mature, 2 immature	Not visited	Not visited	Site not revisited for Palm Grass since initial finding. Continue monitoring.
Helemano Drainage			Huge bowl of Palm Grass discovered 8/03		Control of this population still being considered.

Monitoring

ITAM vegetation monitoring plots. ITAM personnel have accompanied NRS to the Pe`ahināi`a MU on two occasions, October 1998 and August 2000. On both these trips, random monitoring plots were installed. This monitoring data will not only illustrate trends in the area, but will also be extremely valuable in shaping future management. Although hampered by staff limitations, ITAM recently acquired additional personnel to continue the monitoring program. NRS will continue to encourage ITAM to work cooperatively with NRS. NRS will also request a copy of the data from these plots from ITAM.

In the coming year, a new fence will be constructed in the Helemano drainage, adjoining the Pe`ahināi`a fence. NRS will consider installing vegetation monitoring plots in the area prior to fencing, in order to observe the affects of excluding pigs on native vegetation.

2.9.c Lower Pe`ahināi`a MU

Surveys

No new incipient invasive weeds were discovered at either the Pu`u Curta, Pu`u Roberto, or Frog Pond LZs, or along ungulate transects KLO-5 and KLO-13 this year.

Control

The Lower Pe`ahināi`a MU is unique. It is located in mid-elevation, mesic to wet forest on the leeward Ko`olau slopes. It is a large MU, and much of it is covered by native vegetation. The western end of the MU includes a unique, tall native forest and an open pond, nicknamed Frog Pond. The eastern portion is made up of patchy native forest and uluhe banks on the steep slopes of Ōpae`ula stream. The eastern end of the MU is very typical of other leeward Ko`olau slopes, while the Frog Pond area is atypical. The species diversity and physical structure of the habitat make the area important. There are few ecosystem-altering weeds in the MU, but those that are present are very abundant. They include *P. cattleianum* and *C. hirta*. In the past, weed control has focused around the unique Frog Pond area. Control efforts expanded significantly early this past year; approximately 90 hours were spent over 2 days weeding these two weed species.

While weeding activity in the area has increased over the last couple years, NRS are strongly concerned about the ungulate presence in the region. The region is remote enough to discourage many hunters. Pigs act as vectors for many weeds and encourage the growth of weeds by tilling the soil and opening areas in the native forest. In the past NRS have observed a correlation between weeding and increased pig activity. Clearing weeds gives pigs easier access to areas and their presence is detrimental to the delicate understory. Given the interaction between weeds and ungulates, NRS plan to fence the Frog Pond area with in the next two years. Excluding pigs will prevent digging in weeded areas, reduce the spread of weeds, and allow the native forest to regenerate. Until this fence is built, NRS will hold off on large scale weeding projects that might attract pigs. The creation of an exclosure in Lower Pe`ahināi`a is an important step in restoring this patch of unique forest.

NRS are developing a weed control plan for Lower Pe`ahināi`a to better direct management efforts. The discussion of control done in the past year is included with the draft Lower Pe`ahināi`a Weed Control Plan below.

<u>Lower Pe`ahināi`a Weed Control Plan</u>

Long Term Objective

In the Lower Pe`ahināi`a MU the long-term objective of management is to restore the area to 100% native canopy and in select areas, 90% native understory. Complete eradication of all weed species in an area, as always, is a difficult goal. The two primary weeds in the MU, *C. hirta* and *P. cattleianum*, are well established in the general area and are probably well represented in the seed bank. However, there are few other weeds threatening the area. NRS will focus efforts on *C. hirta*, *P. cattleianum*, and any other invasive weeds. Non-ecosystem altering weeds will not necessarily be control targets. NRS spent no time weeding in Lower Pe`ahināi`a this year.

Short Term Objectives

In order to work towards our long-term objectives, NRS will maintain an adaptive list of short-term objectives. This list will guide current management efforts.

1. **Prevent new invasive alien species from becoming established.**

The diversity of weeds in the MU is low. Most of the weeds present are well established, not incipient. NRS will monitor ungulate transects and landing zones for new weed species. Any species found will be evaluated and controlled as necessary.

2. **Target ecosystem-altering species for focused control efforts. Create a High Priority List to guide efforts. Investigate control methods for these species.**

Due to the low weed diversity of the MU, the High Priority List is short: *Psidium cattleianum* and *Clidemia hirta*. NRS installed plots this year to learn more about control methods for both species, and the effects of control on the surrounding environment. These plots are discussed in detail in the Monitoring section below.

3. **Outline an approach to the proposed exclosure area. The exclosure will contain populations of endangered plants and unique diverse tall native forest. It is the area most threatened by weeds and ungulates.**

Weed control efforts will focus on the proposed exclosure area, which includes Frog Pond Flats and the ridge above it. This high priority area will greatly benefit from increased attention. NRS feel that weed control is not worth performing in un-fenced areas, given the high level of pig activity in the area. Weeding will resume once the exclosure is constructed.

a) **Create a detailed map of weedy and native areas. Use Trimble GPS for greater accuracy. Install management trails to facilitate management.**

In August 2003, the core *P. cattleianum* population and some other landmarks were mapped. A combination of GPS maps and schematic maps may be most useful in creating a guide to the Frog Pond area; GPS reception can be poor in the drainage. The *P. cattleianum* map using both mapping methods will be refined and extended to include the entire proposed fenceline in the coming year.

b) **Focus around endangered plant populations.**

The proposed fenceline encompasses three endangered species, *Melicope lydgatei*, *Gardenia mannii* and *Phyllostegia hirsuta*. Clearing *C. hirta* may draw pigs in to an area. Once the fence is complete, weed control will focus around these resources.

c) **Identify and target areas with 80% native cover as high priority weeding sites. Direct control efforts to achieve 100% native composition.**

i) **Frog Pond Flats.** The majority of weed control effort has been centered on the Frog Pond area. This region encompasses the heart of the tall, structured, native forest in the MU, as well as several *G. mannii* and *M. lydgatei*. The core population of P. cattleianum borders the southern side of the flats. The east side of the flats is bordered by Frog Pond. Small stands of *P. cattleianum* are scattered through the flats, and most of the area is covered by a blanket of *C. hirta*. In Frog Pond Flats, NRS feel that achieving 100% native canopy and 99% native understory is achievable, if ungulate impacts can be minimized. Weed control in the area will begin in earnest after the construction of the exclosure. NRS feel that all weeds can be eradicated because of the tall native overstory is so intact.

ii) **Pu`u Melicope.** Located on the ridgeline, Pu`u Melicope encompasses a small patch of native forest surrounded by uluhe. The forest includes a number of common native species, as well as *G. mannii* and *M. lydgatei*. Much of the understory is blanketed by *C. hirta*. NRS will target this site after the exclosure is constructed.

d) **Develop restoration goals for predominantly weedy areas. Direct control efforts to achieve 100% native composition.**

i) **Core *P. cattleianum* population.** A large population of *P. cattleianum* stretches from Frog Pond, below Pu`u Curta, to the saddle between Pu`u Curta and Pu`u Persicifolia. The population was mapped in August 2002. While the core population covers a large area and is fairly dense, native trees are sprinkled throughout it. In fact, on aerial surveys NRS observed that a native canopy persists over the *P. cattleianum* canopy. NRS are optimistic that native species will recolonize the core population. So far, control has focused on the perimeters of the patch. NRS observed some slash resprouting, and some trees that were still alive. Heavy rains may adversely affect control efficacy. For maximum efficiency, weeding efforts should only occur in dry weather. Both the cut stump and cut end of the tree should be treated with Garlon 4 to prevent this. Other methods, including basal application and girdling, do not produce slash and thus may be safer to use in this environment.

ii) ***Lantana camara* patch.** Beside Frog Pond there is a large patch of tall *L. camara*. The population appears to be stable and thus is not a high priority for control at this time. Eventually, NRS hope to eradicate this patch. In the coming year, NRS will walk the perimeter of the patch, control any outliers, and ascertain the full extent of the infestation. Control in this area will focus on pushing back the edge of the patch to increase the size of the LZ and campsite.

iii) **Ridge between Pu`u Curta and Pu`u Melicope.** Except for a few nice areas in the saddle, this weedy ridge is of low weeding priority. Access trails along the ridge will be kept clear of weeds to slow dispersal from the area. The areas directly around the five *M. lydgatei* on the ridge and any patches of diverse native forest will be weeded.

4. Use volunteer labor for large-scale projects.

Since access to the MU is via helicopter, large volunteer groups are difficult to accommodate. However, the weed control projects are ideal for volunteers: terrain is relatively flat, and weed targets are easy to identify and plentiful. NRS will maximize use of volunteers once the exclosure is fenced.

Monitoring

Two different sets of monitoring plots were established in the MU in February 2003. One set of plots looks at the efficacy of different concentrations of Garlon 4 on *Psidium cattleianum* in the unique wet environment of Lower Pe`ahināi`a. The other set looks at the effects of weeding *Clidemia hirta* on *C. hirta* recruitment, and the interactions between weed control and ungulate activity.

1. *Psidium cattleianum* Plots. In response to poor kill observed in *P. cattleianum* treated with 20% Garlon 4 in FCO, NRS decided to test other concentrations of Garlon 4. Lower Pe`ahināi`a, while not as wet as the summit, does receive frequent rainfall. In order to increase efficacy, NRS installed five plots, each using a different concentration of herbicide, to see if a different concentration would be less susceptible to rain. Rains did occur before and after the plots were installed; whether or not the rain occurred directly following treatment is unknown. It is difficult to time weeding in this remote site with the desired environmental conditions.

Five different concentrations of Garlon 4 were tested: 20%, 30%, 40%, 50%, and 60%. Experimental methods are described in the 2003 PCSU report. On the last trip to the area, it was too soon after installation to conclude which treatment was most effective. This year NRS will monitor the plots and adjust treatment methods in response to the results.

2. *Clidemia hirta* Plots. A carpet of tall, climax *C. hirta* blankets much of the forested, flat area in the MU. NRS are interested in looking at several different processes related to *C. hirta* control and ungulate exclusion. *C. hirta* is the main understory weed in the MU. If it were eliminated, the area would be 99% native. It is unknown what will happen to this diverse, predominantly native forest when the dense understory of *C. hirta* is removed. Given the high current level of pig disturbance in Lower Pe`ahināi`a, controlling *C. hirta* may simply open the area, encourage more pig disturbance, and promote *C. hirta* regeneration. Observations of previously weeded *C. hirta* areas support this hypothesis. NRS hope to fence the MU in the next 1-2 years to remove the ungulate threat, but it is uncertain when this action will be approved.

Two plots were therefore established in the MU, one inside the proposed fenceline, and one just outside the proposed fenceline. Experimental methods are described in the 2003 PSCU report. The plots will help to answer immediate questions about *C. hirta* control and will track any changes, which result after fence construction. They will be maintained indefinitely, and read 2-4 times a year when NRS resume regular trips, depending on the rate of vegetation change.

2.9.d Helemano MU

Surveys

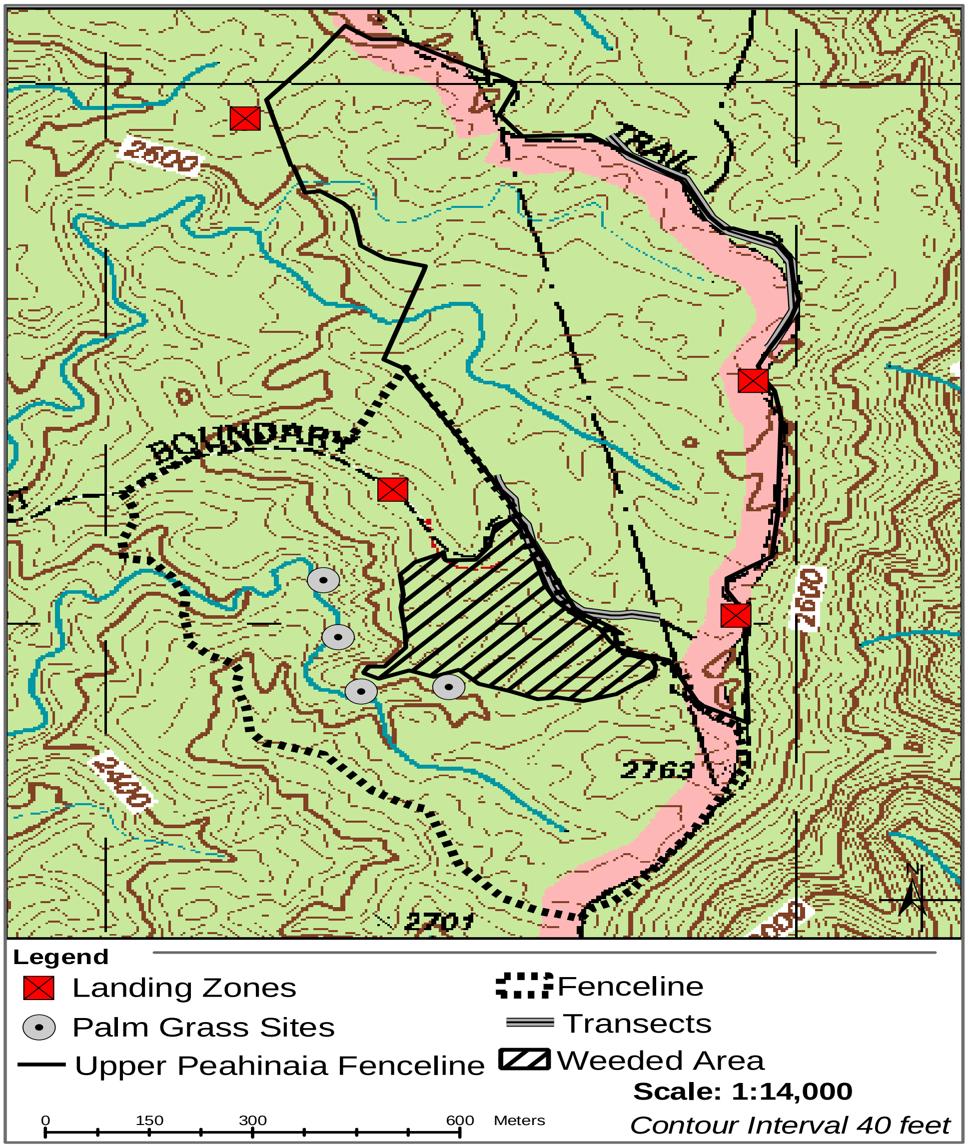
No surveys have been conducted in this MU.

Control

The Helemano MU is the newest addition to the Kawailoa Training Area. Like the Upper Pe`ahināi`a MU, it is a joint project undertaken by the Opae'ula Watershed Protection Project Partners. As this MU shares the southern extension of the Upper Pe`ahināi`a fence, it also shares many of the same geographical and ecological characteristics, as well as management strategies. The fenceline has been scoped, but construction is pending. Though the process is sometimes slow, with any luck the contract for the construction of the fence exclosure should get out to bid, and will be awarded to a fencing contractor within the year. Even without an exclosure constructed, NRS eager to begin protection of this pristine ecosystem have made some initial forays into the field. One of these initial surveys yielded the discovery of a population of *S. palmifolia* that has been treated and marked with GPS. With this discovery of multiple patches of *S. palmifolia* at this elevation within a proposed exclosure, NRS will have to modify its current management strategy for this weed. It is the intent of NRS to survey and map the entire MU for weeds such as *S. palmifolia*, *P. cattleianum* and others target weeds similar to Upper Pe`ahināi`a. With safety concerns having been addressed by NRS, renewed helicopter support will greatly enhance weed surveillance efforts and aid in identification of incipient weed populations in this area. Aerial surveys will also help partition MUs into readily identifiable geographical area's, which in turn help NRS track weed management activities.

NRS began control of *P. cattleianum*, one of the most widely dispersed target weeds within the MU. NRS have spent 53.5 hours treating about 18 acres in the eastern portion of the exclosure. This area was mapped with a GPS as to continue to track the progress of control efforts within the proposed exclosure. It was very encouraging for NRS to have covered such an extensive area in such a relatively short period of time. This suggests that even though ungulates still have access to the area, the extent of their ability to spread *P. cattleianum* has remained relatively low in this area. Treatment for target weeds in this MU will mimic those established and practiced in other MUs. Management activities in this area will most likely be limited to a minimum of two visits per year, and a maximum of four visits per year.

Figure 2-11. Helemano Weeded Areas



Monitoring

No monitoring projects have been established in this MU to date. NRS is considering the installation of vegetation monitoring plots prior to fencing the area, in order to observe the effects of excluding pigs on native vegetation.

2.9.e Castle MU

Surveys

No new habitat-altering weeds were observed along ungulate transect KLO-11 or Solar and Radio LZs this year.

Control

The Castle MU encompasses near-pristine, wet summit forest. In past years, control has focused on the only widespread canopy weed, *Psidium cattleianum*. NRS only conducted one control trip in the MU this year. In part this decision was deliberate; with the completion of the Opae`ula exclosure, NRS felt that weed control efforts should be focused on this pig-free environment. However, poor weather and helicopter restrictions also played a part in limiting efforts in the MU. In the future, NRS will continue to focus on the Opae`ula exclosure and the proposed Helemano exclosure. Limited effort will be spent on weed control in the Castle MU.

Monitoring

In 1997, NRS installed two plots designed to gauge the effect of pig control on the abundance of *P. glomerata*. At the time, the ungulate control effort was just being initiated. The plots were established near snare lines. *P. glomerata* is an herbaceous melastome spread by pigs; it colonizes and thrives in pig-damaged areas. These plots were established to detect change in *P. glomerata* abundance and to determine the effect of pig control on native species recovery. Unfortunately, efforts to control pigs in the area have been only partially effective. Therefore these plots have been left until such a time that effective ungulate control is established. This may be through fencing; NRS are considering proposing this area for fencing to the partners of the `Ōpae`ula Watershed Protection Project.

2.9.f Kahuku Cabin MU

Surveys

Northern, Crispa, and Radio LZs were surveyed this year, while Pu`u Kāinapua`a LZ, and ungulate transect KLO-10 were not surveyed. No incipient weeds were discovered at these LZs.

Control

The northernmost Ko`olau management unit, the Kahuku Cabin region, is plagued by more weed problems than the other summit MUs. NRS focus weed management in this area on two incipients, *L. scoparium* (manuka) and *H. gardenarium* (Kahili ginger), and one more widespread species, *P. cattleianum*. On two trips this year, NRS focused only on *H. gardenarium* control. NRS spent an hour controlling this species in two isolated areas; one just north of the cabin site along the summit trail and the other at the old cabin site. Continued monitoring is necessary at these sites.

Although north of Pu`u Kāinapua`a, there are scattered patches of manuka stretching all the way to Kahuku, NRS did not focus on controlling these populations this year. These populations are so well established and contiguous, NRS felt that they were not a good investment. Instead, efforts were focused on a population in Waimano, where NRS assisted OISC in extirpating a large population. NRS will continue to partner with OISC in identifying and controlling populations of manuka. To this end, meetings will be set to discuss control of manuka populations identified as feasible targets in the Kahuku Cabin and greater Kawailoa Training Area.

Monitoring

No monitoring is being conducted at this time.

2.10 Kahuku Training Area

In KTA, fire, a potential side effect of training, is a threat to rare plants and critical habitat. Fires facilitate the establishment of invasive plant species and thereby irreversibly damage native resources. In July 2003, a fire in KTA burned a number of native species, and burned seedlings of the endangered tree *Eugenia koolauensis*. This fire was facilitated by the large patches of *C. equisetifolia*, which stretch along many ridge tops in KTA. The thick pine needle bed in such a patch allowed a fire to smolder undetected, and eventually flare up close to native forest. Fortunately, many of the SEAs in the training areas are geographically removed from the areas that receive such impacts from training activities. Last year, the Army initiated discussions concerning possible changes that could occur on the training areas due to Transformation. The Transformation process could include the construction of new roads and training ranges, and the acquisition of more land. Currently, contractors are working on the Draft Biological Assessment for Transformation. NRS will follow the Transformation process and will try to reduce potential impacts to natural resources. NRS are constantly on the alert for impacts to SEAs.

Surveys

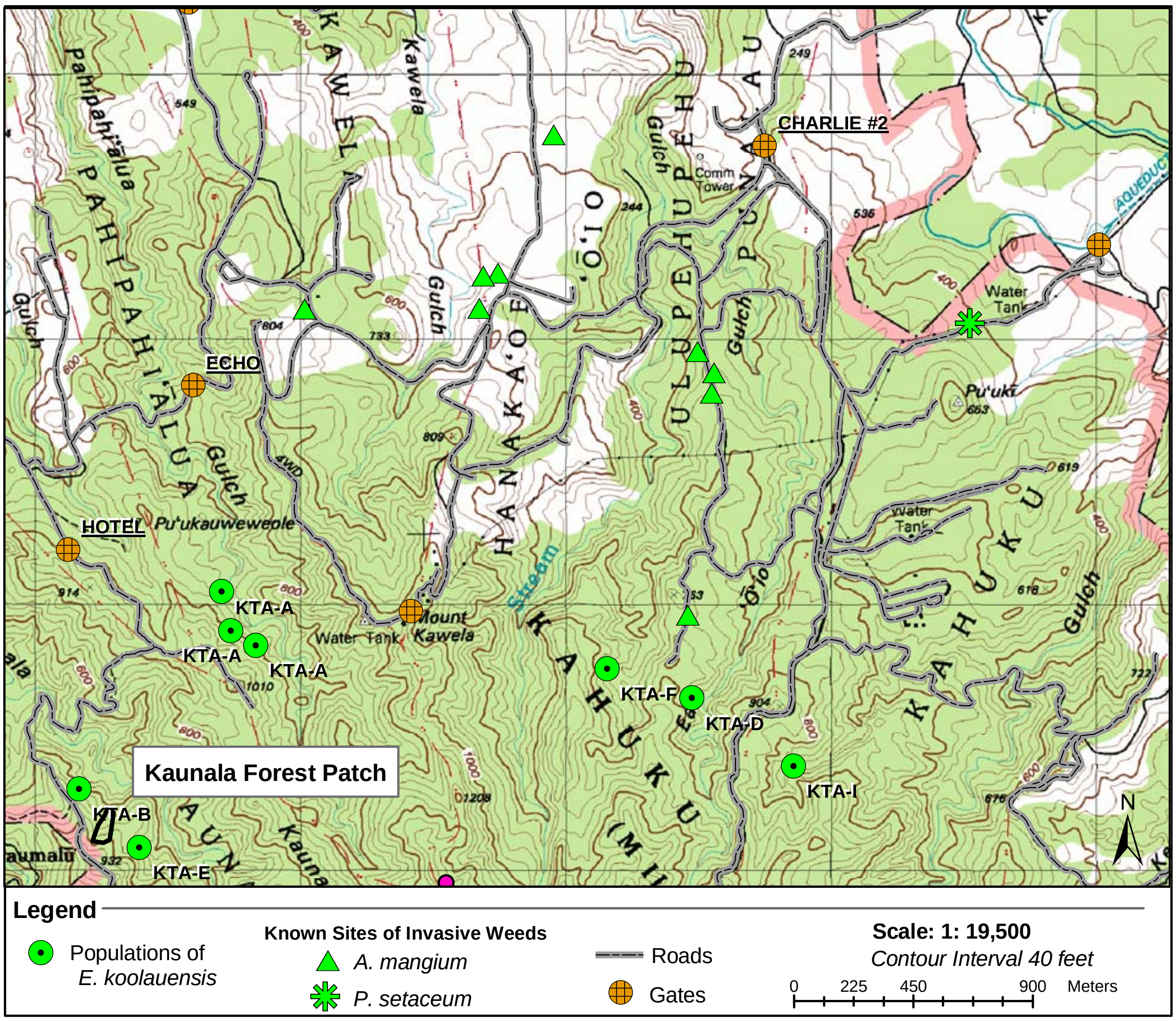
This year during road and landing zone surveys at KTA two new sites of *Melochia umbellata*, a habitat-altering weed were found (Appendix 2-G Weed Surveys Roads, Kahuku Training Area). Ongoing NRS control efforts of *M. umbellata* are described below. Past road surveys also recorded the presence of *L. scoparium* (Manuka). While Manuka is a highly invasive species targeted for control by NRS elsewhere on O`ahu, the population in Kahuku is so large and the forest is so weedy that it is not a current management target. NRS will monitor the population for changes. In addition to these high priority species, two additional species were identified by ITAM and brought to the attention of NRS in July 2000. These include *P. setaceum* (fountain grass) and *Acacia mangium* species. NRS have been controlling these weeds over the past four years. These control efforts are described in below.

Control

Weed control at KTA is primarily focused around rare plants, specifically *E. koolauensis*, and on incipient invasive weeds (see Figure 2-12). Last year however, NRS identified a remnant patch of diverse native forest on Kaunala ridge, thus weed control efforts were expanded to ecosystem-scale management as well as species-specific management. Weed control was performed around four areas where *E. koolauensis* occurs in Kahuku this year. NRS control the following three incipient weeds at KTA: *P. setaceum*, at one site, *M. umbellata* at two sites, and *A. mangium*, at several sites. Throughout Kahuku, NRS spent 98.5 hours performing weed control this past year.

Currently, no MUs have been defined in KTA. However, the native forest patch on Kaunala Ridge may be designated an MU in the future. NRS have already begun weed management in the area. NRS will continue to survey for other possible MUs in KTA.

Figure 2-12. Kahuku Training Area Weed Control Sites.



1. *Eugenia koolauensis* KTA-A (Pahipahialua). NRS spent twenty-one person hours treating several weed species at this site. The population is made up of three distinct patches of *E. koolauensis*. This year, NRS focused in two patches and hope to connect all three patches to create more habitat for *E. koolauensis*. The canopy is very weedy and must be weeded in stages to prevent the creation of open gaps.

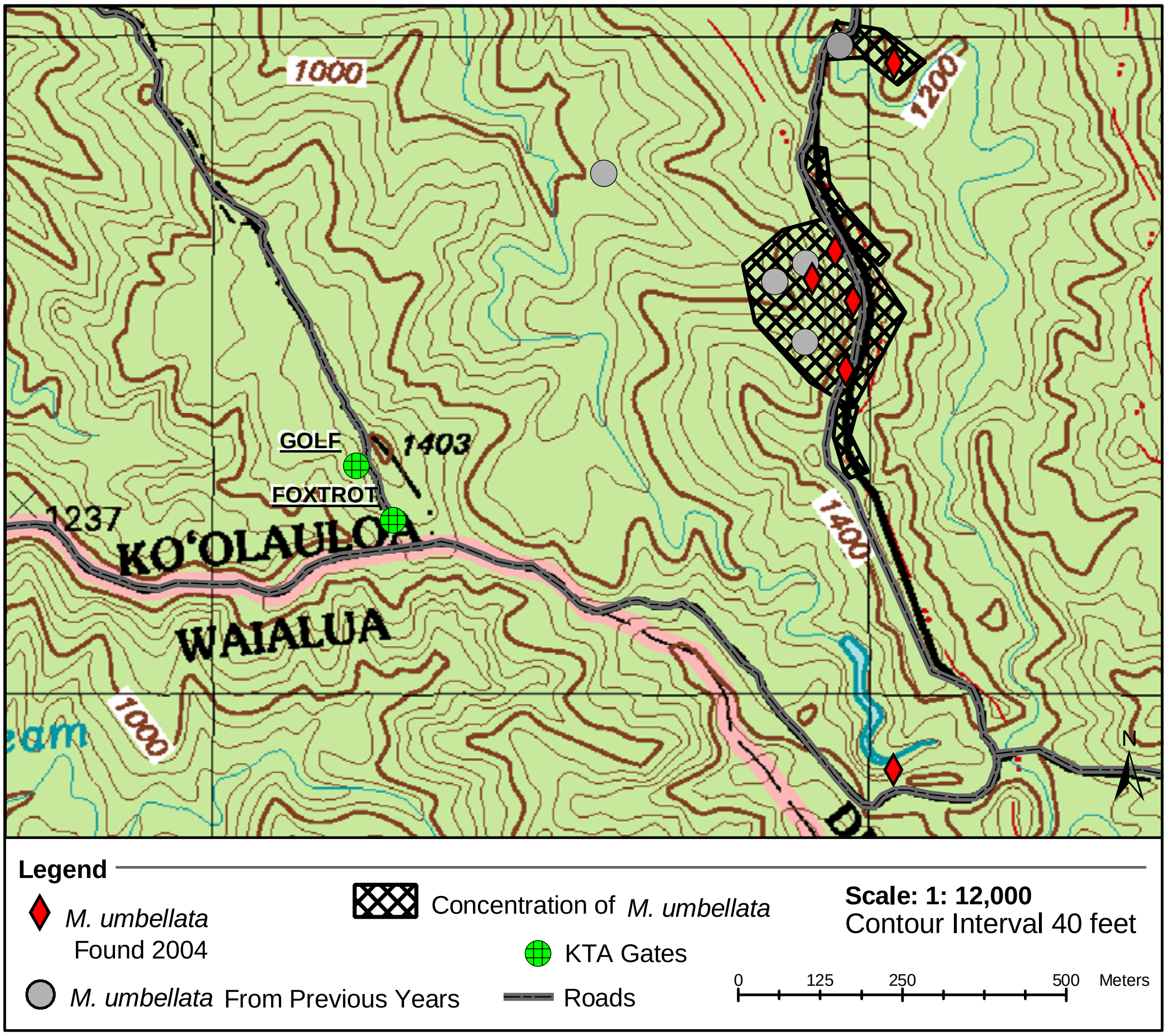
2. *Eugenia koolauensis* KTA-B/E. Previously treated as two different sites, *E. koolauensis* B and E populations have been joined; they are located close together and essentially are patches of the same population. Twenty-one hours were spent weeding at this site last year.

3. *Eugenia koolauensis* KTA-D. This small population of *E. koolauensis* is almost completely surrounded by *P. cattleianum*. Only the area directly around the plants is managed. Given that the canopy is primarily *P. cattleianum*, canopy weeding needs to be gradual, to prevent the creation of light gaps. NRS spent no time weeding at this site this year but plan to treat understory weeds in the coming year, and plan to revisit thereafter once every two years.

4. *Eugenia koolauensis* KTA-F. This population of *E. koolauensis* is spread out over a somewhat large area. Twenty-nine hours were spent removing an assortment of canopy and understory weeds from this site. In addition, NRS spent 2 hours treating the Basket grass, *Oplismenus hirtellus* that completely covered the ground throughout the *E. koolauensis* site. Very large *C. equisetifolia* borders the upper portion of this population. NRS will address this threat by selectively removing or girdling the trees closest to the *E. koolauensis* population.

5. *Melochia umbellata*. This species was discovered at KTA in March of 1999 and is the only known location on O`ahu. *M. umbellata* has a reputation for being extremely invasive on the island of Hawaii, where it is widespread in low elevation forests on the east side of the island around Hilo. In KTA, the *M. umbellata* population is focused along a stretch of road; individuals are sparsely scattered on the slope below the road. A total of 20 hours were spent searching for and treating this weed. NRS combine ground control trips with aerial surveys to effectively locate and eliminate outlying plants. This year NRS made one aerial survey and found 4 plants, all in the vicinity of the road. After the aerial surveys, all plants seen from the air are treated. Many seedlings are seen on the side of the road that has recently been leveled with heavy machinery, but are so small that NRS do not find them worthwhile to pull. NRS are considering spraying this area to expose the seedbed. With regular control of recruitment, NRS believe that the seedbed can be exhausted at this area. In the coming year NRS will also revisit all sites of mature outlier plants for seedlings. NRS will continue aerial surveys, but will likely focus around the new area where *M. umbellata* was found on the road survey this year. Figure 2-13 highlights the concentration of *M. umbellata* in KTA. NRS will also conduct a literature search and attempt to determine the length of time *M. umbellata* seeds remain viable in the seed bank. This information will help NRS determine parameters for the eventual extirpation of this species from KTA. NRS also will work with Range Control to prevent the further spread of this invasive species via roadways.

Figure 2-13. Concentrated Areas of *M. umbellata*



6. *Acacia mangium.* This species was reported by ITAM in July 2000. Last year, NRS sent samples and photographs of this species to Bishop Museum for identification and to establish a collection of this species on O`ahu. NRS control of *A. mangium* is motivated by the possibility that it may hybridize with native *A. koa*. This year, NRS visited four of the five known sites. No plants were found at two sites. Site three has the largest population of this species and required rappelling gear to reach many of the plants. An hour and a half was spent here handpulling and treating *A. mangium* with Garlon 4 at 20%. NRS are uncertain as to the invasiveness of this species. Young plants have been found as far as 200m away from a treated mature plant. NRS plan on sweeping for this plant once a year with a large crew in order to get better coverage and a sense of the extensiveness of *A. mangium.*

7. *Pennisetum setaceum.* The State of Hawaii lists *P. setaceum* as a noxious weed. Tens of thousands of dollars are spent on its control each year on the island of Hawaii. This grass is from Africa, where it co-evolved with fire. Seeds are fire-adapted so that after a burn, germination is rapid and dense, capitalizing on available fire cleared areas. Fountain grass has the potential to greatly modify Hawaiian landscapes. ITAM reported this population to NRS in July 2000. Since then, NRS have been very diligent in regularly visiting the site to control the *P. setaceum.* Fewer plants are found on each trip. This year, NRS conducted three control trips to the site; 8.5 hours were spent surveying and controlling *P. setaceum*. Only 3 mature plants were found in November 2003, and while nine immature plants were found in June 2004, no mature plants have been seen since. Regular weeding trips are vital to control this species, which continues to recruit from the seed bank. NRS will monitor the area every quarter and conduct treatment as needed.

8. Kaunala Ridge. During surveys of KTA, a patch of diverse native forest was discovered on the east side of Oio Gulch, on Kaunala Ridge. Such patches are rare in KTA, where training, ungulate damage, and weed invasion have combined to degrade most of the landscape. This forest patch includes many native species, including one rare species, *P. macrocarpa*. This area may be designated a MU after further surveys. NRS spent no time weeding at this site this year. NRS do not have a good control method for *S. palmifolia*, which is very abundant here. In the coming year, NRS will develop an approach for this species (handpulling, Fusilade, and Glypro+), and continue to control weeds at this site.

Monitoring

Weed plots are not established in KTA.

2.11 Dillingham Military Reservation

Surveys

Road surveys are conducted at DMR to identify new alien species in the area. See Appendix 2-F, Weed Survey Roads, DMR, for a map of the area surveyed. No ecosystem altering weeds were identified in road surveys this year.

Control

Much of DMR is made up of highly degraded habitat, but the rocky talus slopes on the mauka 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.

Weed control in DMR is focused on the large, intact *Sapindus oahuensis* forest on the talus slopes. This year, 9.5 people hours were spent treating 210m² of native forest on the west side of Pinao`ula Stream. *Leucaena leucocephala, S. cumini*, *Ficus microcarpa* and *S. terebinthifolius* were controlled in this area. NRS must be careful to minimize light gaps created while weeding. Such gaps can quickly be colonized by *P. maximum*, which is abundant in the area, as well as *L. leucocephala*.

Since DMR is accessible, with easily recognizable target weeds, it would be a good place to utilize volunteer groups. However, the rocky talus may be difficult for some volunteers to negotiate. With this restriction in mind, NRS will schedule 2-4 trips to DMR in the coming year. NRS will also focus on mapping both native and weedy area's to isolate and focus control activities in the future. NRS hope weed control will not only improve the quality of the existing *S. oahuensis* forest, but also expand the boundaries of it.

Monitoring

Weed plots have not been established in DMR.

2.12 Offsite Management Areas

While Army training areas are the first priority of NRS, in order to preserve stable populations of rare plants, wild populations and reintroductions on non-Army lands sometimes also require management. NRS have further expanded off-site control efforts this year. Currently, NRS perform weed control offsite around populations of wild and reintroduced species at Honouliuli Preserve, Ka'ena Point, and several areas within the Mokulei`a Forest Reserve. Nature Conservancy and State NARS Natural Resource Managers prioritize management in their respective areas. Army NRS assist these managers in their goal of protecting rare and endangered species.

No Surveys take place in Honouliuli Preserve or at Ka`ena Point.

2.12.a Honouliuli Preserve

Control

This year, NRS have expanded their collaboration with The Nature Conservancy to protect endangered plants in the preserve that occur on Military training lands. NRS have recently hired a staff member to work with TNC on rare plant monitoring and weeding projects. Including the time that this staff member and other volunteers work on NRS related weeding projects, 15 hours have been spent weeding around endangered plant populations and reintroduction sites in the following areas within the preserve: Kalua`a Gulch, North Palawai, Palikea, Ekahanui, and Huliwai. This year NRS will continue to focus mostly around endangered plant populations (See Chapter 3: Rare Plant Management for details on specific plant populations) however in the future, NRS plan to expand the weeding program in Honouliuli.

Monitoring

Weed control plots are not established by NRS at these sites.

2.12.b Ka`ena Point

Control

In 2002, *Chamaesyce celastroides* var. *kaenana* was discovered near the mouth of Mākua Valley, close to the firebreak road. Since this population is so close to the firebreak road, it faces a severe fire threat. NRS completed installation of a firebreak around this population, however, since fire poses such a catastrophic risk, its long-term survival cannot be guaranteed. In fact, the population was directly threatened by fire during the July 2003 controlled burn at Makua. To mitigate this fire threat, NRS are working at Ka`ena Point, helping to manage a large population of *C. celastroides*. This 0.9-acre population of 300+ mature plants, protected within a State Natural Area Reserve, is located in a predominantly native coastal habitat. It was also recently shown to be an important pollen source for the native Yellow-faced Bee, *Hylaeus sp*. (K. Magnacca, Hawai`i Conservation Conference 2002). Management at Ka`ena is part of the first and second set of Urgent Actions identified out of the Mākua Implementation Plan.

There are several *C. celastroides* populations along the coast at Keawa`ula, and two at Ka`ena: one at the extreme tip of Ka`ena Point, and one at Ka`ena (east of `Ālau). Many of the Keawa`ula sites are located in poor quality, weedy habitat and have been deemed poor investments for weeding effort. NRS feel that managing the largest Ka`ena population, which is predominantly native coastal habitat, is the most efficient way of protecting this species offsite. However, this year 11 hours were also spent weeding at the smaller *C. celastroides* (Kae-A) population. Continual weed control at this site will be minimal as it is such a small area.

The largest Ka`ena Point *C. celastroides* population is divided into two sections, separated by a thirty meter wide band of common natives and weeds. Target weeds include *L. leucocephala, A. farnesiana*, and *Atriplex semibaccata*. This year the population was also treated for encroaching grass cover of *Chloris barbata* and *Panicum Maximum*. Many herbaceous annual weeds occur in the population, but are not currently being targeted for control, as they pose little direct threat to *C. celastroides*. NRS have developed a three-stage management plan for the population. The goal for the first stage of the weed control effort is to remove these the highly invasive weeds from within the existing population area, while learning efficient control methods. The second stage will focus on expanding the weed-free area to allow expansion of *C. celastroides*. During the third stage, NRS will also remove weeds from the thirty-meter barrier, to encourage *C. celastroides* to close the gap and improve gene flow. NRS are currently working on all stages of control. This year, NRS spent 252 hours conducting weed control at Ka`ena Point.

Through control trials at Ka`ena Point and the Lower `Ōhikilolo MU, NRS found a highly effective control method for *L. leucocephala* (see RCUH report 2003). This year NRS controlled nearly all mature *L. leucocephala* and *A. farnesiana* within the two patches of *C. celastroides*. NRS will continue to focus on treating seedlings within and mature plants between the two patches, and work towards creating a weed free buffer around the entire population.

Levels of *A. semibaccata* have been significantly lower since efforts to control this weed were initiated in 2002. NRS control this herbaceous weed by handpulling. While large plants with long taproots and spreading branches covering 0.25 square meters were very common, now few plants this large are seen. While dense seedling beds exist, seedlings are much more time-consuming to remove than adult plants and are not believed to be as troublesome as the large plants. NRS feel that treatment for *A. semibaccata* is effective after seedlings have had a chance to thin themselves, but have not yet reached high levels of reproductivity (see RCUH report 2003 for details). Both patches of *C. celastroides* were completely swept once this year, while portions of each patch were swept multiple times. NRS foresee that *A. semibaccata* can be controlled within the *C. celastroides* population with minimal management.

Since beginning management, NRS noticed a distinct increase of *Chloris barbata* and *Panicum maximum* grass. It appears that *C. barbata* is spreading into areas cleared of other weeds by NRS. *P. maximum* is encroaching from the hillside above where it is thick, down into the upper boundaries of the *C. celastroides* patches, and also in between the two patches. Like *A. semibaccata* and *L. leucocephala*, these grasses are widespread at Ka`ena Point. This year, NRS have determined through trials that *C. barbata* can be controlled with Fusilade II with little impact on non-grass native vegetation in the area. While use of Fusilade II is desirable because it has little or no impact on native non-grass vegetation, caution must be given using this grass-specific herbicide around native grasses. NRS are investigating natural dieback cycles of the native grasses at Ka`ena Pt. to determine optimal times for spraying with minimal impact on native grasses.

An informal trial using Fusilade II on *P. maximum* showed that this herbicide did not kill the grass completely, but did set it back significantly. During the *C. barbata* spray effort this year, *P. maximum* was also treated as NRS feel that immediate attention must be given to this grass, even if only to set it back temporarily. Results from this spraying may show that the herbicide is effective as it is possible that during the trial, the grass was sprayed at a stage unresponsive to the herbicide. NRS will continue to monitor efficacy of treating *P. maximum* with Fusilade II at Ka`ena Pt.

This year mature plants and seedlings of the incipient invasive weed *Achyranthes aspera* were found within the *C. celastroides* population. All plants found were pulled and bagged, or treated with Garlon 4 20%. NRS hope to eradicate this weed in the population and will continue to sweep for plants in known sites and map areas where new plants are found.

Monitoring

In developing a weed management plan, NRS established several weed plots to monitor success, and guide future control efforts:

1. ***Chloris barbata***. In order to determine an effective means of treating *C. barbata* with minimal impacts to native plants, 1m by 1m plots containing both native, non-native vegetation, and *C. barbata* were established. The following herbicide treatments were applied to two plots for replication: target *C. barbata* using Fusilade II with handsprayer, Glypro at a 2% concentration with handsprayer, and Garlon 4 20% concentration with squirt bottle directed at the base of grass clumps. A Weed Control Plot Data Sheet was used to monitor the change in vegetation cover over the time of the trial. Data showed that all herbicide treatments killed the target weed, however Fusilade II was the only herbicide that had little to no negative impact on native plants. The first large-scale spraying effort of *C. barbata* in the *C. celastroides* patch at Ka`ena Point took place this year, and the results of this spraying will hopefully confirm that Fusilade II is in fact an effective treatment for *C. barbata*.

2. ***Panicum maximum.*** An informal weeding trial was established to determine whether or not Fusilade II can effectively treat *P. maximum* at Ka`ena Point. A 3-meter by 3-meter plot was sprayed with Fusilade II and revisited 5 weeks later. NRS noted that while there was significant dieback of the grass, there were also resprouts in the treated area. NRS hope to implement further trials to find an effective treatment of *P. maximum* with Fusilade II. If no Fusilade II treatment is effective, NRS will consider the use of the more general Glypro Plus herbicide.

In addition to these specific monitoring protocols, NRS will establish photo points to monitor progress in the population.

2.12.c. Mokulei`a Forest Reserve

Management activities within the Mokulei`a Forest Reserve are primarily concentrated between Pahole Natural Area Reserve and West Makaleha. Within this range there are several areas which are important because of their populations of native, rare, or endangered plants, or their potential as outplanting sites. These management areas are Pahole, Kapuna, Keawapilau, and West Makaleha Gulches. All weed management within these sites is done in coordination with the State of `Hawaii in a mutually beneficial effort to improve the structure of the native habitat.

No surveys, or monitoring projects take place at the Makaleha Exclosure Sites, in the Kapuna, or Keawapilau Gulches, or in Pahole Natural Area Reserve.

2.12.c.1 Makaleha Exclosure Sites

The Mokulei`a Forest Reserve borders Makua Military Reservation and is home to two exclosures containing rare plant populations. This year, in addition to the West Makaleha Exclosure (more commonly known as Three Points), another rare plant population of *A. obovatum* was discovered and fenced. As this exclosure is located just north of the original exclosure, it will be referred to as the Northwest Makaleha exclosure, while the original exclosure will now be referred to simply as the Three Point exclosure. The primary focus for weed management in these areas is to support and sustain rare plants populations within the exclosures.

Control

The Three Points and Northwest Makaleha Exclosures are located just below the rim of Makua. These exclosures are home to *Cyanea grimesiana ssp. obatae*, and *A. obovatum*. Taking advantage of the pig-free site, and hoping to better approximate the natural distributions of these species, NRS outplanted *P. kaalae* and *D. subcordata* at Three Points. NRS has spent 91.5 hours weeding around these species within the exclosures this year. This time has primarily been divided between controlling *P. cattleianum* and *M. minutiflora* two of the most prolific weeds within the two exclosures. *P. cattleianum* is more predominant in the Three Points exclosure and has been aggressively treated with volunteer groups, and spraying of large monotypic seedling beds with a dilution of 10% Garlon 3A in water. M. minutiflora is extensively distributed in both exclosures and is being treated with a dilution of 1% Fusilade in water. To assist in spraying and to avoid lugging water up the steep trail to Three Points, a water catchment system was installed this year to compliment control. Koa and other natives will be planted to accelerate native revegetation of these areas.

2.12.c.2 Kapuna

In the past, NRS have helped the state weed in and around one exclosure in Kapuna Gulch where *Cyanea superba ssp. superba* are outplanted. Recently, NRS expanded weeding efforts to other areas. This year NRS began weed control in one of the subgulches of Kapuna that is home to several individuals of *Chamaesyce herbstii* and a single *Hesperomannia arbuscula.* A *Delissea subcordata* was also known from this gulch. In the past couple of months, NRS have spent a total of 60.5 hours in about 7 acres of this gulch. This year NRS hope to improve habitat for these and other endangered plants by scoping and weeding in neighboring areas greater than 80% native, and to continue to weed around wild endangered plant populations.

2.12.c.3 Keawapilau

The drainage west of Kapuna is Keawapilau Gulch. The State has proposed a large fence to exclude pigs from both of these gulches, however it is not known when in fact these fences will be built. NRS are interested in weed control in these areas because of the wild and outplanted rare and endangered plant populations that occur in both gulches. NRS also wish to invest time weeding here because there are many large patches of predominantly native forest that are potentially suitable for outplanting sites. During this first year of weed control in Keawapilau, NRS spent 20 hours targeting weeds around wild and outplanted endangered plant populations such as the *Schiedea nuttallii* and *Phyllostegia kaalaensis* respectively.

2.12.d Pahole Natural Area Reserve

Pahole Natural Area Reserve is a large drainage adjacent to and shares a dividing fence with Kahanahaiki Gulch. The area is comprised of several subgulches that feed into the major gulch and is home to several populations of endangered plants that occur on Military training lands. Historically NRS work in this area has been solely focused on weeding around an outplanted population of *Cyanea superba ssp. superba*. This year, these efforts were extended to include weeding around a snail exclosure near a *Cenchrus agrimonioides* population, as well as near a previously existing population of *Phyllostegia kaalaensis.* NRS spent a total of 148 hours controlling weeds around native plants. Moving forward, NRS hopes to expand control efforts into subgulch 4, an area approved by the state as a potential outplanting area.

CHAPTER 3: RARE PLANT MANAGEMENT

3.1 Introduction to Rare Plant Management

Ninety-seven plant taxa with a federal status are known from Army training lands on O`ahu. There are 57 taxa with Endangered Status, 24 Species of Concern, 15 Candidate taxa, and 1 Threatened taxon. Of these, many are critically endangered with very low numbers of individuals remaining in the wild. Conserving these resources requires a program that integrates large-scale ecosystem protection and single species management. Large-scale ecosystem protection is done primarily with fencing and invasive plant control in Management Units. Single species management incorporates fieldwork, careful planning, ex-situ propagation, storage and reintroduction. Our program draws on a diversity of resources to help plan and prioritize rare plant management actions. These resources include extensive consultation and planning with the U.S. Fish and Wildlife Service, ongoing surveys to clarify current status and adjust goals and systematic monitoring of populations to keep abreast of changes in status and threats. These resources are incorporated in an adaptive management approach that responds throughout the year to new information. Actions in the field are focused on controlling threats, improving conditions for recruitment, collection, propagation, and sometimes reintroduction. The following is a discussion of this process. The species discussed in this report are included because they meet at least one of the following criteria: they are listed as Endangered or Threatened, they are a species in one of the two consultations discussed below or they are otherwise considered worth mentioning by NRS.

3.1.a Consultations with the U.S. Fish and Wildlife Service

NRS is currently involved in two consultations with the U.S. Fish and Wildlife. These consultations have pooled expert opinions on diverse resource management issues including background information on species distribution and abundance, outlining management actions and goals, and developing monitoring frameworks and objectives.

The Mākua consultation process resulted in the production of the Mākua Implementation Plan that outlines impacts of military training in Mākua, requires measures to reduce impacts and outlines required mitigation actions to offset risks of training. NRS actively utilize the stabilization plans developed for each species. These plans outline species status, management actions, and goals to achieve stabilization.

The O`ahu Training Area consultation will result in the development of the O`ahu Implementation Plan. This plan will cover federally listed species on the other four training areas; Schofield Barracks Military Reservation, Kawailoa Training Area, Kahuku Training Area and Dillingham Military Reservation. The development process for this plan has been greatly streamlined and will benefit by utilizing many of the methods and strategies developed in the Mākua plan. The development of this plan has just begun with the hiring of a coordinator by NRS that will oversee meetings and be the principal author.

3.1.b Surveys and Monitoring

3.1.b.1 Rare Plant Surveys

Surveys determine population size and range, which are necessary to provide the basis for management recommendations. Surveys also allow NRS to monitor potential military training impacts. Results of these contracted surveys are summarized as maps and reports stored in the GIS and plant databases. The U.S. Army Garrison Hawai`i first contracted botanical inventories of its training areas in 1977. In 1993, the Nature Conservancy of Hawai`i was contracted to conduct additional surveys, the results of which were used in writing Ecosystem Management Plan Reports. The National Tropical Botanical Garden (NTBG) was contracted during the winter of 1999-2000 to conduct surveys of areas off Army lands for federally Listed species found in and around Mākua Military Reservation (MMR). NRS accompanied the NTBG botanists on these surveys to State and Private lands including: Wai`anae Kai, Mākaha, Makaleha, Lower Ka`ala NAR, Lualualei Naval Magazine, Honouliuli Preserve, Pahole NAR, Mokulē`ia Forest Reserve, and Kuaokala. These surveys targeted populations that had not been visited in a long time and helped determine appropriate management actions.

Every year since 1998, the Hawai`i Natural Heritage Program (HINHP) has been contracted to survey for certain critically endangered plant species on Army training land and has assisted NRS with botanical orientation. Recently NRS has expanded surveys to cover state and private lands. These surveys have helped to identify resources off Army lands that have conservation potential.

NRS schedule time to survey for rare plants, and in addition, incorporate surveys into other daily fieldwork. New populations are recorded on the Hawai`i Rare Plant Restoration Group (HRPRG) Rare Plant Monitoring Form (RPMF) (Appendix 3-A). Once a population is discovered and mapped, it is put on a monitoring schedule.

3.1.b.2 Rare Plant Monitoring

Critical populations are monitored regularly by NRS to track their health, collect propagules for ex-situ propagation, conduct management actions and monitor threats to plants. The RPMF (Appendix 3-A) is used in the field to record monitoring data. NRS use a reference code to track each population and individual plant. The location is mapped with a hand-held GPS unit or from a topographical map when satellite reception is poor. The location is also described on the form by the NRS visiting the population. The field form records individual plant information that may change between visits, such as plant height, basal diameter, age class, reproductive status, sex, vigor, type and number of propagules collected and the propagule destination. Population structure is recorded by defining the age classes and noting the number of individuals in each age class. The field form also records the population information and habitat characteristics. These include phenology, condition, light level, overstory and understory heights, soil drainage, topography, moisture class, slope, and aspect. The associated species are recorded on the form to aid future surveys and locate proper reintroduction sites. In addition, any threats that warrant further attention are listed. This information determines population health and stability, which helps in recommending management and directing threat control for that species. The background form contains information that is unchanging, such land ownership and location.

A database built by HINHP on Microsoft Access is now a central part of NRS's data management system. HRPRG monitoring forms and nursery data is entered regularly. Databases built for the Lyon Arboretum Seed Storage Facility and the Micropropagation Lab are linked to the NRS database and are used to determine the ex-situ status and design reintroductions. The database is queried on an almost daily basis to help direct a diversity of tasks including collection goals, nursery management such as stock amplification, and reintroduction design. The database has become a powerful tool in NRS's adaptive management approach.

3.2 Management Actions

3.2.a Threat Control

Threats identified during surveys and monitoring visits are managed by NRS in many different ways. All threat control is focused on increasing the number of individuals in the field by improving the conditions for recruitment and survival. Management actions addressing threat control are prioritized based on threat levels and manageability. Where control of feral ungulates is a priority, they are excluded around rare plants and habitats using fences and the various hunting methods discussed in the Ungulate section of this report (Chapter 1). During the fruiting season, those species threatened by rats are protected using snap traps and poison bait stations. Invertebrates are very difficult to control. NRS is currently supporting the slug research of Stephanie Joe in the Botany Department at UH Manoa. She is investigating slug impacts to native species and efficiency of different exclosure techniques. NRS has great hopes that her research will result in better understanding of slug impacts and management options. Unfortunately, there is not as much momentum with black twig borer research (*Xylosandrus compactus*). There are still no adequate methods for killing slugs or the black twig borer in a forest. NRS has identified only one systemic insecticide that is approved for use in a forest setting. Although the black twig borer is not a target pest of the insecticide, it is being used at this time on *Flueggea* and *Alectryon* and will be discussed below for each species. Any pest management research project will require approval from the Command Consultant as stated in AR 200-5. Invasive plant species can be controlled using a number of techniques, depending on the threat. These are discussed in detail in Weed Management (Chapter 2).

3.2.b Propagation

For species that have a critically low population size and high threat levels, ex-situ management is necessary. These species may have as few as one individual, or may have very poor population structure as a consequence of seed and/or seedling predation by invertebrates or rats. The threats to these plants can be minimized in the field. However, in some cases, the effective population size is so small and/or threat level so high, that every seed is valuable and should be collected. Propagules are collected for propagation and storage. Alvin Yoshinaga and Lauren Weisenberger are managing the Lyon Arboretum Seed Storage Facility, a short-term deposit/withdrawal type storage facility at the Lyon Arboretum. This facility may be used for storage of seeds that will be needed for future projects. As reintroduction plans and sites are prepared, those collections can be banked and held until called upon. NRS has made many deposits into this storage facility in the past year and will continue to support the facility in the coming year.

Other propagules that can be used right away or have poor storage records are brought to one or more facilities for propagation. There are now six facilities where propagules from rare plants on Army land are grown: Lyon Arboretum, Pahole Nursery, Army Rare Plant Propagation Facility, and the Koko Head, Waimea and Wahiawā Botanic Gardens. The Lyon Arboretum in Mānoa Valley practices both micropropagation and traditional greenhouse propagation. When NRS collect immature seeds, or vegetative material, they are taken to Lyon for micropropagation. The plants that are successful in micropropagation can be stored and cloned in test tubes and then returned to NRS for transplanting and reintroduction. The Pahole Nursery is a State of Hawai`i Division of Forestry facility located at the old NIKE missile storage site near the State's Pahole NAR. It is adjacent to MMR; an area with many managed rare plant populations. Because of the close proximity of the facility to MMR, it is used to harden off plants bound for reintroduction in Mākua.

The Army's Rare Plant Propagation Facility is located on Wheeler Army Airfield. The Facility is permitted to propagate and grow rare plants collected from Army lands on O`ahu. Plants propagated at this facility will be reintroduced into the wild or botanical gardens. NRS also bring propagules to both the Waimea and Wahiawā Botanical Gardens for propagation. Both of these facilities receive funding from the Center for Plant Conservation (CPC) to propagate certain species that are on the Center's genetic safety net list. Propagules of those species on the list that are found on Army lands are brought to the Gardens by NRS. When propagules are turned over to these various facilities, they are accompanied by the RPMF. These forms, completed when the propagules were taken, contain the Population Reference Code that will be used to track the propagules and to ensure they are reintroduced into the proper location. The highest priority plants will be represented by living collections; reintroductions and mature seeds will be stored at Lyon. Other species may only be represented by frozen storage of mature seeds.

In the coming year, NRS hope to cooperate with the Honolulu Botanic Gardens to establish representatives of Army plants on their grounds. This stock would be used to collect mature seed for storage and cuttings for reintroduction. A collection at a Botanic Garden would serve the purpose as a source of collections for Army stabilization projects and serve the public as an educational resource and propagule source.

3.2.c Reintroduction

The Army's Natural Resource Program uses reintroduction as a management tool to help increase the number of individuals in the wild with the goal of increasing the effective population size and establishing good population structure. NRS have reintroduced eleven listed endangered plant species into MMR. Seven have been planted into Kahanahāiki Gulch (*Delissea subcordata, Cyanea superba ssp. superba, Alsinidendron obovatum*, *Cenchrus agrimonioides var. agrimonioides, Alectryon macrococcus var. macrococcus, Schiedea nuttalii,* and *Euphorbia haeleeleana),* two into Kaluakauila (*Hibiscus brackenridgei* subsp. *mokuleianus, Neraudia angulata* var. *dentata),* two onto `Ōhikilolo Ridge (*Pritchardia kaalae, Sanicula mariversa)*, and two into Lower Mākua (*Nototrichium humile, Neraudia angulata* var. *angulata*). One species has been reintroduced into SBS (*Urera kaalae)*, one into SBW (*Labordia* cyrtandrae), and two into KLOA (*Stenogyne sherfii*, and *Sanicula purpurea*). These reintroduced populations are being monitored using a form developed by NRS to track the source of the population and the date they were planted. The success of these reintroductions will be discussed below for each species. These reintroduced plants were collected from the wild parents by NRS and NARS and grown at the Army's Rare Plant Propagation Facility, Lyon Arboretum, and at the State's Pahole Nursery.

Three types of reintroductions are commonly described: augmentation of an existing population, a site within the historical range of the species but separate from existing populations; and a site outside of the historical range. During the reintroduction, sanitation, transport, and planting methods are discussed. After the reintroduction, suggestions are made regarding monitoring, watering and maintenance of threat control operations. The Army's Natural Resource Program assisted the Hawaii Rare Plant Restoration Group (HRPRG) to draft guidelines for reintroduction and has adopted the guidelines for their own program. The guidelines are attached, as Appendix 3-B. NRS will seek approval from appropriate landowners and range control for reintroduction projects.

3.3 Species Accounts

3.3.a *Abutilon sandwicense*

Abutilon sandwicense is a shrub growing up to six meters tall with pale greenish yellow flowers. It is a rare component on steep slopes in dry forest (Wagner et al. 1990).

<u>3.3.a.1 Mākua Military Reservation</u>

A single *A. sandwicense* tree was found during surveys in MMR by HINHP in May of 2002. It is the only report of this species from the MMR and it is the northernmost tree known from the leeward side of the Wai`anae Mountains. Cuttings were taken from the plant by HINHP when the plant was found. Cuttings have been propagated at the Army nursery and NRS plan to reintroduce this plant to Kaluakauila in the coming year. NRS will continue to survey for this plant in Mākua.

<u>3.3.a.2 State Land</u>

There are several known locations for this species in the Lower *Ka`ala* Natural Area Reserve. NRS has noted new locations in the past year and will continue to in the coming year. There is currently no management proposed for this area for this species.

3.3.b *Alectryon macrococcus* var. *macrococcus*

Alectryon macrococcus var. *macrococcus* can grow to eleven meters in height and is found in mesic to dry forests on O`ahu, Moloka`i, Kaua`i and Maui. The fruit contains a glossy pale brown seed surrounded by a bright red aril (Wagner et al. 1990).

3.3.b.1 Mākua Military Reservation

Twenty-eight mature trees are known from MMR. They are found across the Lower Mākua, Kahanahāiki, Ohikilolo and East Rim management units (MUs). Few of the trees have been observed flowering and fewer have been observed with mature fruit. Most of the trees show significant damage from the black twig borer. No trees are protected from ungulates and only two (in the Lower Mākua MU) have bait stations to control rats.

There are two mature trees known from the Kahanahaiki MU and one experimental reintroduction site. The mature trees are in moderate health and are not fenced from ungulate threats. A reintroduction site within the Kahanahaiki Gulch fence was established with plants collected from trees in the Lower Mākua MU. They were planted in December of 2002. The plants were drenched twice in the year after planting. This treatment interval was not sufficient and all the plants were attacked by black twig borers. Since then the plants have been treated four times per year. This interval of insecticide application may be more effective at keeping the plants free of black twig borer. Eight of nine plants have survived though few are healthy. NRS will continue to treat these outplants quarterly in the coming year.

NRS revisited three mature trees in the East Rim MU in April of 2004. They were in moderate health and had no flowers or fruits. Once a propagation method is perfected, cuttings will be taken from these trees.

There are four trees in the Ohikilolo MU. They have been monitored in the last year and cuttings were brought to the Army Nursery. In the coming year, NRS will air-layer these trees as they are declining rapidly.

In order to develop a successful propagation method for these trees NRS performed propagation trials on a mature *Alectryon* tree growing ex-situ. Multiple attempts were made to graft on tip cuttings from material collected from MMR stock. Grafts were also attempted using tip material collected from the same tree. None of these preliminary trials were successful. NRS will attempt to test air-layers on this same *ex situ* tree this winter. NRS installed several air-layers on this same *ex situ* tree this past year. Several have produced roots and have been collected from the tree. NRS will attempt to use this method with other trees in the coming year.

3.3.b.2 Schofield Barracks Military Reservation

There are 24 mature trees on SBW and no juveniles or seedlings have been observed. Most trees are in moderate condition and only some flower and produce fruit. NRS continues to find rat depredated fruit around the 17 trees in SBW, however, controlling rats with bait requires frequent re-stocking and this is not feasible given access restrictions. Three air-layers were put onto one tree in SBW in May of 2003. They were left for a year and one had grown roots and was collected in May of 2004 (Figure 3-1). This air-layer is now established at the Army Nursery in a 3-gallon pot and is over 2 meters tall.

There are seven trees known from SBS. They are in moderate health and only one has been observed fruiting. A small fence has been constructed in the area in the last year and may serve as a potential reintroduction site in the future.

In the coming year, NRS will continue to search for more individuals, monitor known plants for new threats and collect mature fruit when available.

Figure 3-1 *Alectryon macrococcus* var. *macrococcus* Air-layer

3.3.b.3 State land

In Pahole Natural Area Reserve there are approximately 7 mature trees and no juveniles or seedlings are known. Most trees are in moderate condition and only some flower and produce fruit. NRS has just recently begun to work with this species in Pahole. NRS will monitor trees for threats and fruit production and consider trying to collect from these trees for storage.

In West Makaleha there is a more robust population of *Alectryon* with 36 matures and four immature trees. NRS has monitored these plants in the last year. NRS is also in discussion with NARS biologists regarding the construction of a large-scale fence that would encompass these individuals. NRS will continue to monitor these plants in the coming year.

NRS has just begun to work in Central and East Makaleha and has not been to any of the known trees in the last year. In the coming year, NRS will work on propagation methods for this species.

The trees in this area will be monitored and collected from in the coming year. No trees have been monitored in Lower *Ka`ala* NAR or Waianae Kai in the last year. NRS will begin to visit the known trees in the next year and prioritize management actions.

3.3.b.4 TNC Honouliuli Preserve

In Kalua'a NRS has completed status surveys in the central and south branches. Locations reported by TNC staff were visited and new areas surveyed. A total of 21 mature trees and one seedling were observed. There are additional areas to search and NRS believes that more individuals will be discovered. Most individuals were in poor health and no fruit or flowers were observed. NRS will continue to search for and monitor individuals.

A formal survey of South Waieli and Ekahanui has not been conducted. However, in the years following 2000, six individuals have been observed in Waieli and another six in Ekahanui by TNC, NRS, and HINHP staff. In April 2004 two mature fruits were collected from an individual in Ekahanui and the seeds sown at the TNC greenhouse in Kunia. NRS will conduct surveys in South Waieli and Ekahanui in late 2004.

3.3.b.5 Makaha BWS

NRS presently know of about twenty plants in Makaha and believe that there is a significant number more to be found. One of the most prolifically fruiting trees NRS has ever seen is located in Makaha. NRS visited this individual in July of 2004 and collected over fifty mature fruit. This collection is significant because it is large enough to perform storage testing on. This collection was submitted to the Lyon Arboretum for storage testing. NRS will continue to search for additional trees and monitor known individuals in the coming year.

3.3.c *Alsinidendron obovatum*

Alsinidendron obovatum was reported from scattered ridges and gulches in mesic forest throughout the Wai`anae Mountains. It is a small shrub with white and purple flowers (Wagner et al. 1990).

3.3.c.1 Mākua Military Reservation

One individual was known from Kahanahāiki Gulch from 1997 through 28 February 2001, when it was found dead. NRS has annually searched the area where the plant was known. In the last year, none were found. Dozens of fruit were collected and propagated over the years. These plants were reintroduced to several sites in the gulch. There are currently a total of 35 mature *A. obovatum* outplants in Kahanahāiki. Five immature and over 60 seedlings have germinated around those plants, but the hurdle of establishing significant successful recruitment in situ still hinders the progression of this population to stability on MMR. NRS have been collecting mature seed from the reintroduced plants so that there are now over 186,500 mature seed frozen at the Lyon Arboretum. These are available for future reintroduction projects. Weed control is conducted regularly around the old wild site and the reintroductions to improve habitat for this species.

Alsinidendron seedlings are suspected of being very susceptible to slug predation. NRS have begun working with Ms. Stephanie Joe, a graduate student from the University of Hawai`i Botany program studying the effects of slugs on native plants. She installed plots in Kahanahaiki and has been collecting data from these plots for about six months. *Alsinidendron* is one of the species she is using in her plots and she has found that there is significant slug damage to young plants. Preliminary results of slugs test plots show about %30 mortality of seedlings of several species can be attributed to slug predation.

Ms. Joe observed that only at our driest out-planting site do we have mature F1 generation plants. Slugs are not able to survive in dry microclimates; therefore, even though germination may be lower at dry sites, it may be offset by the low rate of slug predation observed at these sites (S. Joe pers. comm.).

In the coming year, NRS will supplement the most successful reintroductions with stock from the original wild plant.

<u>3.3.c.2 State Land</u>

Makaleha is the only site where *A. obovatum* is extant in the wild. There are two sites in Makaleha referred to by NRS as LEH-A and LEH-B. NRS found the plants at LEH-A during surveys in 2000. Since then NRS has been monitoring them and has collected mature fruit several times for propagation and storage. In the coming year, NRS will reintroduce progeny from this site to nearby ungulate exclosure. NRS consulted with NARS about fencing the wild plants at LEH-A. However, due to the steep nature of the site and plans to construct a larger ecosystem scale exclosure in the near future, immediate fencing was not executed.

The plants at the LEH-B site were discovered by HINHP and NRS in November of 2003. This site has a robust population of about 21 mature plants, 12 immature plants and 40 seedlings. This population is by far the healthiest NRS has ever seen. The site was visited with NARS staff in December and on this visit a fenceline was laid out. In February the fence was completed by NRS and NARS. In March a collection was made for seed storage from the site and weeding efforts began with the control of both canopy weeds and invasive grasses. NRS will continue weed control in the area and monitor population trends.

There are three sites in Pahole where this species was known (PAH-A,B,C). All sites where visited by NARS and NRS in the last year, to check for new plants, none were found. The plants originally known from this gulch have not been seen for several years. NRS have visited the site twice in the last year and have not seen any seedlings. Collections were made by Dr. Steve Weller of U.C. Irvine, in 1999. Those seed were grown in the greenhouse at U.C. Irvine and seed produced by those plants were sent to NRS and deposited at the Lyon Arboretum. In the coming year, NRS will grow plants from Dr. Weller’s seed and the plants will be used as a propagule source and reintroduced.

In January of 2003, NRS supported NARS in the reintroduction of stock collected from the PAH-B population back into Pahole NAR. The site was chosen by NARS staff. NRS monitored the site in April of 2004 and was astonished by what was seen. There were thirty of the original 50 out-planted plants remaining, 21 new immature F1 plants and 295 seedlings! As discussed above this site may have also somehow escaped intense slug herbivory suspected in other reintroduction sites. NRS will continue to monitor this site and will take Stephanie Joe to the site to get her input on the dynamics of slug population in the area.

3.3.c.3 TNC Honouliuli Preserve

A. obovatum was known from the Southern end of the Honouliuli preserve in the early 1990's. NRS accompanied HINHP botanist on a survey of the area. No plants were seen.

3.3.d *Alsinidendron trinerve*

Alsinidendron trinerve is known to be rare on slopes in wet or wet-mesic forest from between Pu`u Kalena and Mt. Ka`ala (Wagner et al. 1990).

3.3.d.1 Schofield Barracks Military Reservation

Over this last year surveys by NRS staff dramatically increased the number of known plants. From only 76 plants last year, there are now 508 known plants. Most are found on the summit of Ka`ala while others are known from the ridge between Pu`u Kalena and Ka`ala. Many seedlings and juveniles have been found at these sites. NRS feels that since new plants are found and mapped virtually every time we enter a new gulch at *Ka`ala* NAR, and since there is no predation observed on these plants, collecting and monitoring of this plant is not a priority.

Pigs continue to be a threat to these plants, especially all those found in the flat areas in the bog. However, in the past year, NRS has been working with other landowners to exclude ungulates from the bog. NRS and staff from BWS, NARS and TNC installed four sections of fence around the bog. These sections do not form a complete exclosure but rather bridge gaps between natural barriers (i.e. cliffs). Although NRS felt they should serve to exclude ungulates from the bog, pigs are continually seen. It is unclear if the pig sign occurs from resident pigs that were fenced in, or if pigs found places to go around the fences, or both. In the coming year, NRS will continue to monitor the bog for ungulate sign and respond accordingly to make it ungulate-free. In the past year, NRS used staff hunters to control pigs in the bog and determine where if any, the pigs are entering the bog. This will continue in the coming year.

In 2001, NRS helped the State NARS staff reintroduce ten plants into the Mt. Ka`ala NAR. In 2002, about 70 plants, grown from seed collected by NRS from Mt. Ka`ala and grown by Lyon Arboretum, were reintroduced into the Mt. Ka`ala NAR site by NARS staff. In the last year, NRS and NARS staff supplemented this reintroduction with stock grown from NRS collections. NRS will work with NARS staff to ensure these plants are monitored and any new threats addressed.

There are 20 counted plants, and an estimated 91 other plants, located at two sites between Mt. Ka`ala and Pu'u Kalena. These plants are significant because they are the largest group of plants not on Mt. Ka`ala. The habitat where they occur is considerably drier and steeper. At this time they are more threatened by goats and pigs, and may be fenced if control does not significantly reduce the threat. In 2002, NRS documented major pig damage around these plants. The only surviving plants were being sheltered at the base of large trees or growing above ground in a larger tree. There is more appropriate habitat in this area and more plants may be found.

Due to the vast increase in plants found this past year, collecting from all the plants for seed storage and reintroduction is no longer a priority.

3.3.e *Bobea sandwicensis*

This *Bobea* species is a tree that grows up to 10 meters tall. It was known from the dry to mesic forest of the Wai`anae Mountains and Wailupe Valley in the Ko`olaus on O`ahu and also from Maui, Moloka`i and Lāna`i (Wagner et al. 1990).

3.3.e.1 Mākua Military Reservation

On MMR, *Bobea sandwicensis* is known from the Lower Mākua, Kahanahāiki, `Ōhikilolo and Kaluakauila MUs. There are about 50 known mature trees on MMR and this species is found in areas considered to have a high fire threat. This species is not monitored regularly.

There are thought to be more than 20 mature trees in Lower Mākua and NRS monitor the trees only in conjunction with other management work. Monitoring has not been systematic, but it appears that there is a decline in population in general.

In Kahanahāiki, there are three mature trees that were observed in January of 2003. They are within an area that is proposed to be fenced by 2006.

On `Ōhikilolo, the few trees are not monitored regularly.

In Kaluakauila, there are about 20 *Bobea* and they are protected from ungulates by a pig fence. NRS continue to control fuels by removing guinea grass (*Panicum maximum*) from the forest patches and may focus more effort around *Bobea* populations in the future. In July of 2003, there was a prescribed burn that escaped the firebreak road. This fire burned three *Bobea sandwicensis* trees at the edge of a native forest patch. All of these trees appear to be alive and are producing new leaves.

3.3.f *Bobea timonioides*

This species is known from dry to sometimes-mesic forests from Hawai‘i, Maui, O‘ahu and Kaua‘i. It can grow up to ten meters tall (Wagner et al. 1990).

3.3.f.1 Kawailoa Training Area

NRS conducted surveys above the drum road in the Kawailoa Training Area for rare and endangered species that could be impacted as part of road construction. The Drum road may be widened to accommodate the needs of the new Army Stryker Brigade. In these surveys NRS identified a *Bobea* that is suspected to be species *timonioides*. Unfortunately the tree had no reproductive structures and therefore could not be positively identified to the species level. This may be a significant discovery as *B. timonioides* has become extremely rare. NRS will monitor the individual for reproductive structures so that it may be keyed to the species level. NRS will ask HINHP for review once material is collected.

3.3.f.2 Kahuku Training Area

There is one known individual in KTA, and there are no juveniles or seedlings known. NRS will map this species as individuals are found to better assess population size and structure. MUs must be surveyed and defined in KTA. This species will be a target for any surveys in KTA next year.

3.3.g *Bonamia menziesii*

This species is known from Hawai‘i, Maui, Moloka‘i, O‘ahu and Kaua‘i. It is a rare liana found in dry to mesic forests (Wagner et al. 1990).

3.3.g.1 Mākua Military Reservation

On MMR, this species is known from the Kaluakauila and Lower Mākua Management Units. There are estimated to be about eleven mature individuals.

There are less than ten known individuals in the Kaluakauila MU, and all the plants are in a pig exclosure. A single mature fruit was collected for seed storage in the last year. The fuel load in and around these plants has been reduced significantly in the last year, and NRS will continue to remove grass from inside the exclosure. NRS will continue to monitor and collect from these plants in the next year.

In June of 2004, NRS discovered a single *Bonamia menziesii* growing in the Lower Mākua Management unit. This was the first time that this species has been seen in the nine years that NRS has been working in the area. NRS suspects that the removal of goats from the management unit has contributed to its return. This species would have been easily browsed by goats and could have been easily extirpated by them.

3.3.h *Cenchrus agrimonioides* var. *agrimonioides*

This endangered species of grass is known from Lāna`i, O`ahu and Maui. The other variety (var. *laysanensis*) was known from the northwest Hawaiian Islands and is thought to be extinct (Wagner et al. 1990).

3.3.h.1 Mākua Military Reservation

Thirty-nine mature wild individuals are known from four sites in the Kahanahāiki MU. Three of these sites are located inside a large-scale exclosure, and the fourth has just one individual and is outside the fence. Approximately 100 meters separate the three subgroups within the exclosure.

In the last year, NRS conducted weed control around all of the known *C. agrimonioides* individuals and in the vicinity of the three reintroductions in Kahanahāiki MU. This has improved habitat for this species.

The population trend for MMR-A shows a general increase in the number of plants in all size classes since the fence was installed in 1997 (Figure 3-2). NRS controlled weeds around these plants in the last year and will continue to collect cuttings to supplement existing reintroductions in the coming year.

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

MMR-C has about twenty mature plants, and has displayed a positive growth trend for the past few years (Figure 3-3). The site is protected from pigs and weed control around these plants in the last year should help to limit competition for the *Cenchrus*. NRS will continue to collect propagules in the coming year to supplement the reintroductions in Kahanahaiki and Pahole.

The MMR-E reintroduction site is located just inside the fence near the Mākua Rim. Thirty-two plants were planted here in December 2000 and eleven more were added in January 2002. There are many juvenile plants that have come from seed germinating on site. NRS expects this trend to continue and there may be several wild born mature plants in this site in the coming year (Figure 3-4). In the next year, NRS will supplement the MMR-E reintroduction with un-represented and under-represented stock from the wild populations.

A few plants have been found in new locations in the last year (MMR-F, G, H). These plants will be collected from and represented in the existing reintroductions. There is one reintroduction site that NRS has abandoned (MMR-D). The plants never did very well and the stock was represented elsewhere.

3.3.h.2 State Land

Cenchrus agrimonioides was known from two locations in Pahole NAR. NRS visited one site in July of 2004. At this site NRS found thirteen mature, six immature and one seedling. NRS did not have time to completely monitor the site and expect that there may be more individuals. There are significant weed threats at this site including encroaching *Melinus minutiflora* and *Psidium cattleianum*. NRS discussed these weed issues with NARS biologists and have developed a plan to implement weed control for the area. NRS will also begin seed collection for storage and reintroduction in the next year.

NRS installed a reintroduction of *C. agrimonioides* in Pahole in December of 2000 (PAH-A). This reintroduction has flourished since. There are presently 114 seedlings and 37 immature plants at the site (Figure 3-5). These are all plants that have germinated on-site. NRS will continue to balance founders at this site and conduct monitoring and weed control twice a year.

3.3.h.3 Waianae Kai and Makaha

The *Cenchrus* along the ridge-top between Makaha and Waianae Kai are considered one population by NRS. The large fire in that area last year did not burn any of these plants, but significantly changed the habitat along the ridge-top. In June of 2003, NRS counted nine mature plants, two juveniles and one seedling. Cuttings were taken from all the mature plants and one juvenile and were brought to the Army nursery for propagation. Plants grown from these propagules will be used to produce seed in the greenhouse for storage and will be reintroduced into a fenced unit in Makaha when the fence is complete. NRS will continue to monitor this population and will continue collections to ensure good ex-situ representation.

3.3.h.4 Honouliuli Preserve

There are two wild populations in Honouliuli, one in North Ekahanui and the other in South Huliwai. Within the Kalua‘a fence there are also two populations of reintroduced *C. agrimonioides.* Along with TNC staff, NRS mapped and tagged all individuals in the wild and reintroduced populations in 2003-2004. There are a total of 69 individuals within the wild populations (49 in Ekahanui and 20 in Huliwai) and 144 within the reintroduction sites. The wild populations are currently not protected from browsing by ungulates, but the Ekahanui population will be included in the upcoming Ekahanui fence expansion. The Huliwai population is to be managed for genetic stock only. TNC is currently searching for additional reintroduction sites of suitable habitat within fenced areas.

3.3.i *Chamaesyce celastroides* var. *kaenana*

Chamaesyce celastroides var. *kaenana* is a shrub with prostrate stems and erectly held red fruit. This variety is rare and is found along beaches and in dry shrublands on O`ahu (Wagner et al. 1990). *Chamaesyce celastroides* var. *kaenana* is known from MMR, Waianae Kai, Keawa`ula and Ka`ena Point. There are estimated to be almost 900 plants on Oahu.

3.3.i.1 Mākua Military Reservation

This species was first found on MMR in 2000. There are now at least 475 plants known from six sites. Seedlings and juveniles have only been found in the bigger populations. They are found from 200 to almost 2000 feet above sea level. All known sites are surrounded by grass, are highly threatened by fire, and most of the populations on MMR show signs of being burned in the past ten years. No rat damage has been observed at any of the monitored populations. NRS developed a bagging technique that made collecting seed from this species possible. The bags are made of a synthetic material, which is light, durable and well ventilated. Branches that have pollinated flowers and young fruit are carefully selected and bagged. When the bags are removed NRS sends the seeds to Lyon Arboretum for seed viability tests and storage. Some of the seeds were germinated and are currently growing at the Army Nursery. The fire in July of 2003 burned plants at three of the sites. NRS have established photopoints and will monitor the long-term effects of the fire on individual plant survival.

In Punapohaku, approximately nine *C. celastroides* var. *kaenana* were impacted by the fire of July 2003. NRS returned to evaluate impacts in July of 2004 and found that three of the nine plants were dead. These three plants were located at the base of lowest cliff within the area. This lower cliff abuts fields of *Panicum maximum,* whereas the rest of the population does not. The photos below show plant number three (Figure 3-6), which was located at the base of the lowest cliff and did not recover from the fire (Figure 3-7). Plant number six (Figure 3-8) did recover and is shown in the other picture (Figure 3-9).

Figure 3-6 Plant #3 Burned in July 2003

Figure 3-7 Plant #3 July 2004 Dead


Figure 3-8 Plant #6 Burned in July 2003


Figure 3-9 Plant #6 July 2004 Recovered

Although six of the plants appear as if they will survive, they are not fully recovered. None of the six plants that were impacted by fire produced as much fruit as un-impacted plants. Two of these six plants had no fruit at all. NRS placed bags around fruit on eight plants to facilitate collection this year.

There are two plants in Lower Kahanahaiki. One was heavily impacted by the fire of July 2003 (Figure 3-10). The other was higher on a cliff and further from alien grass fuel and was not impacted by fire. NRS returned to monitor the effects of the fire in August 2004. The lower plant was still recovering from the fire and had only a few live branches and no sign of reproduction (Figure 3-11). In contrast, the upper plant was covered with flowers and immature fruit (Figure 3-12). NRS believe that it will take at least another year if not two for the lower plant to recover from the effects of the fire. See pictures below for an illustration of the impacts and contrast to the upper plant.


Figure 3-10 *Chamaesyce* (MMR-A-1) Burned at C-Ridge July 2003


Figure 3-11 MMR-A-1August 2004


Figure 3-12 Upper *Chamaesyce* flush with fruit, August 2004

In Kaluakauila there are about twenty plants. They are located on State land just north of Kaluakauila Gulch. These plants were not burned in the 2003 fire and are monitored just once a year. In the coming year, NRS will collect from these plants for genetic storage.

In Lower `Ōhikilolo there has been an impressive increase in recruitment of individuals over this past year, attributed to both the fuel break installed and maintained by NRS staff, and the high amount of rain this winter. Thirty-one new individuals (mature and large immature) were tagged at lower `Ōhikilolo bringing the total count in the upper and lower patch to 104 seedlings, 55 immatures, and 57 matures as compared with the last thorough count on October 10th 2001, which found 21 seedlings, 26 immatures, and 27 matures.

On Puaakanoa Ridge, there is a large group of 145 mature plants with at least ten immature and probably many seedlings. The plants are on nearly barren cliffs and it would be very difficult to access all the plants. This area was not burned in the fire of 2003. In the coming year, NRS will monitor this area, and will determine whether to collect from these plants or not.

At the Kahanahaiki site, there are thought to be about twenty plants and they have not been monitored in the last year.

In the up coming year NRS will focus again on bagging immature fruit at populations at risk of fire in MMR. NRS will continue to maintain the fuel break at Lower `Ōhikilolo and work to monitor the effects of the fire on MMR's populations of this taxon. In addition, NRS will conduct a thorough annual monitoring of the Lower `Ōhikilolo population during the wet season and present population trends in the next year-end report.

3.3.i.2 State Land

There are estimated to be about 70 plants on the Keawa`ula side of Ka'ena Point (KAE-C). Several plants were bagged in July of 2003 in an effort to collect mature seed for germination trials and storage testing. The bags were removed in October of 2003, and mature fruit were taken to Lyon Arboretum. In the coming year, NRS will monitor the plants once. No weed control had been conducted at this site.

There are estimated to be about 320-470 plants in two groups, on the north side of Ka`ena Point (KAE-A and B). Many of these fall within the NAR and are protected from off-road vehicles. NRS has been conducting weed control around these plants. In the coming year, NRS will continue to expand weed control. These efforts are described in detail in the Weed Chapter (Ch. 2).

About thirty mature plants were found in Waianae Kai during surveys in the spring and fall of 2002. Some of these plants were burned in fires in 2003. The sites have not been revisited since the fire. In the coming year, NRS will monitor the plants when working in the area, but they will not be targets for management.

3.3.j *Chamaesyce herbstii*

C. herbstii is a small tree growing up to 8m tall. It is found only on O`ahu in the northern and central Wai`anae Mountains (Wagner et al. 1990).

3.3.j.1 State Land

C. herbstii is found in four different locations in Pahole NAR. A total of 41 plants were observed, all are mature. In one location there were an additional twenty dead plants. NRS will attempt to locate additional plants in Pahole in the future. NRS will return to the plants to place collection bags over the immature fruit in an attempt to acquire seeds for seed storage and trials at Lyon Arboretum. NRS will also begin weeding around these populations in the next year.

In the past year, NRS has begun to work in this area. During weed control in an area where plants have been known in the past, 2 mature and 3 immature plants were discovered. In the coming year, NRS will work on propagation methods for this species. NRS will begin to visit the other known locations in the next year and prioritize management actions. Weed control will continue around the plants as directed by NARS staff.

3.3.j.2 TNC Honouliuli Preserve

The last of the known Ekahanui population died in 2002. TNC staff has checked the area in the last year and no plants were found. In the coming year, NRS will revisit the site to check for seedlings. The historical site is protected from pigs by the S. Ekahanui exclosure.

3.3.k *Chamaesyce rockii*

Chamaesyce rockii is known only from the upper crest and cloud-swept summit ridges in the Ko`olau Mountains. The large red capsules of this species are unique in the genus (Wagner et al. 1990). It is also known from the windward side in deep wet gulches.

3.3.k.1 Kawailoa Training Area

There are six different locations in KLOA with about thirty of the estimated 600 mature individuals on O`ahu. There are estimated to be hundreds more in KLO, however this has not yet been confirmed.

The Army has been working with the Ko`olau Mountains Watershed Partnership (KMWP), which funded the construction of the pig exclosure in the upper `Ōpae`ula drainage. NRS participates in this partnership by having directed the fence route, slingloading gear, maintaining the unit and surveying for protected species. In the coming year, NRS will continue to participate in the KMWP as it moves towards beginning construction of another exclosure in the upper Helemano drainage. This fence will surround a number of the known plants of this taxon and over a hundred acres of undersurveyed habitat. This species will not be a target for management action in the next year but NRS will continue to survey for it when working in appropriate habitat. Plans for the stabilization of this species will be developed by the OIP.

3.3.l *Ctenitis squamigera*

Ctenitis squamigera is a fern with a short creeping rhizome. It is found on Kaua`i, Moloka`i, Lāna`i, West and East Maui and in the Wai`anae Mountains (HINHP 2000).

3.3.l.1 Mākua Military Reservation

On MMR, *C. squamigera* is known from the Lower Mākua MU. This population is not considered significant because it included four plants and represents less than 2% of those known statewide. Large populations of this fern are found elsewhere in the Wai`anaes in Mokulē`ia Forest Reserve and Lower Ka`ala NAR. NRS currently monitors this population, but have not successfully collected mature spores from it. NRS collected spores again this past year and results are pending. NRS expects that this species will present many propagation challenges. This species will benefit from ecosystem-scale weed and ungulate control but will not be the target of any prioritized management action besides tissue storage if propagation trials are successful. NRS will continue to survey for this species while in Mākua and note locations for the GIS database.

3.3.l.2 State Land

NRS have observed this species while conducting other management in Makaleha in the last year. There are estimated to be over 200 plants in this area. In the coming year, NRS will work with State NARS staff to identify populations and monitor them while conducting other work in Makaleha.

3.3.m *Cyanea acuminata*

Cyanea acuminata is known from mesic to wet forest in the Ko`olau and Wai`anae mountains on O`ahu, Lāna`i, Moloka`i and West Maui. It has narrow leaves and a white and purplish corolla (Wagner et al. 1990).

3.3.m.1 Kawailoa Training Area

NRS knows of about 74 plants in KLOA and there are estimated to be over 2000 statewide. These plants are mostly found along the Ko`olau Summit, although some are found on the leeward side down slope from the summit. *Cyanea acuminata* will not be a target for management action in the next year but NRS will continue to survey for it when working in appropriate habitat. In the coming year, NRS will continue to participate in the KMWP as it moves towards beginning construction of another exclosure in the upper Helemano drainage. This fence will surround a number of known plants of this taxon and over a hundred acres of undersurveyed habitat.

3.3.m.2 Schofield Barracks Training Area

On SBW, 107 plants are known from three sites. Rat damage has been observed at one of the populations in the past. NRS has monitored two of these sites in the past year. NRS discovered a new location with about 50 more *C. acuminata* this year and expect that with more surveys, more plants will be found.

3.3.n *Cyanea crispa*

Cyanea crispa is known from mesic to wet forest in the Ko`olau Mountains. It has fleshy stems, broad obovate leaves and a pale magenta corolla (Wagner et al. 1990).

3.3.n.1 Kawailoa Training Area

There is one site with about 5-10 *Cyanea crispa* in KLOA. The site is severely degraded and slugs, which damage the plants, cannot be controlled at this time. Weed control may harm the *Cyanea*, which are smothered in and growing throughout *Clidemia hirta*. Removing the *Clidemia* would greatly increase the light levels, potentially impacting the plants. Rat bait stations meant to protect snails are already in the area and may be expanded to protect fruiting plants. NRS collected cuttings from this population in previous years and now has established plants in the nursery. NRS plan to reintroduce these plants into the Opaeula exclosure in the coming year. The location of this species in KLOA is on the periphery of its range thus there are not many other appropriate reintroduction sites in KLOA (J. Lau, pers. Comm. 2004).

3.3.o *Cyanea humboldtiana*

Cyanea humboldtiana is found throughout the Ko`olau Mountains. It grows to be a small shrub with woody stems up to two meters tall. It has dark magenta or rarely white flowers and pale orangish-yellow berries (Wagner et al. 1990).

3.3.o.1 Kawailoa Training Area

There are estimated to be at least 100 mature individuals statewide. There are four sites in KLOA with 13 known individuals. There are hundreds of acres of undersurveyed habitat for this species in KLOA. This species will not be a target for management actions in the next year but NRS will note new locations. The proposed Helemano fence will surround over 100 acres of appropriate habitat.

3.3.p *Cyanea koolauensis*

Cyanea koolauensis is a small woody shrub up to 1.5 meters tall, having three to six flowers with dark magenta corollas. It is found on exposed ridges in wet cloudswept forest and less often in mesic valleys (Wagner et al. 1990).

3.3.p.1 Kawailoa Training Area

Cyanea koolauensis is endemic to the Ko`olau mountains and is known from Kawailoa Training Area and Schofield Barracks East Range. It is one of the more common *Cyanea* species on O`ahu and not a high priority for management. NRS knows of this species from 20 sites in the Ko`olau Mountains and discovers new locations every year. NRS will continue to map new populations and monitor some existing populations for new threats. A fence project is being planned for the Helemano drainage of KLOA and it would surround some known plants and over a 100 acres of appropriate habitat.

3.3.r *Cyanea grimesiana* ssp. *obatae*

Cyanea grimesiana ssp. *obatae* is a shrub 1-3.2 meters tall. It has pinnately divided leaves, and the flowers are white and purple or magenta. The sub-species *obatae* is distinguished by having linear to triangular calyx lobes, separated at the base by small sinuses.

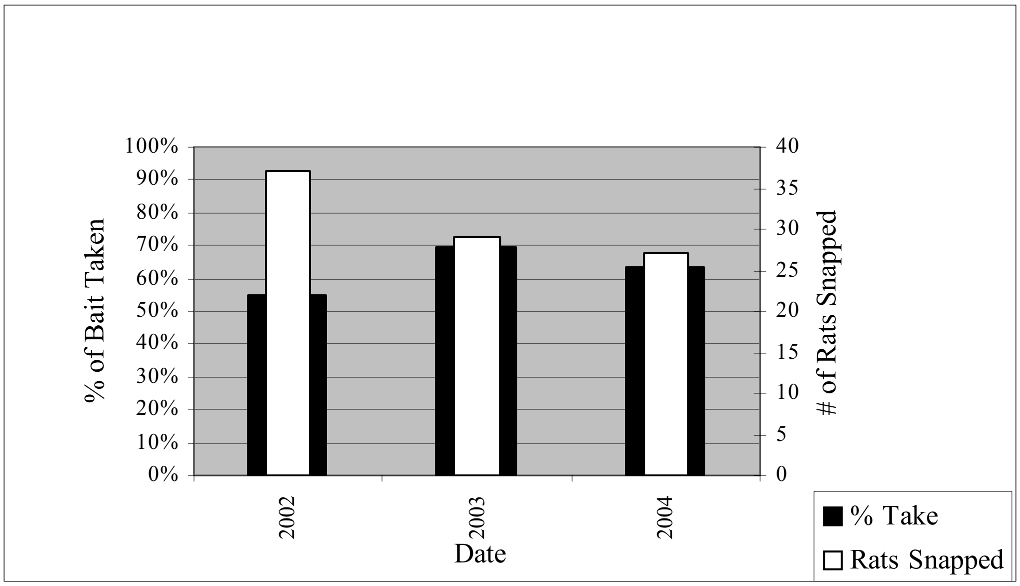
3.3.r.1 State Land

During surveys in 2000, NRS found a group of *Cyanea grimesiana* ssp. *obatae* in the headwaters of West Makaleha. There are five mature plants, two juveniles and one seedling. Predator control for rats was initiated in 2000 by NARS. An exclosure fence for these plants was completed in 2001, for protection against feral ungulates. During the flowering/fruiting season of 2001, NRS established six rat bait stations and 15 snap traps in the area to control rats. In May 2002, NRS discovered major rat damage to the five mature plants. Four had leaves eaten off and one had a damaged stem. By September 2002, the damaged plants were back to health and mature fruit was collected and brought to Lyon for propagation and storage. In response to the rat damage, NRS increased the number of bait stations to eight in the area and monitors them twice a quarter. No mature fruit was collected in 2003. Mature fruit collection is anticipated for 2004 with two mature plants flowering at the present time.

During the first seven months of 2004, a total of 486 blocks (13.8 kg) of rodenticide were taken from bait stations. The total bait consumed was 63.3% of the bait put into the bait stations. Twenty-seven rats were caught in snap traps during the first seven months of 2004 with an average of 4.5 rats per monitoring trip (6 monitoring trips). Figure 3-13 below is a graph of the amount of bait taken from the stations and the number of rats caught in snap traps for the last 2.6 years. Continued bait station and snap trap monitoring twice a quarter and bait station modifications, initiated in 2004 to increase bait viability, will increase bait availability and more effectively control rats resulting in lower levels of take.

There is one juvenile plant inside a small fence in Palikea Gulch at Lower Ka`ala NAR. It has not been observed flowering yet but may in the coming year. If fruits are produced, they will be collected and germinated and if enough are collected, stored at the Lyon Arboretum. NRS will monitor the plant and the fence again in the coming year.

Figure 3-13 Rat Control at *Cyanea grimesiana* ssp. *obatae*



3.3.r.2 TNC Honouliuli Preserve

There are currently no known wild populations remaining in Ekahanui. NRS is assisting TNC in managing stock from plants known from the area. Currently there are nine individuals of mixed stock reintroduced within the Ekahanui fence, with three bearing flowers this July. TNC plans to collect fruit from these individuals for additional reintroductions.

In Kalua'a gulch there are presently two wild *Cyanea grimesiana*. KAL-A is in South Kalua'a and KAL-B is in Central Kalua'a. KAL-A is the type location for this species and therefore has great taxonomic importance. NRS constructed a fence in May 2004, to protect this plant from ungulates. There are 15 outplanted individuals remaining of the KAL-A stock, with several bearing fruit this August. KAL-B was recently discovered in central Kalua'a in close proximity to actively managed areas. The plant was previously buried by *Clidemia* and was not visible. NRS received more than a hundred seedlings from this plant from TNC and plans to outplant these individuals into the northern-most gulch of Central Kalua'a.

Pu`u Palikea, the southernmost area of the preserve under active management, has a small fence containing a healthy wild population of eight mature plants, seven immature plants, and 15 seedlings when monitored in July. The population was augmented twice in the 2003 and 2004 winters with 35 individuals of its own stock. NRS along with TNC staff manage the site for rats with baiting, and control feral pigs outside the fence with snares.

3.3.r.3 State Land

There are two extant *C. grimesiana* in Pahole NAR. The NARS biologist has been monitoring and collecting from these plants. NARS is working to develop a plan for the management of these plants and will enlist the help of NRS if necessary.

3.3.s *Cyanea longiflora*

C. longiflora is a shrub growing up to 3m tall. When individuals are young, they have small, sharp projections that gradually become smooth with age. This plant is only found on O`ahu. It previously occurred in the Ko`olau Mountains, but is now only known from the Wai`anae Mountains.

3.3.s.1 State Land

Recent surveys conducted by NRS in Pahole NAR located 19 seedlings, 40 immature, and 22 mature plants in 2 gulches and in 1 sub-gulch. NARS biologists estimate that there may be around 50 plants in the enclosure. These plants are all within the Pahole fence and are protected from ungulates. NRS plan to work with NARS to achieve a big collection by the end of this summer since the mature plants possess abundant immature fruit.

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

There are two known sites in Keawapilau Gulch. NRS has not monitored these sites, but will in the coming year. There is currently no ungulate control in this area and pigs undoubtedly affect the plants. NRS will monitor these plants in the coming year and determine the need for management at this site.

There are three mature plants located in West Makaleha. The plants are not within a fence but are not thought to be threatened directly by pigs. This past year, NRS didn’t collect any fruit since Lyon Arboretum has over 2000 seeds in stock from these plants. NRS is hopeful that by not collecting, and allowing seeds to hit the ground, they will germinate on their own. In the upcoming year, NRS will monitor the mature plants as well as look for seedlings. No seedlings have been observed at this site.

3.3.s.2 BWS Makaha

There are currently three or four mature plants left on the Kumaipo ridge, which separates Waianae Kai and Makaha. A campfire that got out of control in early September 2003 killed one plant (Figure 3-14). NRS has worked with the BWS biologist to collect from this population and over 2700 seeds have been deposited at the Lyon Arboretum seed bank for storage and trials. NRS monitored the plants in August of 2004 but did not collect. NRS will continue to monitor and collect from the unrepresented individual should it flower.

Figure 3-14 Burned *Cyanea longiflora*

3.3.t *Cyanea st.-johnii*

Cyanea st.-johnii is known only from the windy cloudswept ridges and gulches of the Ko`olau Mountains. It is relatively short for an O`ahu *Cyanea,* 0.3-0.6 meters tall, with white flowers that are sometimes tinged pale purple (Wagner et al. 1990).

<u>3.3.t.1 Kawailoa Training Area</u>

This species was found on Army land in 2000. There is one site with four mature plants and one juvenile plant in the Helemano drainage of KLOA. This population is the northernmost population in the Ko`olau Mountains and one of the few known from the leeward side. It is in a very intact native area. To reduce impact to the area, it has not been monitored often. On the trips that NRS have taken to visit the site the focus has been on trying to secure stock for propagation and reintroduction. Cuttings have been taken on two occasions and parts of a fruit were once retrieved from the ground. The cuttings were tried with both traditional methods and tissue culture. Unfortunately, no cuttings have yet rooted. Fortunately, there are presently approximately thirty plants in tissue culture at the Lyon Arboretum Tissue Culture Lab. These plants are from two seeds found in the partial fruit that was collected off the ground. NRS will ask Lyon to propagate these plants for storage and reintroduction. It will most likely take at least another year for individuals to move through the lab and mature in a greenhouse setting before being ready to plant. In July 2004, immature fruit was observed on one individual. NRS will work to collect mature fruit this year.

The upper Helemano drainage is going to be fenced in the near future. This will exclude ungulates from the area around the plants and secure additional habitat that may be used for reintroduction. The fence should have been completed last year but there were problems with consolidating moneys from the partners and finding a route that had low overhead.

3.3.u *Cyanea superba* ssp. *superba*

Cyanea superba ssp. *superba* is known only from the Northern Wai`anae Mountains. Plants can reach six meters in height and have long dangling inflorescences (Wagner et al. 1990).

3.3.u.1 Mākua Military Reservation

The wild population of this species died out in 2003. NRS have reintroduced 251 *Cyanea superba* ssp. *superba* plants at four sites in Kahanahāiki Gulch from fruit collected from the wild plants. This is the first year that these sites have flowered. Last year NRS collected 30 leaf samples from *Cyanea superba* ssp. *superba* reintroductions for genetic analysis. Dr. Clifford Morden at the University of Hawai`i has analyzed these samples. Although NRS haven't received his written report at this time, personal communication with him reveals that the reintroduced plants are all genetically similar. If any plants show genetic variation, NRS will focus collection efforts on them. Plants grown from this stock will be used to supplement existing outplantings.

NRS will continue to monitor and perform weed control regularly around these plants.

3.3.u.2 State Land

Eighty nine plants were planted at one site in Pahole Gulch. Last year, only two plants were mature. This year there are now twelve mature plants. As seedlings of this species are susceptible to slug predation, NRS hope that S. Joe's slug research may result in techniques that could be applied to an area like this. (S. Joe's research is described in the *A. obovatum* section.) NRS will use this Pahole site to refresh the seed stock at the Lyon seed bank. NRS will continue to monitor and perform weed control regularly around these plants.

There are two sites with about ten mature and 45 reintroduced *Cyanea superba* ssp. *superba* in Kapuna Gulch. State NARS staff planted them in 1997 and 1998 and NRS supplemented the sites with stock from MMR in 2001. NRS monitors these sites periodically when conducting other management. In the past, NRS has assisted the State in controlling rats around these plants and collecting the fruits for storage at Lyon Arboretum. Recent research by Dr. Cliff Morden of the University of Hawai`i Botany Department shows that these plants are not much different from those plants found in other reintroduction sites. Based on this, NRS will manage other existing reintroductions in Kahanahaiki and Pahole Gulch.

3.3.u.3 Lyon Arboretum

Five plants were planted on February 14, 2003 in the Hawaiian section of the Lyon Arboretum. However, the plants are not thriving. NRS will strive to create a healthy living collection at a Botanical garden in the future.

3.3.u.4 Honouliuli Preserve

The Palikea fence now houses 39 individuals planted in spring 2004. Another 97 individuals of mixed stock were planted within the Kalua‘a fence in spring 2004. NRS and TNC continue to monitor their growth and manage the rat populations with bait stations.

3.3.v *Cyrtandra dentata*

Cyrtandra dentata is a shrub growing one to five meters tall. It gets its name from the dentate margins of its leaves. It is known only from two distinct areas in the northern Ko`olau and Wai`anae Mountains (Wagner et al. 1990).

3.3.v.1 Mākua Military Reservation

In Mākua, there is a thriving group of plants in the fenced exclosure in Kahanahāiki Gulch. All the known individuals of this species on MMR are within this fence. There are 156 mature plants, 57 juveniles and 27 seedlings at this site. It is suspected that the seedlings of this taxon are highly susceptible to slugs but no impact has yet been observed. Stephanie Joe, a graduate student from the University of Hawai`i is studying the impacts of slugs on native taxa in Kahanahāiki. NRS will continue to support her important research in the up coming years. In the last year, NRS conducted weed control on two occasions around the *Cyrtandra dentata*.

In April of 1999, following fencing and ungulate removal, there was a spike in the number of seedlings observed. In September of 2001, a large number of those seedlings became juveniles. As of the most current monitoring, a large number of these juveniles had become mature. The overall trend at the Kahanahāiki population of this taxon is very positive.

This species is monitored annually by NRS, additional threats or changes in the population structure will be noted. In the coming year NRS will collect seed from this taxon to determine its seed storage potential. In addition NRS will continue to conduct weed control to improve and expand habitat for this population.

3.3.v.2 Kawailoa Training Area

In KLOA, *Cyrtandra dentata* is known from three sites with over 100 individuals. This represents a small fraction of the more than 2,000 plants known statewide. There are seedlings and juveniles in these populations, although none of the Ko`olau plants are protected from ungulates. NRS has seen populations grow rapidly when protected from ungulates in the northern Wai`anae Mountains. This species will not be a target for management actions in the next year but NRS will continue to survey for it when working in appropriate habitat.

3.3.v.3 State Land

Recent surveys in Pahole NAR found a large amount of plants. 174 seedlings, 390 immature, and 405 mature plants were observed. NRS is confident that future surveys will reveal more plants. In this coming year, NRS will document any new plants in other locations.

HINHP reported *Cyrtandra dentata* from West Makaleha in the summer of 2003. There is no estimate of numbers and plants are recorded as "locally common". NRS will monitor the recorded location in the next year and better quantify numbers and threats.

3.3.w *Cyrtandra subumbellata*

Cyrtandra subumbellata is known only from the North and Central Ko`olau mountains. It is rare and is found in moist gulch bottoms and ridges near the summit on the leeward and windward sides. It has white flowers and white berries (Wagner et al. 1990). Expert botanists believe that the center of abundance for this species is mid-elevation Windward Ko`olau forest to the east of SBE.

3.3.w.1 Kawailoa Training Area

There are 30 plants at two sites on SBE. Both sites have seedlings and juveniles and there are hybrids with two other *Cyrtandra* species in one of the populations. NRS accompanied botanists from the NTBG and HINHP to a large population of *C. subumbellata* on the windward side of the Ko`olau Mountains east of Kawailoa. There were more than a hundred individuals and many were hybridizing with other species. There were eight species of *Cyrtandra* found in this one small area. Finding this population makes the plants on the Army's portion of land less significant. NRS will continue to map new populations.

3.3.x *Cyrtandra viridiflora*

Cyrtandra viridiflora is known only from scattered windy cloudswept ridge tops in the Ko`olau Mountains on O`ahu. It is a small shrub growing half a meter to two meters tall with densely pubescent leaves and stems (Wagner et al. 1990).

3.3.x.1 Kawailoa Training Area

There are 61 known individuals of this species found in KLOA. The `Ōpae`ula Watershed Protection Project Fence surrounds most of the known individuals of this species in KLOA. This fence has secured the area around the plants, especially those close to the Ko`olau Summit Trail, which is frequented by pigs. Those individuals outside the fence are still at a high risk for ungulate damage. In the coming year the Helemano exclosure will be completed and protect another 14 plants and over a hundred acres of undersurveyed habitat. NRS has been storing mature seeds at Lyon Arboretum. In the coming year, NRS will store mature seed from unfenced plants and those individuals not represented *ex situ*.

3.3.x.2 Schofield Barracks Military Reservation

One individual was found by NRS during surveys in SBE in 2002. It has not been monitored in the last year. There has been no management for this plant. The area in which this plant is found is not visited by NRS regularly and requires helicopter access. NRS will monitor this plant when in the area for other management. This species is also known from the USFWS Refuge to the south of SBE.

3.3.y *Delissea subcordata*

Delissea subcordata was known from O`ahu, in the Wai`anae and Ko`olau Mountains. This species grows to three meters tall, has green and white flowers, and berries that turn purple when ripe. It is now found only in diverse mesic forest on the windward side and crest of the Wai`anae Range (Wagner et al. 1990).

3.3.y.1 Mākua Military Reservation

Only one possibly wild mature plant is known from MMR. The origin of this single plant is still unclear. There is a reintroduction of *Delissea subcordata* from the Pahole NAR nearby and this plant may have come from seed dispersed from those plants. It may also be a new seedling from a historic population. NRS collected leaf material from the plant for Dr. Cliff Morden to analyze. Until the results of the study are in, NRS will treat this individual plant as unique and significant.

The *D. subcordata* reintroduction site in Kahanahāiki Gulch was initiated in January 1999. There are now over 30 reintroduced plants at this site and they have been observed flowering and fruiting. No seedlings apart from the possible plant discussed above have been observed in this reintroduction. Mature fruit has been collected for genetic storage trials at the Lyon Arboretum.

3.3.y.2 Schofield Barracks West Range

Last year, two plants were known in Mohiakea gulch. However, on a recent access day into West range, only one healthy mature plant could be located. The other plant appears to have died after the top was broken off by a rock fall. Access to the population is restricted by training activity, which limits the management options available to NRS. There have been successful collections of mature fruit from this population in the past. Collections are being stored at Lyon Arboretum. Seedlings from germination testing were grown at the Army Nursery. Plants from this population have been reintroduced to Kalua`a gulch.

3.3.y.3 Honouliuli Preserve

All the outplanted plants in the Kalua`a exclosure are doing great. This past year, mature fruit was collected from reintroduced plants for seed sowing trials being conducted by TNC. Two plants were recently discovered on a ridge in central Kalua`a, in a fenced area. NRS will outplant, among other things, *Cyanea grimesiana* ssp. *obatae* in the area around the plants. NRS will also conduct rare plant surveys to locate more plants.

This year NRS began working with TNC to manage the two mature and three immature plants found in two different areas in Palawai gulch. Fences were constructed around both areas and some weeding occurred. Two mature fruits were collected from PAL-A in July 2004 for seed storage.

In Ekahanui gulch, there are two sites with plants. One has two mature and one immature plant and the other has one mature plant. NRS and TNC built fences around these sites in the last year. Collections have been made and are being grown for reintroduction and stored at Lyon. This coming year NRS will continue to monitor the plants and collect fruit for seed storage at Lyon Arboretum.

3.3.y.4 State Land

NRS visited the known population location in Kapuna gulch with State NARS staff in the last year, and no live plants were found. Weed control is being done in this area to support other species and NRS will continue to monitor for more plants at this site.

A new site with one mature plant was discovered near the historic location in Kapuna in the last year. In the coming year, NRS will assist NARS staff to monitor this plant and collect fruit for genetic storage at the Lyon Arboretum.

Joel Lau and NRS visited the historic location for this species in Kaawa Gulch in Lower Ka`ala NAR in the last year. No live plants were found. 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.

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

In 2002, NRS worked with NARS at West Makaleha to establish a reintroduction of stock collected from the LKN-A population. Twenty plants were planted inside the exclosure in January 2003. Two plants sustained damage from rats and several from slugs in May 2003 and were in moderate health at that time. In July 2004, the two plants damaged by rats had died and the remainder of the plants were in good health with several fruiting. In May 2003, five bait stations were placed around the out-planted plants and are monitored quarterly. During 2004, monitoring increased to twice quarterly and 10 snap traps were added to the baiting area. A total of 143 blocks (4.1 kg) of rodenticide was taken from bait stations during the first seven months of 2004. The total bait consumed was 59.6% of the bait put into the bait stations. Twelve rats were caught in snap traps during the first seven months of 2004 with an average of 2.0 rats per monitoring trip (6 monitoring trips). Continued bait station and snap trap monitoring twice a quarter and bait station modifications, initiated in 2004 to increase bait viability, will hopefully increase future control efficiency. In the coming year, NRS will work with NARS to restock the stations and monitor the plants.

3.3.z *Diellia falcata*

Diellia falcata is a medium-sized endangered fern found in scattered populations in loamy soil. It is known only from the mesic forests of O`ahu (Palmer 2003).

3.3.z.1 Mākua Military Reservation

D. falcata is known from at least two sites on MMR. One site has fewer than ten individuals and the other several hundred. There are estimated to be more than 1000 individuals statewide. Although no specific management is conducted for this taxon, *Diellia* benefits from MMR-wide goat control efforts and from protection within the Kahanahāiki exclosure. NRS has worked with researchers from the NTBG to track population trends at the Kahanahāiki site in the past year. Results from these studies will be presented when they are available.

3.3.z.2 Schofield Barracks South Range

There is one small population of *D. falcata* in SBS. The site is not protected with a fence and will not be a target for management. Ungulate control would help to stabilize these populations and prevent further habitat degradation; however, access restrictions limit the ability of NRS to control weeds around rare plant populations in SBW where most are located. This species is not a priority for management given the relatively small number of individuals known from SBW.

3.3.aa *Dubautia herbstobatae*

Dubautia herbstobatae is known from the Northern Wai`anae Mountains. It is a small spreading shrub known only from dry ridges and cliffs (Wagner et al. 1990).

3.3.aa.1 Mākua Military Reservation

There are thousands of individuals known from the Northern Wai`anae Mountains. Over 98% of the known individuals are found on `Ōhikilolo ridge in MMR. Goats have been almost completely removed from MMR by control efforts. Elimination of goats from MMR potentially will have a large positive impact on this taxon by possibly no longer limiting it to places inaccessible to goats. NRS continue to control goats with in MMR with the short-term goal of complete eradication. In the coming year, NRS will work to develop a monitoring method for this species and collections of mature seeds will be made to conduct seed storage trials.

3.3.aa.2 Waianae Kai

There is one site with this species on the cliffs of Waianae Kai. There are at least five mature individuals there, but this site has not been adequately surveyed. In the coming year, NRS will survey more of this site and adjacent areas and attempt to collect from the known plants to keep as a living collection.

3.3.aa.3 Makaha

There was one known location of *D. herbstobatae* from Makaha. Presently no plants are known. The site where plants occurred has been surveyed in the last year. Stock was collected from this location before it was extirpated. NRS maintain this stock in the Army greenhouse. Once the Makaha fence is complete, NRS plan to reintroduce individuals into the fenced area.

3.3.ab *Eugenia koolauensis*

Eugenia koolauensis is known from dry gulches and slopes on O`ahu and Moloka`i (Wagner et al. 1990).

3.3.ab.1 Kahuku Training Area

There are estimated to be 210 mature, 195 juvenile and 1540 seedlings of this species in eight different sites in KTA. This is over 90% of the *Eugenia* trees known statewide. They are threatened by weed encroachment, especially from Ironwoods, ungulate damage from pigs, motocross use of the area and fire. In 2000, a fire suspected to have been ignited by a flare and grenade from Marines using the Training Area burned within 400 meters of a stand of *Eugenia* trees. In 2003, another fire burned near two known populations of this species. One juvenile and one mature tree showed signs of heat stress. The fire burned to within a half meter of seedlings, likely killing others and the fire burned to within six meters of juvenile and mature trees. The fire occurred while troops were clearing a helicopter-landing zone. A branch of a mature tree was cut in order to fortify a firebreak. Along the perimeter of the fire, invasive plant species have invaded aggressively. Weed control is conducted twice a year in each population. In the coming year, NRS hope to prioritize the populations and implement further management. There are plans to fence and control Ironwoods at these locations.

3.3.ab.2 Kawailoa Training Area

There are two locations in Kawailoa Training Area where NRS has discovered Eugenia koolauensis. Both sites are in the vicinity of the Kamananui drainage and drum road. A single tree was discovered in June of 2000. The second location is a more robust patch with 15 mature trees, 16 juveniles and 15 seedlings. This site was discovered in February of 2004. NRS will monitor this larger concentration of plants and continue to survey for more individuals.

3.3.ab.3 State Lands

Two mature trees and two seedlings were found in 2000, during surveys of Palikea Gulch in Lower Ka`ala NAR. In the coming year, NRS will work to prioritize the populations and determine management designations.

One mature tree was found in Hauula in 1999, but has not been monitored since. In the coming year, NRS will determine the priorities for this species and collect from those for genetic storage. The Papali Loop population has not been monitored by NRS at this time, but in the coming year, NRS will work to prioritize the populations and determine management designations.

3.3.ac *Euphorbia haeleeleana*

This species is a small dioecious tree known from Kaua`i and the Wai`anae Mountains of O`ahu. On Kaua`i, it is most often found in mesic forest, but it is found in drier forest on O`ahu (Wagner et al. 1990).

3.3.ac.1 Mākua Military Reservation

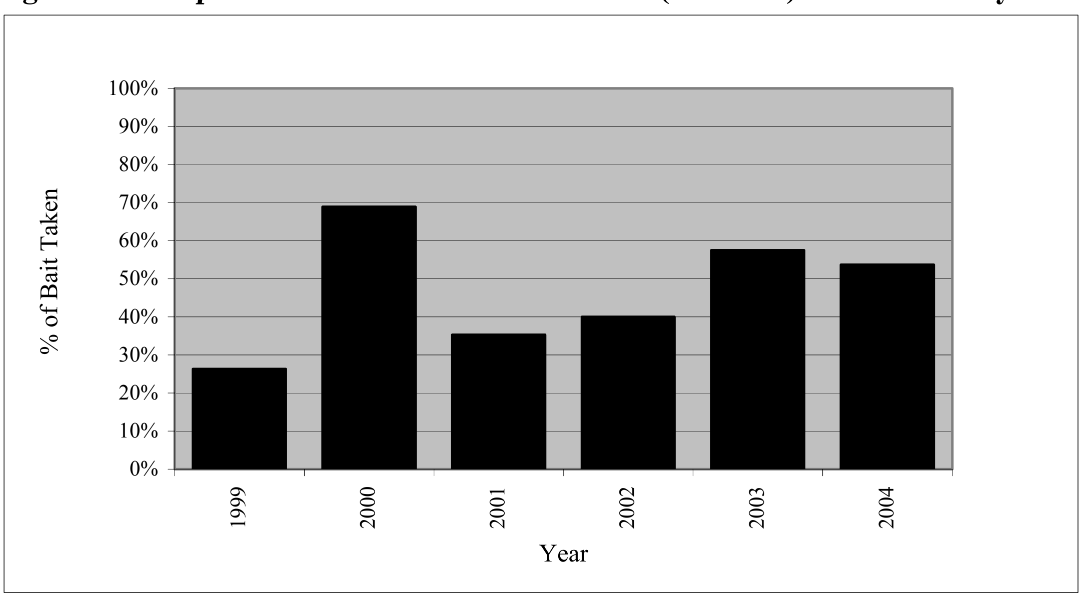
The *Euphorbia* in MMR are found in the Kaluakauila Gulch MU. There are two groups of trees (MMR-A and MMR-B) in the gulch, and both were fenced in 2002. A thorough count of the mature individuals was done in 2002, significantly increasing the known population size. Rats are known to eat the seeds of this species. A complete count of all individuals will be done every few years.

There are about 175 mature trees in the MMR-A population (lower patch). There are a few additional trees that appear old enough to flower, but have not yet been observed in flower. These are considered to be juveniles. Seedlings have been observed in the patch but seldom live for more than two years.

Baiting for rats in Kaluakauila began in 1999 and the grid was expanded in 2001. NRS continue to control rats at both the patches, MMR-A and B. A large baiting grid of 39 stations, which covers a 4.29-acre area, is established at MMR-A the Lower Patch. A grid of 18 stations, which covers a 2.5-acre area, is established at MMR-B the Upper Patch. Bait is restocked twice per quarter.

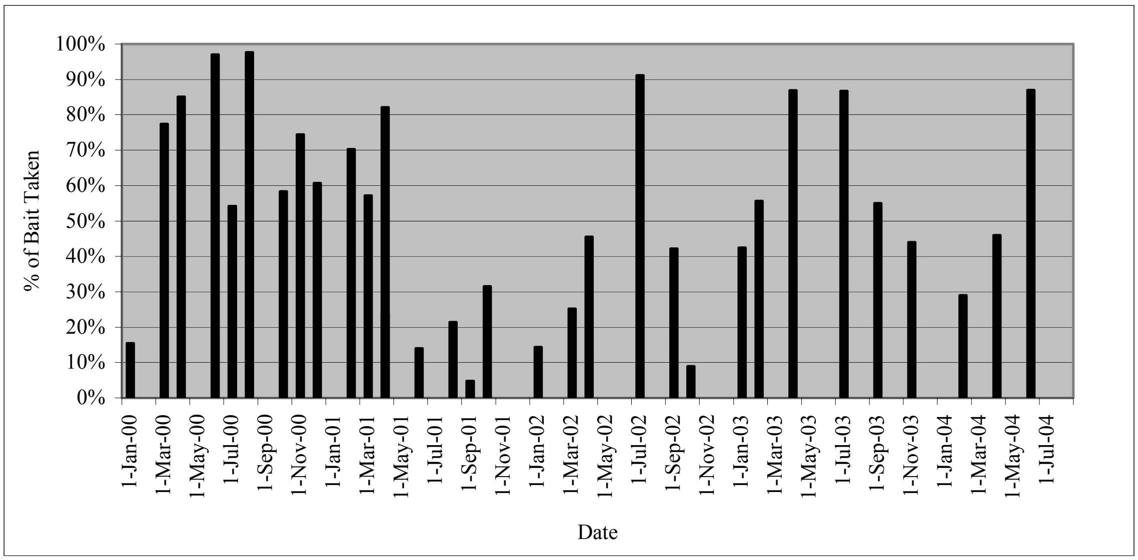
Figure 3-15 shows that in 2002 the percent bait take for the year was 40%, for 2003 it was 57%, and for 2004 it was 54%. The percent take for 2004 is average with respect to the previous years.

Figure 3-15 *Euphorbia haeleeleana* Lower Patch (MMR-A) Rat Control by Year



In Figure 3-16, a seasonal trend shows that the highest bait take in the lower patch occurred during the late spring to summer then dropped off into fall and winter in every year since 2000. This may indicate an annual trend for the rat population in Kaluakauila. Although there has never been 100% take during the spring to summer season, NRS may consider changing the amount of bait available during the different times of the year to better match the take. In general, this may produce less wasted bait during the slow season and prevent the take from approaching 100% in the summer.

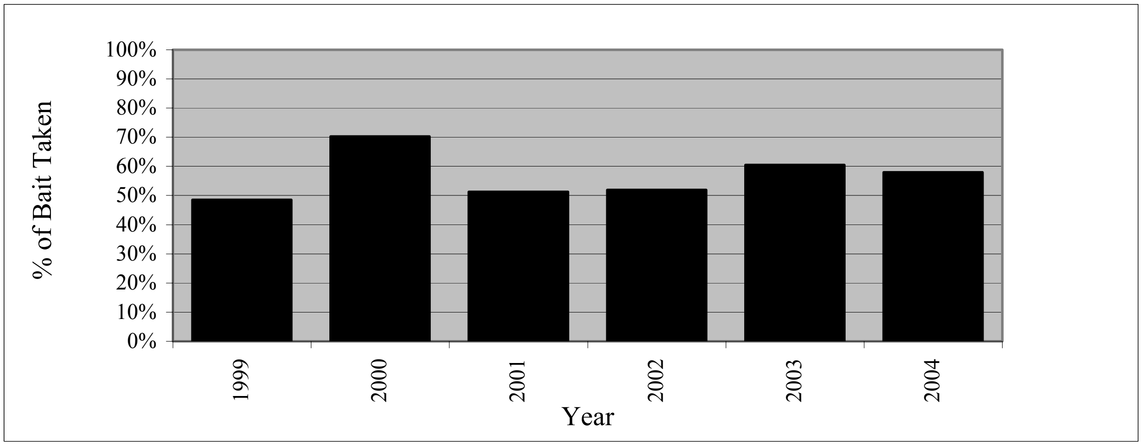
Figure 3-16 *Euphorbia haeleeleana* Lower Patch Seasonal Trends 2000-2004



There are about twenty known mature trees in MMR-B (upper patch). A few seedlings have been observed in this patch over the past few years, but none have grown to a juvenile tree.

Figure 3-17 shows that in 2002 the percent bait take for the year was 52%, for 2003 it was 60%, and for 2004 it was 58%, which is about average for the past few years.

Figure 3-17 *Euphorbia haeleeleana* Rat Control at the Upper Patch by Year

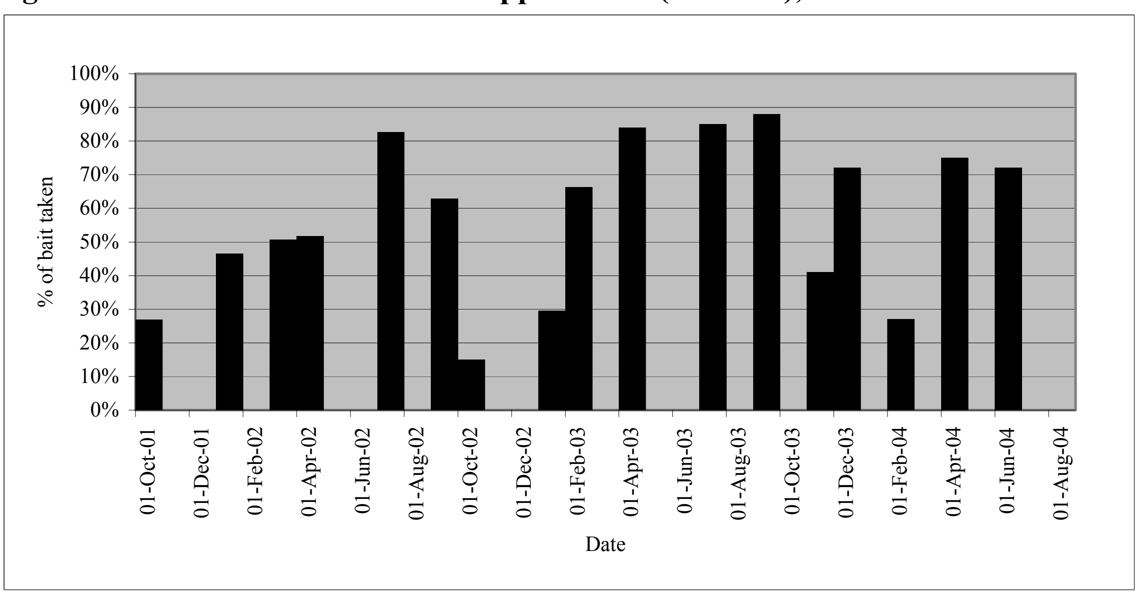


In Figure 3-18, a seasonal trend similar to the one in the lower patch shows that the highest bait take in the upper patch occurred during the late spring to summer then dropped off into fall and winter in every year since the winter of 2001.

NRS reintroduced stock from the Kaluakauila population of *E. haeleeleana* into Kahanahāiki in January 2000, at the MMR-D site. Thirty-four of the 39 survived and most are healthy. No plants have been observed flowering yet.

In the coming year, NRS will continue to monitor the wild population for new threats and trends, continue rat control, and monitor the exclosure to ensure that it is ungulate free. The reintroduction site will be monitored once. A fire prevention plan is being developed for this area. NRS is helping to identify priority areas for fuel control.

Figure 3-18 Seasonal Trends in the Upper Patch (MMR-B), 2001-2004



3.3.ac.2 Dole Lands

There are three mature trees reported from two different sites below the Lower Ka`ala NAR access road. These trees have not been visited in the last year. In the coming year, NRS will prioritize management for this area. This may involve fencing and weed control for other species near the *Euphorbia* and they may benefit from this management.

3.3.ad *Flueggea neowawraea*

Flueggea neowawraea is one of the rarest trees in Hawai`i. It was known from all the major islands. On O`ahu it is known only from the Wai`anae Mountains. This taxon is known to grow to thirty meters tall with a base two meters in diameter and is dioecious (Wagner et al. 1990). Most plants are terribly impacted by the black twig borer. NRS have been successful in propagating *Flueggea* from air-layers (Figure 3-19, and 3-20), however access and BTB damage limit the success of this method. Air-layers can dry out during the months between visits and the material being air-layered is still vulnerable to the black twig borer. Cuttings have been successful as well and are proving to be a more efficient method. NRS are currently working with researchers from the University of Hawai`i and the State Department of Agriculture Extension Service to control this threat. This will require much lab and fieldwork to determine the interaction between the tree, the borer, and the fungus associated with the pest and possible control methods. NRS is currently seeking out interested researchers to work on this issue.

3.3.ad.1 Mākua Military Reservation

There are five live mature trees in four different sites on MMR. Access to two of the trees is restricted and therefore, NRS are limited to quarterly monitoring. NRS have conducted weed control around most of these trees, and two are within a fence to exclude pigs and goats. The main threat to these trees is the damage caused by the black twig borer.

Population MMR-A consists of one tree and is located on the rim of Mākua Valley. It is not within a fence, but one will be built in 2005-06. NRS has been unsuccessful getting cuttings from this tree to produce roots. More will be taken in the coming year and air-layers will be put on the tree. Propagules collected from this tree will be grown out at the Army nursery and cloned for reintroduction.

Population MMR-B consists of one mature tree, it is inside the Kahanahaiki Gulch fence. NRS have collected an air-layer cutting from this tree and other tip cuttings have been successfully rooted in the last year. Stock collected from this tree will be grown at the Army Nursery and cloned for reintroduction.

Figure 3-19 Air-layer on *Flueggea neowawraea*

Figure 3-20 Rooted Air-layer from *Flueggea neowawraea*

Population MMR-C consists of two mature trees in the Lower Mākua Management Unit. A fence to exclude goats, which were browsing the suckers, was built around one of these trees. Fruit has been collected from this site, however none have ever germinated.

Population MMR-E consists of one mature tree below the Kahanahaiki management unit. This tree is outside the fenced enclosure. However, the canopy is taller on this tree and it is not at risk from ungulate browse. NRS have never collected fruit from this individual and cuttings and air-layers have not established in the nursery. NRS will work in the next year to establish *ex situ* stock from this tree.

In Kahanahaiki Gulch, MMR-F consists of a reintroduction initiated in the last year with 26 immature trees grown from fruit collected from a tree in West Makaleha (LEH-A-2). These trees were planted in December of 2003 and are treated quarterly with a systemic insecticide Merit. As of April of 2004 no plants had died, but several had black twig borer damage. NRS will continue to apply Merit quarterly and monitor the success of this technique.

3.3.ad.2 Schofield Barracks Military Reservation

The single tree that was known from SBMR was inspected again this year and appears to be completely dead.

3.3.ad.3 Lualualei Naval Magazine

NRS has helped the Navy to collect from trees known from Lualualei in the last year. There are four trees known and cuttings and air-layers have been collected from two in the last year. The propagules are being grown at the Army Nursery and will be cloned. One tree is within a small fence and the others are unprotected. NRS will collect from the other trees in the coming year and work with Navy staff to monitor the other trees.

3.3.ad.4 State Land

There are two trees known from Central Makaleha. NRS has relocated and installed air-layers on these trees in the last year. Both trees are in moderate condition and are not fenced. Cuttings have rooted from one tree so far and will be grown and cloned at the Army Nursery. In the coming year, NRS will continue to monitor these trees and collect from the unrepresented tree.

In West Makaleha there are three *Flueggea* known by NRS. NRS attempted to establish air-layers on these trees in the last year however, the air-layers were destroyed by black twig borer. Cuttings were successful in the greenhouse for two of the three trees. NRS will work to secure stock from the third individual in the next year.

In East Makaleha, four trees have been reported. NRS has not visited these sites in the last year. In the coming year, NRS will revisit these trees and collect for propagation at the Army Nursery.

In Pahole Gulch NRS there are three mature trees. NRS recently collected cuttings from these trees and they are being propagated at the Army Nursery. They are looking good and NRS expects that they will root.

One tree is known from Kapuna Gulch in the Pahole NAR. The tree is not within a fence and NRS has just begun weed control in the area in the last year. NRS has visited and collected from this tree. Cuttings were taken to the Army Nursery and will be grown for cloning and reintroduction.

In Lower Ka`ala Natural Area Reserve, Kaawa Gulch, there are three mature trees, one tree was discovered by NRS in the last year. NRS has collected from two of the trees and cuttings are being rooted at the Army Nursery. Propagules will be grown from cloning and reintroduction in the future.

In Lower Ka‘ala Natural Area Reserve, Manuwai Gulch, NRS relocated one of the two known trees in the last year, and it had died. The other tree was not located and others may be found in this area in the coming year. If trees are found, cuttings will be taken and grown at the Army Nursery.

The tree known from Waianae Kai was found to be dead in the last year. NRS will continue to look for more trees when working in the area.

3.3.ad.5 BWS Makaha

NRS worked with BWS biologist in the last year to install air-layers on three of the five known trees. The air-layers were successful on two of these trees and they are now rooted in the Army greenhouse. NRS will work in the coming year to secure stock from the other three trees. Four of these trees are within the proposed Makaha fence exclosure.

3.3.ad.6 TNCH Honouliuli Preserve

One *Flueggea* was known from Honouliuli, it died sometime in 2002. NRS never saw this tree. Nature Conservancy Biologists visited the location this year and report that the tree is dead.

3.3.ad.7 Waimea Botanical Garden

NRS has worked with the staff of the Garden to plant immature trees that were grown from fruit collected from the West Makaleha (LEH-A) trees in the last year. Fourteen trees were planted and are being treated with a soaking of Merit quarterly. NRS will continue to treat and monitor these trees to assess the success of this site.

3.3.ae *Gardenia mannii*

Gardenia mannii is known to be uncommon from mesic to wet forest on O`ahu. It is one of three species of *Gardenia* endemic to Hawai`i. This species is a tree growing from five to fifteen meters tall. The leaves are clustered at the tips of the branches. The white, fragrant flowers open in the late afternoon and last for two days. The fruit is yellow to orange with reddish orange pulp (Wagner et al. 1990).

3.3.ae.1 Kawailoa Training Area

NRS know of 40 trees in six different areas on KLOA. There are likely to be many more, as hundreds of acres of appropriate habitat remain undersurveyed. In the last year NRS weeded *Psidium cattleianum* and *Clidemia hirta* from around populations of *G. mannii* in the Lower Peahinaia Management Unit. A fence planned as part of the Ko`olau Mountains Watershed Partnership would surround many of the known trees in this area. In the coming year, NRS will continue to search new areas.

3.3.ae.2 Schofield Barracks West Range

There is one site with two *Gardenia* trees in SBW (Figure 3-21). These individuals do deserve attention and management because they are among the few known from the Wai`anae Mountains. NRS had planned to construct a fence around these individuals last year. However, because of range restrictions and changes in safety planning requirements the fence was not completed. NRS is working with the Army Safety Office to gain permission to construct the fence. The fence line has already been laid out and cleared. In the past five years fruit has been collected on four occasions and taken to Lyon Arboretum for storage. Most recently a collection was made in June of 2004. Due to ordnance and schedule restrictions and the remote nature of much of SBW, there is much area that remains under-surveyed. These areas have good habitat for this species and more plants may be found.

Figure 3-21 *Gardenia mannii* from SBW

<u>3.3.ae.3 Schofield Barracks East Range</u>

Two *Gardenia mannii* trees are known on SBE. They were found in 2002 and have not been monitored since. There are about 300 trees known from the Ko`olau Mountains making these two individuals low priority. In the coming year, NRS will continue to search new areas as access allows. A long-term botanical garden type setting should be found for this species, so ex-situ stock can be held as mature trees.

3.3.af *Hedyotis degeneri* var. *degeneri*

Hedyotis degeneri var. *degeneri* is known from diverse mesic forests in the Wai`anae Mountains of Oåhu. The other variety (var. *coprosmifolia*) is known also from the Wai`anaes. *Hedyotis degeneri* var. *degeneri* is distinguished by having glabrous stipules (Wagner et al. 1990).

<u>3.3.af.1 Mākua Military Reservation</u>

There is one site with eleven individuals of *H. degeneri* var. *degeneri* in Mākua. This site represents less than 5% of the individuals known statewide. The population is located within the Kahanahāiki MU, but is outside the Kahanahāiki fence. Seedlings were observed in the population this year. This species benefits from ongoing ungulate and weed control and a fence is planned for this area. In the last year, NRS attempted to collect mature fruit for genetic storage. This taxon does not have a predictable phenology and collections were not successful. Stock is being stored at the Lyon Arboretum. The MMR fire of 2003 burned to within 50 meters of this population. NRS will continue to try and collect for genetic storage and will continue ungulate and weed control in the area.

<u>3.3.af.2 State Land</u>

This year NRS began working more frequently in Pāhole Gulch and visited a known population of *H. degeneri*. NRS approximated 24 plants at the site and there may be more. On a separate day NRS discovered a new site with 12 plants. As NRS spends more time in Pāhole it is expected that more plants will be discovered. NRS will monitor the known sites for fruit for storage.

At this time there are 45 mature plants in Central and East Makaleha at 4 different locations. There are a few juveniles and seedlings between the populations. In the coming year, NRS will obtain genetic representation from these plants, survey for more, and determine the best place for a proposed fence in this area.

There are 58 mature plants known from two sites in the Lower Ka‘ala NAR. These plants should benefit from ungulate removal in the area. In the coming year, NRS will continue ungulate control, survey for more plants in this area, and collect for genetic storage.

3.3.ag *Hedyotis fluviatilis*

Hedyotis fluviatilis is a scandent shrub with white fleshy and waxy flowers. It is rare in mesic to wet forest on Kaua‘i and in the Ko‘olau Mountains of O‘ahu (Wagner et al. 1990).

There are three groups of plants in KLOA with a total of 110 individuals. This species will not be a target for management action in the next year but NRS will continue to survey for it when working in appropriate habitat.

3.3.ah *Hedyotis parvula*

Hedyotis parvula is known only from rock ledges, cliffs and outcrops in the Mountains. It is a small shrub with white flowers (Wagner et al. 1990).

3.3.ah.1 Mākua Military Reservation

There are two known sites with *H. parvula* in MMR, one with 46 mature plants, and the other with about 45. NRS believe that goats are nearly eliminated from MMR and are pursuing the few remaining animals. The elimination of goats from the valley will reduce the ungulate threat to this taxon. NRS is controlling the incipient population of *Rubus argutus* in the vicinity of one *H. parvula* site. Both of the wild sites were visited in the last year. Both sites still have about the same number of mature plants and are stable. In the coming year, NRS will monitor the plants and determine the management strategy for these plants.

3.3.ah.2 Lualualei Naval Magazine

Twelve mature plants are known from one site in Halona. They were healthy and had no pressing threats when observed in July of 2003. No collections were made. In the coming year, NRS will survey more in this area, search for other reported plants, and collect for genetic storage.

3.3.ai *Hesperomannia arborescens*

Hesperomannia arborescens is known from wet forest on O’ahu, Moloka‘i and Lāna‘i. It appears to be extirpated from Lāna’i and is rare on other islands. It is a small shrubby tree averaging 1.5 to 5 meters tall with a yellowish brown or purple tinged pappus (Wagner et al. 1990). It was also found in mesic forest in the Wai`anae Mountains of O’ahu.

3.3.ai.1 Schofield Barracks East Range

There are three known populations in SBE. One population has fifteen mature plants, one has 25 and another has about 50. While this species will not be a target, in the coming year, NRS will continue to search new areas and map new populations.

3.3.ai.2 Kawailoa Training Area

Further north in KLOA, there are twelve groups of plants with over 102 known individuals. There are juveniles and seedlings found in all sites. There are hundreds of acres of under-surveyed habitat appropriate for this species in KLOA. While this species will not be a target, in the coming year, NRS will continue to search new areas and map new populations.

3.3.ai.3 State Land

In Lower Ka'ala Natural Area Reserve, Palikea Gulch, three mature plants and one juvenile were found during surveys of this area in 2000. In the coming year, NRS will monitor these plants and survey the area for more.

3.3.aj *Hesperomannia arbuscula*

Hesperomannia arborescens is a tree growing up to five meters tall. It was known from O'ahu, Moloka'i and Lāna'i (Wagner et al. 1990

3.3.aj.1 State Land

There is one mature plant known from Kapuna Gulch. Air-layers were put on the plant and have been monitored in the last year. Weed control in this gulch was begun in the last year. In the coming year, NRS will assist NARS staff in monitoring and collecting from this plant.

In Wai`anae Kai there were five mature plants and one juvenile in August of 2003. NRS conducted weed control at this site in the past but not in the last year. A fence has been scoped for this site and is pending approval from State Forestry officials. The plants are declining rapidly at this site and very few propagules have been secured from them. Also, someone picked the flowers of the tree. In the coming year, NRS will work with State NARS staff as well as GSN staff to monitor and collect from the plants. As soon as a fence is approved, it will be built. Propagules will be grown at the Pāhole Nursery.

3.3.aj.2 BWS Mākaha

The management of the *Hesperomannia arbuscula* plants in Mākaha has been executed by the BWS biologist and the O'ahu Genetic Safety Net biologist. Air-layers were installed, however they never rooted successfully. NRS scoped a fence route that encompasses the plants and is in the final stages of seeking permission to install this fence. NRS will become more involved with the BWS biologist in the management of this population in the coming year.

3.3.aj.3 TNC Honouliuli Preserve

As with the Mākaha population, much of the management for this species was conducted by the O'ahu Genetic Safety Net biologist and TNC staff. NRS constructed a fence to exclude ungulates from the area. (See Chapter 1: Ungulates for details.) Five air-layers successfully rooted and are at Pāhole Nursery. One air-layer fruited this year in the greenhouse, however it aborted before the fruit matured. 5 seedlings were relocated to Pāhole Nursery as well. Thirteen fruits were delivered to Lyon, and several proved to be viable as germination in test tubes has occurred.

3.3.ak *Hibiscus brackenridgei* ssp. *mokuleianus*

Hibiscus brackenridgei ssp. *mokuleianus* is known to be rare in the dry forest and shrublands of all six of the major islands. They are sprawling to erect shrubs and trees up to five (-ten) meters tall. There are two subspecies. The *mokuleianus* subspecies occurs on Lāna'i and O'ahu (Wagner et al. 1990). There are three slightly different types of ssp. *mokuleianus* found on O'ahu (Joel Lau pers. comm. 2001). Two of the types are found on the north end of the Wai`anae Mountains from Waialua to Ka'ena. The other is found in Mākua Valley. The type known from Mākua resembles the plants historically known from Moloka'i (subsp. *molokaiana*). No plants are known from Moloka'i today.

3.3.ak.1 Mākua Military Reservation

There are now 18 mature, 8 juvenile and 11 seedling *Hibiscus* plants located in Mākua valley. NRS collected cuttings from almost all of the mature plants in the population and from the juvenile plants that were large enough to collect from. NRS have a complete complement of these clones at the Army propagation facility. Clones are also planted at Mākua Range Control, Kaluakauila management unit and Koko Head Botanic Garden. A full complement of clones is not yet established at any one of these reintroduction sites but in the next year NRS will work to achieve a complete set of founders at all three sites. NRS will be phasing out the living collection at the baseyard as plants are established in at least two living collection sites and in seed storage.

NRS removed all ornamental *Hibiscus* spp. that were planted at Mākua Range Control in the summer of 2004. This action was spurred by concerns over possible hybridization and pollen competition. NRS interviewed a number of horticultural expects before taking action. NRS emailed or spoke with among others, the following, Dr. Criley (UH Manoa), Dr. Koob (US Fish and Wildlife), Joel Lau (Hawai'i's Heritage Program), and Amy Tsuneyoshi (Board of Water Supply). In general, most thought that hybridization was unlikely but that removing the ornamental plantings would be the conservative decision.

NRS have collected more than twelve thousand mature seeds for storage from the living collection at Mākua Range Control. Unfortunately, much of the seed that has been collected is not viable. In addition, there is a long processing time required to get the seed out of the woody capsule making it difficult to obtain large numbers to offset low viability. NRS investigated seed for other living collections at Koko Head and Ka'ala Learning Center and found similar results. Lauren Wiesenberger from the Lyon seed bank came to Mākua to investigate that site and see if she could determine causes for low viability. She found that the growing tips of some plants appeared stressed and suggested that perhaps this was why the plants did not produce viable seed. NRS will work with her next year during collection to examine causes and improve efficiency of collection.

To investigate methods to improve seed viability, NRS this year began to manage the Range Control collection differently. In an attempt to improve vigor, plants were selectively pruned to reduce plant stress and to direct next season's flowering branches. A slow release fertilizer was broadcast after pruning. A slow release insecticide was also applied to address the insect pests in the area. The plant response to the actions taken appear favorable.

Since grass control began at the Lower ʻŌhikilolo population in 2001, NRS have maintained 30 meter firebreak buffer around all plants. NRS has also almost completely removed all *Leucaena leucocephala* (koa haole) and *Acacia mearnsii* (klu). For more details see Ch.2: Weed Mgmt.

In December 2002, NRS reintroduced 38 *H. brackenridgei* from Lower ʻŌhikilolo stock into the Kaluakauila exclosure. The survivorship of these outplants was over 90% as of July 2004. The fires of 2003, from Mākua Military Reservation affected these plants. A few were killed and the area is now smothered in *Panicum maximum* responding to the fire. In 2004, eight more plants were put into a different area in the upper patch. These sites will be analyzed in the coming year to determine if the plants are able to maintain their characteristics in different microclimates. These plants will be monitored in the coming year and the sites will be supplemented with available stock.

<u>3.3.ak.2 State and Dole Lands</u>

Surveys for *H. brackenridgei* ssp. *mokuleianus* were conducted in areas of the Lower Ka'ala Natural Area Reserve and Dole owned lands below the NAR in the last year. At least ten mature, 210 immature and several seedlings were found in four gulches in the area. Some locations were known historically, however, the majority were never reported. In the coming year, NRS will prioritize management for this area and determine where to build a large proposed fence. Ideally, the fence will surround the most plants in the area with the most potential for restoration. Goats, *Panicum maximum, Coffea arabica* and other weeds pose the largest threat to this species in this area, as well as a threat of fire. Proposed management would include fencing, hunting and massive weed control. All plants not within the proposed unit would be collected from and planted into the managed unit.

In the May of 2004, NRS survey the Kealia vicinity for *H. brackenridgei mokuleianus*. One mature, ten immature, and six seedlings where seen. Collections where made for genetic storage from the mature and two immature. Plants where seen growing on exposed ledges smothered by *Panicum maximum* and *Sicyos pachycarpus*. NRS was in search of an area to perform in-situ management. This site is marginal given its low numbers of plants and steepness.

In May of 2004, NRS surveyed the Kawaiu gulch area for *H. brackenridgei mokuleianus*. Six immatures and two seedlings were seen. Collections were made from five plants for genetic storage. This area is also very steep and occupied primarily by *P. maximum* therefore, management in this area is difficult.

<u>3.3.ak.3 Private Lands</u>

The known site in Kaomoku Nui Gulch was not monitored in the last year. There were estimated to be at least 750 seedlings at this site in 2002. Only 2 plants were mature. Collections made at that time were grown at the Army Nursery and have been planted at the Army's Wheeler Baseyard. Other living collections were established at Kaiser High School and Waialua High School. In the coming year, NRS will work with State NARS staff to monitor this site for changes in population and threats.

3.3.al *Huperzia nutans*

Huperzia nutans (formerly *Phlegmariurus nutans)* is a rare club moss that is endemic to O'ahu and Kaua'i. It is a medium-sized stout, terrestrial or epiphytic plant. The sterile portions of the stem gradually transition to the fertile portions (Palmer 2003). *Huperzia nutans* has a scattered distribution around the Ko'olau Mountains, including several known plants from the windward side. They often occur as single plants and most are isolated, some being miles away from the other known plants. Though few are now known, much undersurveyed habitat still exists for this species and other botanists estimate many more are undiscovered. We have collected strobili from individuals of this species many times in the last few years, but have not been able to grow it. NRS has begun to collect rhizomes of the more common *H. phyllantha* to try and determine a propagation technique that may work for both. NRS will continue to look for this species while conducting management.

<u>3.3.al.1 Kawailoa Training Area</u>

There are five individuals known from four different areas in KLOA. NRS monitored all the locations in the last year and plants appear healthy. NRS will continue to monitor these sites and focus on trying to develop a propagation technique.

<u>3.3.al.2 Schofield Barracks Military Reservation</u>

There is one known individual from SBE. NRS monitored this location in the last year and the plant appeared healthy. NRS will continue to monitor this site and focus on trying to develop a propagation technique.

3.3.am *Labordia cyrtandrae*

Labordia cyrtandrae is a rare Kāmakahala found only on O'ahu. Last year, only eighteen mature plants were known. It was thought to have been extirpated from the Ko'olau mountains where it was once primarily, until one mature plant was recently found in Manana by GSN staff. All other plants are found in the Wai`anae mountains in the vicinity of Mount Ka'ala. It is a shrub up to two meters tall and has long (3-4 cm.) bi-valved capsules. This species is known to be dioecious (Wagner et al. 1990). There are now forty-four plants known from SBW, Makaleha, and Manana at fifteen different sites. NRS only works with the locations at Schofield Barracks Military Reservation. This species is found only on the steep sides of Mt. Ka'ala and some plants may be visited only with a rope.

3.3.am.1 Schofield Barracks Military Reservation

This past year NRS staff nearly quadrupled the amount of known plants through survey efforts. The range for this species covers hundreds of acres of remote habitat. Surveys would likely locate more plants. There are about four male, six female and 34 plants of unknown sex. Many of these unknown plants were recently found. NRS will determine their sex over the next year with additional monitoring. There have been no seedlings observed at these populations, and only one juvenile. While the numbers are encouraging, this species still faces major challenges as it has a very poor population structure.

NRS has been collecting seed from these plants since 1996. Seed was brought to the Lyon Arboretum and grown out at the Army Nursery. Two individuals were reintroduced by NRS and NARS staff into a protected area in the Mt. Ka'ala NAR in 2001. These plants are doing well and are monitored by NRS and NARS. Nine more juveniles were added in 2003, for a total of 11 plants. In the last year NRS has collected cuttings from all the wild plants on SBW, in an effort to secure stock for future reintroduction. However, there have been low success rates and presently NRS is focusing efforts on air-layer techniques. If this propagation technique proves to be successful, NRS will work on installing more in the coming year. Collecting from all the plants is still a priority since all known plants are mature. Plants grown from cuttings and air-layers in the greenhouse will be reintroduced into protected areas on Mt Ka'ala. The air-layers take a long time to root and are expected to grow very slowly. In the coming year, NRS expect to be able to reintroduce several more to help supplement the natural wild population.

Pigs continue to be a threat to these plants, especially those found in accessible areas. However, NRS has been working with other landowners to exclude ungulates from the Ka'ala bog. NRS and staff from BWS, NARS and TNC have installed four sections of fence around Ka'ala. These sections do not form a complete exclosure, rather bridge gaps between natural barriers (cliffs). Although NRS felt they should serve to exclude ungulates from the bog, pigs are continually seen. It is unsure if the pig sign is from resident pigs that were fenced in, or if the pigs found places to go around the fences. In the coming year, NRS will continue to monitor the bog for ungulate sign and respond accordingly to make it ungulate-free. In the past year, NRS has used staff hunters to control pigs in the bog and determine where if at all, the pigs are entering the bog. This will continue in the coming year. See Chapter 1: Feral Ungulate Management.

In review, this upcoming year NRS staff will do the following: 1) try to determine why there is such low recruitment of individuals, 2) reintroduce plants grown in the greenhouse into a protected area at Ka'ala to help supplement the natural wild population, 3) work to determine air-layer techniques that prove successful in *L. cyrtandrae*, 4) continue to monitor and collect fruit from the in-situ plants for seed storage and trials, 5) survey new areas for more plants, 6) survey for gaps in the fence to determine if pigs still have access into the protected area, and 7) continue performing controlled hunts to eradicate remaining pigs from inside the fence.

3.3.am.2 State Land

There are six mature and one immature individual known from three locations in East Makaleha. The habitat for this species in this area has not been adequately surveyed. The majority of the current distribution for this species appears to be closer to the summit of Mt. Ka'ala. No management has been done in this area in the past year. In the coming year, NRS will determine the management priorities for these locations.

The Oahu Genetic Safety Net Biologists discovered a single *Labordia cyrtandrae* in the Manana area in the Ko'olau Mtns. while surveying this year. Manana is on private land controlled by Doug Smith. NRS will collaborate with him as well as GSN staff in the near future in additional surveys.

3.3.an *Lepidium arbuscula*

Lepidium arbuscula is known from open dry ridges and cliffs in the Wai`anae Mountains on O'ahu (Wagner et al. 1990). This species will not be a target for management actions in the next year but NRS will continue to survey for it when working in appropriate habitat.

3.3.an.1 Mākua Military Reservation

Fewer than ten plants are known from two sites in Mākua. One site is protected by a fence, and weeds have been controlled in the surrounding area in the past. In the coming year, NRS will map any new locations. There is currently no management proposed specifically for this species.

3.3.an.2 Schofield Barracks Military Reservation

There are eleven known individuals in Schofield from two sites. In the coming year, NRS will map any new locations and there is currently no management proposed specifically for this species.

3.3.ao *Lobelia gaudichaudii* ssp. *koolauensis*

Lobelia gaudichaudii ssp. *koolauensis* is known from cloudswept summit forest in the Ko'olau Mountains. It is a short shrub with a dense apical rosette of leaves. The subspecies *koolauensis* is rare and its inflorescence is sometimes branched and has greenish white flowers (Wagner et al. 1990).

3.3.ao.1 Schofield

In Schofield Barracks *Lobelia gaudichaudii* ssp. *koolauensis* is known only from one population of about 50 plants. This is more than 30% of those known statewide. As a member of the Campanulaceae this species is considered susceptible to seedling predation by slugs. Rats may also damage mature plants or fruit. These plants are monitored annually during the flowering season and any mature fruit will be collected and stored. No plants have flowered in the past three years. The population could be threatened by ungulates because it is not fenced. Snares are in place to protect plants and ungulate sign in the area has been low. This area may be the target of fencing in the coming year as part of the Oahu Implementation Plan.

3.3.ap *Lobelia niihauensis*

Lobelia niihauensis is only found on dry cliff faces, and is known from Ni‘ihau, Kaua’i and the Northern Wai`anae Mountains on O’ahu (Wagner et al. 1990).

3.3.ap.1 Mākua Military Reservation

There are estimated to be about 450 individuals on MMR. There is great potential for more undiscovered *Lobelia* on cliffs hundreds of feet above the valley floor and below the ridge. This plant likes mid-elevation, very exposed cliffs, making detection and monitoring difficult, even with ropes. There are thousands of plants known on Kaua`i and Ni‘ihau. Since only about 10% of the plants known statewide are found in Mākua and many of them inaccessible, there has been little management. The Fire Threat Level for this species is Medium. The Ungulate Threat Level is High because of goats. This species benefits from the control of goats in Mākua. NRS have not conducted any specific actions for this taxon.

In the last year, NRS has continued to find new areas with *L. niihauensis*. Next year, NRS will continue goat control and will note any new plants and threats.

3.3.aq *Melanthera tenuifolia*

Melanthera tenuifolia is known from diverse mesic forest and cliffs from the Central and Northern Wai`anae Mountains. It is a sprawling perennial herb with yellow ray florets (Wagner et al. 1990). NRS are currently trying to develop a reliable seed collection technique. With the few small collections and two better size collections in the last year, NRS and staff of the Lyon Arboretum hope to determine the storage potential for this species. In the coming year, NRS will determine the most efficient method for holding this species ex-situ.

3.3.aq.1 Mākua Military Reservation

There are estimated to be over 2500 individuals on MMR in at least seven different areas. Some of these areas are distinct, separated by geographical and ecological boundaries, and others may represent large populations broken up for ease of management. Fire was identified as a significant threat to this taxon because three of the seven areas where this taxon occurs are surrounded by or abut alien grasslands. Only the populations where NRS conducted work in the last year will be discussed below.

In July of 2003, an arson-ignited fire burned the ‘Ōhikilolo Makai population of *Melanthera tenuifolia*. Many plants were affected by the fire. This population is represented in living collections by plants from 27 founders at the NIKE site nursery as backup genetic material. NRS have been charged with maintaining living collections and developing seed storage protocols because of the high fire risk in this area. NRS worked with this *M. tenuifolia* living collection as well as others, in an attempt to collect seed for seed storage trails. Unfortunately, NRS has been unable to collect seed from the plants in the living collections due to low seed production. NRS plan to investigate moving this living collection to tissue culture in the next year to streamline greenhouse operations.

In August of 2003 four goats were discovered within the Lower ‘Ōhikilolo strategic fence exclosure. To address this issue NRS also extended a strategic fence above the population this year. (See Chapter 1: Feral Ungulate Management for details.)

At the C-ridge population of this taxon there are about 100 mature plants. Most plants occur in a small forest patch surrounded by alien grasses. NRS has collected from a total of 79 individuals over the last two years. Cuttings from 73 individuals are rooted at the Army and Pāhole nurseries. This population was impacted by the July 2003 fire, which burned outside the firebreak road. At least 5 individuals of *M. tenuifolia* from C-ridge were burned and another couple dozen were stressed by heat from the fire (Figure 3-22). In August 2004, the area of the burn was surveyed and surprisingly there are now more plants in the area than there were before the fire. Perhaps the fire lessened competition from invasive grasses, *Melinus minutiflora* and *Andropogon virginicus*. NRS expects that the grass will come back strongly over the next year and will exclude the *M. tenuifolia*. NRS is monitoring this population via photopoints in order to document the long-term impact of the fire. NRS feels that the greatest impact of the fire is that it destroys the native forest that supports the *M. tenuifolia* and replaces it with invasive grasses. With reoccurring fires the native forest area continues to shrink, and with it, endangered plant habitat.

Note in the right-hand picture (Figure 3-23) the burned *Schinus* branches in the background. There is also a dead iliahi trunk on the left hand margin of the picture. This year there were multiple *M. tenuifolia* plants in this area, where only a single mature individual had been before the fire.

Figure 3-22 Burned plants at C-Ridge in July 2003

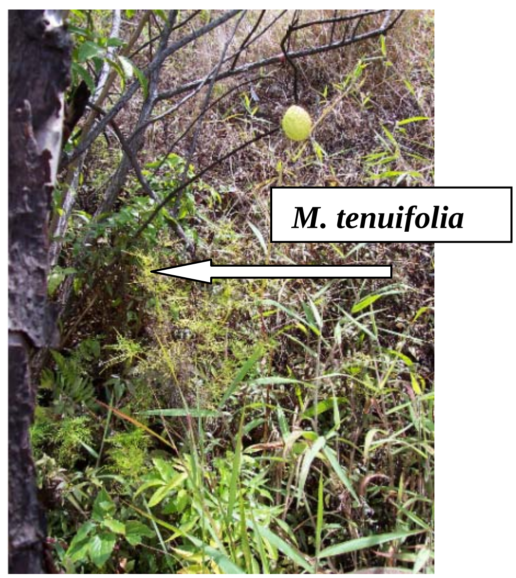


Figure 3-23 New plants growing at C-Ridge in August 2004

There are estimated to be over 100 mature individuals in the Kaluakauila Gulch MU. The July 2003 fire did not directly impact the Kaluakauila population of this taxon, yet the fire did burn within 30 or 40 meters. NRS has monitored this area in the past year. There are no major changes in distribution or abundance. This site will be monitored in the next year and management prioritized.

<u>3.3.aq.2 State Land</u>

There are estimated to be over 250 mature individuals at Lower Ka'ala Natural Area Reserve, Manuwai Gulch. The plants were monitored in the last year and there was no change in the estimates of population distribution or abundance. NRS has been conducting ungulate control in the vicinity of this population for two years. Through these efforts goats numbers have dramatically dropped. See Ch.1: Feral Ungulate Management for details. In the coming year, NRS will continue ungulate control and monitor this site for changes in the population.

In Waianae Kai, there are estimated to be almost 200 hundred plants at four different locations. NRS has not monitored these plants in the last year. In the coming year, NRS will determine the management priorities for this species in Waianae Kai.

<u>3.3.aq.3 BWS Mākaha</u>

In Mākaha NRS know of five sites with hundreds of individuals. NRS visited most of these sites in the last year, monitoring them conjunction with other management actions. One of these sites will be protected in the planned Mākaha fence enclosure in the next year. See Ch.1: Feral Ungulate Management for details.

3.3.ar *Melicope cinerea* var. *cinerea*

Melicope cinerea is known only from diverse mesic forest on O'ahu and Maui. It is a small tree up to seven meters tall and three varieties are described. One is found on Maui, one in the Ko'olau Mountains and the last variety *cinerea*, is known from the Wai`anae Mountains. It is distinguished by having a densely pubescent inflorescence (Wagner et al. 1990).

<u>3.3.ar.1 Kawailoa</u>

There are 2 trees known from one site on SBW. This species is considered a Species of Concern but needs more surveys to determine its current status. NRS have conducted surveys for this species in the last year, but no new plants were found. NRS feels that with more time in West range, more plants could be found. In the coming year, NRS hope to return to the known trees and will note new locations.

3.3.as *Melicope hiiakae*

Melicope hiiakae is known only from the Ko'olau and Wai`anae Mountains of O'ahu (Wagner et al. 1990).

There are four groups with six individuals between them of this rare *Melicope* known in KLOA. This species would benefit from ecosystem-level ungulate removal and weeding. It is a Candidate for Endangered Status and more surveys should be done to better determine population size and range. While this species was estimated to have about a 100 individuals in the state, recent estimates show a population of less than 25 individuals, making the Army plants much more significant. Joel Lau of the HINHP believes that this species is underreported, given its cryptic appearance and taxonomic challenges, which require flowers for identification. NRS will continue to survey for this species when in appropriate habitat.

3.3.at *Melicope lydgatei*

Melicope lydgatei is known from scattered populations in the Ko'olau Mountains. It is a small shrub with opposite leaves and glossy leaf surfaces (Wagner et al. 1990).

3.3.at.1 Kawailoa Training Area

In KLOA, 28 *Melicope lydgatei* are found in the Lower Pe‘ahināi‘a MU and near the Kawailoa Trail. No seedlings have been observed in the populations, but juveniles are present. This species has documented threats from aphids, and ungulates impact its habitat. Ungulate control has been suspended in this area due to conflicts with illegal hunting. Collection and reintroduction of extirpated individuals will be pursued by NRS once a suitable site and founder material are identified and we have landowner approval. This species would benefit from large-scale ecosystem protection from fencing and more weed control. In the coming year, NRS hope to work with the landowner to facilitate hunting access to the lower areas in KLO. A fence planned as part of the Ko'olau Mountains Watershed Partnership would surround many of the known trees. In KLOA, weed control is most effective in areas where ungulates are excluded. Weed control will begin on a large scale once the fence is built. In the Kawailoa trail area NRS will do additional surveys to better assess population size in area.

3.3.au *Melicope makahae*

Melicope makahae is known only from mesic forest in the Wai`anae Mountains. It is a shrub or a shrubby tree growing up to three meters tall (Wagner et al. 1990).

3.3.au.1 Mākua Military Reservation

About twenty plants are known from the forest patch on ‘Ōhikilolo and a few more are known from the upper slopes of Lower Mākua. While the Army has few known plants on MMR, this species is rare and has a very restricted population range. This taxon benefits from fencing and weed control at the ‘Ōhikilolo forest patch and goat control across MMR. NRS will continue working on these actions in the coming year. NRS were not able to collect mature fruit from this taxon in the last year but will attempt again this year in order to determine germination techniques and storage potential.

3.3.av *Neraudia angulata*

Neraudia angulata is known to be rare in the diverse mesic forests of the Wai`anae Mountains. It is an erect shrub growing one to three meters tall (Wagner et al. 1990). The fruit are red when ripe and are held closely to the stems.

3.3.av.1 Mākua Military Reservation

There are three sites in Lower Mākua (MMR-A, MMR-B, and MMR-D). MMR-A and MMR-B have been monitored regularly by NRS since 1998. MMR-D was monitored by HINHP and NRS in the last year. This species has proven to be an easy one to propagate vegetatively. Tip cuttings have the highest success rate at 80-90%. NRS now have established material propagated from collections made in 2003-2004 that currently serve as nursery stock plants. NRS have observed that many of these cuttings will flower and set fruit within one year. Seeds from these plants have been taken to Lyon Arboretum for storage and viability testing

Population MMR-A in Ko‘iahi Gulch experienced a large boom in numbers of seedlings and juveniles. Twenty-nine new immature and close to forty seedlings were observed. This increase in individuals is attributed to the low numbers of goats in Mākua and the high rainfall this past year. NRS has collected cuttings from 22 of these new plants and from eleven other plants that were previously tagged. This brings the total collected to greater than 60 individuals. In this coming year, NRS will outplant more individuals to the augmented population at MMR-D. NRS will also build two new fences around the two groups of plants that make up the MMR-A assemblage. These proposed fences will protect the habitat of these plants from pigs, which have dug up all plants that have germinated below the cliffs that support the bulk of the population. By installing a single fenceline between cliffs at the entrance to the two sub-gulches. NRS feel that pigs can be excluded. The first line is approximate 40m and the second sub-gulch fenceline is approximate 35m. NRS will continue to monitor MMR-A on a biannual basis.

MMR-B is presently only a single plant growing on the side of a waterfall makai of MMR-D. This plant has been collected from and is represented at the MMR-D augmentation site.

In March of 2003, and again in December 2003, NRS augmented a gulch that has a natural population (MMR-E). This action was chosen because this area could be blocked off from pigs by the installation of a single short fence between cliffs. A total of 47 juvenile plants were outplanted. These plants are all from the natural populations (MMR-A and MMR-B). The last monitoring of these plants was conducted in January 2004 and the majority of the plants looked healthy. NRS will continue to monitor this reintroduction.

3.3.av.2 Private Land

NRS has secured material from the single plant at Dillingham Ranch. Cuttings were taken to the Army facility and cloned. In January 2003, three plants were reintroduced onto the Kaluakauila Management Unit in MMR. Five more plants were planted in March 2004. They were monitored in April of 2004, and all eight plants are in healthy condition. NRS has additional plants in the Army greenhouse and will continue to out plant until the numbers are substantial. Mature seed collected from this site will be stored at Lyon. NRS will monitor the wild plant in the coming year for additional threats.

3.3.av.3 BWS Mākaha

In July of 2004, NRS observed seven mature and four immature *N. angulata* in the Kamaili area of Mākaha. Cuttings were made from eight of these plants and they are growing in the greenhouse at the Army facility. These plants are threatened by ungulates but will not be included in the larger planned Mākaha enclosure because they are geographically removed from it. This coming year, NRS, with along with Amy Tsuneyoshi the Board of Water Supply's Biologist, will survey the area around the existing known plants, as well as new areas in Mākaha for additional plants. NRS will also collect from all known individuals that are large and healthy enough.

3.3.av.4 State Land

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

There are four sites known in Waianae Kai. There are about 45 mature plants at one site (WAI-A/E), one plant at the second (WAI-C), an estimated 45 at the third with 35 juveniles (WAI-B) and one at the forth (WAI-D). Three sites have been monitored in the last year and the other has not been monitored since being reported by NTBG in 2000. In the coming year, NRS will continue to monitor these sites. Fences to protect the plants from pig damage have been proposed and the permission is being processed by the State.

3.3.aw *Nototrichium humile*

Nototrichium humile is found in the Wai`anaes and recently was found on East Maui. The plants are shrubs, which hold the flowers on slender spikes 3-14 cm. long. They are found in dry forest, on cliffs, steep slopes and in gulches (Wagner et al. 1990). NRS continue to work with the Lyon Arboretum seed storage lab to determine the storage potential of this taxon.

3.3.aw.1 Mākua Military Reservation

There are over 400 mature individuals in at least six locations on MMR in the Kahanahāiki, Lower Mākua, C-Ridge, Punapōhaku, and Kaluakauila MUs. This represents over 55% of the known statewide population. Juveniles and seedlings have been observed at these populations.

In Kahanahāiki there are estimated to be about 10 mature plants. All of these plants are within the fence. Weed control in conducted regularly in the gulch but rarely directed at this site. In the coming year, NRS will monitor this site to note any change in the population size or distribution.

In Kaluakauila, there are at least 200 mature plants. Almost all are within the fence, and weed control is done in the surrounding area on a regular basis. The plants are found from the gulch bottom up the south side. All the plants are found under canopy of at least 2 meters. The *Panicum maximum* found in and around the known plants is not continuous with the large grasslands that are found on the north and south side of the Kaluakauila MU. The fires in this area have burned areas where this plant may have been found in the past, but none were burned in this area in 2003.

In the Lower Mākua management unit *N. humile* is scattered in the lower dry gulches. Six individuals have been recorded but there are many areas where additional plants could be found. NRS will continue to record new individuals as they are found.

In Ko'iahi Gulch there are at least 50 *N. humile*. The steep sides of this gulch most likely conceal additional plants.

In Punapohaku, there are 152 mature plants, with 14 juveniles and at least 7 seedlings. This area was burned in the fire of July 2003. NRS approximated that five *N. humile* were burned by the fire. This species has a soft herbaceous stem and the individuals that burned were completely consumed by the fire, leaving no trace. This made quantifying damage difficult.

The C-ridge management unit contains excellent habitat for *N. humile*. However, the native forest area has been greatly reduced by past fires and the forest area is relatively small. There are more than twenty-five *N. humile* found within the forested area of this patch. These plants have been collected from to secure a living collection to guard against a catastrophic fire event.

3.3.aw.2 BWS Mākaha

NRS know of about twenty plants in Mākaha and believe that there are many more. There are extensive areas of undersurveyed habitat that most likely contain many more plants. In the areas where NRS have looked, all age classes were also observed.

3.3.aw.3 State Land

One plant is known from Lower Ka'ala Natural Area Reserve, Kaimohole Gulch. NRS monitored this plant and took cuttings in the last year. Propagules are being grown at the Army Nursery. In the coming year, NRS will develop management plans for this site. This plant will be reintroduced into protected habitat in the coming years.

There were seven mature plants reported from one site in Palikea Gulch in May of 1999. NRS have not been to this site since. In the coming year, NRS will monitor and collect from the plants and determine management goals for this site. These plants will be reintroduced into protected habitat in the coming years.

There is one site with an estimated 200 mature plants in Waianae Kai. In the coming year, NRS will determine how to keep goats from accessing this site, and monitor the plants for threats, and changes in the distribution and abundance.

There are estimated to be about 150 plants in the Keawa`ula area. The forest patch that these plants are in is surrounded by grasslands that have burned several times. These plants have been monitored in the past year. In the coming year, NRS will continue to monitor the plants. They appear to be relatively healthy and stable.

3.3.aw.4 Private Land

There are five mature plants known from Dillingham Ranch, Keawapilau Gulch. They were visited in the last year and cuttings were taken from all the plants. The propagules are now growing at the Army Nursery. They will be kept as a seed source for propagation/storage trials and serve as a living collection of these plants. These plants look very different than all other living collections.

3.3.aw.5 Lualualei Naval Magazine

There are at least four plants known from one site in Mikilua. They are within a small ungulate exclosure and are monitored by Navy staff. In the next year, NRS will assist Navy staff in monitoring and collecting from these plants.

3.3.ax *Phyllostegia hirsuta*

Phyllostegia hirsuta is a rare mint that grows as a shrub or liana. It is known from the Wai`anae and Ko'olau mountains of O'ahu. It is distinguished by having dense pubescence on the leaves and branches (Wagner et al. 1990).

3.3.ax.1 Kawailoa Training Area

This species is known from 7 sites totaling 8 individuals in KLOA, though there are estimated to be dozens more. Juveniles and seedlings have been noted in the populations. The proposed Helemano fence would protect several individuals and a hundred acres of appropriate habitat. This species will not be a target for management action in the next year but NRS will continue to survey for it when working in appropriate habitat.

3.3.ax.2 Schofield Barracks Training Area

There are four populations with about 75 individuals known from SBW and SBE. These populations will not be the target of management action due to the relatively small number found on Army lands.

3.3.ay *Phyllostegia kaalaensis*

3.3.ay.1 State Lands

In 1998, NRS staff along with Joel Lau observed about 10 plants in Pāhole Gulch. At that time, 2 cuttings were taken and sent to Lyon Arboretum. In April of 2001, NARS biologist Talbert

Takahama returned to the site to weed around the plants. He noticed a decline in the population with only 7 plants remaining. He collected cuttings from three plants which were sent to the NIKE site, were they are now living. However, in March of 2004 NRS staff revisited the site to find that all the plants were extirpated. NRS plans to reintroduce about 50 plants into Pāhole NAR this coming November. These plants came from 2 of the founders from Pāhole NAR.

The plants from Kapuna gulch are no longer there. This site was monitored by NRS in the past year.

The plants known from Keawapilau are no longer there, however collections by NARS staff are growing at the Pahole nursery and stock was reintroduced in the past year. Thirty-four plants were planted into a fenced area in the past year. When monitored this year, 20 had survived. In the coming year, NRS will assist NARS in supplementing this site with more stock from the Pahole Nursery.

The plants known from Waianae Kai were not found in the last year. They are thought to be gone. Early collections from this site are being grown and will be kept as a living collection. In the coming year, NRS will re-establish this collection at the Lyon Arboretum Micro-propagation Lab. This stock will be available for reintroduction in to Makaha when the fence is complete.

The plants known from Lower Ka`ala Natural Area Reserve were dead when the site was monitored in the last year. Collections from this site are being propagated and will be kept as a living collection and available for reintroduction once suitable habitat is protected.

3.3.az *Phyllostegia mollis*

Phyllostegia mollis was known from Moloka'i, East Maui, the Ko'olaus above Honolulu and the Wai`anae Mountains. Today this species is known only from the Wai`anae Mountains and there are estimated to be less than 50 individuals at several different locations. It is a sub-erect perennial herb and is found in mesic forest (Wagner et al. 1990).

3.3.az.1 Schofield Barracks West Range

In the last year NRS conducted only partial monitoring of the population. NRS have monitored the site within the small fence exclosure in Mohiakea where there were once two mature plants but found no *P. mollis*.

NRS continue to maintain the reintroduction site KAL-B within the Central Kaluaʻā exclosure in Honouliuli Preserve. Three of the original nine founder plants in Mohiakea are represented at the KAL-B site and one is available at the Army Greenhouse. NRS will supplement the KAL-B reintroduction with more plants to increase founders and boost total numbers of plants.

3.3.az.2. Schofield Barracks South Range

There have been as many as 4 plants in SBS in the past, however there is only one mature individual known now. There is a small fence in SBS that surrounds areas where there once were plants, however 1 mature plant is not within the fence. Outside the fence, pig sign has been noted in the past. NRS have collected from plants in the past and the propagules have been kept at the Army Nursery. There are now plants grown from cuttings from four separate individuals. These plants will be reintroduced into Kalua‘a Gulch in the coming year. NRS will continue to search for more plants in SBS. If found, cuttings will be grown at the Army Nursery for reintroduction into Kalua’ā.

3.3.az.3 TNC Honouliuli Preserve

Fifty-one plants grown from collections made from the SBW-A population have been reintroduced into Kalua’a gulch in Honouliuli Preserve. Twenty-five individuals are inventoried in Kalua‘a. In the coming year, NRS will work with TNC to balance the founders at this site and maintain native cover through weed control. Mature seed produced at this site will be stored at Lyon.

3.3.ba *Plantago princeps* var. *princeps*

Plantago princeps var. *princeps* is known from the Wai`anae Mountains of O’ahu. It can grow up to a meter and a half tall with branching stems (Wagner et al. 1990).

Figure 3-24 *Plantago princeps* var. *princeps*

3.3.ba.1 Mākua Military Reservation

There have been about 8 individuals known from one site on MMR since 2000. In the last year NRS counted 22 mature plants and twelve seedlings when rappelling in different spots in the same area. Weeds and goats are still threats to this population; however, the population benefits from MMR wide goat control efforts. NRS have not conducted weed control at this population because it is on a cliff and the weed threat is not significant. These plants were visited three times in the last year and mature seeds were collected from eleven plants. These were brought to the Lyon Arboretum for storage and may be used as a source for reintroduction in the future.

3.3.ba.2 Schofield Barracks Military Reservation

There is one population of 20 mature plants and at least three juveniles in SBW. These plants are designated for collection for genetic storage. NRS collected a single cutting for propagation trials at the Army nursery. The cutting rooted successfully but later died. NRS also collected dozens of fruit for seed storage at Lyon Arboretum. In the coming year, NRS hopes to collect mature seed for long-term storage at Lyon and will monitor for any new threats.

3.3.ba.3 State Land

In June of 2004 NRS visited the *P. princeps* site in Pāhole Gulch. Thirteen plants were seen and fruit was collected for storage. Only one plant was reproductive this year. NRS will continue to monitor the population and will strive to collect from more individuals in the coming year. The site is accessible by rope and the area is quite pristine but NRS will monitor for threats.

The Waiawa site in the Koolau Mountains was visited by NRS for the first time in the last year. There were 16 mature plants, 17 immature and about 50 seedlings. Mature seed was collected from thirteen of those plants and is being stored at Lyon. A fence is proposed for this area in a few years. In the coming year, NRS will monitor the plants and assess the need for additional management.

3.3.ba.4 TNC Honouliuli Preserve

There are two sites with this species in Ekahanui Gulch. Both are outside the existing fence, but are not significantly threatened by pigs. In the past year, NRS collected from these plants and the mature seed was stored at the Lyon Arboretum. In the coming year, this site will be assessed for fencing and mature seed will be collected and stored at Lyon. A reintroduction site will be selected with TNC staff for planting in 2004-05.

There were two sites in Pālāwai gulch that contained *P. princeps*. NRS and TNC staff visited both these sites in the past year. NRS observed seedlings at the PAL-B site but these seedlings disappeared by the next monitoring. At the PAL-A site, TNC staff observed two mature plants and two seedlings this August. NRS will continue to monitor these areas for any new plants. Collection will be a priority if plants become mature.

3.3.bb *Platydesma cornuta* var. *cornuta*

Platydesma cornuta var. *cornuta* grows one to two meters tall and is uncommon in mesic forest in the Ko'olau Mountains (Wagner et al. 1990). It is a Candidate for Endangered status.

3.3.be.1 Kawailoa

There are three sites with a total of sixteen mature plants in KLOA. None of these sites are protected by a fence. In the last year, NRS monitored one population of five individuals and all were healthy. NRS has collected from these plants in the past, but none has germinated. In the coming year, NRS will collect cuttings and seed for propagation trials.

3.3.bc *Pritchardia kaalae*

This palm species is known to grow up to five meters tall. It is found in mesic forest and on cliffs only in the Wai`anae Mountains (Wagner et al. 1990). There are thought to be 222 individuals in Mākua, Makaleha, Lower Ka'ala and on the boundary of SBW and the Wai`anae Kai Watershed Protection Area.

3.3.bc.1 Mākua Military Reservation

There are about 72 mature individuals in Mākua, all on 'Ōhikilolo Ridge. Rats are known to feed on the fruit of *P. kaalae,* and NRS continue to administer poison bait to control rats at three locations (MMR-A, MMR-B and MMR-D). Access to 'Ōhikilolo Ridge can be difficult. The most feasible way of accessing the area is via helicopter.

MMR-A has 60 mature trees and about 50 of these are within an exclosure completed in 2003. Weed control is conducted in the vicinity of these plants regularly. When NRS first began to monitor the trees in 1997 there were no seedlings and no fruit maturing on the trees. Now, there are hundreds of seedlings.

Figure 3-25 below shows rat bait take trends at population MMR-A. The bait take for this year was relatively high. This trend may be attributed to infrequent restocking because of lack of helicopter support from December 2003 through April 2004. Take will continue to be monitored to ensure enough bait is available. Management will be adapted to meet these goals in the coming year.

Figure 3-26 below shows rat bait take trends in the MMR-A patch from 2002-2004. In 2004 there were 3 bait checks and restocks. The bait was not restocked from January through April due to the helicopter shutdown. This led to the high percentage of bait taken in March and June. Also fewer rats were snapped due to the infrequent resetting of the snap traps. Fig. 3-16 shows a general trend with increasing take during the late spring and summer, dropping off into the winter months. During the months of January through March, where the bait wasn't changed, we would expect low take, increasing into the spring and summer.

Figure 3-25 Rat Control at *Pritchardia kaalae* MMR-A

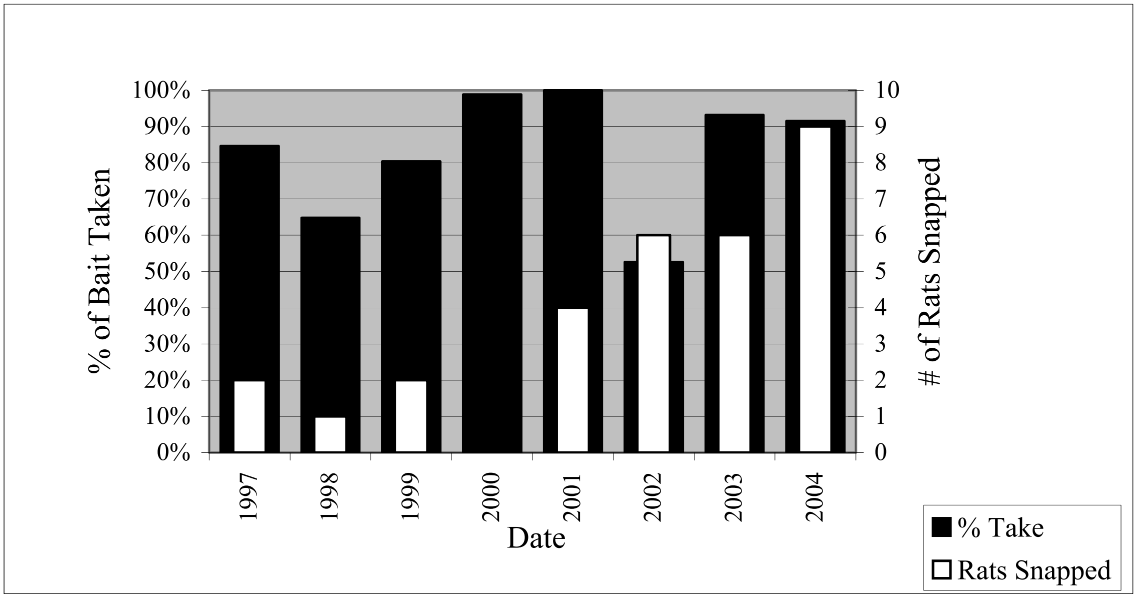
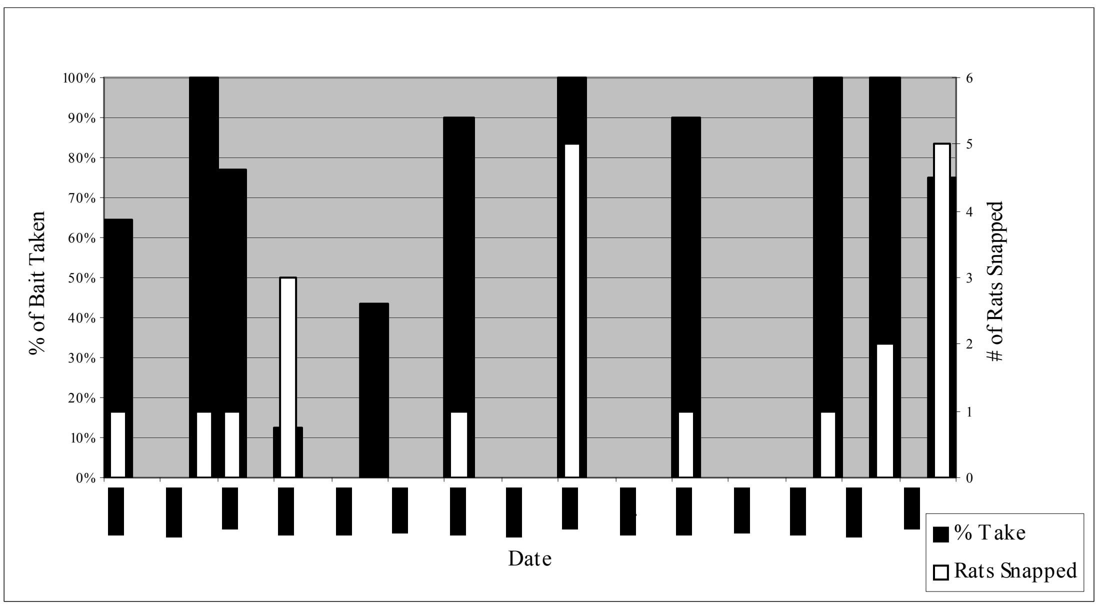


Figure 3-26 Seasonal Trends in Rat Control 2002-2004 *Pritchardia kaalae* MMR-A



MMR-B has three mature trees. One seedling has been seen in the patch, and three were observed in August 2004. In addition to more extensive rat baiting, NRS erected a chicken wire catchment below the mature trees on March 2003. This was done in order to encourage germination in the immediate vicinity of this small cluster of plants. Otherwise most of the fruit produced by these trees may roll off of the cliff just below these mature plants. NRS also continued to spray grass within this population in order to lessen the competition with seedlings.

Figure 3-27 below shows rat bait take trends at population MMR B. It shows that in 2002 the percent bait take for the year was 93%, for 2003 it was 92%, and for 2004 it was 82% which is a bit lower than the past few years. One might expect a higher value in 2004 due to the infrequent bait restocking and limited space for high numbers of stations, but it is still about average.

There are four sites with only one mature tree (MMR-C, J, K, L). Two have one immature tree as well, and one has eight seedlings. No rat control or weed control has been conducted at these sites, however the Christmas berry (*Schinus terebinthifolius)* has been removed from the canopy. NRS have collected from two of these trees in the last year and will strive to collect from the others in the coming year. The plants grown from those collections will be used in supplementing existing reintroductions.

NRS continue to bait at MMR-D where there are five mature trees. Rat control began at this population in 1999. Baiting is having a positive impact on germination. The number of seedlings found in MMR-D has increased significantly from none prior to baiting to over 40 as of July 2004.

Figure 3-27 Rat Control at *Pritchardia kaalae* in MMR-B

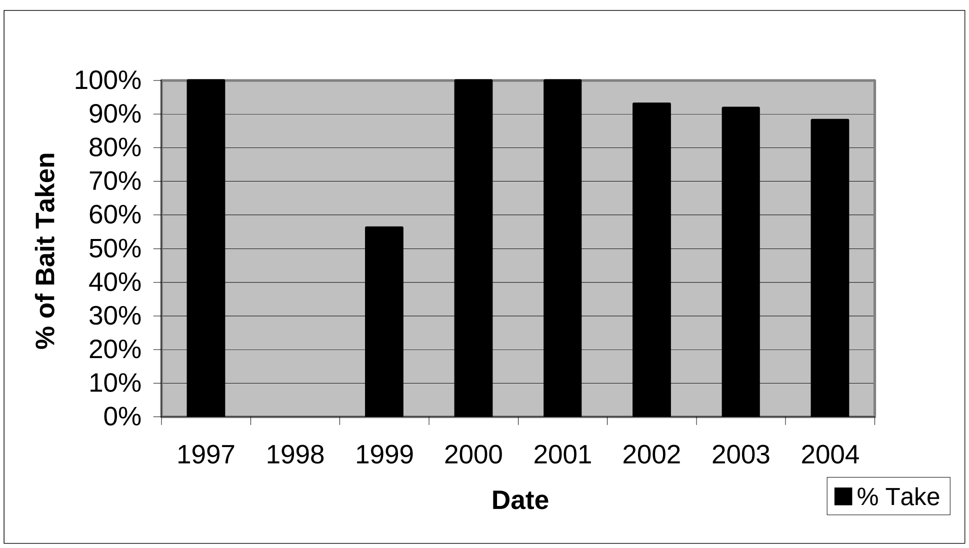
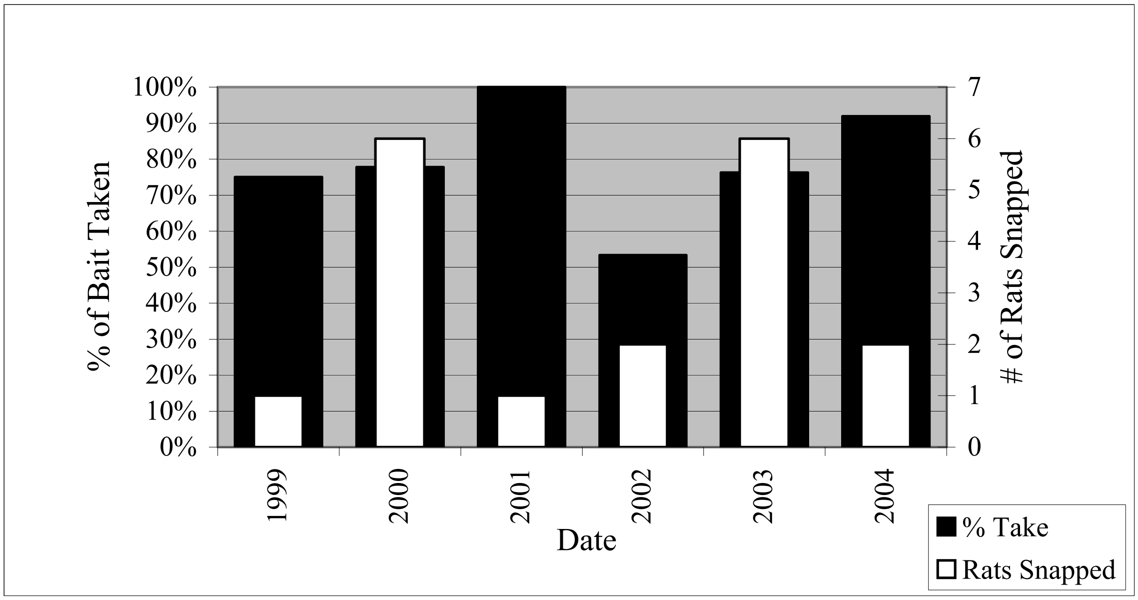


Figure 3-28 below shows rat bait take trends at population MMR-D. The bait take for this year was relatively high. The amount of snapped rats is also low. This trend can be attributed to the lack of access to restock bait and reset snaps because of the helicopter shut down.

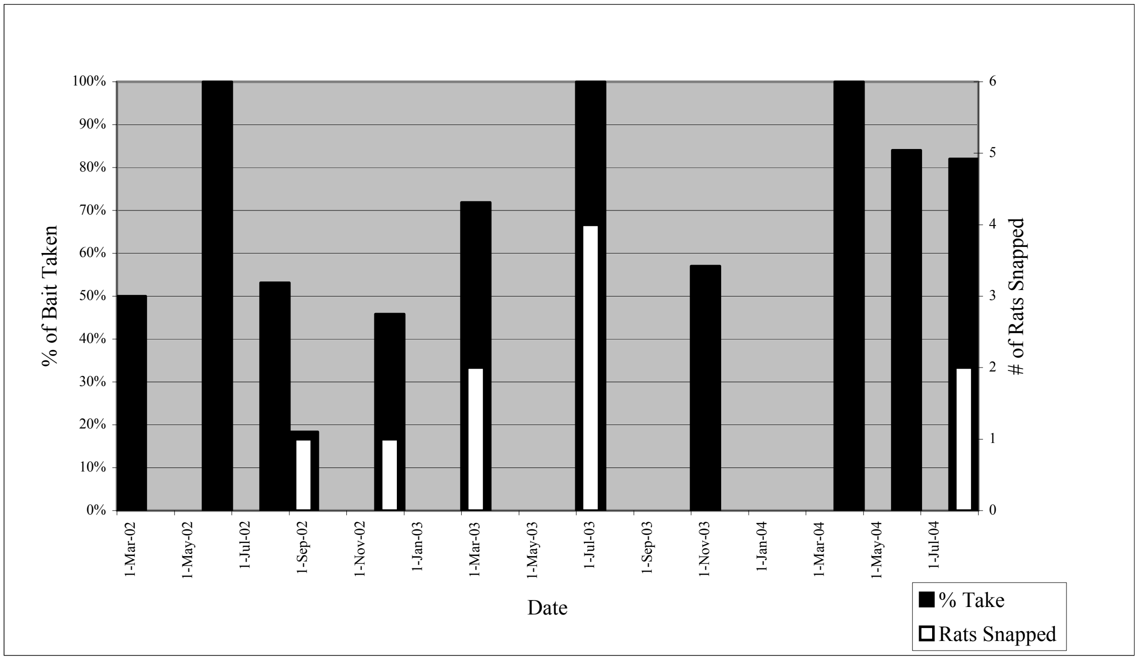
Figure 3-28 Rat Control at *Pritchardia kaalae* MMR-D by Year



In December 2001, NRS established five sites for *P. kaalae* reintroductions in MMR. A total of 265 plants were reintroduced. At the sites in Mākua where pigs are controlled, the plants are doing very well. A fence is proposed to be built around one of the unprotected sites in the coming year. The successful sites will be supplemented with plants from unrepresented sites in the coming year.

Figure 3-29 below shows rat bait take trends from 2002-2004. In 2004 there were three bait checks and restocks. The bait was not restocked from January through March due to the helicopter shutdown. This led to the high percentage of bait taken in March and June. Also fewer rats were snapped due to the infrequent resetting of the snap traps. Fig. 3-29 shows a similar trend to Fig. 3-26 with increasing take during the late spring and summer, dropping off into the winter months. This may show a rat population trend at ʻŌhikilolo Ridge.

Figure 3-29 Seasonal Trends in Rat Control at *Pritchardia kaalae* in MMR-D



3.3.bc.2 State Land

There are four mature and six juvenile trees on the boundary of SBW and Wai`anae Kai Watershed Protection Area. These trees are on the leeward side of the ridge on State land and not on SBW. In August 2001, rat bait stations were installed around the trees. In 2002, NRS expanded the grid, doubled the number of stations and in 2003 changed the bait four times. Rats were being controlled at the site in an effort to collect mature fruit for storage and establishing a living collection at a secure site. There is no long-term management proposed for this site and in the past year rat control was stopped. In the coming year, NRS hope to establish a living collection of this population at Lyon Arboretum.

There are a few dozen mature plants in East Makaleha, but most are on cliffs that are difficult to access. However, there is one patch of about a dozen trees that State Foresters had identified as a potential site for rat control in the past. NRS visited these trees in the last year and installed a rat grid with bait stations and snap traps. There were eleven mature trees and one immature when NRS visited in June of 2004. In the coming year, NRS will continue to restock bait in an effort to control rats at the site and encourage recruitment.

NRS have not visited any populations in Lower Ka'ala NAR in the last year. In the coming year, NRS will assess these areas for any needed management.

3.3.bc.3 BWS Mākaha

There is a single *P. kaalae* tree known from the back of Mākaha Valley. NRS have never visited the site. In the coming year NRS will work with the BWS biologist to monitor and collect fruit from this tree.

3.3.bd *Psychotria hexandra* ssp. *oahuensis* var. *oahuensis*

Psychotria hexandra ssp. *oahuensis* var. *oahuensis* is known only from the Ko'olau Mountains. It grows to a six-meter tall tree (Wagner et al. 1990). It is a Candidate for Endangered Status.

3.3.bd.1 Kawailoa Training Area

There are fewer than 20 trees known statewide. One plant is known from KLOA. It was found in March of 1999, and NRS has monitored and collected cuttings once in the last year. In December 1999, mature fruit was collected and brought to Lyon Arboretum, where there are two seedlings in the micro-propagation lab. Surveys may identify other individuals in KLOA. In the coming year, NRS hope to collect more cuttings from this plant and grow it at the Army Nursery as a living collection and propagule source.

3.3.bd.2 State Lands

In November of 2003 NRS accompanied the Oahu Genetic Safety Net Biologist on a survey of Makaua Gulch on the windward side of the Koolau Mountains. The survey was principally for *Schiedea kaalae* however *Psychotria hexandra* were also observed. A total of six trees were counted making this the largest known population on Oahu. Six cuttings were taken and although they rooted well in the greenhouse they all later died for unknown reasons.

3.3.be *Pteralyxia macrocarpa*

Pteralyxia macrocarpa is a tree found in diverse mesic forest on O'ahu. It can grow up to fifteen meters tall and has milky white sap (Wagner et al. 1990). It is found along the upper rim of MMR in Mākua and Kahanahāiki Valleys. It is Federally listed as a Species of Concern. NRS continue to note all new *P. macrocarpa* plants that are found in order to clarify the conservation potential for this taxon and to prioritize management.

3.3.be.1 Mākua Military Reservation

There are a few dozen trees known so far on Army lands from KLOA, SBE, SBW, SBS and MMR. There also have been numerous plants observed by NRS in Mākaha, Wai`anae Kai Honouliuli, Pāhole NAR, and Lower Ka'ala NAR. Small groups of trees are distributed in the mesic forest of the Ko'olau mountains as well as the Wai`anae Mountains. There are usually two to twenty trees in a group and large gaps between the groups. The fruits are large and probably not dispersed far from the parent tree. HINHP estimated fewer than 250 individuals on O'ahu. However, NRS feels this estimate is too conservative. On 'Ōhikilolo alone there are about 65 mature trees in one small subgulch. In a recent discussion with The Nature Conservancy's Dan Sailer, he said he'd stopped counting *Pteralyxia* because of the numerous amounts(pers. comm. August 3, 2004).

This taxon benefits from rat control intended to protect *Achatinella mustelina* populations at ‘Ōhikilolo. At this site recruitment of *P. macrocarpa* was zero four years ago when baiting began and is now substantial with sixty-five seedlings present. *P. macrocarpa* also benefits from the weed control conducted at the Kahanahāiki, ‘Ōhikilolo , and Lower Mākua management units.

3.3.be.2 Schofield Barracks Military Reservation

There is a medium ungulate threat identified for this species due to the large group of goats just north of SBW. This species has large fruit with big endosperms that would be attractive to rats. In Mākua, NRS noted better recruitment of seedlings from two *Pteralyxia* trees in an area where rat control is being conducted around a snail population. Large-scale rat control via aerial dispersal would benefit this species in SBW. It is listed as a Species of Concern but may warrant better protection given the small population size and threat levels. NRS will continue to map and note population data for new plants of this species in the coming year.

3.3.bf *Pteris lydgatei*

Pteris lydgatei is a medium-sized terrestrial fern, and is known from especially wet locations usually near gulches. It is known from O’ahu, Maui and Moloka’i (Palmer 2003).

3.3.bf.1 Schofield Barracks Military Reservation

There is one site with six individuals in SBE. There is much under surveyed habitat for this species in the Ko’olau Mountains and targeted surveys would likely turn up more plants. NRS will continue to monitor this population. It is fairly safe from ungulate impacts because it is up on the stream-bank but other appropriate habitat continues to be degraded by pigs. Large-scale fences are necessary to exclude pigs from these fragile habitats. NRS may propose a fence for this area in the coming years as part of the Oahu Training Areas Implementation Plan The fence would run adjacent to the ‘Ōpae’ula fence and will protect more habitat for this species.

3.3.bf.2 Kawailoa Training Area

There are three plants at one site in KLOA, and one plant at another. The first site is a streamside cliff next to a waterfall. Spores have been collected from these plants but none were successfully grown to maturity.

The second site was found by NRS in 2002. There is much more habitat for this species in the Ko’olau Mountains and surveys will likely turn up more plants. NRS will continue to monitor this population. These 2 populations are fairly safe from ungulate impacts but other appropriate habitat continues to be degraded by pigs. Large-scale fences are necessary to exclude pigs from these fragile habitats. A fence is being planned by the KMWP to exclude pigs from the upper section of the Helemano drainage. The fence would run adjacent to the ‘Ōpae’ula fence and will protect habitat for this species.

3.3.bg *Sanicula mariversa*

Sanicula mariversa is known only from the leeward Wai`anae Mountains. It is a perennial herb with flowers in a terminal cluster (Wagner et al. 1990). This species comes up with the rains every winter, grows through spring, and goes dormant every summer. Based on NRS observations of greenhouse plants, plants at the MMR population and at Mākaha, it appears that they flower only once and then die.

<u>3.3.bg.1 Mākua Military Reservation</u>

The number of mature individuals at MMR-A fluctuates yearly. This last year was difficult to monitor the population, as NRS were not allowed to fly in helicopters for about four months of the year. Only one mature plant was seen with immature fruit in the last year. This plant had dropped its infructescence by the time NRS got back to it, so no fruit was collected in the last year. No plants were observed at the reintroduction site in the last year.

<u>3.3.bg.2 BWS Mākaha</u>

On June 1, 2004 NRS monitored the MAK-A population. On this trip more than 2500 mature seeds were collected for storage at the Lyon seed bank. A total of 35 plants were seen on this date. Goats are a significant threat to this population and NRS is in the final stages of seeking permission to construct a small fence to protect the population. In the coming year the fence will be constructed, and NRS will continue to monitor these plants and collect for storage at Lyon Arboretum.

On June 1, 2004 NRS and the BWS Biologist monitored the MAK-B population. There were no fruiting plants present. However, NRS counted a total of 36 plants. This greatly increases the number known from this location. In previous years NRS has collected seeds for storage. Goats are a significant threat to this population and NRS is in the final stages of seeking permission to construct a small fence to protect the population. The fence will be constructed in the coming year. NRS will continue to monitor this population in the summer for fruit production.

<u>3.3bg.3 State Lands</u>

There is one site with this species in the Keaau Public Hunting Area. This site has been monitored by NRS for years and collections of mature seed have been stored at the Lyon Seedbank. In the coming year, NRS will scope a fence for this site and collect from all plants for storage at Lyon.

3.3.bh *Sanicula purpurea*

Sanicula purpurea is known from mossy slopes and bogs in wet forest on Maui and O’ahu. It is a perennial herb with a large root. The flowers are in a terminal cluster and have purple petals (Wagner et al. 1990). All known plants are on steep wet windy slopes where the vegetation is thick and short. There are two sites with this species on Maui. One is monitored regularly by Maui Land and Pineapple Co., and is known to have about 250 individuals.

3.3.bh.1 Kawailoa Training Area

There are three sites with about 40 individuals in KLOA. All three are right on the summit of the Ko'olau Mountains. There is a High Weed Threat for this species because *Axonopus fissifolius* smothers much of the appropriate habitat in the Ko'olaus. Seedlings and juveniles have been found and mature fruit has been germinated easily by NRS.

In February of 2002, four plants were reintroduced into a site just outside of the 'Ōpae'ula fence. Only one plant was found when this site was monitored in the past year. In the coming year, NRS will continue to monitor the wild and reintroduced plants. The storage potential for this species should be determined.

3.3.bi *Schiedea hookeri*

Schiedea hookeri is a small shrub known from the Central and Northern Wai`anae mountains. It is described as being scattered and locally common in diverse mesic forests (Wagner et al. 1990).

3.3.bi.1 Mākua Military Reservation

There are three locations of *S. hookeri* on MMR. Two are in Kaluakauila Gulch and the other one is in Kahanahāiki. In Kaluakauila, one population with about 50 mature plants was discovered in 2003. Another location with five plants has been known since 1999. In 2003, a prescribed burn that escaped the firebreak road burned to within 20 meters of this taxon. Another fire, which started near Yokohama Bay, burned toward the Kaluakauila management unit, re-emphasizing the significance of the fire threat to this taxon. These plants are protected from pigs by the fence exclosure around the management unit. In addition, NRS conduct grass control at Kaluakauila to reduce fuel and competition. NRS will continue to collect for genetic storage from the Kaluakauila population of *S. hookeri*.

In Kahanahāiki Gulch, 20 plants are known. In the coming year, NRS will monitor this site and determine management priorities.

3.3.bi.2 Schofield Barracks Military Reservation

There is one site on SBW with 5 mature plants and there is one large group of a 100 plants located on the Wai`anae Kai side of the boundary with SBW, but these are not included in the SBW plant total. There is no management prioritized for this species because UXO restricts the large-scale management options available to NRS in SBW.

There is one site with 40 mature plants in SBS. Seedlings and juveniles have been observed in this population. NRS has successfully rooted cuttings of this species in the past year during propagation trials. NRS will monitor these plants in the coming year for changes in population structure and threats.

3.3.bj *Schiedea kaalae*

Schiedea kaalae is known only from O'ahu. It is usually an unbranched shrub with the leaves clustered at the apex (Wagner et al. 1990).

3.3.bj.1 Schofield Barracks Military Reservation

In late 2002, one mature individual was found in SBW. This is the first time this species has been reported from there, it is a significant find. A broken branch was taken as a cutting at the time, but later failed to root. NRS collected mature seed from the plant.

Plants grown from these collections are growing vigorously in the Army greenhouse and will be reintroduced into Kalua'ā and used to produce seed for storage. NRS also constructed a small pig exclosure around the plant this year. See the Chapter 1: Feral Ungulate Management for details.

Figure 3-30 *Schiedea kaalae*

3.3.bj.2 State Land

There is one location with this taxon in Pāhole Gulch. Recently a NARS biologist indicated that he would get the location to NRS so that they could monitor the plant for seed collection and perform threat control. NRS will visit the site in the coming year.

There are two mature plants known from Kaipapa'u in the Ko'olau Mountains. They have been collected from and are being grown at Lyon. They are not within a fence, but are not highly threatened by ungulates. Slug damage has been observed at this site and no doubt impact seedling survival. In the coming year, volunteers will monitor these plants.

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

There are two mature plants known from Ma’akua. They are within a small fence and have been collected from. The propagules will be used as a source for mature seed, which will be stored at Lyon. These plants are monitored by NRS and other volunteers.

In the last year, eleven mature plants were discovered in a side gulch of Kahana Valley. The site is on private land and a small ungulate exclosure was built around some *Cyanea truncata* in the area. The *Schiedea* were collected from and cuttings are being grown at Lyon. These will be used as a propagule source in the future and serve as a living collection of these plants. In the coming year, these plants will be monitored by volunteers.

3.3.bj.3 TNC Honouliuli Preserve

A single individual plant collected from Huliwai (HUL-A) by TNC staff was received by NRS in the last year. This plant is being grown in the greenhouse to be used as a propagule source and living collection. Propagules collected from this plant will be stored at Lyon and grown for reintroduction.

There are six mature plants known from three sites in Ekahanui Gulch. In the past year, NRS has collected from three of these plants and mature seeds have been stored at Lyon. One of the sites has been fenced in the last year, and the others are within the larger proposed fence. In the coming year, NRS will assist TNC in monitoring the plants in Ekahanui, collecting mature seed, maintaining the fences and conducting weed control. Propagules collected from these plants will be grown and reintroduced into protected areas in Ekahanui. Currently there are 75 individuals of mixed stock that have been reintroduced into the protected areas of Ekahanui.

There are no wild extant plants in Kalua’a. TNC has reintroduced stock from Ekahanui and Pālāwai into this site for a total of 53 individuals. NRS plan to reintroduce Schofield stock to this site in the coming year.

There is a single *S. kaalae* plant in Pālāwai. This plant has seeded prolifically in past years. NRS worked with TNC to secure stock for storage this year. NRS also constructed a small ungulate exclosure around the plant to protect it from ungulates. See ungulate section for details. Small scale weeding was also conducted. NRS will continue to work with TNC to monitor this site.

3.3.bk *Schiedea kealiae*

This species is found in the Wai`anae Mountains in *Sapindus* forest and on steep slopes and exposed ledges. It is a sprawling subshrub that flushes with winter rains. It is thought to be dioecious (Wagner et al. 1990).

3.3.bk.1 Dillingham

There is one population with 15 mature individuals in DMR. There were 28 seedlings and three juveniles in this population when monitored in 2003. The population is located on a rocky outcrop at about 350 feet in elevation above the *Sapindus* forest patch. There is a large strip of grass (*Cenchrus ciliaris*) between the forest patch and the outcrop that is smothering potential habitat for this species. The grass would be difficult to control because it extends onto a cliff and because of the huge amounts of seed being produced in the area. There are other populations of this species in the Mokulē'ia area and there is more unsurveyed suitable habitat within DMR to the east of this population. NRS will monitor this population when in the area.

3.3.bl *Schiedea nuttallii*

This rare species of *Schiedea* is found on Maui, Kaua'i and in the Wai`anae Mountains of O'ahu. It is a shrub with glabrous purple-tinged leaves and small dark brown seeds (Wagner et al. 1990).

3.3.bl.1 Mākua Military Reservation

Schiedea nuttallii is known from one population in Kahanahāiki. There are 22 mature plants and 7 immature plants at this site. Seedlings have been found here, and when last monitored, there were 10. The Kahanahāiki population has lost a good deal of the koa canopy that used to partially shade the site. This may have caused a change in the light regime and made the site drier. *Acacia koa* has been planted at the site and more will be in the coming year. NRS have conducted weed control in the vicinity of this population and will continue to manage weeds throughout the Kahanahāiki MU. NRS reintroduced 17 plants into Kahanahāiki in (MMR-C) and 9 have survived. In the last year, another site (MMR-D) was established with seventeen plants. All have survived so far. In the coming year, NRS will continue to monitor the wild and two reintroduced populations. These reintroduction sites will be compared and supplemented with unrepresented plants in the coming year.

3.3.bl.2 State Land

There were three sites with *S. nuttallii* in Pāhole Gulch. NRS knows of one site with about ten individuals and is working with the NARS biologist to collect cutting for propagation and reintroduction. NRS will assist NARS in the monitoring and protection of this site if deemed necessary. There are three plants known from a different site on the Pāhole-Keawapilau ridge. NRS has monitored and collected from them twice in the last year. Weed control has been conducted to remove a few canopy trees and mostly under-story competitors. Cuttings were taken from the mature plants and are being grown at the Army Nursery. They serve as a living collection and will be used as a propagule source for future reintroductions. The last site are visited by the NARS biologist and only have a single plant.

3.3.bm *Schiedea pentamera*

Schiedea pentamera is known only from the Wai`anae Mountains on O'ahu and was recognized as a species in the recent revision of the Manual (Wagner et al. 2001). It was known as *Schiedea pubescens var. purpurascens*.

3.3.bm.1 Schofield Barracks Training Area

There are six sites with about fifty-seven mature individuals on SB. None of the sites are protected by fences and goats are a threat to some of the sites. In the past year, NRS has built a small exclosure in SBS. It protects some of the plants found there and provides secure habitat for recruitment. Ungulate control is not feasible in SBW due to ordnance restrictions.

3.3.bn *Sicyos lanceoloidea*

Sicyos lanceoloidea is a perennial vine, has a woody base, and broad ovate leaves. It is uncommon in the mesic forest on O'ahu (Wagner et al. 1990).

3.3.bn.1 Schofield

There are five mature and six immature plants known from four sites in SBW. However, these sites have not been monitored recently because of the limited access into SBW due to Army training. This species is increasingly rare, and there are estimated to be less than 50 individuals in the wild. This species would benefit from weeding and fencing; however, access restrictions in SBW limit management options. It is only a Species of Concern, but should receive more protection, given the small known population size. NRS will attempt to collect more seed for storage in the next year.

3.3.bo *Silene lanceolata*

Silene lanceolata is known from nearly all the islands. It is a sub-shrub with oblanceolate to linear or lanceolate leaves and flowers in cymes with white petals (Wagner et al. 1990).

3.3.bo.1 Mākua Military Reservation

There are several thousand plants on other islands and the eleven plants known on MMR are a small percentage of the greater population. The population on 'Ōhikilolo continues to benefit from MMR-wide goat control. Goats have not been observed near this population in a few years. NRS do not conduct any specific management for this taxon. In the coming year, NRS will determine the need to store seeds from these plants.

3.3.bp *Spermolepis hawaiiensis*

Spermolepis hawaiiensis is known from all the major islands. It is an annual herb with a slender taproot (Wagner et al. 1990).

3.3.bp.1 Mākua

This species is known from the lower portions of ‘Ōhikilolo Ridge and two plants were found on the northern ridgeline of Kahanahāiki Valley. NRS does not conduct any specific management for this taxon. *S. hawaiiensis* is threatened by fire, so in the coming year, NRS will attempt to collect seeds to conduct seed storage trials.

3.3.bq *Stenogyne kaalae var. sherfii*

Stenogyne sherfii is no longer known from the wild. It was known from one location in mesic forest in the Ko’olau Mountains above Wahiawā (Wagner et al. 1990). The last plant was salvaged from the wild and brought into cultivation in 1999.

3.3.bq.1 Kawailoa Training Area

Local botanists had known about these plants and collected from them years before the Army Natural Resource program started. Mr. John Obata, who found the population, brought NRS to it in 1995, when there were five individuals. Since then, NRS monitored the plants at least once a year until the last one died in November 1999. The decline of this population was documented by NRS on Rare Plant Management Forms. One had died by May 1997 and major invertebrate damage was observed on the remaining plants by NRS. One more died in 1998 leaving three plants in December 1998. By this time, collections had been sent to the Lyon Arboretum and to Dr. Steve Weller at U.C. Irvine although it is not clear which individual he was given. By June 1999, another plant had died and NRS contacted other agencies to help salvage material from the site. Cuttings were taken from one of the wild plants and the other wild plant was removed from the site by Nellie Sugii from Lyon Arboretum, NRS and Desmond Ogata of the UH Plant Diagnostics Lab. The cuttings and salvaged plant both survived and were cloned at Lyon. The last remaining plant at the site was found dead three months later when NRS revisited the population. Since then, NRS has been back to the site at least twice without finding any live plants.

Material was gathered from Dr. Weller and the Lyon Arboretum and clones were made to equalize founders for a reintroduction in 2001. NRS and Joel Lau chose a site in KLOA and 47 plants were reintroduced in January of 2002. When the plants were first monitored, pigs had dug up and damaged many of the plants. In March of 2003, NRS returned to the site and found only 25 plants left. Ungulates had uprooted and disturbed most of the plants. There was a significant amount of disturbance to the surrounding area and at least 50 Hāpu’u ferns were killed. September 2003 monitoring revealed only 21 plants were still alive. The decline in numbers will most likely decrease without a fence installation. NRS has surveyed lower Pe‘ahinai‘a and feels this area will be a good site for reintroduction, provided a fence is built. Until then, cuttings from four individuals are at Lyon and the Army facility. NRS is also optimistic that a living collection could be held at Waimea Audubon Center as well. NRS believes that invertebrates were primarily responsible for the demise of *S. sherfii* in the wild and will monitor the reintroductions closely.

3.3.br *Stenogyne kanehoana*

Stenogyne kanehoana is an endangered mint previously known only from a single population in the Waianae Mountains near Pu'u Kanehoa in The Nature Conservancy's Honouliuli Preserve. There have only ever been three to four plants known from this area (Wagner et al. 1990**).**

Figure 3-31 *Stenogyne kanehoana*

In July of 2004 NRS discovered a robust patch of *S. kanehoana* while surveying the Schofield Barracks West Range in Haleauau gulch. This is one of the most significant discoveries NRS has ever made. NRS quickly responded by constructing a fence around the patch to protect it from feral pigs. It is difficult to determine how many plants are present at this site as long runners root in multiple places. Cuttings were taken across the patch to insure good genetic representation. These cuttings are rooting in the Army greenhouse. NRS did additional surveys in the area but no more plants were found.

NRS plans to reintroduce this stock into the Kalua'a fenced area in The Nature Conservancy's Honouliuli preserve. Stock from both Haleauau and Pu'u Kanehoa vicinity will be mixed in this site because numbers are so low. NRS feels that by mixing these two genetic lines in the field, they may cross-pollinate, producing stronger plants than if they were kept separate. NRS as well as The Nature Conservancy staff will maintain pure stock from each site in a living collection in the greenhouse.

3.3.bs *Tetramolopium filiforme*

Tetramolopium filiforme is known only from the Northern Wai`anae Mountains. It is found on dry ridge crests, cliffs and ledges, and over 90% of the plants are found on ‘Ōhikilolo Ridge. *T. filiforme* is a dwarf shrub five to fifteen centimeters tall (Wagner et al. 1990). The leaves are clustered at the apex of the branches and the flowers are often held above the leaves.

<u>3.3.bs.1 Mākua Military Reservation</u>

There are estimated to be about 5,100 individuals left on O’ahu. There are over 5000 plants in Mākua and Kahanahāiki and other valleys on MMR. The plants in Mākua are known from ‘Ōhikilolo Ridge and there are about 40 plants in the C-Ridge MU in Kahanahāiki. There are areas in both places where there is a high threat from fires.

The plants along ‘Ōhikilolo Ridge were historically very threatened by goat browsing. There are estimated to be nearly 5000 plants on the cliffs and steep ridges and seedlings are found in all known locations. No major declines in abundance or distribution have been observed by NRS in the last year. There are undoubtedly more places where these plants have yet to be found on ‘Ōhikilolo Ridge. Most plants are on the cliffs and ridges above the forest on the southern side of lower Mākua Valley, and Ko’iahi Gulch. Most are separated from the grasslands of the lower section of the valley by forest patches and large cliffs. This may prevent fires from burning these areas. There is one place on ‘Ōhikilolo where some of the plants are on the cliffs and ridges where the grass comes to the bottom of and onto the cliffs with the plants. The population in this area has been the target for seed storage because of the fire threat. NRS has made several collection trips toward this goal. Since the most recent trip in August of 2004 there are approximately now 50 individuals represented with at least 50 seeds in the Lyon seed bank. NRS will clarify the status of this target in the next year and perform additional collections if necessary. NRS will focus on collections from the lower elevation end of this large population to target those plants most threatened by fire.

The July 2003 fire burned within 20 meters of *T. filiforme* on C-ridge. This population is buffered from fires by a very narrow strip of forest. One more fire in the C-ridge vicinity could result in the destruction of this population. NRS supplemented the seed storage collection in 2003 with collections from eighteen new plants. NRS will continue to collect to bolster ex-situ collections in the coming year. NRS has been storing seeds of this species with Alvin Yoshinaga at the Lyon Arboretum. NRS will continue to monitor this site and will collect from any unrepresented mature plants.

<u>3.3.bs.2 State Land</u>

There have been four known sites with this species in Waianae Kai (WAI-A, B,C and SBW-A). There are no longer plants known from WAI-A. This site was last monitored in 2002. In this past year plants were found in an adjacent gulch. There are at least two mature plants with two immature and three seedlings in one place (WAI-B) and an estimated twenty plants in another (WAI-C). In the coming year, NRS will search this area to determine the population size and management priorities. This site is accessible only with a helicopter and rappelling gear. A fence proposed for *Neraudia angulata* and *Nototrichium humile* in this area would protect the *Tetramolopium* here as well.

3.3.bt *Tetraplasandra gymnocarpa*

Tetraplasandra gymnocarpa is known from scattered locations in mesic to wet forest in the Ko‘olau Mountains. It can grow up to 10 meters tall (Wagner et al. 1990). The majority of the individuals of this species are known from the windward side. They can be found in wet summit to mid-elevation mesic forests.

3.3.bt.1 Kawailoa Training Area

Only eight *T. gymnocarpa* are known from five sites in KLOA. This taxon is not the target of management actions. This species has a wide and scattered distribution and there are likely more trees to be found. There is no ex-situ stock from KLOA. NRS will continue to map locations of this species and note threats. NRS will try to collect from this species in the coming year for seed storage trials.

3.3.bt.2 Schofield Barracks Military Reservation

There are three known individuals of this species in Schofield Barracks East Range. It is not the target of management actions. NRS will continue to map locations of this species, and note threats. This species will not be a target for surveys in the coming year.

3.3.bu *Urera kaalae*

Urera kaalae is known to be rare on slopes of and gulches in the south and central windward Wai`anae Mountains. It is a member of Urticaceae and is thought to be dioecious or occasionally monoecious (Wagner et al. 1990). *U. kaalae* has been declining recently throughout its range. It is found only in the Wai`anae Mountains.

3.3.bu.1 Schofield Barracks Military Reservation

The trees in SBS are the northernmost plants known. There were three trees known from SBS in 1997 and now only one *U. kaalae* is left. Mature fruit have been collected from two trees and brought to Lyon for long-term seed storage. These propagules have been grown for reintroduction. In 1999, three juvenile plants were introduced to SBS to augment the declining population. These trees are healthy, flowering and are monitored annually by NRS. A small fence has been built in SBS in the last year to protect a small population of snails. This fence will provide a larger protected site for *Urera* to be planted in the future. In the coming year, NRS will maintain the fence and monitor and collect from the remaining tree. Figure 3-31 below shows a healthy mature reintroduced plant.

3.3.bu.2 TNC Honouliuli Preserve

NRS has cooperated with TNC to reintroduce plants collected from Army lands and other TNC lands into Kaluaʻā gulch. NRS and TNC have planted several dozen *Urera kaalae* at a site in Kaluaʻā. Presently there are 73 individuals in the area. There are also reintroduced populations at Palikea (24 individuals) and Ekahanui (125 individuals) of mixed stock. In the coming year, NRS will continue to work with TNC to supplement the reintroduction site with unrepresented individuals, and maintain native cover.

There is also a wild population in Pālāwai consisting of 9 mature plants and 1 seedling. Currently it is unprotected from ungulates but will be fenced by TNC staff by the end of the year.

Figure 3-32 *Urera kaalae* Reintroduction

3.3.bv *Viola chamissoniana* subsp. *chamissoniana*

Viola chamissoniana subsp. *chamissoniana* is known to be rare on dry cliffs in the Wai`anae Mountains. It is a slender shrub with the leaves clustered toward the ends of the branches (Wagner et al. 1990). It is usually found on cliffs or very steep slopes and has flowers with large white petals. In the coming year, NRS will be trying different methods to keep a living collection of this species. Cuttings were taken from several of the locations discussed below and grown at the Pāhole and Army Nurseries. The plants require a lot of space in the nursery and do not produce a lot of seed. This makes it hard and expensive to keep lots of plants around to serve as the collection or to use them as seed producers. In the coming year, NRS will work with the staff of the Tissue Culture Lab at Lyon to determine if this species is easily kept in small vials and can be grown out reliably. This may prove the best method for keeping this species in an ex-situ collection.

3.3.bv.1 Mākua Military Reservation

The plants on ‘Ōhikilolo represent more than 65% of the *Viola chamissoniana* subsp. *chamissoniana* known throughout the State. There are estimated to be about 250 plants on the cliffs and steep ridges and seedlings are found in all known locations. No major declines in abundance or distribution have been observed by NRS in the last year. There are undoubtedly more places where these plants have yet to be found on ‘Ōhikilolo Ridge. Most plants are on the cliffs and ridges above the forest on the southern side of lower Mākua Valley, and Ko‘iahi Gulch. Most are separated from the grasslands of the lower section of the valley by forest patches and large cliffs. This may prevent fires from burning these areas. In the past year, NRS has monitored two sites in MMR and will visit the others in the next year.

3.3.bv.2 Schofield Barracks Military Reservation

In SBW, there are estimated to be about 55 mature plants. A few juveniles and seedlings have been observed. This site has been monitored by NRS for several years and cuttings were taken several times to establish a collection at the Army Nursery. Plants were relocated by NRS on Pu’u Hāpapa in Schofield Barracks South Range in 2000. There are about 15 mature plants and a few seedlings. NRS has collected from this population to establish a living collection.

3.3.bv.3 State Land

There is one site in the Nānākuli Forest Reserve (HAL-A) that has 32 mature and 3 juvenile plants. All plants were healthy when monitored in July of 2003, and there were no major threats. No collections were made. In the coming year, NRS will monitor this site, search for more in the area and determine management priorities for this area.

In the Kea`au public Hunting Area, about 40 mature plants and 10 juveniles are known. This area is not protected by a fence. NRS has not been to this site but will in the coming year.

3.3.bv.4 BWS Mākaha

NRS revisited two sites where *V. chamissoniana* ssp. *chamissoniana* had been reported by NTB botanists in Mākaha. Unfortunately, NRS was unable to find plants at either site. NRS will be in contact with NTBG botanists in the near future to clarify information about these sites. NRS will then revisit the sites and search again.

3.3.bw *Viola oahuensis*

Viola oahuensis is known from cloud-swept areas and wet forest along the summit of the Ko’olau Mountains. It is an erect, un-branched sub-shrub and has pale yellow flowers (Wagner et al. 1990).

3.3.bw.1 Kawailoa Training Area

This species is known from more than 10 sites in KLOA totaling at least 101 plants. During surveys in 2002, over 50 individuals were estimated to be in the area inside the proposed Helemano fence. This species has proved to be more plentiful than previously thought. NRS still maps locations of plants but has stopped doing thorough counts and monitoring because of the increasing numbers. The ‘Ōpae’ula fence encloses and protects some of the KLOA plants. This species is expected to benefit greatly from protection within the ‘Ōpae’ula and proposed Helemano fences due to the susceptibility of its habitat to ungulate damage. Weed control focused within the fence exclosures will benefit the *Viola* along with other rare species. Large-scale fencing must continue to secure the habitat necessary to support this species. NRS will continue to search for this species, note threats, and support ecosystem protection.

In the coming year, NRS will continue to participate in the KMWP as it moves towards beginning construction on another exclosure in the upper Helemano drainage. This fence will surround a number of the known plants of this taxon and over a hundred acres of undersurveyed habitat. This species will not be a target for management action in the next year but NRS will continue to survey for it when working in appropriate habitat.

3.3.bw.2 Schofield Barracks Military Reservation

This species is known from one site in SBE. NRS has not monitored these plants since they were discovered by HINHP. Large-scale fencing is necessary to secure the habitat needed to support this species, but no fences are currently planned for SBE. NRS will continue to search for this species, note threats and support ecosystem protection.

3.3.bx *Zanthoxylum oahuense*

Zanthoxylum oahuense reaches heights of three to six meters and is known from mesic to sometimes-wet forest in the Ko’olau Mountains (Wagner et al. 1990).

3.3.bx.1 Kawailoa Training Area

There are more than ten trees known in KLOA from six sites and there are estimated to be less than 250 island-wide. NRS maps locations of this species but it is not targeted for management action. Given the scattered distribution of this species, NRS does not expect to see high numbers of seedlings and juveniles in proximity to mature trees. NRS has observed possible rat damage on this species and will continue to monitor for this threat in the coming year. The KMWP surrounds two individuals. The proposed Helemano fence will surround three known mature individuals, one juvenile and lots of undersurveyed habitat. NRS will continue to map locations of this species and monitor for juveniles and seedlings. This species will not be a target for management action in the next year, but NRS will continue to survey for it when working in appropriate habitat.

3.3.bx.2 Schofield Barracks Military Reservation

There is only one tree known from SBE, although a few are known just north of the boundary in KLOA. NRS will continue to map locations of this species but it is not targeted for management action.

CHAPTER 4: RARE VERTEBRATE MANAGEMENT

4.1 Introduction to Rare Vertebrate Management

Rare native vertebrate fauna on O`ahu training lands include native birds and the Hawaiian Hoary bat or `Ōpe`ape`a (*Lasiurus cinereus semotus*). The Hawaiian hoary bat is not known to have breeding populations on O`ahu. There are six native forest bird species which have been reported from Army-controlled lands in the past twenty years: `Apapane (*Himatione sanguinea*), O`ahu `Amakihi (*Hemignathus flavus*), O`ahu Creeper or O`ahu `Alauahio (*Paroreomyza maculata*), Hawaiian Short-eared owl or Pueo (*Asio flammeus sandwichensis*), `I`iwi (*Vestiaria coccinea*), and Hawaiian Flycatcher or O`ahu `Elepaio (*Chasiempis sandwichensis ibidis*). `Amakihi and `Apapane are not listed species and still relatively common on Army lands. The O`ahu `Alauahio is federally listed as an endangered species (USFWS 1993) and in the past had occasionally been reported from Army-controlled lands. NRS have never seen O`ahu `Alauahio in the wild and thus have not implemented any management actions for this species. The Hawai`i Division of Forestry and Wildlife lists the Pueo as an endangered species on O`ahu (HDLNR 1990) and it is protected under Hawaii Revised Statute 195-D. NRS have observed pueo in Mākua Valley; however, no management actions for this species have been undertaken aside from ecosystem-level management. `Elepaio and `I`iwi populations have declined in numbers precipitously on O`ahu over the past 20 years. The Hawaii Division of Forestry and Wildlife lists `I`iwi as an endangered species on O`ahu (HDLNR 1990) and it is protected under Hawaii Revised Statute 195-D. The `I`iwi has been observed in two areas on Army lands, Schofield-Waikāne Trail in SBE and Mount Ka`ala in SBW. NRS survey for `I`iwi, but have not developed any intense management scheme for this species besides ecosystem level management. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the O`ahu `Elepaio endangered species status under the federal Endangered Species Act (USFWS 2000) and designated critical habitat on O`ahu for the `Elepaio (USFWS 2001). Intensive vertebrate management actions have been taken for the `Elepaio.

In addition, there is potential habitat for four endangered wetland bird species in all of the training areas on O`ahu: the Hawaiian Duck or Koloa maoli (*Anas wyvilliana*), Hawaiian Common moorhen or `Alae`ula (*Gallinula chloropus sandvicensis*), Hawaiian Coot or `Alae ke`oke`o (*Fulica americana alai*), and the Hawaiian Stilt or Ae`o (*Himantopus mexicanus knudseni*). The habitat is such that NRS does not believe that breeding populations could be supported for most of these species, and only `Alae`ula, Ae`o, Koloa maoli and the common Black-crowned Night-Heron or `Auku`u (*Nycticorax nycticorax hoactli*), have been documented. The Koloa maoli could potentially breed along the streams throughout the Kawailoa Training Area.

Rare vertebrate management on Army lands follows a three-step approach that includes surveying, monitoring, and threat control. The O`ahu `Elepaio is the only species at this time to be the focus of intensive vertebrate management efforts. Ecosystem-wide management actions, such as pig removal, should address some of the threats that may affect the native forest birds.

4.2 Rare Vertebrate Surveys

In 1977, Robert Shallenberger conducted bird and mammal surveys on O`ahu Army training lands. In 1993, the Nature Conservancy was contracted to conduct additional biological surveys on Army training lands. Results of these surveys are summarized in survey reports that are kept on file in the Army's Natural Resource Center. NRS have continued survey efforts using historical occurrences as a basis for prioritizing search areas. Surveys are also incorporated into daily field activities. NRS are familiar with field markings and songs of all species. A technique called "playback" is used to increase detection efficiency (Johnson et al. 1981, Falls 1981). A playback is a recorded bird song played aloud in the field. If individuals of the species are within earshot, they often respond and are easily detected. With these efforts, extensive areas have been surveyed and additional individuals found.

4.3 Rare Vertebrate Threats

Hawaiian avifauna have experienced a tremendous number of extinctions since the arrival of the first humans. More than 80% of the known endemic species and subspecies of birds have gone extinct or are listed as endangered by the USFWS (James and Olsen 1991, Jacobi and Atkinson 1995). There are four major threats that are suspected of causing these declines. First, human-induced ecosystem changes have resulted in the loss of habitat needed to support native bird life. Second, introduced diseases have been shown to have a devastating effect on native birds (Warner 1968, van Riper et al. 1986, Atkinson et al. 1995, 2000, Yorinks and Atkinson 2000, van Riper and Scott 2001). Of particular concern are avian malaria (*Plasmodium relictum*) and a poxvirus (*Poxvirus avium*) that are transmitted by the introduced southern house mosquito (*Culex quinquefasciatus*). A potential future mosquito borne threat to native birds could be the West Nile Virus (Flavivirus spp.). West Nile Virus has not yet reached the Hawaiian Islands, but there are serious concerns that it will as it makes it's way across the contiguous 48 states. Third, introduced bird species may compete with native birds for resources such as food or space (Mountainspring and Scott 1985, Williams 1987, van Riper and Scott 2001). Finally, introduced predators including Black rats (*Rattus rattus*), Polynesian rats (*Rattus exulans*), feral cats (*Felis catus*), and small Indian mongooses (*Herpestes auropunctatus*) have had detrimental effects on native island birds and/or their eggs and compete with native birds for food (Whitaker 1973, Banko and Banko 1976, Ramsay 1978, King 1985, Thibault and Meyer 2001, van Riper and Scott 2001).

NRS control weeds and outplant common and rare native species to slow habitat loss and restore native ecosystems. At present, there is no practical method for controlling avian diseases or their vectors in the field. NRS control feral pigs in the hope that a reduction in pig numbers will lead to a reduction in possible breeding sites for the southern house mosquito. To date, there is not enough evidence to substantiate intra-specific species competition. To eliminate the threat of nest predation by introduced predators, a series of snap traps, bait stations, and live traps are placed within a breeding pair's territory during the nesting season (January through June). Predator control work has proven to be successful in other areas of the Pacific at reducing population numbers of target pests and increasing populations of endangered forest birds (Robertson et al. 1994, Hooker and Innes 1995, O'Donnell et al. 1996). At present, predator control has only been implemented within territories of O`ahu `Elepaio. Initially, protocols for predator control methods were obtained from Dr. Eric VanderWerf, who had been implementing a similar program for other `Elepaio populations in the Southern Ko`olau's. His efforts significantly increased nest success, female survivorship and the number of fledglings per pair within his study areas (E. VanderWerf unpublished reports to DOFAW). NRS now combine his protocols with protocols from a similar study conducted at Hakalau Forest National Wildlife Refuge (HFNWR) on the Big Island. This study also looked at the effectiveness of rodent control and monitoring techniques for different rat species (VanderWerf 2001, Nelson et al. 2002). Nelsen et al. (2002) found that Polynesian rats were more apt to be removed through snap-trapping efforts, while rodenticide baiting was a more effective tool for removing black rats. Through live-trapping efforts they found that there were twice as many black rats as Polynesian rats in their study area. This fact indicates that the observed results were not the product of a general shift in species ratio independent of the rodent control program. Nelson et al. (2002) found that the rodent population rebounded to pre-treatment numbers by the next baiting season after predator control efforts came to an end.

NRS are currently assisting individuals from the Toxicant Working Group to encourage the Environmental Protection Agency to produce a label for a rodenticide to be aerially broadcasted. This type of distribution would allow for greater area coverage and incorporate a larger number of `Elepaio territories than can be covered by foot. Restrictions to aerial broadcast would be that the area to be covered would have to be fenced and ungulate free in order to minimize non-target species ingestion of the poison. At present, the labeling process is almost complete and NRS anticipate gaining permission for aerial broadcast by 2005.

There is also mounting evidence that low elevation populations of native birds (`Amakihi, `Apapane, `Ōma`o, Puaiohi and `Elepaio) may be developing immunogenetic resistance to the avian malaria parasite (van Riper et al. 1986, Jarvi et al. 2001, Atkinson et al. 2001, Klein et al. 2003).

4.4 Rare Vertebrate Monitoring

Rare bird monitoring is facilitated by mist netting and color-banding individuals. Once captured, individuals are inspected for external sores, which are an indication of poxvirus. Blood samples are taken and used to determine whether or not an individual bird has malaria. All mist-netting operations are done under the authority of Dr. Eric VanderWerf's (USFWS) state and federal banding permits.

In order to facilitate mist netting, a playback is used to elicit an aggressive response from the birds. This technique is especially effective on species that exhibit strong territorial behavior, such as the O`ahu `Elepaio (VanderWerf 1998). Playbacks are most effective just prior to and during the breeding season when the birds are more apt to aggressively defend their territories from invasion by others. Concentrating monitoring efforts during the breeding season (January through June) also allows NRS to be more effective in predator control efforts. NRS are able to easily locate mated pairs, note specific locations on a map, and initiate threat control methods within their territories.

Banding results for `Elepaio are summarized on tables 4-1 and 4-2. Individual birds are identified by a four-letter code that corresponds to a unique color band combination. (A= aluminum; B= blue; R= red; G= green; W= white). The "Date banded" column refers to the date that the bird was captured. The "Last observed" column reports the last date the bird was observed. The "Last monitored" column refers to the date that the banding area was last visited and a search conducted. The "Disease" column indicates whether or not the bird was diseased with avian pox virus when captured. The "Mate Observed" column reports whether or not the bird was observed with a mate the last time it was observed. The "Range or Gulch" column reports the area in which the bird was banded. Schofield Barracks South Range (SBS) and Schofield Barracks West Range (SBW) have been separated into each different gulch. The "Sex" column reports the sex of the bird. In the following sections the status of rare vertebrate species is discussed for each training area.

4.5 O`ahu `Elepaio Management

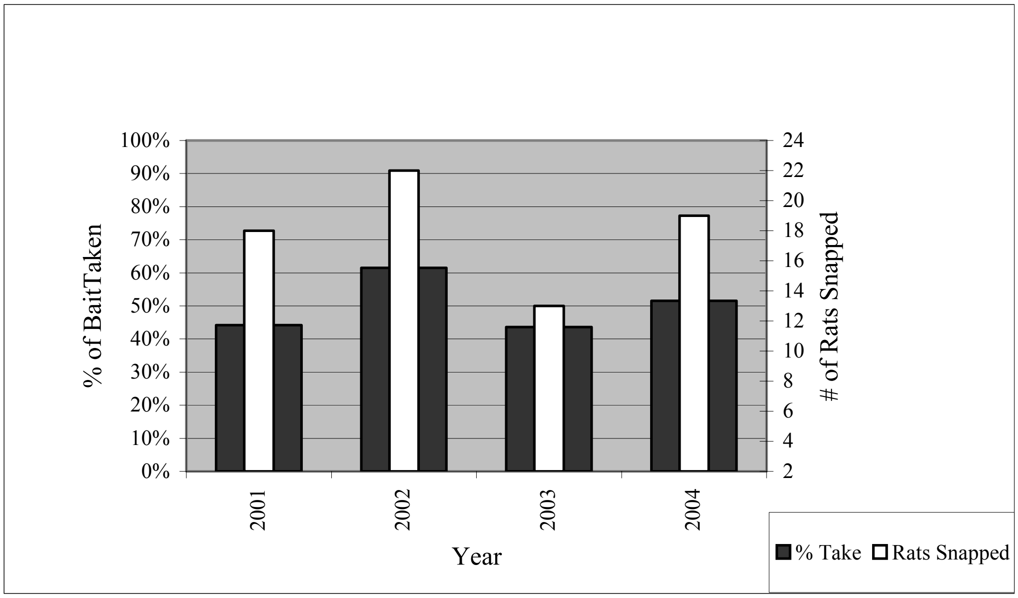
4.5.a Mākua Military Reservation

At MMR, `Elepaio are known from Kahanahāiki, Kaluakauila, and Lower Mākua MUs and the East Rim Ungulate Control Area (UCA). The population of `Elepaio in Kaluakauila was comprised of two unpaired males, which were monitored biannually. NRS have been unable to relocate these birds since 1999 and believe that they may have perished. It is unknown how old these birds were when NRS first located them in 1996, as they already had their adult plumage. All suitable habitat in Kahanahāiki, C-Ridge, and Lower Mākua MUs has been surveyed in recent years. Suitable habitat in the East Rim UCA has not been completely surveyed. An additional survey was conducted this year in Lower Mākua without success of finding any additional pairs. Continuing further surveys into East Rim UCA is restricted at this time, due to the possible threat of Improved Conventional Munitions (ICM's) in the area. NRS will work with the Army Safety Office to regain access to Lower Mākua, so that NRS can continue to do further surveys and other more labor-intensive management that involves camping and flying.

4.5.a.1 Lower Mākua MU

In 2001, NRS initiated predator control efforts for the pair that was known from the Lower Mākua MU and in 2002 a second newly discovered pair was added. From 24 December 2003 to 16 June 2004, NRS again implemented predator control efforts during the `Elepaio breeding season in Lower Mākua. Twelve Protecta® rodent bait stations and 24 Victor® rat traps were deployed throughout both territories. A total of 633 blocks (17.95 kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone) were taken from bait stations. The total bait consumed was 45.9% of the total bait put into the bait stations. A total of 19 rats were caught in snap traps during the breeding season with an average of 4.8 rats per monitoring trip (4 monitoring trips). Rodent control efforts from 2001 through 2004 are shown in Figure 4-1.

Figure 4-1 Lower Mākua Rodent Control 2001- 2004.



Nesting success of the two pairs of `Elepaio in this region is uncertain since fledglings were never observed. NRS was able to band one female of a pair on 05 May 2004 (see Table 4-1). The female was observed to have a brood patch and avian pox lesions on one wing and foot. After the female was released, the active nest was found. The stage of the nest was unknown do to the height of the nest. The success of the nest was uncertain since fledglings were not observed on the next visit 15 June 2004. An attempt to band the female of the second known pair was unsuccessful. No nesting attempts for this pair were observed during the four monitoring trips taken during 2004.

4.5.a.2 Kahanahāiki MU

In 1996, three males and one female were banded in Kahanahāiki MU. Since that time BGAW (see Table 4-1) has not been detected since 1999 and this bird is thought to be dead. ARRB was

Table 4-1 Bird Banding Data Mākua Military Reservation.

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

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

Predator control was implemented again this year from 06 January through 01 August 2004. It entailed bi-monthly maintenance of 12 Protecta® rodent bait stations, 12 Victor® rat traps, and four Tomahawk® live traps. Prior to annual predator control in this area, a graduate student of the University of Hawai`i maintained bait stations and snap traps monthly from 20 August 2003 through the start of the annual baiting. The stations were maintained during this time to prevent predation of outplanted plant seedlings. A total of 1015 blocks (28.8 kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone) were taken from bait stations. The total bait consumed was 68% of the total bait put into the bait stations. A total of 17 rats were caught in snap traps with an average of 1.4 rats caught per monitoring trip (12 monitoring trips). A mongoose, feral cat, and Erckel's Francolin (*Francolinus erckelii*) were caught in Tomahawk® live traps in 2004. Figure 4-2 shows the results of the rodent control efforts during the 2004 breeding season. Bait take remained consistently high through most of the breeding season with few rats being caught in snap traps. Predator control efforts from 1998 through 2004 during the `Elepaio breeding season are shown in Figure 4-3.

Figure 4-2 Kahanahāiki Rodent Control Results, 2004.

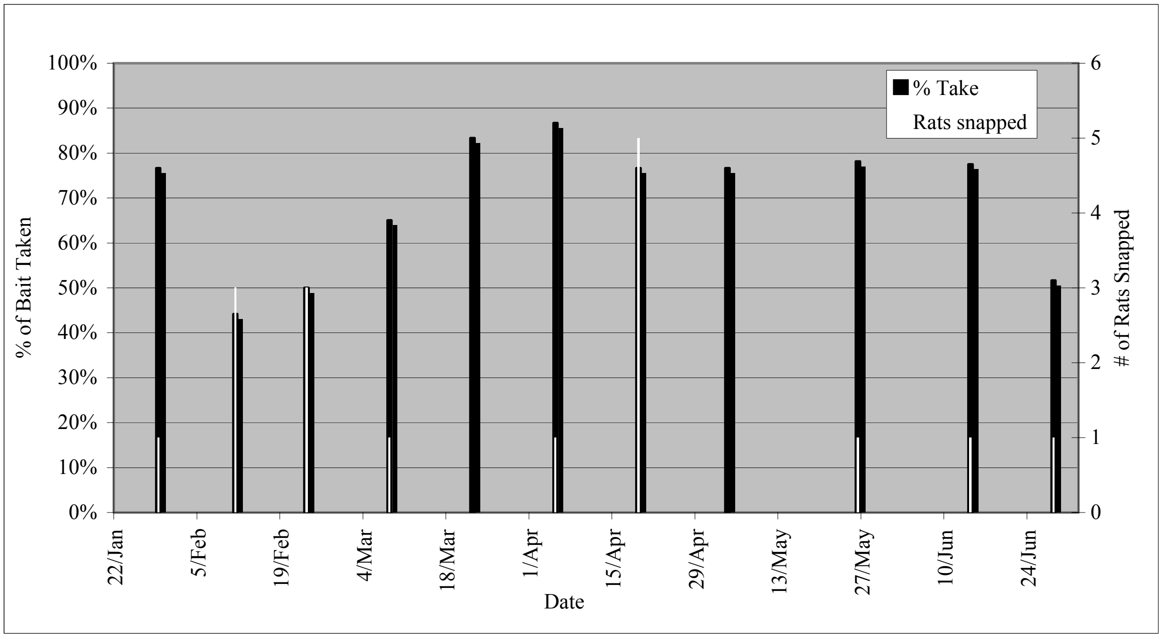
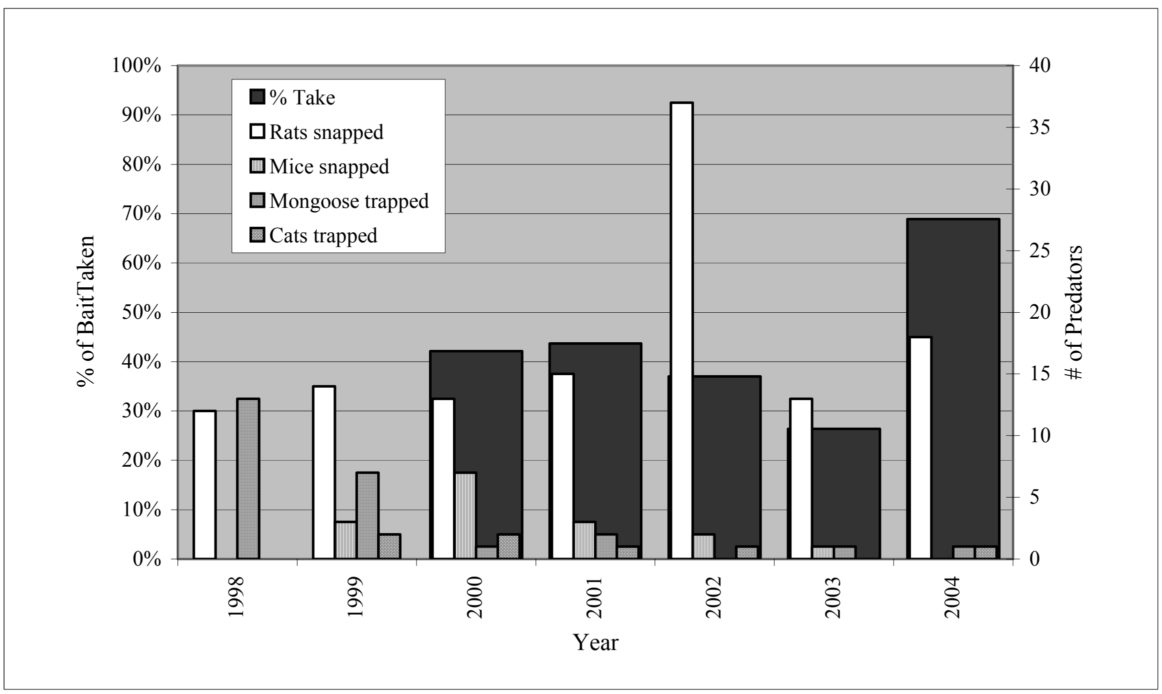


Figure 4-3 Kahanahāiki Predator Control Efforts For 1998-2004.



4.5.b Schofield Barracks Military Reservation

4.5.b.1 Schofield Barracks South Range

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. This year only one bird (RGAR) responded to playbacks. Due to the lack of females within the population, predator control methods have never been initiated and monitoring has not been consistent.

4.5.b.2 Schofield Barracks East Range

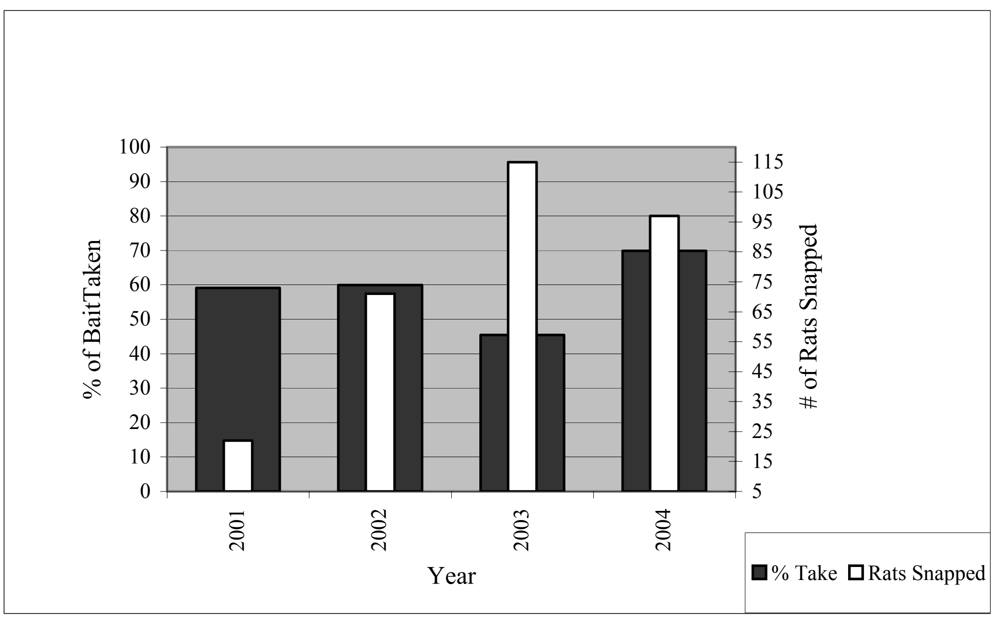
Shallenberger reported one bird from SBE in 1977. No birds were detected during surveys of the area in May 1997 or 2002. On 24 February 2003, a survey was conducted in South Kaukonahua Stream in the area of SBE that Shallenberger had detected `Elepaio. No birds were detected at that time. This area was not surveyed prior to and during the 2004 breeding season.

4.5.b.3 Schofield Barracks West Range

The third largest population of `Elepaio on O`ahu is located at SBW. It consists of approximately 340 birds, comprising roughly 155 breeding pairs (VanderWerf et al. 2001). To date, NRS have banded 52 birds over a nine year period and are monitoring them as frequently as access allows. Of the 52 banded birds 17 of them have not been observed since prior to 2000. Banding has been conducted in four gulches (Table 4-2).

NRS initiated predator control for the 2004 breeding season from 30 December 2003 to 24 June 2004. Sixty Protecta® rodent bait stations and 120 Victor® rat traps were installed in 15 `Elepaio territories in three gulches (Hale`au`au, N. Mohiākea S. Mohiākea). A total of 2715 blocks (77kg) of molasses/peanut-butter flavored Ramik® Mini Bars (.005% diphacinone), were taken from bait stations. The total bait consumed was 69.8% of the total bait put into the bait stations. A total of 97 rats were caught in snap traps with an average of 32.3 rats per monitoring trip (3 monitoring trips). Rodent control efforts from 2001 through 2004 are shown in Figure 4-4.

Figure 4-4 Schofield Barracks West Range Rodent Control 2001-2004.



Two `Elepaio nests, two nestlings, and a gravid female were observed during this time period. During the breeding season, monthly visits to `Elepaio territories in SBW would be ideal for monitoring birds and baiting rodent bait stations. NRS were only able to visit each of the `Elepaio territories a total of three times (April: 1 day, May: 1 day, June: 4 days) due to the heavy usage of the ranges, partially caused by the training restrictions at MMR. Most of the time spent there was occupied with refilling bait stations and monitoring snap traps, with insufficient time to thoroughly resight all previously known territories.

Table 4-2 Bird Banding Data, Schofield Barracks Military Reservation

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	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	05/02/04	05/02/04	N	N	Hale`au`au	M
WARG	05/02/04	05/02/04	05/02/04	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	05/02/04	05/02/04	Y	N	Hale`au`au	M
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
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	U	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	04/04/04	04/04/04	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
ABGB	06/15/97	06/14/99	06/14/99	Y	N	S. Mohiākea	M
WRGA	06/15/97	05/24/02	05/24/02	Y	N	S. Mohiākea	M
GAGB	06/15/97	02/17/00	02/17/00	N	N	S. Mohiākea	M
GBAB	06/15/97	06/08/04	06/08/04	Y	N	S. Mohiākea	M

Bird	Date Banded	Last Observed	Last Monitored	Disease	Mate Observed	Range or Gulch	Sex
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	06/08/04	06/08/04	Y	N	S. Mohiākea	M
RABB	01/17/00	03/27/02	03/27/02	N	N	S. Mohiākea	F
BWWA	01/17/00	03/27/02	03/27/02	Y	N	S. Mohiākea	M
GRAR	01/17/00	08/28/02	08/28/02	Y	N	S. Mohiākea	M
WRAB	01/17/00	05/18/03	05/18/03	N	N	S. Mohiākea	F
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

4.5.b.3.a Habitat Alteration along Fire Break Road

On 21 June 2004, NRS observed extensive tree clearing, that occurred prior to this date, along the Fire Break Road within designated critical habitat for the `Elepaio. A substantial portion of a single unbanded male's territory was altered with the felling of many large *Falcataria moluccana* and *Aleurites moluccana* trees along the road edge (Fig. 4-3). The tree clearing along the roadway occurred during scheduled road maintenance to improve the fire-break. On 22 June the male was observed down the gulch from the clearing, but still within its known territory. The future affect of this habitat alteration on the single male in this territory is unknown at this time and will be evaluated with continued resighting efforts.

Figure 4-5 Habitat Alteration

4.5.c Kawailoa Training Area

Shallenberger (1977) detected 12 \`Elepaio while surveying the Kawailoa Training Area (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 1994b). NRS have visited all of the areas in which these birds were reported without detecting any birds. However, playbacks were not always utilized in these survey efforts. In order to better survey these areas, playbacks should be performed in all locations. On 18 March 2003 a survey for \`Elepaio was conducted in a small gulch that empties into Kaiwiko\`ele Gulch. This area is very near a site where Shallenberger had located a bird. No birds were detected on this survey. In November 2003, two surveys were conducted along two unnamed streams in KLOA with no detections of \`Elepaio. The first was at the base of Pu\`u Kapu and the second stream was in the Pa\`ala\`a Uka region of the training area and empties into Helemano stream. During a survey on 10 February 2004, no \`Elepaio were detected in Pa\`ala\`a Uka region again. This unnamed stream was explored again but much further up in a different region. (Appendix 4-C ) No \`Elepaio are currently known from KLOA. NRS will continue to survey areas in KLOA in hopes of locating a remnant population of \`Elepaio.

4.5.d Kahuku Training Area

Shallenberger (1977) reported a single observation of `Elepaio in KTA. In the summer of 1998, Sandee Hufana, an intern with the University of Hawaii Hawaiian Internship Program, completed a project surveying KTA for rare species. Ms. Hufana, accompanied by NRS, visited the site where Shallenberger had reported the `Elepaio and was unable to detect any birds. She and NRS also systematically covered other areas searching for `Elepaio, utilizing playbacks, but surveys were unsuccessful. On 16 April and 14 February 2002 Kaunala Gulch was surveyed for `Elepaio in conjunction with other management actions. No `Elepaio were located during these two surveys. No surveys were conducted in 2004. During extensive routine management work in this area over the years by NRS, no `Elepaio have been heard. NRS will continue to survey other areas at KTA in hopes of locating `Elepaio.

4.5.e Dillingham Military Reservation

All suitable habitat at DMR has been surveyed for `Elepaio. No birds have been detected.

4.5.f Offsite `Elepaio Areas

Currently there are four offsite locations that NRS monitors presently or will in the very near future.

<u>4.5.f.1 Pahole Natural Area Reserve</u>

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 through the area.

<u>4.5.f.2 Mākaha Management Unit</u>

At least two pairs and three single males of `Elepaio are known from an area where a proposed fence to protect endangered plants will be constructed in the coming year. The fencing of this area is a joint project between the Honolulu Board of Water Supply and NRS. In 2004, three birds were banded for future monitoring efforts. NRS will assist with predator control operations being conducted during the breeding season for both pairs. NRS will conduct surveys to locate additional birds in the area.

<u>4.5.f.3 Lower Ka`ala Natural Area Reserve</u>

During a cooperative hunt in August 2004, NRS re-sighted a known single male `Elepaio in Manuwai Gulch.

<u>4.5.f.4 The Nature Conservancy of Hawaii Honouliuli Preserve</u>

NRS will assist The Nature Conservancy with monitoring (banding and nest searching) `Elepaio pairs in Honouliuli Preserve in the coming year, as well as assist in funding of predator control work.

4.6 `I`iwi Management

4.6.a Mākua and Dillingham Military Reservations

No reports of `I`iwi from either of these training areas have been received. DMR does not have any habitat and MMR does not have enough suitable habitat to sustain an `I`iwi population as they have a severely restricted habitable range. This is due in part to their high susceptibility to malarial infection (Atkinson et al. 1995). Earlier biological surveys by the Environmental Impact Study Corporation (1977) and Hawaii Heritage Program The Nature Conservancy of Hawaii (1994c) did not hear or observe any `I`iwi in MMR.

4.6.b Schofield Barracks Military Reservation

4.6.b.1 Schofield Barracks South Range

`I`iwi have never been reported from SBS. `I`iwi habitat is limited in SBS. NRS have surveyed this small area in the past without finding any `I`iwi.

4.6.b.2 Schofield Barracks East Range

In 1976, Shallenberger surveyed SBE and found several `I`iwi. On 14 June 2000, NRS and University of Hawaii Botany graduate student, Susan Ching were collecting *Hesperomannia arborescens* in the south fork of South Kaukonahua Gulch, when a single `I`iwi was heard. This site is located in SBE, roughly two to three kilometers from the gulch where the `I`iwi are regularly observed in KLOA.

4.6.b.3 Schofield Barracks West Range

In 1976, Shallenberger surveyed SBW. Shallenberger's survey route followed the old tramline trail up to the top of Mount Ka`ala from the south fork of Hale`au`au. He reported observing a total of fifteen `I`iwi, including both adult and juvenile birds. This was the largest population of `I`iwi found on Army lands during his survey. NRS have focused survey efforts for `I`iwi in this vicinity. NRS and Dr. Eric VanderWerf detected at least one `I`iwi on 29 November 1996. Despite additional surveys that year, `I`iwi were not detected again. Nor were they detected in 1997. However, survey efforts were not extensive. On 15 April 1998, NRS again detected `I`iwi in the same area. One bird was seen and another heard simultaneously. `I`iwi were not detected in 1999 or 2000. On 20 March 2001, NRS, State DOFAW staff and two volunteers detected `I`iwi on top of Mount Ka`ala within the bog area. 2001 appeared to be a year of heavy flowering for Koli`i (*Trematolobelia macrostachys*), which may account for the birds being so easily observed in the bog. One `I`iwi was detected on 17 July 2003 during an archeological survey along the proposed fence line. No `I`iwi were observed or heard in 2004 while completing management tasks. To date, NRS have not attempted to band any of the `I`iwi on

Mount Ka`ala due to the infrequency of sightings and unreliability of locating a bird to band. NRS will strive to better survey the area and pinpoint a locale that would provide the best netting and banding opportunities.

4.6.c Kawailoa Training Area

`I`iwi have been observed in KLOA in the recent past. Shallenberger reported one bird from the Poamoho Trail in a survey of military training lands in 1976. Several more sightings were recorded from the Poamoho and Schofield-Waikāne Trail areas from another survey that Shallenberger did covering the Central Ko`olau Mountains in 1978. More recently, during a 1993 survey by The Nature Conservancy's Hawai`i Natural Heritage Program, a single `I`iwi was seen near the junction of the Castle and Summit trails. On 5 December 1995, NRS discovered a population of `I`iwi in Kawailoa (VanderWerf and Rohrer 1996). That winter NRS worked with Dr. Eric VanderWerf in an effort to color band individuals and determine if there were any signs of disease in the population. A total of six birds were observed but unfortunately, none were captured. All observations and mist netting were centralized around a population of *Hibiscus arnottianus* ssp. *arnottianus*, which appears to bloom heaviest in winter. Birds were often seen feeding on *Hibiscus* flowers and NRS believe that it is this resource that draws them into the area. Banding efforts and monitoring continued from 1996 through 2001. On the Christmas bird count in 2002 NRS and Dr. VanderWerf were able to locate just a single `I`iwi. Vocalizations were heard and the bird was observed in and amongst the *Hibiscus*. On 16 August 2003, NRS visited the site again and were unable to observe or hear any birds. The weather was a bit rainy and windy making for sub-optimal resighting conditions. During the 2003 Christmas Bird Count, NRS and Dr. Vanderwerf were unable to locate any `I`iwi. On 26 February 2004, Jim Johnson and NRS heard and observed a single `I`iwi along the Poamoho Trail. For 2004-2005, NRS will continue with the Christmas bird count and monitor for `I`iwi while conducting other natural resource management throughout the range.

4.6.d Kahuku Training Area

`I`iwi have never been reported from Kahuku. There is little habitat left that would be expected to support `I`iwi in the KTA. Since KTA is relatively low in elevation, `I`iwi there would be more susceptible to infection from avian malaria. NRS will continue to monitor for `I`iwi while conducting other natural resource management in the training area.

4.7 O`ahu Creeper Management

4.7.a Mākua Military Reservation

An unconfirmed O`ahu `Alauahio sighting was reported in 1976 from MMR. NRS have revisited the location multiple times and detected nothing. It is very unlikely that `alauahio still persist in MMR due to the lack of essential habitat. NRS will continue to monitor for `Alauahio while conducting other natural resource management in the area.

4.7.b Schofield Barracks Military Reservation and Kawailoa Training Area

Shallenberger did not report `Alauahio from either of these ranges. However, this species had been reported from these areas in the years preceding his 1977 survey. In addition, there were two unconfirmed reports of `Alauahio from the Poamoho vicinity in Kawailoa in 1985 and 1991. NRS have never detected this species despite frequent visits to areas where `Alauahio have been sighted. On two separate occasions in 2003, NRS heard unfamiliar bird calls in the Lower Pe`ahināi`a region and in 2004 in the Helemano drainage. These areas are ideal habitat for the `Alauahio, so NRS plan to conduct several surveys of the area and attempt to conduct netting and banding operations.

4.7.c Kahuku Training Area and Dillingham Military Reservation

`Alauahio has never been reported from these training areas.

4.8 Pueo Management

4.8.a Mākua Military Reservation

NRS detected Pueo in Mākua on seven occasions. It is expected that Pueo use the grasslands in the lower elevations of the training area to forage for rats and mice. Because this species nests on the ground, feral dogs, cats, mongoose, and fire may pose a threat to both adults and chicks in the nest. While Wildlife Services has removed feral dogs from the area, no specific management actions for this species have been undertaken, aside from ecosystem level protection. The reason for this is that NRS have never discovered the exact location of a nest. Nesting and behavior indicative of nesting was observed in Mākua in May and June of both 2001 and 2002 (PCSU 2002). The pair was not utilizing the floor of the valley as was supposed but rather built their nest in shelf areas amongst the cliffs. Nesting and nesting behavior was not observed in 2003. A pair has been observed flying around the back of the valley and over the ridge into Mākaha Valley several times in 2003. Two Pueo sightings have been documented by NRS during 2004. A sighting of a pair soaring above `Ōhikilolo Ridge occurred on 15 April. The second sighting was on 13 July when a Pueo was flushed from the ground inside the fire break road below Lower `Ōhikilolo. No nesting behavior was observed during these two sightings.

4.8.b Schofield Barracks Military Reservation, Kawailoa, and Kahuku Training Areas

Though all of these areas have habitat that may support populations of Pueo, NRS have rarely observed these birds. On two occasions, a single pueo was observed, once on the border of SBE and KLOA along the Schofield-Waikāne Trail, and once in KLOA along the Pe`ahināi`a Trail. NRS believe that Pueo do utilize these areas to forage for food but no specific management actions for this species have been undertaken, aside from ecosystem-level protection. It would be extremely difficult to execute any specific management actions for this species in any of these training areas due to the ruggedness of the terrain and the wide foraging range of this species.

4.8.c Dillingham Military Reservation

NRS are unaware of any Pueo sightings from DMR. There are only small areas of habitat that could support this species at DMR.

4.9 Wetland Bird Species

Each of the training areas on O`ahu contains, to some extent, some possible wetland bird habitat. The types of habitat found in each of the areas vary from fast flowing stream regions to very slow meandering portions of streams and on down to marshy/lake areas. Three of the four endangered species (`Alae`ula, `Alae ke`oke`o, Ae`o) prefer such habitats as fresh and saltwater ponds, estuaries, and marsh areas. These types of habitats are extremely limited on Army training lands so NRS do not expect to find breeding populations of any of these endangered species. Previous surveys of the training areas have never revealed any nesting activity by endangered wetland bird species (Environmental Impact Study Corporation 1977, Shallenberger 1977, Hawaii Heritage Program The Nature Conservancy of Hawaii 1994a, b, c).

The endangered Koloa maoli and the common `Auku`u do inhabit and quite possibly nest along mountain streams and river valleys as well as the other wetland habitats. Since these stream habitats are on Army lands it is quite possible that Koloa have made nesting attempts and NRS were unaware as these birds are very secretive and difficult to observe. The `Auku`u is quite common throughout the pacific so are not discussed to any extent in this chapter.

4.9.a Dillingham Military Reservation

NRS surveyed the swampy area within DMR, which is thought to be suitable habitat, in the winter of 1996. No birds were found. This area may only be a seasonal wetland, thus not suitable for water bird nesting. If there is enough standing water at any time throughout the year, some birds may utilize the area to feed. Since 1996, NRS have been unable to document any standing water or any water birds at DMR. NRS continue to monitor the area annually, during the winter rains, for wetland habitat.

No protection actions have been implemented for wetland bird species as none have been observed.

4.9.b Mākua Military Reservation

In 2000, community members from Wai`anae expressed concern about training impacts to endangered water birds that had been seen at seaside ponds located at the mouth of Mākua Valley. Community members have observed three endangered waterfowl, the Koloa maoli, `Alae`ula, and Ae`o occasionally utilizing the ponds from seaside ponds (Aila personal comm. 2000, Salbosa personal comm. 2002). In addition, `Auku`u have frequently been observed making use of the ponds.

On 24 January, 19 June, and 8 August 2001, NRS surveyed these ponds for the presence of wetland birds and any possible migratory species. NRS surveyed again on 26 February and 21 March 2002. No birds were observed on any of these dates. No further surveys were conducted this year. It is possible that the birds occasionally come late in the day to feed but do not actively use the area for nesting. Many people and stray and feral animals frequent the area, which would threaten any nesting activity. NRS will continue to monitor the area in conjunction with other management actions in Mākua. Community members have agreed to assist.

4.9.c Schofield Barracks Military Reservation

No Koloa maoli has been documented from any of the streams in SBE. No protection actions will be implemented for wetland bird species until nests are documented.

4.9.d Kawailoa Training Areas

In January 2002, NRS spotted a koloa on Kamananui stream just below the Drum Road in KLOA. There is lots of suitable stream habitat within the training area and even two small high elevation ponds but no Koloa maoli were documented from anywhere in KLOA in 2003. No protection actions will be implemented for wetland bird species until nests are documented.

4.9.e Kahuku Training Area

No Koloa were spotted in KTA. No protection actions will be implemented for wetland bird species until nests are documented.

4.10 Hawaiian Hoary Bat

4.10.a Makua and Schofield Barracks Military Reservations

Observations of \`Ōpe\`ape\`a (Hawaiian Hoary bats) are very infrequent on O\`ahu Army Training Lands. In December 1976, an \`Ōpe\`ape\`a was seen flying above the Schofield-Waikāne Trail. In April 1998, NRS observed a single bat flying over \`Ōhikilolo Ridge on MMR. No management actions have been conducted for this species to date due to infrequent sightings.

In June 2001, NRS purchased an ANABAT II Bat Detector in order to facilitate confirmation of possible bat detections. It is very easy to confuse the introduced Black-witch moth (*Ascalapha odorata*) with the \`Ōpe\`ape\`a, as both have similar flight patterns, are roughly the same size and color, and can be observed emerging from daytime roosts at about the same time. NRS has initiated surveys for bats by incorporating them into camping trips and using the bat detector. Surveys are conducted starting at least 30 minutes prior to sunset and continue for up to an hour after, as this is the best time to observe any individuals that may be roosting nearby. There is some variation in time of first detection, which has been attributed to reproductive status and day of the year (Menard 2001).

4.10.b Dillingham Military Reservation and Kahuku and Kawailoa Training Areas

\`Ōpe\`ape\`a have never been observed in any of these training areas. To date, it is unknown whether any surveys directed towards this species have been undertaken. \`Ōpe\`ape\`a could inhabit any of the habitat contained within these training areas, and simply may not yet have been detected. In June 2002, Menard observed a single bat flying over her house in Pūpūkea-Paumālu. This area borders the southwest region of KTA. Mrs. Menard has since confirmed the sighting with a bat detector. Menard again detected a single bat flying over her house several times in June and July 2003. NRS has initiated `Ōpe`ape`a surveys on all Army training lands during overnight camping expeditions. The bat detector will greatly enhance the potential success of the surveys.

CHAPTER 5: RARE INVERTEBRATE MANAGEMENT

5.1 Introduction to Rare Snail Management

The island of O`ahu has 41 listed endangered species of land snails (although many of these are probably already extinct) and, in fact, the entire genus of *Achatinella* is listed as endangered. Since 1970, ten species of *Achatinella* (as well as a few equally rare land snails of other genera) have been found on Army training lands on O`ahu. Included here are: *Achatinella apexfulva*, *A. byronii*, *A. curta*, *A. decipiens*, *A. leucorraphe*, *A. lila*, *A. livida*, *A. mustelina*, *A. pulcherima*, *A. sowerbyana*, *Amastra micans*, and *Laminella sanguinea*.

There are three steps in the Natural Resource Staff's (NRS) snail management approach: surveying to identify new populations of snails; monitoring known populations; and prioritization and management of known sites. NRS are presently working in close cooperation with Dr. Michael Hadfield, Professor of Zoology at the University of Hawai`i at Mānoa. Since 14 August 1997, NRS have been listed as sub-permittees on Dr. Hadfield's U.S. Fish and Wildlife Service (USFWS) permit to work with endangered snails. As sub-permittees, three NRS personnel are authorized to handle (capture, measure, mark, collect tissue samples, and release) the O`ahu tree snails (*Achatinella* spp.) for the purposes of gathering ecological and life history data, and re-establishing wild populations.

In July 2002, the Snail Working Group was reorganized with the help of the USFWS. This multi-agency group discusses snail management statewide and helps to direct future management actions. The group met in October 2002 and again in February and July 2003. Most recently NRS met with Dr. Hadfield in May and September 2004 to discuss the Urgent Actions projects for 2002 to 2004, and also the O`ahu Implementation Plan.

5.2 Rare Snail Surveys

Snail surveying involves hiking in areas expected to contain rare snails, searching trees for arboreal tree snails and appropriate ground substrate for terrestrial snails. NRS have concentrated survey efforts in areas of known snail habitation as reported in the 1984 and 1985 surveys and from other documented sightings. Some specific snail surveys focus on taxa of which no populations are currently known but which have been observed within the past ten to thirty years. Survey routes are mapped via GPS/hand mapping and maintained in the NRS GIS system. Sites are mapped and provided at the end of this chapter. NRS have obtained maps from the Hawaii Natural Heritage Program (HINHP) with points designating past sightings to help in survey efforts. NRS have surveyed with malacological experts including Dr. Hadfield and his associates of the University of Hawai`i, Dr. Daniel Chung of Kapiolani Community College, and USFWS Field Staff.

5.3 Rare Snail Threats

Various factors are thought to be responsible for the swift decline of land snails in Hawai`i: loss of habitat, predation by rats and *Euglandina rosea* (a carnivorous snail), drought, change in climate, disease, and over-collection by humans. Predation pressures on *Achatinella* are compounded by its slow growth, late maturity, low motility, and a low rate of fecundity (approximately one offspring per adult per year) (Hadfield and Mountain, 1980). In addition, during years of drought chances of survival are diminished, further reducing fecundity. *Achatinella* probably had few predators in pre-human times and it is believed that they were able to form dense populations. Post human contact, tree snails survived nearly 150 years of European rat predation and more than 1,000 years of predation by the Polynesian rat. It is not definitively known whether or not this long-term predation significantly reduced snail numbers. The Hawai`i Department of Agriculture introduced *E. rosea* in 1958 to control the African snail, *Achatina fulica*. Its effect on Hawaiian snails has been much more devastating than that of rats. Like many other plants and animals of oceanic islands, native snails have lost all defenses against introduced predators and competitors. The destructive forces of rats and predatory snails present a picture of imminent extinction. Dr. Hadfield had acquired an Experimental Use Permit for bait developed to control *E. rosea*. The bait consisted of ground "apple snail" flesh (*Pomacea sp*.), 2% metaldehyde (the toxin), and 5% propionic acid (a food preservative). The cost to patent this product for widespread use against predatory snails is astronomical and thus impossible with the current funding available.

5.4 Rare Snail Monitoring

NRS employ two types of monitoring techniques. In the simplest form of monitoring, trees in which snails are found are tagged and the total number of snails in each tree recorded. Trees within sites are then mapped. NRS sometimes also utilize a more extensive mark and recapture technique. This method entails marking individual snails with a unique number and/or color combination to track them over time. In this manner, NRS are able to observe the growth rate, death rate, and the movement of snails between trees. An estimate of total population size can be made using the proportion of marked to unmarked snails captured on subsequent visits. Marking the snails poses many difficulties, as conditions must be dry for the paint to set. NRS record pertinent snail data on a Rare Snail Monitoring Form and keep accurate records to be able to measure changes in snail populations over time.

5.4.a Rare Snail Observation Forms

NRS made great improvements in the snail data management program this year. NRS revised the rare snail monitoring form (Appendix 5A) to incorporate new fields. A significant addition is the delineation of size classes based on data collected by Dr. Michael Hadfield from snails that he reared in captive propagation. Size class definitions differ between Ko`olau *Achatinella* taxa and *A. mustelina* from the Wai`anaes. In addition, there are fields to record information on predator presence in the area and any evidence of predation. Also, the number of person hours spent searching is recorded so that variability in numbers of snails observed can be better understood. Another significant addition to the form is the field for a population reference code.

This allows NRS to track data on population structure in a spreadsheet. Population reference codes are composed of a three-letter abbreviation for either the Hawaiian gulch name or a training area where a population is found and a single letter following it that is simply assigned in the order that populations are discovered. For example, SBW-A is the reference code for the first *A. mustelina* site discovered in Schofield Barracks West Range. In addition these reference codes are the common field that ties a rare snail observation form to a point location in the GIS database. NRS plan to link the spreadsheet/database to the GIS database, making data entry and retrieval easier and more effective in the future.

5.5 Rare Snail Management

In the following sections each rare snail species reported from O`ahu Army lands since 1982 is discussed. The status of each species and the management conducted for it is described.

Thus far NRS have deployed a total of 49 rat bait stations stocked with diphacinone in snail populations in both the Wai'anae and Ko`olau Mountains. In the Wai'anae Mountains four areas were selected. `Ōhikilolo "Pteralyxia Gulch" and SBS were selected because rat-eaten shells had been seen at both of the sites. Pu`u Hāpapa was chosen because of the rare *Amastra* snails that are found there, as well as a healthy population of *Achatinella mustelina*. Also, in December 1998 three rats were trapped here during an overnight camp. The area surrounding the snail enclosure in Kahanahāiki is baited to help reduce pressure. Although the enclosure is designed to be rat-free, NRS have trapped rats on two occasions inside the enclosure during the past year. Seven sites are baited in the Ko`olau Mountains and these are primarily small pockets of snails that remain along the Summit Trail where a couple of hiking hours separates known snail populations. NRS also perform weed control in areas of high snail density as a means of habitat restoration. More will be discussed in the individual snail sections pertaining to specific site management.

Recently, NRS discussed the prioritization of snail management and questioned why baiting is done in certain areas and not done in others. There are small populations of Ko`olau snails that are being protected with rat bait stations and there are other large populations (248 snails) that are not being protected. To rectify this discrepancy it was decided that in the future some of the larger unprotected sites would be monitored and surveyed specifically looking for signs of rat or *E. rosea* predation. In the past emphasis was placed more on counting the live snails and not searching for predated shells on the ground. It is generally accepted that rats are ubiquitous on the island but, for whatever reasons, are more problematic in certain areas. It has been the policy of NRS not to bait around some of the larger populations without first seeing signs of rat predation. Although the bait is designed to kill rats, it might also act as an attractant and NRS would not wish to create a problem where none exists. Then again, NRS do not want to fail to recognize a rat predation problem because it has not been adequately looked for. NRS will conduct surveys to include live snail counts, specifically monitoring for evidence of predation. This is a new development in snail management and an attempt to utilize the available resources in the best possible manner to ensure the survival of native snails on Army training lands on O`ahu.

5.5.a *Achatinella apexfulva*

The historical range of *A. apexfulva* (Pop Ref Code: KLO-A) comprises parts of the KLOA. In recent years, this species has only been found along the Poamoho Trail. It is considered extremely rare and its present range is very restricted. One new snail was seen in this area during a hike on 26 February 2004. Another search was made 18-20 May 2004. A group of four NRS surveyed the areas south of the Poamoho Stream on a ridge where d'Alte Welch had recorded snails during the 1930s. Much of this habitat looked promising for snails, but the end result was the usual one; searching so far from the summit at lower elevations is very unlikely to yield snails. No additional *Achatinella apexfulva* were identified.

During a trip to the Poamoho Trail area in April 2003 a tissue sample was taken of a dark colored snail. Genetic analysis showed this snail was actually *A. sowerbyana* and not *A. apexfulva*. If more individuals are discovered in the future, NRS will discuss bringing them into captivity with Dr. Hadfield and the State of Hawai`i.

This species has been slow to reproduce in captivity. Dr. Hadfield theorized that this might be because it is found at lower elevations where the temperature is a bit warmer than in the captive facility. A new refrigerated chamber that can be maintained at a slightly warmer temperature was added to the tree snail lab two years ago. Early signs are that this higher temperature may be more suitable for these snails. In 2001, pathogens negatively affected the lab populations of snails. More time and effort has been given towards making sure that the environment is as clean as possible, and other experts were consulted to help solve the problem. The problem has not reappeared this year. NRS will continue to search the Poamoho Trail site on an annual basis. As of September 2004 the total number of individuals in the lab was 10. Unfortunately, only one of these is an adult.

5.5.b *Achatinella byronii/decipiens*

There is some confusion amongst Hawaiian malacologists as to the distinction between *Achatinella byronii* and *Achatinella decipiens.* For simplicity, NRS have treated both as one taxon. This snail was historically known from the southern boundary of KLOA and areas to the south, primarily along the Summit Trail and upper elevations above 2,000 ft. It is considered to be extant with some recent sightings by Dr. Hadfield (USFWS 1992). A healthy population of 178 *A. byronii* (Pop Ref Code KLO-E) was counted in the Schofield-Waikāne Trail area on 9 August 2000. On 21 August 2002, a total of 93 snails were found on a ridge closer to the summit in a previously unexplored area. Including the 79 snails seen at the original site, a total of 172 snails were counted on this trip. On the most recent survey on 15 December 2003 there were 72 snails counted in the second, newer area. Figure 5-1 shows the number of snails counted as well as the amount of time spent searching.

Figure 5-1 *Achatinella byronii* Survey Trend

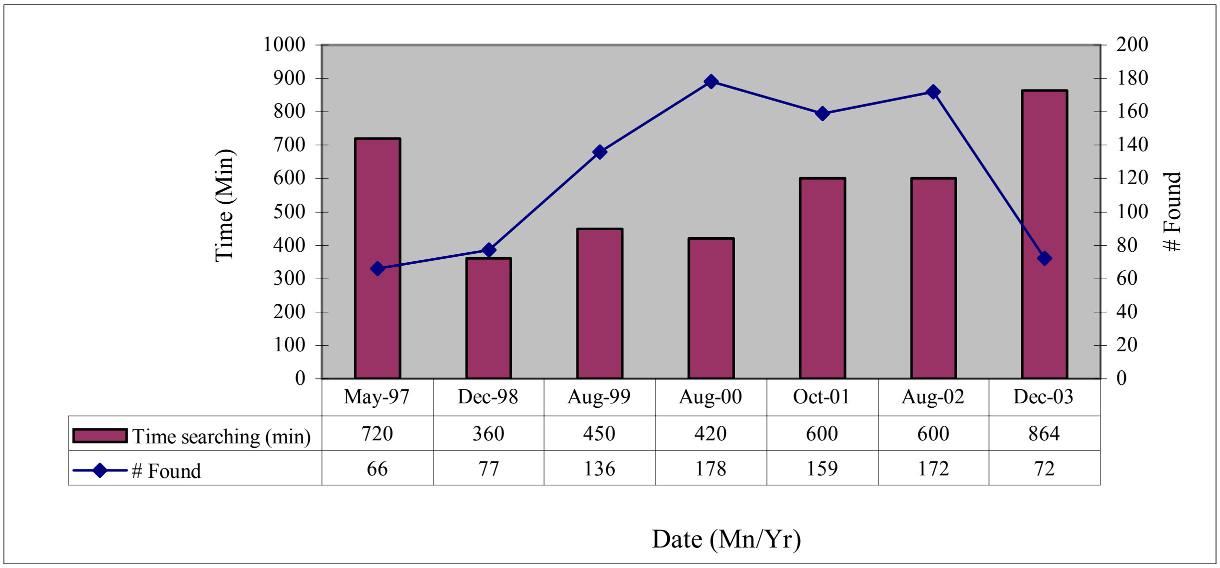


Figure 5-1 gives information about the main site just north of the Schofield-Waikāne Trail. Numbers of snails observed on five trips over the past seven years are given as well as an estimate of the amount of time spent searching. The rising numbers should not necessarily be interpreted as increases in snail populations, but rather are more likely indications that searchers are becoming more familiar with preferred snail habitat, so that more snails are found with less time searching. Sometimes, as in the December 2003 trip, fewer snails are counted with more time spent searching because new areas are surveyed.

Because this is the largest population of *Achatinella* snails known in the Ko`olau Mountains, its protection and management are very important. NRS does not bait for rats at this site because no signs of rat predation have been discovered here. It was decided in 2002 to visit the area twice per year to survey for rat or *E. rosea* predation and continue monitoring once a year to perform a snail count.

During an April 2003 survey of the Poamoho Trail area, UH staff collected tissue samples from a low elevation population of snails that were thought to be *A. sowerbyana*. Surprisingly, the genetic analyses matched them with the *A. byronii/decipiens* population from the Schofield-Waikāne Trail. There are a couple of miles of forest that separate these two populations and no known snails between the two sites.

5.5.c *Achatinella curta*

A. curta was historically found throughout KLOA. In the past eighteen years only two snails have been seen; one on the Kawailoa Trail and one on the Pe`ahināi`a Trail. None have been seen in the past fifteen years. NRS have been searching the areas where these snails were last seen for the past nine years and have not been able to find any. Although additional surveys were planned for this year, none were conducted due to helicopter restrictions and other priorities.

NRS recommend continuing these periodic searches in areas where *A. curta* were known to live. NRS will collect specimens for captive propagation, if found, before the species goes extinct in the wild.

5.5.d *Achatinella leucorraphe*

A. leucorraphe is considered critically rare and may only be surviving in a very restricted habitat. Historically, it was found in SBE and further south. Only one snail has been identified in the past fifteen years and it was found along the Schofield-Waikāne Trail. NRS have searched appropriate habitat in the SBE, including the area where Dr. Steve Miller of USFWS last reported seeing one *A. leucorraphe* in 1989, and have been unsuccessful in finding any more. This species may also be extinct because it was known to thrive in lower elevations where *E. rosea* first invaded and the 1989 sighting is the only documented one for the past 44 years. NRS will continue surveying SBE to find *A. leucorraphe* and will collect it for captive propagation, if found. Two of the surveys that were conducted during 2000-2001 were in *A. leucorraphe* historical habitat but none were found. In February 2002 NRS spent two days searching for snails in the SBE but did not find any *A. leucorraphe*. However two new helicopter landing zones were established so in the future NRS will be able to land closer to prime unexplored forest areas and thus conduct more searches. Further searching will be required before this species can be considered extinct. NRS plan to conduct searches next year to look for *A. leucorraphe*.

5.5.e *Achatinella lila*

This species is historically known from the Schofield-Waikāne Trail, Poamoho Trail and connecting Summit Trail areas. NRS no longer find it in the southern regions around Schofield-Waikāne but have seen individuals north and south of the Poamoho Trail and Summit Trail junctions. It is considered to be uncommon within a very restricted range. NRS have identified *A. lila* from four different areas and presently bait for rats at two of these sites. One site that has the largest known population of *A. lila* was surveyed in March 2003. NRS decided that it would be prudent to bait for rats at this site because, although there are no signs of rat predation nor is any decline recognized in the snail population, the nearby snail sites are showing decline. This is a fragile habitat due to low vegetation and steep terrain, and the potential benefits of rat baiting here will need to be considered against any possible trampling and destruction of vegetation. NRS will continue monitoring the known populations for evidence of predation while searching new areas for *A. lila*.

Five snails were counted at the Pe`ahināi`a Trail and Summit Trail junction on the 14 January 2003 trip. A large portion of this site is now protected within the exclosure. NRS have been putting out diphacinone bait blocks at this site since August 1999. In 2002 NRS also began using snap traps that are reset when the bait stations are restocked. Presently, there are five rat bait stations and ten snap traps at this site. Helicopter support is used to restock bait which used to be done biannually, but now is done bimonthly. Bait "take" at this site has consistently been at approximately 50%. NRS will continue following the present schedule of restocking and will reevaluate the project, if the bait take continues at a high rate.

On 25 September 2000 Dr. Hadfield led a group of six people to survey some of his old sites along the Summit Trail. One site is approximately five minutes hiking south of the Poamoho/summit junction on the windward side and another is approximately five minutes north of the junction. Five *A. lila* were found at the southern site. Unfortunately, a live *Euglandina rosea* was also found at this site; this shows the precarious circumstances that threaten native Hawaiian tree snails. On the 18 March 2003 survey no *A. lila* were seen at this site. During the 18 March 2003 survey a total of 14 *A. lila* were counted at the site north of the Poamoho Trail monument. Because of the importance of this site NRS set up eight rat bait stations and eight snap traps on 19 August 2003 and plan to restock on the usual bimonthly schedule.

At the present time there are 218 *A. lila* living in the lab at UH.

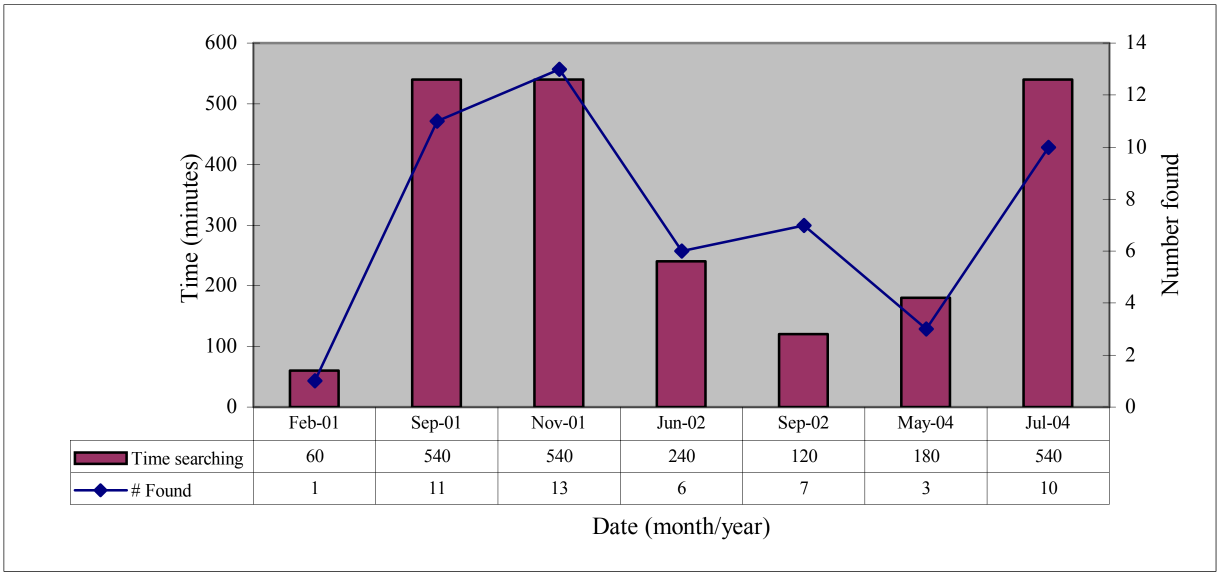
5.5.f *Achatinella livida*

A. livida is a species known from KLOA. In 1981, one live snail was found in the area where the Lā`ie Trail meets the Summit Trail. No snails have been found this far north in recent surveys, but NRS do know of individuals at some of Dr. Hadfield's study sites further south near the old Kahuku Cabin. The following three sites are presently monitored by NRS: "Northern", "Crispa Rock", and "Radio LZ".

Five years ago NRS initiated predator control at the "Northern" (northernmost) site north of the old Kahuku Cabin. At this site six bait stations and 12 snap traps are used to control rats. The number of snap traps was increased from six to 12 traps in 2004. A total of 185 blocks (5.2 kg) of rodenticide were taken from bait stations during the first seven months of 2004. 96.3% of the total bait deployed was consumed. Ten rats were caught in snap traps during the first seven months of 2004 with an average of five rats per monitoring trip (2 monitoring trips). The take of bait from this site has generally been high over the years and NRS are considering expanding the number of bait stations.

The northernmost site is significant because there are no known snails further north and the only snails known to the south are about an hour's hike along the trail. During a bait-restocking trip in June 2002 a total of six snails were counted and on 10 March 2003 seven were recorded. On 18 May 2004, three *A. livida* were found, along with two live *Euglandina rosea*. The most recent survey was performed on 21 July 2004 and a total of 10 *A. livida* were observed during a night survey. Figure 5-2 shows the number of snails found at the "Northern" site. NRS plan to visit the site bimonthly in the coming year.

Figure 5-2 Snail Surveys For "Northern" Site



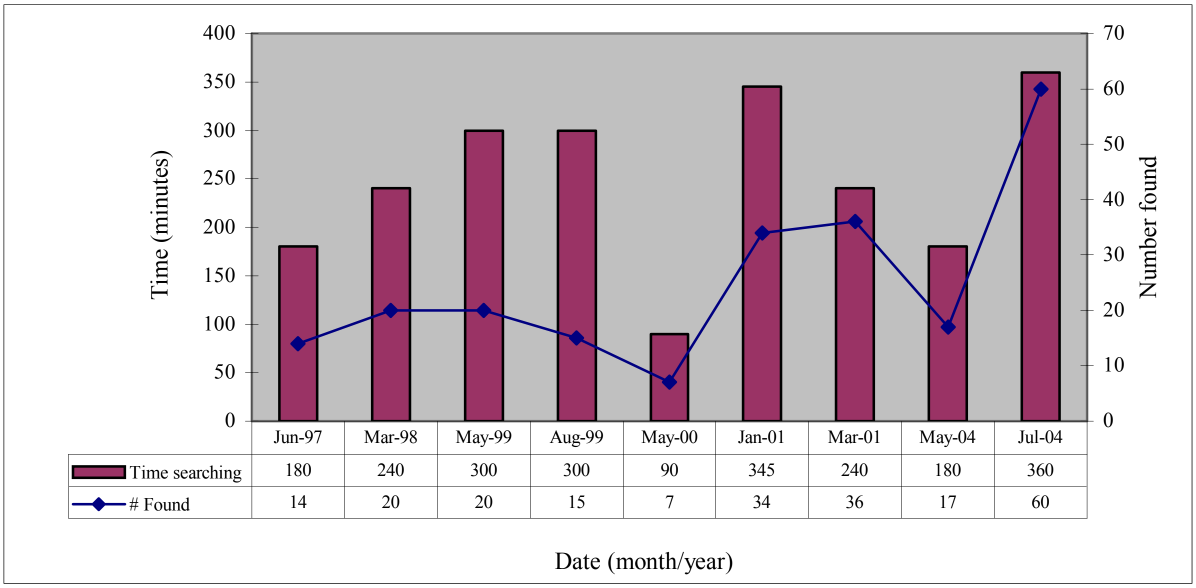
The "Crispa Rock" site supports a vibrant population found in an area where there are otherwise only scattered individual snails.

On 10 August 1999, staff visited these sites with Dr. Hadfield and his associates: Chela Zabin, Kevin Olival, and Dr. Brenden Holland. Dr. Holland was doing genetic research on the different *Achatinella* species and took samples from four sites along the Summit Trail back to the University of Hawai`i to analyze. This genetic research will help clarify relationships between and within species. Initial data indicates that *A. livida* and *A. sowerbyana* are closely related and their low genetic diversity suggests a relatively recent evolutionary separation.

In order to control rats at the Crispa Rock site the number of bait stations has increased from an original of two stations when baiting started 5 years ago to six stations at present. The number of snap traps was increased from six to 12 in 2004. A total of 180 blocks (5.1kg) of rodenticide were taken from bait stations during the first seven months of 2004. The bait consumed was 93.8% of the total bait put into the bait stations. Eleven rats were caught in snap traps during the first seven months of 2004 with an average of 5.5 rats per monitoring visit (2 monitoring trips). NRS recorded high rates of bait take over the years and will continue monitoring to determine whether or not more stations need to be added. Restocking here has also been increased from quarterly to twice a quarter.

On 18 May 2004, a total of seventeen snails were marked at this site. When NRS returned on 21 July 2004 only six marked snails were positively identified. Other unmarked snails were found in the marked trees but it is likely that the water resistant acrylic paint used was not readable after two months of Ko`olau weather. A total of 36 snails were counted in the ten marked trees and another 24 snails in neighboring vegetation. This total of 60 snails is the largest number recorded at this site (Fig. 5-3).

Figure 5-3 Snail Surveys For "Crispa Rock" Site



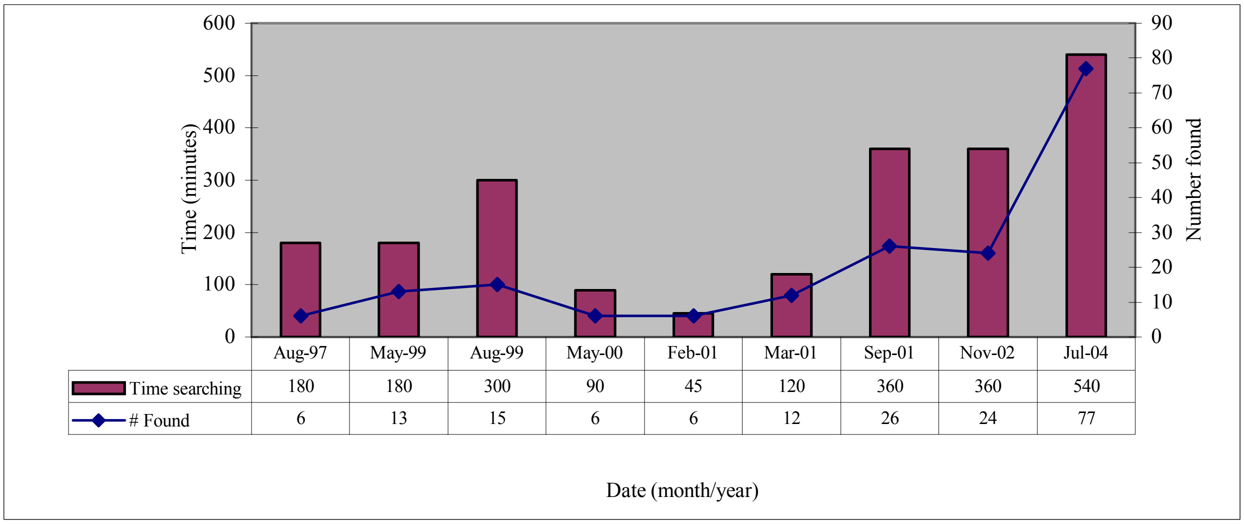
The "Radio LZ" site is another one of Dr. Hadfield's old study sites and it is now monitored six times per year. Samples were collected from this site during the snail sample collection surveys of August 1999. This location is an isolated pocket of snails. Searches of the surrounding areas have found no new snails. The bait stations at this site were increased from two to four in 2001, and for better coverage in 2003 the total was increased to six. Snap traps were increased from six to 12 in 2004. A total of 175 blocks (5.0kg) of rodenticide were taken from bait stations during the first seven months of 2004. Total bait consumed was 92.1% of the total bait put into the bait stations. An average of 3.5 rats were caught per monitoring visit (2 monitoring visits) during the first seven months of 2004. If the bait continues to be taken at the present rate, NRS will consider adding more bait stations.

During the most recent surveys on 20 July 2004 a total of 77 snails were counted (Fig. 5-4). This is the largest number of snails observed at this site and this increase may be attributed to utilizing a night search as part of the survey.

Dr. Daniel Chung believes that the snails referred to in this report as *A. livida* are actually *A. sowerbyana* and that *A. livida* was a lower elevation snail that may possibly be extinct.

There are 72 *A. livida* at Dr. Hadfield's lab at UH.

Figure 5-4 Snail Surveys For "Radio LZ"



5.5.g *Achatinella mustelina*

5.5.g.1 *Achatinella mustelina* MIP requirements

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

5.5.g.2 *Achatinella* Stabilization Plan Summary

Long Term Goals:

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

Table 5.1 Field Sites for Stabilization Efforts

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

New ESU	Old ESU	Site No.	Location	# of Snails	Final Mākua IP Year 1 Recommended Actions	Revised Year 1 Recommended Actions
D	**N/A**	20	Mohiākea	10+	Determine management after genetics analysis is completed	None
D	**N/A**	21	Pu`u Kūmakali`i	~20	None	None
D	**N/A**	22	Central and North Kalua`a	5 (seen incidentally)	Determine management after genetics analysis is completed	None
E	**G**	17	Pu`u Kaua (`Ēkahanui)	12	Survey for manageable population; Collect for captive propagation	Manage for stability
E	**N/A**	23	Huliwai	30+	Determine management after genetics analysis is completed	None
F	**H**	18	Pu`u Palikea	~40	Manage for stability; Collect for captive propagation	Manage for stability

5.5.g.3 Captive Propagation

One of the requirements outlined in the MIP stabilization plan is to represent in captive propagation snails from each of the six ESUs and from the two extra sites in ESU-B and ESU-D. All but one site is represented and the snails are prospering at Dr. Hadfield's laboratory at the University of Hawai`i. Detailed snail captive propagation data are included in Attachment 1. In reviewing these data it appears that eight lab populations from 7 field sites that are designated as manage for stability are still growing in the laboratory. Snails should be collected from the East Branch of East Makaleha site since none have been taken into the laboratory yet. The MIP stabilization plan states that lab populations should be refreshed with wild stock if the lab population remains small or declines in numbers. In addition, it states that lab populations should be refreshed every two years and lab-reared snails rotated back out into the wild. NRS have concerns about the potential drain on the field population and the potential for lab borne pathogens to harm the wild population.

5.5.g.4 ESU Updates

5.5.g.4.a ESU A (Pahole to Kahanahāiki)

Table 5-2 Number of snails counted from ESU A

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

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

Management for ESU A is well underway. This ESU encompasses a relatively flat forest area in the uppermost reaches of 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 are shown above as MMR-A and MMR-B. MMR-C is the area between the two existing exclosures called "maile flats". *A. mustelina* from ESU-A are represented at the U.H. Tree Snail Laboratory.

5.5.g.4.a.1 MMR-A (Kahanahāiki Exclosure)

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 *N. sandwicensis* fruit has been observed inside the exclosure in past years. Bait is not placed within the exclosure because NRS do not want to provide any attractant that may encourage rats to cross the barrier. Rat control has been conducted since 2001 and a total of six bait station and 12 snap traps are deployed.

Table 5-3 Kahanahāiki Snail Enclosure Rat Information

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

The 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 have discovered *A. mustelina* in the salt trough of the snail exclosure; it is unclear if these snails were trying to enter or exit the exclosure. The electrical barrier is often not functioning properly because of rain or shorts in the system and requires monthly maintenance. NRS will investigate exclosure design modifications to address these issues before constructing any new exclosures.

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

5.5.g.4.a.2 PAH-A (Pahole Exclosure)

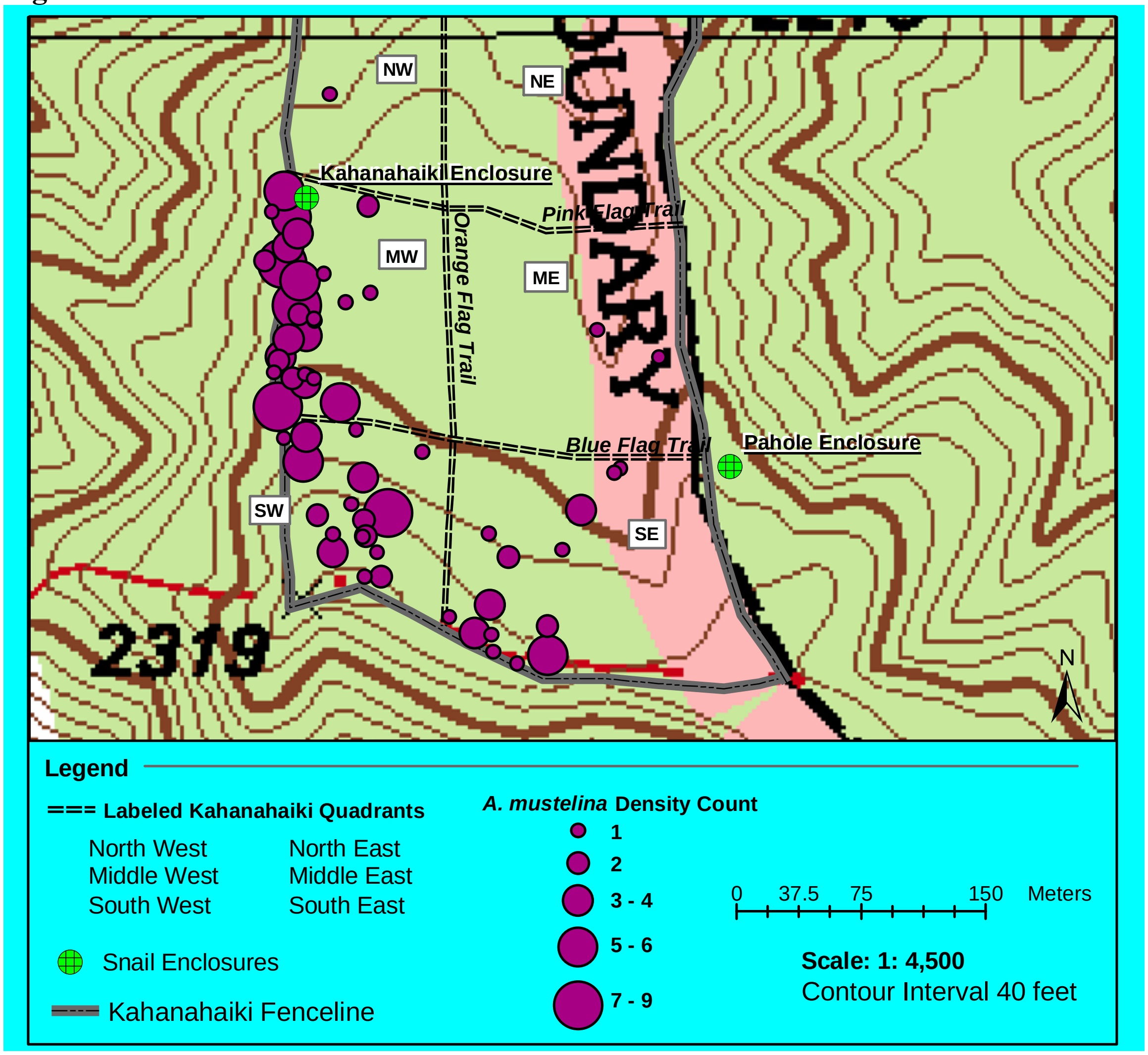
For a detailed description of the Pahole snail exclosure, see PCSU Report 2003. The Pahole snail exclosure is located on the Pahole side of the boundary between Mākua Military Reservation and the State of Hawai`i's Pahole Natural Area Reserve. This site protects what remains of the population, which University of Hawai`i researchers have been studying for over 20 years. On 27 May 2004, a total of 39 *A. mustelina* were counted. *Euglandina rosea* has penetrated the exclosure barriers in the past killing *A. mustelina*. Significant predation was documented and live *E. rosea* were found within the exclosure. Over the past year NRS have been assisting the State of Hawai`i with maintenance of this exclosure.

5.5.g.4.a.3 MMR-C (Maile Flats)

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

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

Figure 5-5 ESU MMR C



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

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

5.5.g.4.b ESU B1 (`Ōhikilolo)

ESU B is very large. Based on Holland's 2002 genetic studies it stretches from East Makaleha to `Ōhikilolo 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 `Ōhikilolo (B1). The habitat present at these two sites is very different. See 2.3.c. ESU B2 for a description of the E. Makaleha site. Most of the snails found on `Ōhikilolo ridge are located within the `Ōhikilolo 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*. *M. 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. *A. mustelina* from ESU-B1 are represented at the U.H. Tree Snail Laboratory. Rat control on `Ōhikilolo has always shown a pattern of high rat bait take. This is mainly because we only visit the site once every three months via helicopter because of the remote nature of `Ōhikilolo. This high-take pattern should be considered when designing and expanding rat baiting grids in order to compensate for the long period of time between visits.

Table 5-4 Number of Counted Snails at `Ōhikilolo

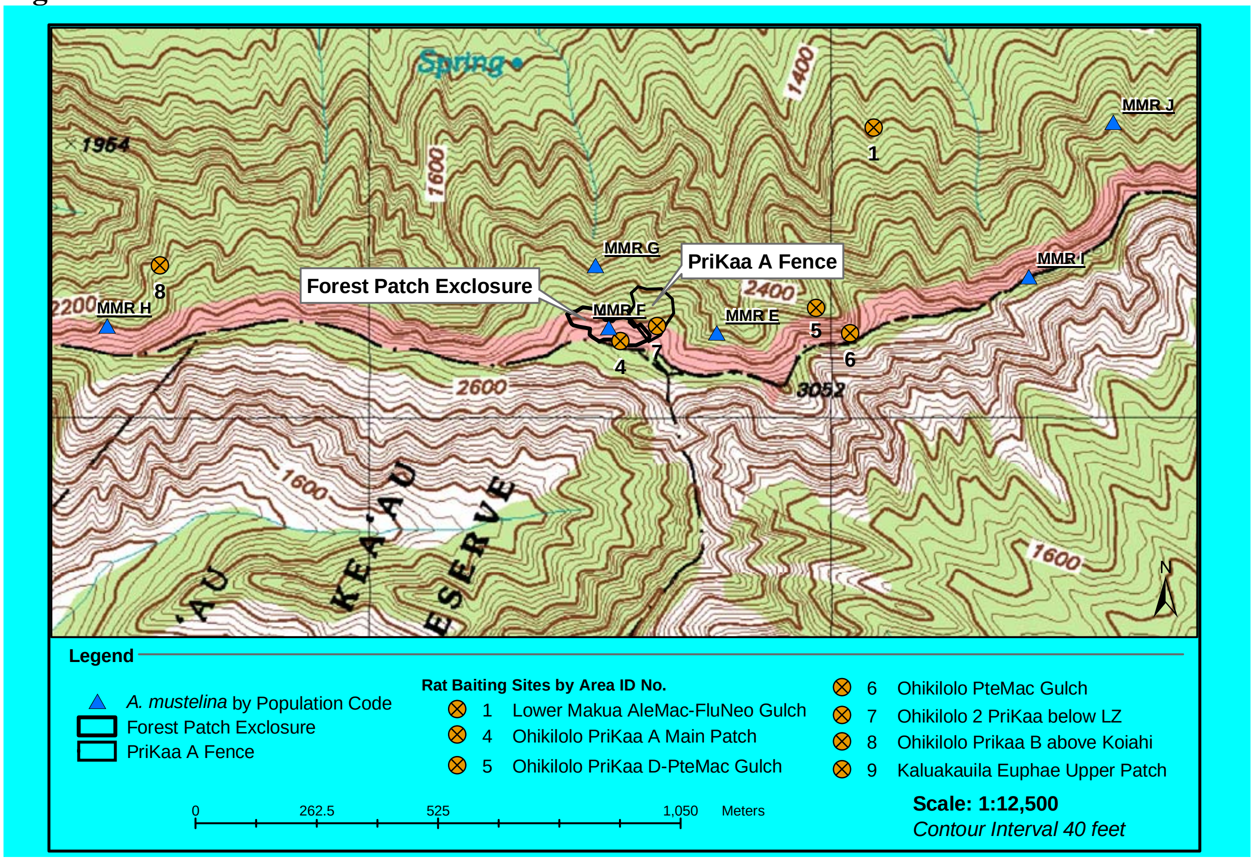
Pop Ref Code	**No. Snails**	**Size Classes**			**Pigs/ Goats**	**Weeds**	**Rats**	***Euglandina***
		Lg	**Med**	**Sml**				
MMR-E `Ōhikilolo Mauka	77	62	8	7	X	X	X	
MMR-F `Ōhikilolo Makai	210	166	22	22	X	X	X	
MMR-G Alemac Site	24	20	4		X	X	X	
MMR-H `Ōhikilolo Koi`ahi Prikaa Reintro Site	16	9	7		X	X	X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

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

5.5.g.4.b.1 MMR-E (`Ōhikilolo Mauka)

The `Ōhikilolo Mauka population encompasses the full area in the main forest patch "mauka" of the landing zone. NRS have been observing significant rat predation at this site since 1995 and began controlling rats in 1999. The rat control currently being conducted is centered on a high-density snail area and the rare plant *Pteralyxia macrocarpa*. There are a total of six bait stations in this area. *E. rosea* has never been observed at this site. Extensive surveys were conducted in August of 2004 and many snails were discovered outside the existing grid. NRS will continue to monitor for evidence of rat predation and will expand rat baiting based on the August 2004 data. Currently this site is protected from pigs because of the steep cliffs that surround the site. Goats within Mākua have almost been completely removed. Goat numbers are very low and remaining herds reside in other parts of the valley. No evidence of goat browse has been observed in the last two years. Weed control at this site is extensive and on-going.

Figure 5-6 ESU B1



5.5.g.4.b.2 MMR-F (\`Ōhikilolo Makai)

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 this summer, 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 this summer and eight rat-predated shells were observed at one site. All the predated shells were estimated to be between three and six years old. With this new information, NRS will reconsider the best rat control/monitoring approach for this site. No evidence of *Euglandina rosea* has ever been observed at this site. NRS will continue to monitor for *E. rosea* in \`Ōhikilolo Makai. Care should be taken to ensure that all field gear that has the potential to transport *E. rosea* to the site is strictly inspected. This site is completely protected from ungulates by fencing. Extensive canopy and understory weed control efforts are underway.

5.5.g.4.b.3 MMR-G (*Alectryon macrococcus* Site)

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

5.5.g.4.b.4 MMR-H (`Ōhikilolo Koi`ahi *Pritchardia kaalae* Reintroduction Site)

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

5.5.g.4.b.5 MMR-I (*Hedyotis parvula* MMR-B)

Only two individual *A. mustelina* have been observed at MMR-I, elevation 2,700 feet. They were found in tiny forest pockets on steep cliffs by NRS on rappel. The small forest pockets are dominated by *Metrosideros tremuloides*. This site does not have much management potential as this terrain is too steep 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.

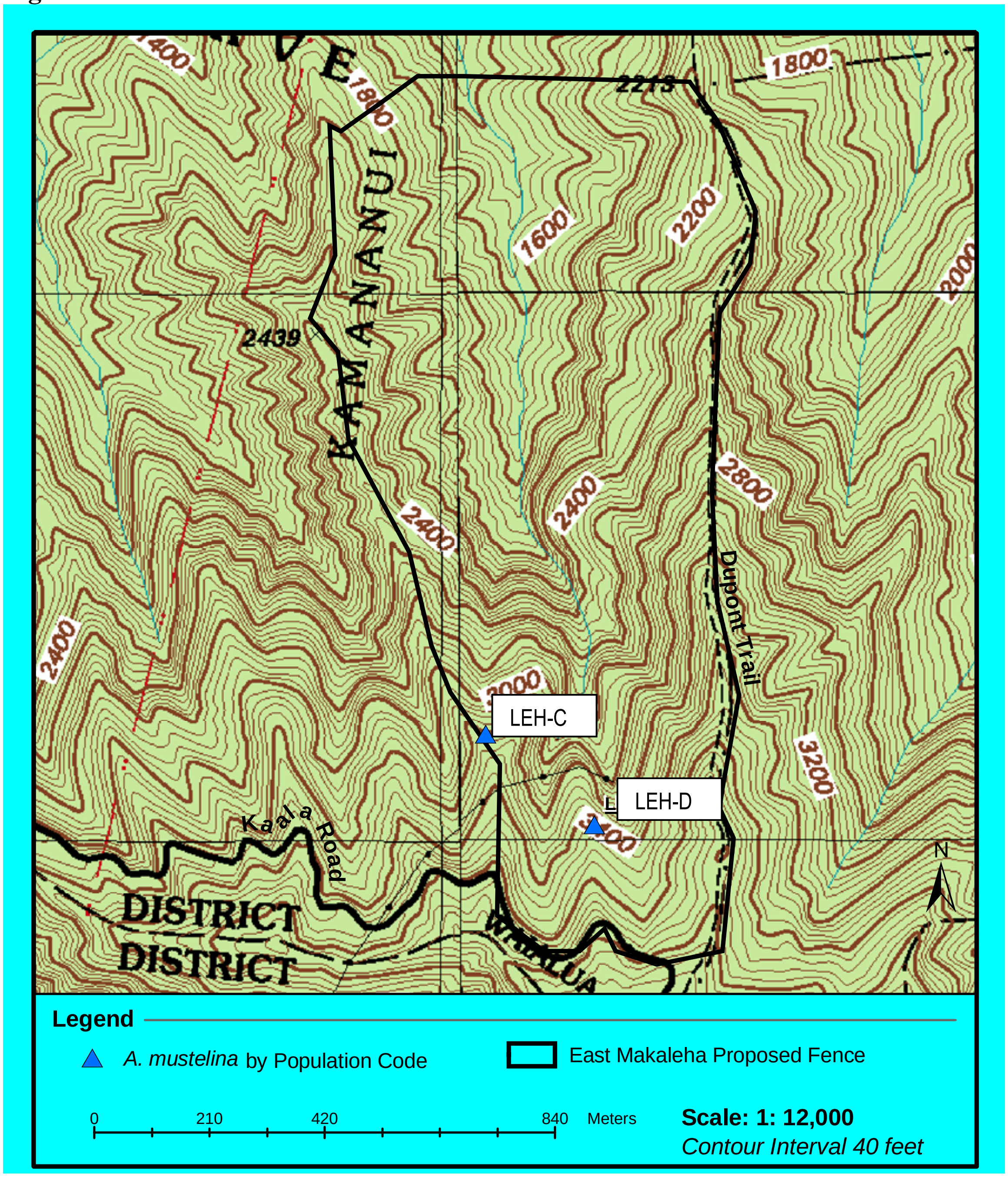
5.5.g.4.c ESU B2 (East Branch of East Makaleha)

Table 5-5 East Branch of East Makaleha

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

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

Figure 5-7 ESU B2



5.5.g.4.c.1 Culvert 69

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

5.5.g.4.c.2 Culvert 73

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

5.5.g.4.e ESU C

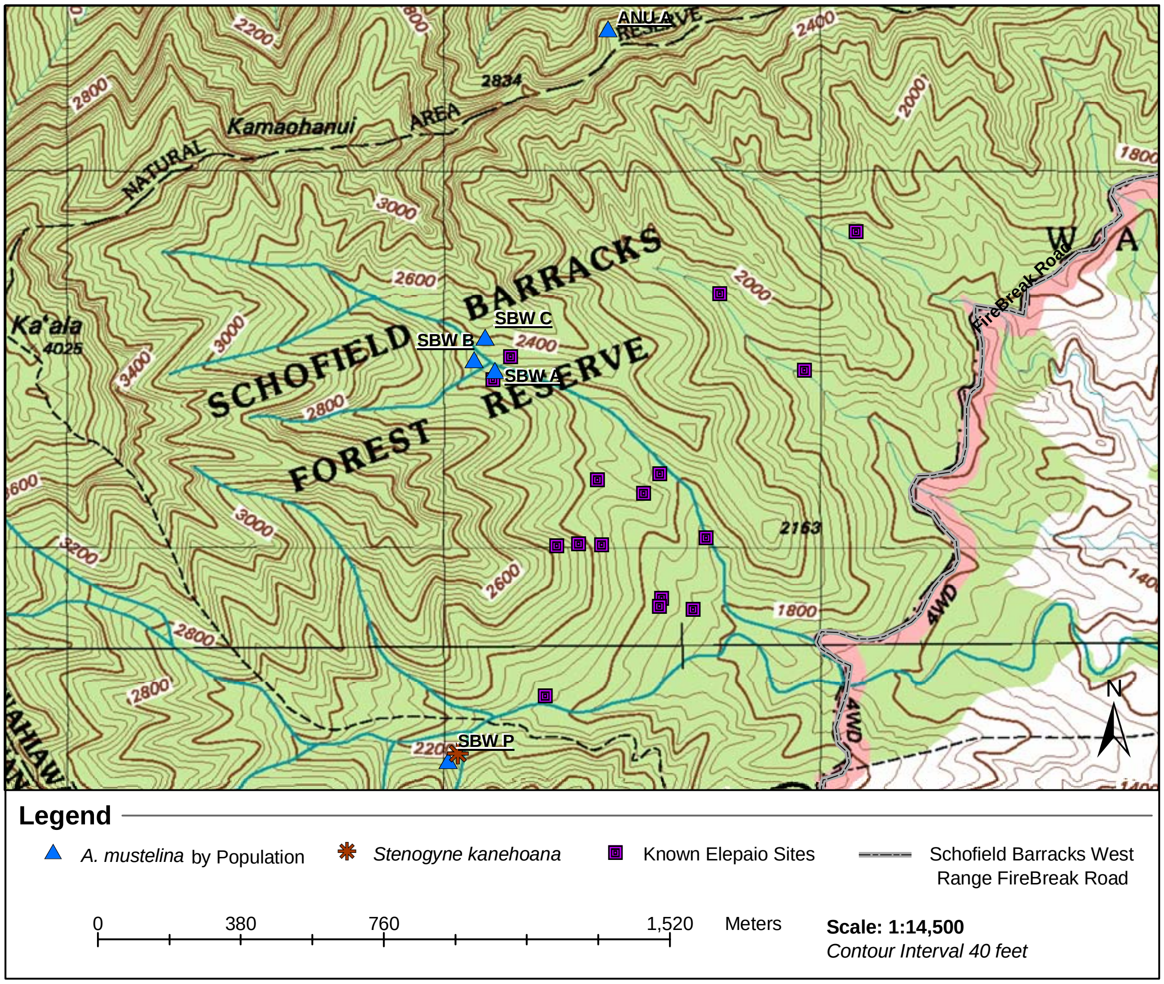
Table 5-6 Number of Counted in ESU C

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

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

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

Figure 5-8 ESU C



5.5.g.4.e.1 Schofield Barracks West Range-A, B, C, and P

These four sites will be discussed collectively because their situations are similar and related. All of these sites are located in North Hale`au`au gulch between 2,500 and 2,600 ft in elevation. The habitat is infested with pigs. This area is off-limits to hunters, therefore the pig population grows un-checked. There are no fences installed here. The high pig numbers facilitate the spread of *Psidium cattleianum*, which is a dominant canopy tree in the area. Native forest areas have a very tall canopy in Hale`au`au, which is dominated by *Metrosideros polymorpha*. The subcanopy is composed of *Antidesma platyphyllum*, *Melicope spp*., *Cheirodendron platyphyllum* and *Elaeocarpus bifidus*. This area was proposed for management because the terrain is relatively flat in portions of this ESU and suitable for constructing snail exclosures similar to those in ESU-A. Since these exclosures require intense maintenance, Hale`au`au may not be suitable because of access restrictions. This being said, if management of *A. mustelina* overlapped with management of other species in SBW, then adequate access may be possible to obtain. The O`ahu Biological Opinion (O`ahu BO) mandates that two species must be managed within SBW, *Stenogyne kanehoana* and O`ahu `Elepaio. In this last year, one new *A. mustelina* site was discovered in the south fork of Hale`au`au in a spot where the other two O`ahu BO taxa are present. This is referred to in the table above as SBW-P. If substantial numbers of *A. mustelina* are found at the SBW-P site, rat baiting could be conducted in conjunction with O`ahu `Elepaio predator control and a fence could be constructed to protect all three species together. Additional surveys in the vicinity of the *S. kanehoana* in South Hale`au`au for *A. mustelina* are recommended. If substantial numbers of *A. mustelina* are found, NRS will collect genetic material so an ESU determination can be made.

5.5.g.4.e.2 ANU-A (Manuwai)

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 this year, NRS are re-evaluating again where and how to conduct management for *A. mustelina* in ESU-C. Therefore, the lone snail was not sampled to determine its ESU status. Other sites in Lower Mt. Ka`ala NAR are available for management. Surveys will be conducted in other gulches within this portion of ESU-C in order to determine if there are populations located in moderate terrain, within a healthy native forest and in areas that overlap with other species the Army must manage.

5.5.g.4.f ESU-D1 North Kalua`a and Pu`u Hāpapa

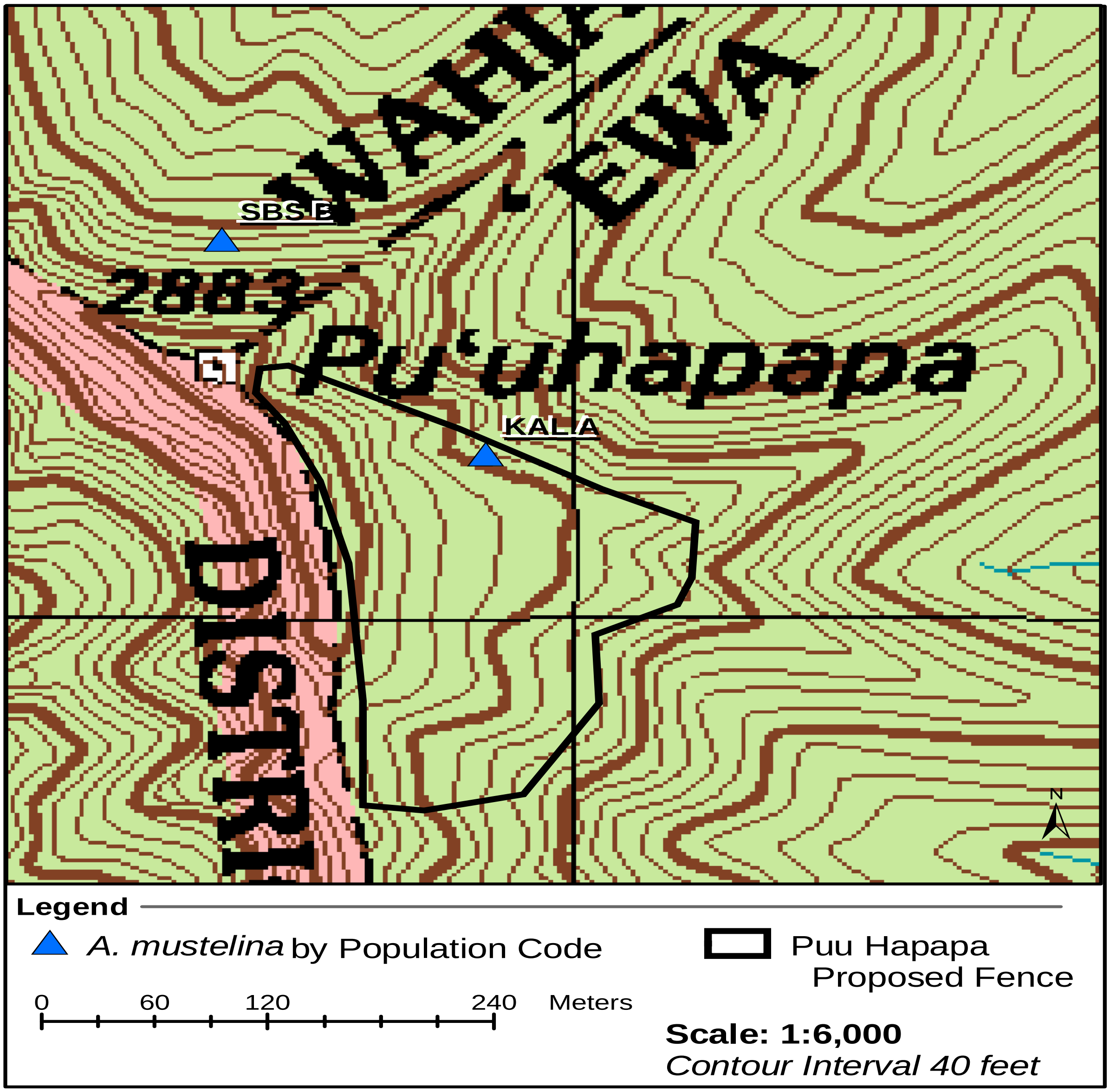
Table 5-7 Number of snail in ESU D1

Pop Ref Code	**No. Snails as of 8/04**	**Size Classes**			**Pigs/ Goats**	**Weeds**	**Rats**	***Euglandina***
		Lg	**Med**	**Sml**				
KAL-A Kalua`a and Wai`eli	481	158	237	86	X	X	X	X
SBS-B Pu'u Hāpapa	196	131	44	21	X	X	X	X
TOTAL	**677**	**289**	**281**	**107**				

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

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

Figure 5-9 ESU D1



5.5.g.4.f.1 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. TNC stocks 16 bait boxes each month and checks five snap traps near the core of the population. This year the Army funded a full-time field position to work on species covered in Army consultations located on Honouliuli Preserve. This staff person has been assisting with the rat baiting and ungulate control efforts at the Kalua`a and Wai`eli *A. mustelina* site. TNC applied for grant money to obtain fence materials to construct a fence to protect this site. NRS will assist TNC with this fencing effort. NRS will work with TNC staff to cooperatively maintain the rat bait stations and expand the rat-baiting grid if necessary.

5.5.g.4.f.2 Schofield Barracks South Range-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 using diphacinone bait atop Pu`u Hāpapa since 2000. This year a total of 172 bait blocks were administered in 8 stations. Rat control is also intended to protect two other species of native snails that are found amongst *A. mustelina*. These taxa are *Laminella sanguinea* and *Amastra micans*. On a recent survey to 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. Nonetheless, NRS would like to expand the fencing project planned for KAL-A to include as much of SBS-B as possible. Weed control is underway at Pu`u Hāpapa and should directly improve the quality of habitat for *A. mustelina* in the area.

5.5.g.4.g ESU-D2 Mākaha

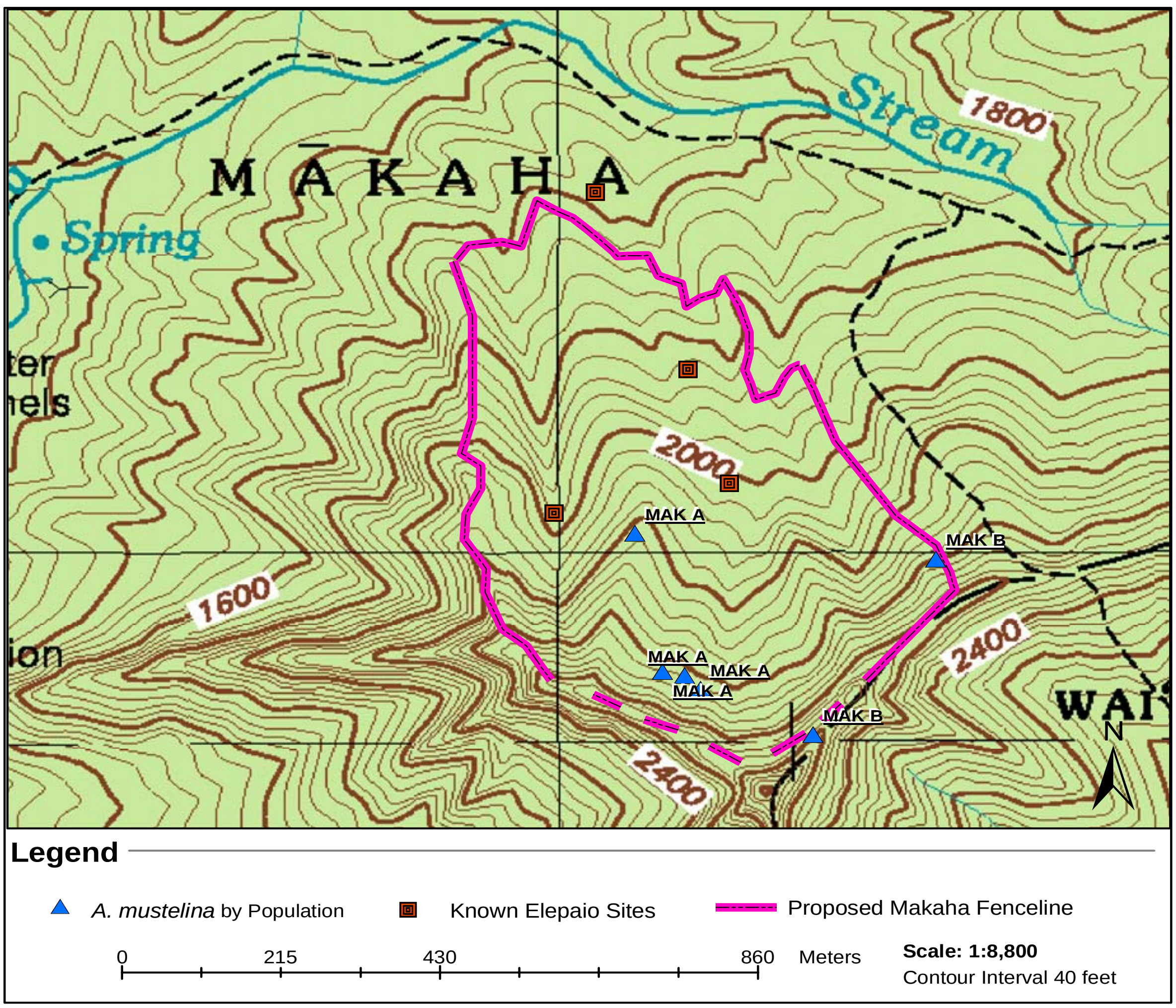
Table 5-8 Snail numbers for ESU D2

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

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

Management of ESU D2 has been limited thus far. Comprehensive surveys have yet to be conducted in Mākaha. In the lower elevation gulches within Mākaha (MAK-A), the native canopy is a mix of *Diospyros spp*., *Antidesma platyphyllum*, *Nestigis sandwicensis* and *Pisonia spp*. The forest canopy near the Kumaipo ridge crest (MAK-B) is dominated by *Acacia koa* and *Metrosideros polymorpha*. The numbers of snails at MAK-A is an old number and needs to be updated. The MAK-B number represents an incidental observation made along a portion of the proposed fence line near the Kumaipo ridge crest. NRS need to conduct methodical surveys to identify hot spots, look for evidence of predation and develop management plans. At this point, most of the staff time spent in Mākaha has been planning a large-scale fence project. MAK-A and MAK-B are both located within the proposed fence project. Ungulates are currently having a significant negative impact on the forest within Mākaha. NRS have determined the best fence route, flagged the line, determined where strategic fencing is necessary and put together supporting paperwork for the project. The fence will protect 100 acres of mesic forest, most of which is suitable habitat for *A. mustelina*. The fence construction has been funded this year and construction is expected to begin in late Fiscal year 2005. Extensive weed control is required in order to improve the condition of this forest area. The most abundant canopy weeds are *Psidium cattleianum* and *Schinus terebinthifolius*. The Board of Water Supply has yet to authorize the use of pesticides in Mākaha Valley but the issue is being considered. BWS conducts rat baiting between January and June, during the O`ahu `Elepaio nesting season. This rat control probably benefits the snails found within those `Elepaio territories, if there are any. *A. mustelina* from ESU-D2 are represented at the UH Tree Snail Laboratory.

Figure 5-10 ESU D2



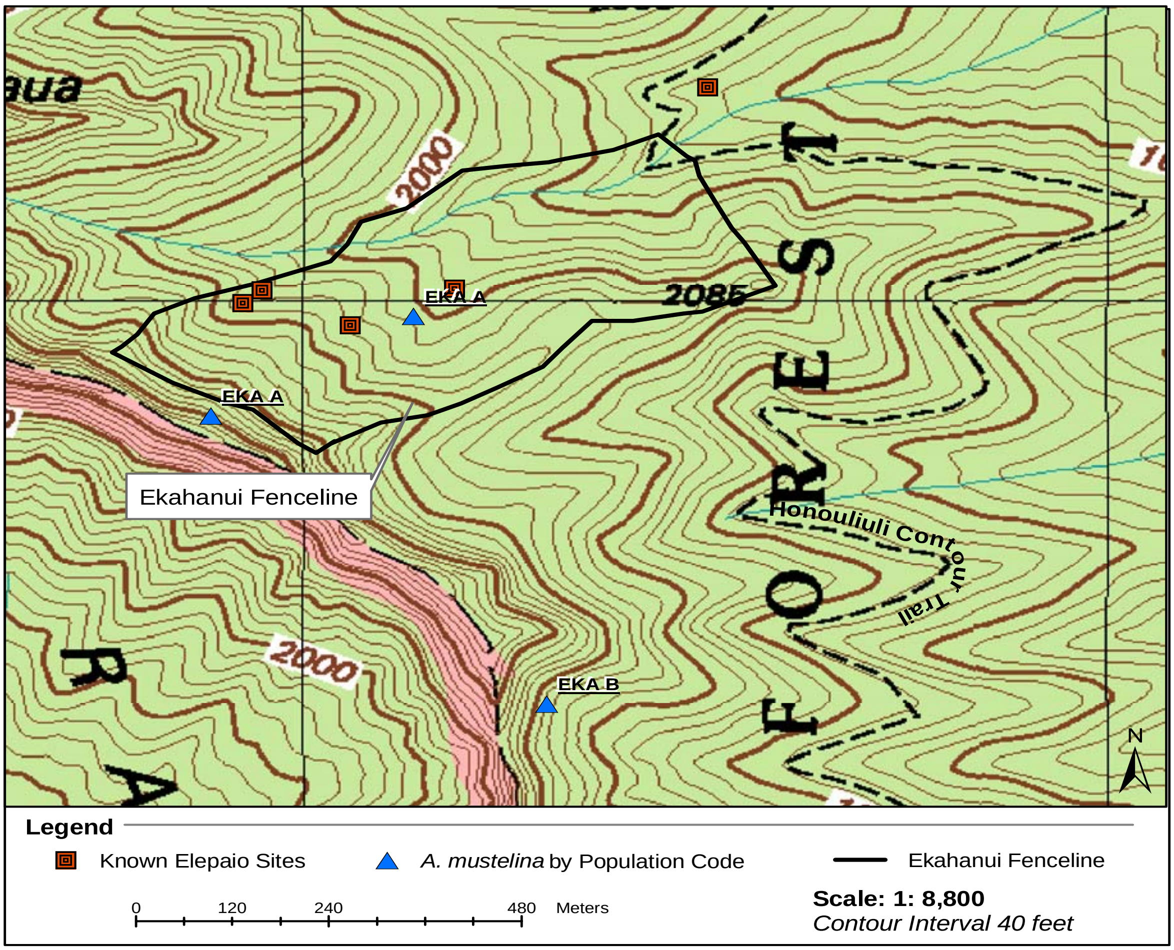
5.5.g.4.h ESU-E Pu`u Kaua/`Ēkahanui

Table 5-9 Number of snails in ESU E

Pop Ref Code	No. Snails as of	Size Classes			Pigs/ Goats	Weeds	Rats	*Euglandina*
	——	Lg	Med	Sml				
EKA-A (Pu`u Kaua)	51	51			X	X	X	X
EKA-B (Plapri site)	9	4	3	2	X	X	X	X
TOTAL	**60**	**55**	**3**	**2**				

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

Figure 5-11 ESU E



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

5.5.g.4.i ESU-F Pu`u Palikea

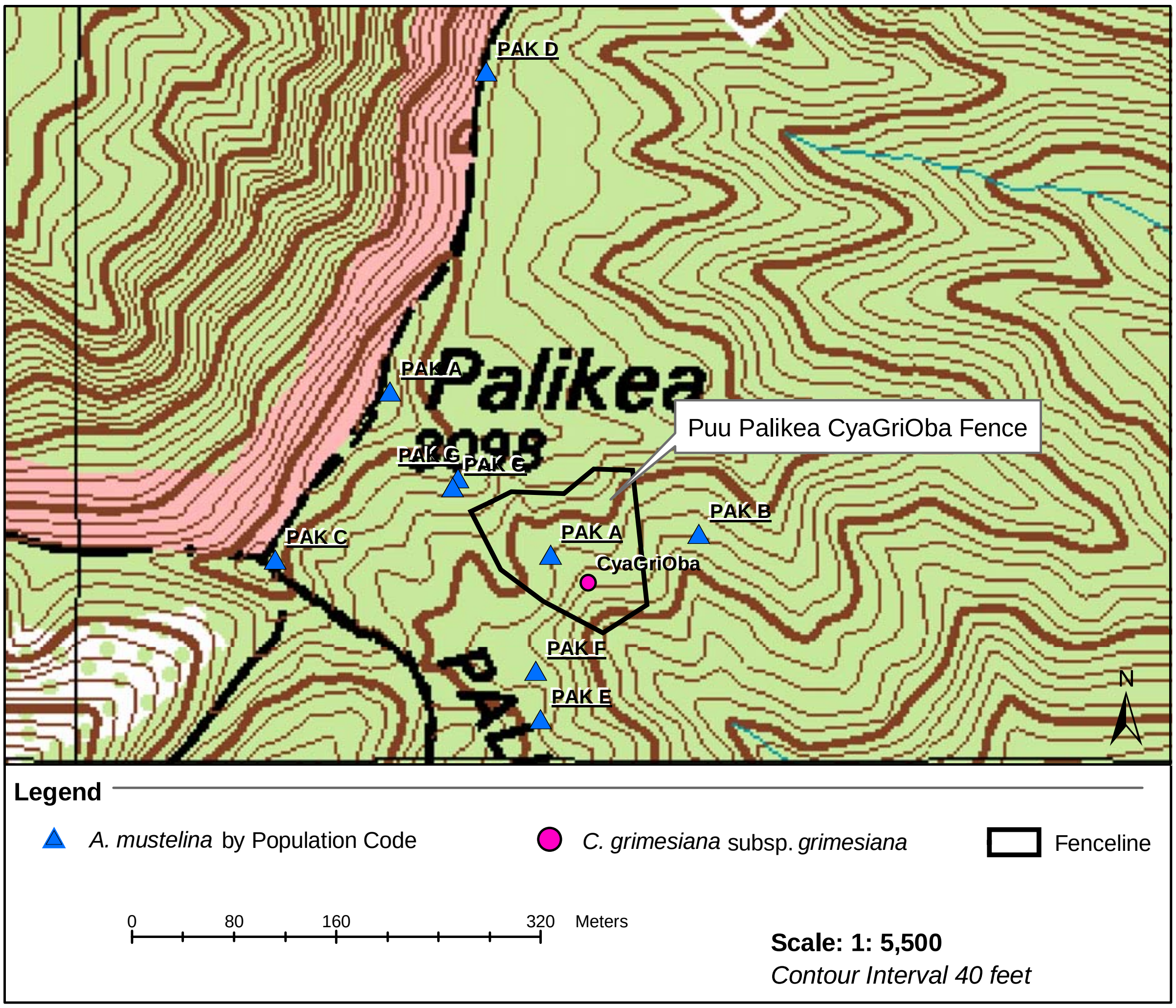
Table 5-10 Numbers of Snails in ESU F

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

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

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

Figure 5-12 ESU F



5.5.h *Achatinella pulcherima*

Achatinella pulcherima was reported from two sites I KLOA; in 1974 from the Helemano drainage vicinity, and in 1993 from the `Ōpae`ula drainage. NRS have been unable to locate it. The areas where it was reported from 1993 are actually inside the `Ōpae`ula fence exclosure. Snails have been found here but have been classified as *A. sowerbyana*. Annual surveys will continue to be conducted between the Pe`ahināi`a and Poamoho Trails to search for individuals of this species. It is likely that *A. pulcherima* may already be extinct because it was known from lower elevations, where land snails have historically been extirpated. No surveys were conducted this year.

5.5.i *Achatinella sowerbyana*

Presently, this species is the most widespread of all the Ko`olau *Achatinella*. Historically it was found throughout KLOA, but today is found mostly in the Ko`olau Summit region in the Pe`ahināi`a and Poamoho Trail areas. Next to *A. mustelina*, it is considered to be the most common *Achatinella* species on O`ahu.

NRS have flagged trees in the Pe`ahināi`a and Poamoho areas where these snails have been identified. Considering the poor state of Ko`olau *Achatinella* in general, *A. sowerbyana* is doing surprisingly well. Although *A. sowerbyana* is subject to all the same threats that other Ko`olau *Achatinella* species face, they continue to survive at lower elevations and in a diversity of microhabitats.

Biannual surveys will be conducted to look for signs of predation. Census counts will be continued annually. Three of the known sites are currently baited for rats: “Shaka,” “290” and “Poamoho”. An emergency predator control plan will be developed in case rat predation is found at other sites. NRS recommend that further genetic studies be done to help distinguish between the species and determine management strategies. The table below details information pertinent to these three sites.

Table 5-11 Snail Sites With Rat Bait Stations in the Ko`olaus

Site Name	# bait stations	# snap traps	% bait take 2002	% bait take 2003	% bait take 2004
"Shaka"	6	6	52	47	72
"290"	6	12	23	69	59
"Poamoho"	8	8	site not baited	set up on 8/19/03	93

Predator control was begun at Poamoho after a NRS survey of some of Dr. Hadfield’s old study sites along the summit. On 25 September 2000 Dr. Hadfield escorted NRS to sites in the vicinity of the Poamoho Cabin. NRS had not surveyed these areas before. At the site south of the Poamoho Trail monument, at 2,450 ft elevation, a total of 17 *A. sowerbyana* were found. Only six *A.* sowerbyana were found here in March 2003. At the site just north of the Poamoho Trail junction a total of 64 *A. sowerbyana* were counted. A total of 41 were counted on the March 2003 survey and most of these were found in areas that extended the boundaries of the previous survey area. In response to these survey results, NRS set up eight rat bait stations at the northern site on 19 August 2003.

The `Ōpae`ula Watershed Project constructed a fence exclosure in the Pe`ahināi`a/Summit area in 2001. During the October 2002 survey, a total of 14 *A. sowerbyana* were counted above the hypalon stream crossing area of the exclosure. A total of six *A. sowerbyana* have been identified while surveying for the Helemano Watershed Project. Because of the weather conditions, terrain and thick vegetation in the Ko`olaus, it is often difficult to find evidence of rat-eaten snail shells. It is easier to prove the presence of rats and then discuss how best to implement a predator control program. NRS have not set up predator control at these sites.

A. sowerbyana have been seen during the most recent trips to the upper Poamoho Trail region for weed control. A total of 23 snails were counted on the February 2002 trip and 104 were recorded in February 2003 along the Poamoho Trail.

There are 41 *A. sowerbyana* in the lab at UH.

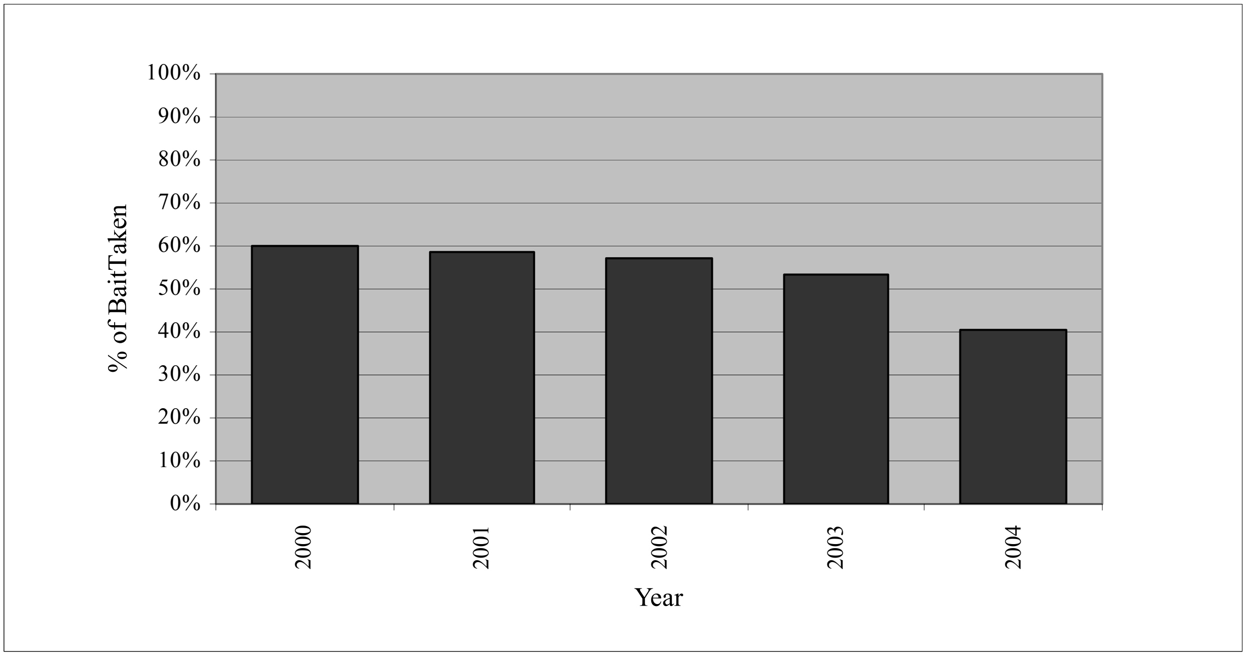
5.5.j *Amastra micans*

The amastrid land snails, a family of pulmonate gastropods endemic to the Hawaiian Islands, have been little investigated in recent years, and their biology is poorly known. Most biologists have largely ignored *Amastrids*, and this, along with their increasing rarity in the last few decades, has been responsible for their absence in the biological and conservation literature. Many shells of *Amastra* can be found in SBMR but it is very difficult to find any live specimens.

In SBS there are two areas of importance for *Amastrids*: the Pu`u Hāpapa area at 2500 ft. and the site below at 2300 ft. The upper area has eight rat bait stations and is considered too steep to fence. The lower area has six rat bait stations and was fenced in October 2003. NRS have concentrated weed control efforts to the area inside this exclosure. Long-range plans involve out-planting native plants and working to restore the habitat. So far, the fence has eliminated pig damage and demonstrated how fences can be important tools in protecting snail habitat. During the past three years no live *A. micans* have been observed although searching has not been extensive. NRS camped on Pu`u Hāpapa on 6-7 July 2004 and searched the area for *A. micans* but were unable to locate any in the vegetation or leaf litter.

Figure 5-13 below shows the four-year trend in diphacinone take from the eight bait stations on Pu`u Hāpapa.

Figure 5-13 SBS Pu`u Hāpapa Snail Population Rat Control 2000-2004

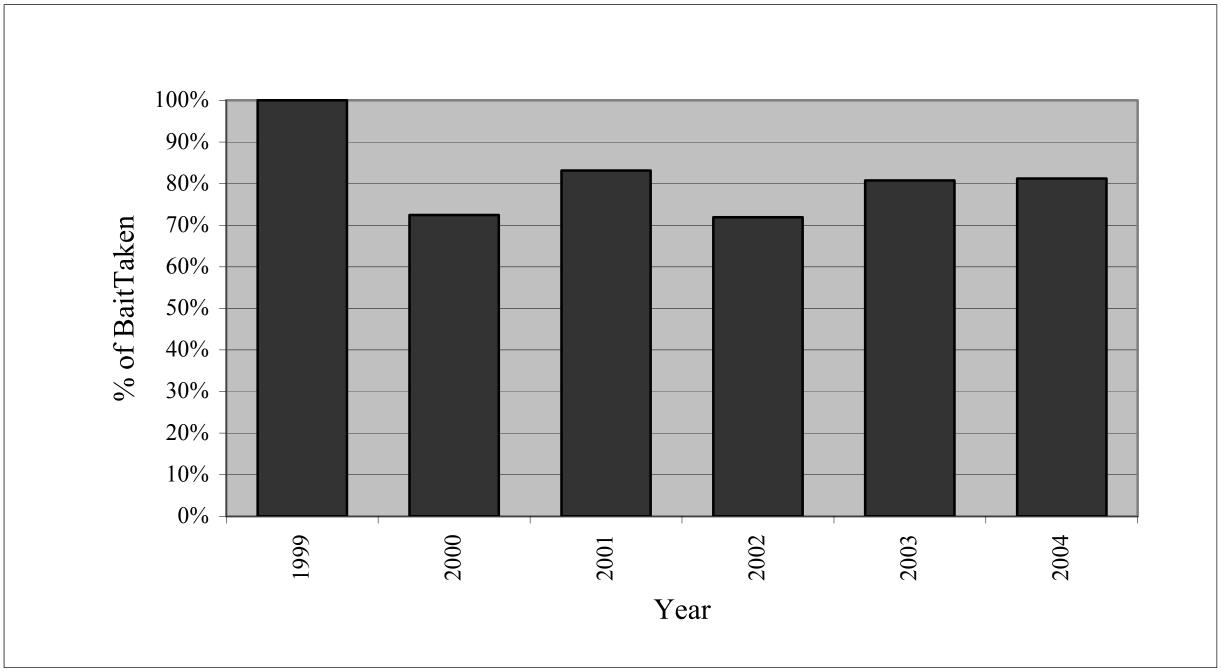


5.5.k *Laminella sanguinea*

L. sanguinea has also been found at the *A. micans* sites in SBS mentioned above. On 15 May 2003 a total of three *L. sanguinea* were counted in an area near the rat bait stations on Pu`u Hāpapa where they had never been seen before. In October 2002 a total of seven *L. sanguinea* were counted. On 31 July 2002 NRS visited the area with two staff from The Nature Conservancy of Hawai`i (TNCH). Pu`u Hāpapa forms the boundary between Army land to the north and Honouliuli Preserve (TNCH) to the south. On this day a total of five *L. sanguinea* were again seen here. The two agencies share similar natural resources as well as management challenges and often collaborate to solve problems together. There are proposals to work together on future fence projects in this area that would help to exclude pigs from rare snail habitat.

NRS camped on Pu`u Hāpapa 6-7 July 2004 and surveyed for snails. A total of 23 *L. sanguinea* were counted and all of these were found within the rat bait station grid. Figure 5-14 details the percent of rat bait take over the past five years in SBS.

Figure 5-14 SBS `Ie`ie Patch Snail Population Rat Control 1999-2004



5.6 Rare Snail Management Recommendations

The recent history of the native Hawaiian land snails shows that they are literally struggling for their existence and losing battles daily to the many threats opposing them. NRS will continue the following management:

- Marking and recapturing snails and collecting data to assist in management.
- Maintaining the Kahanahāiki snail enclosure as an area where native snails can live in a healthy environment free from the threats of rats and predatory snails and outplant native trees into the exclosure.
- Continuing to research and improve snail exclosure technology.
- Searching in areas of historic snail habitat with the expectation that if any critically rare snail is found, it will be given to the UH Snail Laboratory for captive rearing.
- Controlling predators while monitoring effectiveness.
- Supporting the licensing of a more effective tool to improve rat control in remote areas, such as aerial broadcast.
- Working with other agencies to develop long-range snail management strategies.

5.7 Rare Snail Monitoring and Management Schedule

This schedule is made to help NRS plan the continued searches for rare snails and the monitoring of known sites. Management actions to control threats will be determined as data is collected and analyzed. For some of these snails there are no known populations in the wild. For these snails an 'X' will identify the quarter in which NRS will plan to search for this species. For species having known populations, an 'X' next to the species will designate in which quarter new areas will be searched for more populations.

Table 5-12 Recommended Action Time Table

Range	MU	Action	Q4	Q1	Q2	Q3
MMR	Kahanahāiki	Achmus mark/recapture			X	
MMR	Kahanahāiki	Monitor Achmus site/check salt/caulk/check current and voltage	X	X	X	X
MMR	Kahanahāiki	Achmus rat control (bimonthly)	X	X	X	X
MMR	Kahanahāiki	Outplant Nessan		X		
KLOA	KLOA	*Achatinella apexfulva* search		X		
KLOA	KLOA	*Achatinella byronii* search				X
KLOA	KLOA	*Achatinella curta* search (Kawailoa Trail)	X			
KLOA	KLOA	*Achatinella leucorraphe* search			X	
KLOA	KLOA	*Achatinella lila* search	X		X	
KLOA	KLOA	*Achatinella livida* search		X		X
KLOA	KLOA	*Achatinella pulcherima* search		X		
KLOA	KLOA	*Achatinella sowerbyana* search		X		X
KLOA	KLOA	Achlil bimonthly rat control (Pe`ahināi`a LZ and "Poamoho")	X	X	X	X
KLOA	KLOA	Achliv mark/recapture		X		X
KLOA	KLOA	Achliv bimonthly rat control("Northern," "Crispa" and "Radio")	X	X	X	X
KLOA	KLOA	Achsow bimonthly rat control ("Shaka" and "290")	X	X	X	X
KLOA	KLOA	Monitor known Achbyr sites				X
KLOA	KLOA	Achbyr survey for *E. rosea* or rat predation		X		X
KLOA	KLOA	Monitor known Achliv sites		X		X
KLOA	KLOA	Monitor known Achsow sites		X		X
MMR	`Ōhikilolo	Achmus bimonthly rat control (Kahanahaiki snail enclosure and Pteralyxia Gulch)	X	X	X	X
MMR	`Ōhikilolo	Monitor known Achmus sites	X	X	X	X
MMR	`Ōhikilolo	Outplant Myrles		X		
SBMR	SBS	Amamic & Lamsan bimonthly rat control	X	X	X	X
SBMR	SBS	Monitor Amamic & Lamsan sites		X		X
SBMR	SBS	Construct Amamic fence		X		
SBMR	SBW	Survey for Amamic and Lamsan		X		X
		Develop monitoring techniques	X	X	X	X
	General	Evaluate predator control efficiency at all sites and respond accordingly	X		X	
	General	Snail Working Group meeting	X	X	X	X
	General	Toxicant Working Group		X		
		Elecoq support control efforts	X	X	X	X
		Meet to discuss site options for Megxan	X			

Range	MU	Action	Q4	Q1	Q2	Q3
		translocation				
		Tripler Damselfly monitoring		X		X
	Offsite	Land of 10,000 snails – bait, coordinate with TNC	X	X	X	X
	Offsite	Ekahanui survey – set up rat bait	X	X	X	X
		East Makaleha	X	X	X	X
		Manuwai survey			X	

5.8 Rare Damselfly Management

NRS have been searching for a suitable stream for a translocation of the native Orange-black damselflies (*Megalagrion xanthomelas*) from Tripler Army Medical Center (TAMC). Most streams on O`ahu contain alien fish that would negatively impact the damselflies, making it difficult to find appropriate habitat for such a project.

The USFWS received grant funding to continue monitoring the TAMC site and are working in conjunction with the Bishop Museum to locate another site for a translocation. The South Fork of Kaukonahua Stream above the Canon Dam was surveyed in September 2002 by Bishop Museum staff, USFWS, and NRS to see if it is free of alien fish and crayfish. It did not prove to be a suitable habitat for *Megalagrion xanthomelas* because Chinese catfish were found above the dam. The USFWS and the Bishop Museum staff continue to monitor the TAMC site and the population appears to be stable. In July 2004 Bishop Museum staff translocated *Megalagrion xanthomelas* adults and niads into Makiki Stream in Honolulu. NRS will coordinate with the Bishop Museum staff and follow-up on this translocation.

5.9 *Eleutherodactylus coquí* Management

This taxon is discussed in this section because it potentially threatens native invertebrates.

In April 2001, NRS was alerted to the presence of *E. coquí* on SBE. Both the U. S. Fish and Wildlife Service and DOA had become aware of the infestation in a residential area of Wahiawā. While following up on the reports, personnel noted that the frogs had crossed the fence onto military property in SBE. NRS then became involved in coquí control. Coquí feed in leaf litter in the daytime, and at night males crawl up into trees to perform mating calls. Mating season is in the summer, and hence, summer is the best time to conduct control. Female coquí may be able to store sperm for as long as six months.

In 2002, FWS hired an Invasive Species Technician to facilitate and perform coquí control on O`ahu, OISC designated the coquí frog as one of its primary targets, and researchers found that 16% citric acid effectively kills coquí upon contact. Armed with a new management tool and increased support, FWS, DOA, OISC, and NRS pooled resources to attack the infestation. FWS mapped the extent of the infestation: the population includes a gulch which stretches between SBE and private homeowners' backyards, houses bordering SBE, and a flat strip of land on SBE next to these houses. A management plan was developed involving monitoring trips and large citric acid spray operations. The purpose of the monitoring trips was to hand capture frogs, spray frogs with backpack sprayers, census the frog population by observing numbers of calls, and track success of large spray efforts. NRS assisted with one monitoring trip in 9/2003. NRS primarily assisted with the large spray efforts and vegetation clearing done to facilitate the spray efforts. Large spray efforts occurred in 9/2003, 6/2004, and 7/2004.

Efforts have been relatively successful; however the coquí population is persistent, and the concerned agencies committed to spraying the entire infested area at least twice this year. NRS expect the same level of commitment next summer.

Attachment 1: Captive Snail Propagation Data

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

Species	# *juv*	# *sub*	# *adult*	# Individuals
A. apexfulva	*3*	*7*	*1*	**11**
A. decipiens	*6*	*17*	*7*	**30**
A. fucsobasis	*165*	*60*	*112*	**362**
A. lila	*113*	*101*	*5*	**218**
A. livida	*35*	*31*	*6*	**72**
A. sowerbyana	*12*	*23*	*12*	**47**

Number of snails as of April, 2004

Attachment 2: Assessment of Genetic Variation among Populations of *Achatinella mustelina*: Results of DNA Sequence Analyses and Implications for Management Prioritization. By Brendan Holland and Michael G. Hadfield

In order to investigate intra-specific genetic divergence among populations of *Achatinella mustelina* in the Wai`anae Mountains, we selected a relatively rapidly evolving target gene from the mitochondrial genome: cytochrome oxidase subunit I (COI). At this time, we have generated a data set for *A. mustelina* consisting of DNA sequences of 680 basepairs each, from three individuals, from each of 16 different Wai`anae Range populations. Tissue samples were obtained using a laboratory tested, non-lethal technique. During the course of this study, we found that the COI gene is ideally suited to the objectives of this project, and the resulting data set has proven highly informative. Results of DNA analysis show a high degree of interpopulation genetic structure. The pattern of genetic variation is strongly correlated with regional geographic features. The primary breaks in genetic variation occur across valleys and mountain summits. Genetic variation remains extremely low along relatively long geographic distances following ridge crests.

Data summary:

- Overall within-population mean genetic distance = **0.006 (*i.e.*,. 0.6%)**
- For 2 of 16 populations (12.5%), all three individuals characterized were genetically identical (100% sequence identity).
- For 3 of 16 populations (19%: 10, 11, and 12), or 3 individuals of the 48 characterized (0.6%), genetic divergence was relatively high, 1.2-3.0%. In each case the mean value was drastically increased by a single anomalous individual sequence, an indication of a relatively recent migration event. These three populations account for about half of the overall within population mean genetic distance. An alternative interpretation is that 19% of populations show evidence of interpopulation migration.

There is a strong geographic component to the overall pattern of genetic variation. Several unique haplotypes were identified, and several historical migratory events were detected. Reproductive barriers in the form of geographic features, principally valleys and the 1220 m peak of Mt. Kaala, rather than strict geographic distances, are correlated with the highest genetic distance values observed. The data reveal numerous instances where low genetic distances (*i.e.*, great genetic similarity), values at or below the mean within-population value, persist over relatively long geographic distances following ridge crests in roughly linear patterns (*e.g.*, Figure 1, ESU-F). There are two alternative interpretations of the observed geographic pattern of DNA sequence variation. One possible explanation is that observed genetic similarity along ridge crests indicates geologically recent dispersal and colonization events along these features. A more likely explanation is that the patterns of genetic similarity indicate that the distribution of forest coverage (tree-snail habitat) along ridge crests was previously continuous, allowing panmixia via tree-to-tree migration and gene flow, despite current fragmentation of suitable tree snail habitat.

Table 2.3 Pairwise Genetic Distance Matrix This table shows mean inter and intrapopulation molecular sequence divergence values and standard errors (SE) for 69 specimens from 18 populations of *Achatinella mustelina* sampled in the Wai`anae Mountains of O`ahu . Within population mean distances are underlined, shown along diagonal. Mean among population distances are below diagonal. SE values (above diagonal) were computed using the bootstrap method with 500 replicates and a random number seed. Values were determined based on partial COI sequences using a Kimura 2-parameter substitution model (Kumar *et al*. 2001). Populations comprising the eight distance-based ESUs are as follows: ESU A = 1 - 3; ESU B = 4 - 7; ESU C = 8; ESU D = 9; ESU E = 10; ESU F = 11 - 16; ESU G = 17; and ESU H = 18. Note that populations are arranged in roughly north-south, west-east fashion, from 1-18 (Fig. 1).

	ESU A			ESU B				ESU C	ESU D	ESU E	ESU F						ESU G	ESU H
Pop	1	2	3	**4**	**5**	**6**	**7**	8	**9**	10	**11**	**12**	**13**	**14**	**15**	**16**	17	**18**
1	**0.000**	0.001	0.000	0.004	0.004	0.004	0.004	0.004	0.006	0.005	0.008	0.008	0.008	0.008	0.008	0.008	0.006	0.008
2	0.001	**0.005**	0.001	0.004	0.004	0.004	0.004	0.004	0.006	0.005	0.008	0.008	0.008	0.007	0.008	0.007	0.006	0.008
3	0.000	0.001	**0.005**	0.004	0.004	0.003	0.004	0.004	0.006	0.005	0.008	0.008	0.008	0.007	0.008	0.007	0.006	0.007
4	0.011	0.011	0.010	**0.006**	0.001	0.001	0.002	0.005	0.007	0.005	0.008	0.008	0.008	0.008	0.008	0.008	0.007	0.008
5	0.013	0.013	0.011	0.001	**0.003**	0.000	0.002	0.005	0.006	0.005	0.008	0.008	0.008	0.008	0.008	0.007	0.007	0.007
6	0.010	0.011	0.009	0.000	0.001	**0.005**	0.001	0.005	0.007	0.005	0.008	0.008	0.008	0.008	0.008	0.008	0.007	0.008
7	0.014	0.015	0.013	0.003	0.004	0.001	**0.002**	0.005	0.007	0.006	0.009	0.009	0.009	0.008	0.009	0.008	0.008	0.008
8	0.020	0.021	0.018	0.021	0.019	0.021	0.024	**0.019**	0.000	0.000	0.006	0.005	0.006	0.005	0.005	0.005	0.005	0.006
9	0.027	0.027	0.026	0.028	0.025	0.028	0.032	0.000	**0.008**	0.001	0.006	0.006	0.006	0.006	0.006	0.006	0.005	0.006
10	0.022	0.022	0.020	0.021	0.018	0.021	0.025	0.000	0.001	**0.013**	0.006	0.006	0.006	0.006	0.006	0.005	0.005	0.006
11	0.041	0.040	0.039	0.039	0.037	0.039	0.043	0.024	0.025	0.024	**0.002**	0.001	0.002	0.003	0.003	0.003	0.006	0.007
12	0.039	0.038	0.037	0.038	0.035	0.037	0.042	0.022	0.023	0.023	0.002	**0.004**	0.000	0.002	0.003	0.002	0.005	0.007
13	0.040	0.040	0.038	0.039	0.036	0.039	0.043	0.024	0.025	0.025	0.003	0.000	**0.000**	0.002	0.002	0.002	0.006	0.007
14	0.039	0.039	0.037	0.039	0.035	0.037	0.040	0.023	0.025	0.024	0.008	0.006	0.005	**0.005**	0.002	0.001	0.005	0.007
15	0.041	0.040	0.039	0.040	0.037	0.040	0.044	0.023	0.025	0.025	0.008	0.005	0.004	0.003	**0.002**	0.001	0.006	0.007
16	0.039	0.038	0.037	0.038	0.034	0.037	0.041	0.021	0.024	0.023	0.007	0.004	0.004	0.001	0.002	**0.007**	0.005	0.007
17	0.030	0.029	0.029	0.030	0.028	0.031	0.035	0.018	0.016	0.019	0.024	0.021	0.023	0.021	0.024	0.021	**0.000**	0.004
18	0.039	0.039	0.037	0.040	0.037	0.040	0.044	0.026	0.025	0.026	0.032	0.031	0.032	0.030	0.033	0.031	0.015	**0.001**

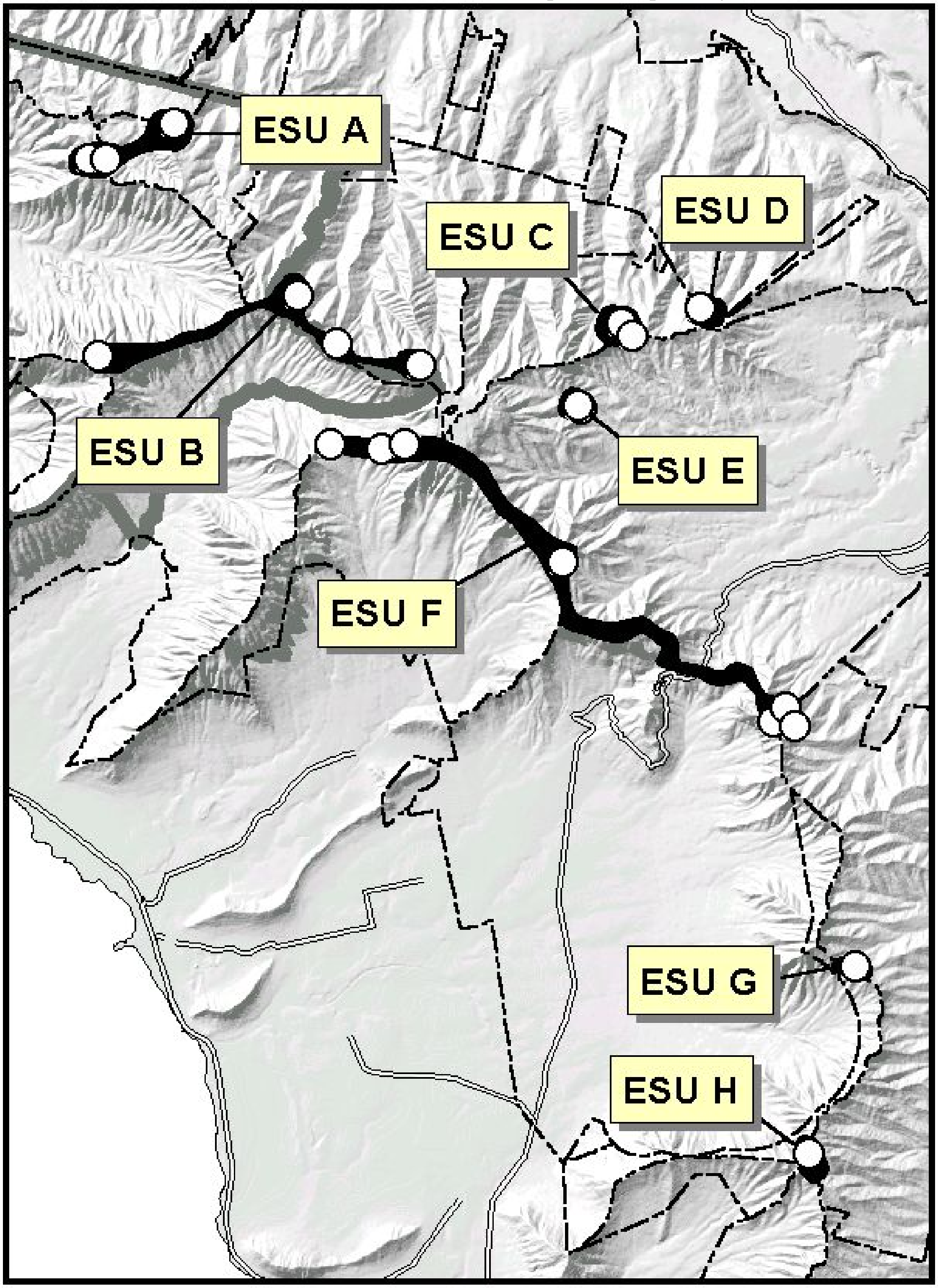
Conservation and Management Implications of Findings

A. mustelina is widely and patchily distributed throughout the upper elevations of the Wai`anae Mountain Range of the island of O`ahu . In order to utilize available financial resources in the most effective way possible, genetic data were used to construct guidelines by which the maximum amount of genetic diversity might be preserved. By designation of genetically similar populations as ESUs, it is possible to divide extant tree snail populations into genetically similar ESUs, and to focus management efforts on those biological entities or groupings that are thought to be evolving independently of one another. We felt that the most appropriate genetic threshold upon which to base the designation of ESUs approximates the empirically determined mean intrapopulation genetic divergence, or an uncorrected pairwise average value of 1.0% or less (average intrapopulation genetic divergence was 0.006 or 0.6%).

When this level is applied, all populations sampled in this study collapse into 8 ESUs as indicated in Figure 1. All populations sampled from within each ESU depicted were at or within the 1% genetic distance threshold (note: the highest within-ESU genetic distance was that between populations 9a and 17 at the extreme ends of ESU-F: 0.010 or 1%). It is assumed that populations within each ESU which were not sampled also fall within the 1% genetic divergence threshold.

Historically there has been some controversy surrounding the taxonomic status of *A. mustelina.* Welch's (1938) attempt to subdivide the species into 26 subspecies based on shell characters and distribution data was never widely accepted by the scientific community, and the genetic data presented here also provide little support to most of Welch's separations. Although a precise molecular clock has yet to be applied to the Hawai`ian tree snails (Achatinellinae), genetic divergence values at the higher end of the range indicate reproductive isolation periods approaching hundreds of thousands of years. At the very least, the data strongly indicate that presently isolated populations are evolving independently of one another, and that we may be witnessing evidence of incipient speciation. From a conservation biology perspective, this notion strengthens the justification for maximizing preservation of observed genetic diversity in *A. mustelina* populations sampled during this investigation.

Figure 1. Grouping of 18 *A. mustelina* sampling sites into 8 ESU's. ESU's A through H show the relative positions of each in the Wai`anae Mountains of western O`ahu . 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.



Attachment 3

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Islands within an island: phylogeography and conservation genetics of the endangered Hawai`ian tree snail *Achatinella mustelina*

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Abstract

Mitochondrial DNA (mtDNA) sequences were used to evaluate phylogeographic structure within and among populations of three endangered Hawai`ian tree snail species (*n* = 86). The primary focus of this investigation was on setting conservation priorities for *Achatinella mustelina*. Limited data sets for two additional endangered Hawai`ian tree snails, *A. livida* and *A. sowerbyana,* were also developed for comparative purposes. Pairwise genetic distance matrices and phylogenetic trees were generated, and an analysis of molecular variance was performed on 675-base pair cytochrome oxidase I gene sequences from multiple populations of Hawai`ian tree snails. Sequence data were analysed under distance-based maximum-likelihood, and maximum-parsimony optimality criteria. Within the focal species, *A. mustelina*, numbers of variable and parsimony informative sites were 90 and 69, respectively. Pairwise intraspecific mtDNA sequence divergence ranged from 0 to 5.3% in *A. mustelina*, from 0 to 1.0% in *A. livida* and from 0 to 1.9% in *A. sowerbyana*. For *A. mustelina*, population genetic structure and mountain topography were strongly correlated. Maximum genetic distances were observed across deep, largely deforested valleys, and steep mountain peaks, independent of geographical distance. However, in certain areas where forest cover is presently fragmented, little mtDNA sequence divergence exists despite large geographical scales (8 km). Genetic data were used to define evolutionarily significant units for conservation purposes including decisions regarding placement of predator exclusion fences, captive propagation, re-introduction and translocation.

Introduction

The Hawai`ian Islands contain the most isolated terrestrial ecosystems on Earth. The nearest landmasses to Hawai`i are North America, >4300 km away, and Japan >6400 km away (Coles et al. 1999). The combined evolutionary effects of geographical isolation and habitat diversity have resulted in unparalleled levels of endemism of Hawai`ian biota. It is estimated that 95% of the native terrestrial Hawai`ian flora and fauna are endemic (Carlquist 1970). Among native Hawai`ian land snails, more than 750 valid species are recognized, 99% of which are endemic (Cowie et al. 1995).

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The endemic Hawai`ian land snail fauna is considered by some researchers to be the most remarkable in the world (e.g. Zimmerman 1948).

Among the most distinctive and diverse elements of the Hawai`ian land snail fauna are the species within the endemic subfamily Achatinellinae (Pulmonata, family Achatinellideae). The shells of these tree dwelling snails exhibit a diverse array of color and banding patterns that have fascinated and confounded scientists and shell collectors for over a century (Gulick 1873; Zimmerman 1948; Cooke & Kondo 1960). Hawai`ian tree snails exist in relatively small, fragmented populations and have limited vagility. They are therefore particularly attractive for studies of population structure and speciation, and played a significant role in the early development of evolutionary thought (Gulick

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Appendix 1-A Ungulate Transect Data Sheet

DPW Environmental Ungulate
Transect Data Sheet

Transect:__________ Date:_____________

Range:____________ Observer:____________

Location:____ Weather:____________

____

____

Pigs							Goats							
Meters	F. trail	F. feed	F. scat	O. trail	O. feed	O. scat	Meters	F. trail	F. feed	F. scat	O. trail	O. feed	O. scat	Comments/ species disturbed/wallow/nests
10							10							
20							20							
30							30							
40							40							
50							50							
60							60							
70							70							
80							80							
90							90							
100							100							
110							110							
120							120							
130							130							
140							140							
150							150							
160							160							
170							170							
180							180							
190							190							
200							200							
210							210							
220							220							
230							230							
240							240							
250							250							
260							260							
270							270							

280							280							
290							290							
300							300							
310							310							
320							320							
330							330							
340							340							
350							350							
360							360							
370							370							
380							380							
390							390							
400							400							
410							410							
420							420							
430							430							
440							440							
450							450							
460							460							
470							470							
480							480							
490							490							
500							500							

________ Total stations with fresh sign
________ Total stations with old sign
________ Total stations

________ Total stations with fresh sign
________ Total stations with old sign
________ Total stations

Appendix 1-B Ungulate Transects: Makua Military Reservation

Appendix 1-C Ungulate Transects: Schofield Barracks West Range

Appendix 1-D Ungulate Transects: Kawailoa

Appendix 1-E Ungulate Transects: Schofield Barracks East Range

Appendix 1-G DPW Environmental Snare Report Form

Date________

Range:______________

Location:____

____

Flagging Scheme:____

Total # snares_____ # knockdowns______

Schematic Map

Catch Report

Number	Sex	Age	Weight	Location

Appendix 2-A Weed Plot Methodology and Data Sheets

Weed Plot Methodologies

Introduction:

Different weed control efforts and purposes require different monitoring plot methodologies. NRS typically use one of four different types of monitoring plots. These are: long-term change plots, weed control test plots, Weedy tree control tests, and qualitative change plots.

Goal:

Long-term change plots: To gauge the effectiveness of weed control efforts by tracking vegetation change over time.

Weed control test plots: To gauge the effectiveness of a particular control technique on a target weed species, and observe any non-target effects. This method is most useful for non-tree species.

Weedy tree control tests: To gauge the effectiveness of a particular control technique on a target weedy tree species, and observe any non-target effects.

Qualitative change plots: To gauge the effectiveness of a particular control technique on a target weed species on a broad scale.

Supplies/Equipment:
- PVC stakes
- Measuring tape
- Flagging, various colors
- Orange spray paint or orange flagging for stakes
- 1 m squared quadrat
- Forms
- Sledge/hatchet to hammer in stakes
- Weed control tools/herbicide

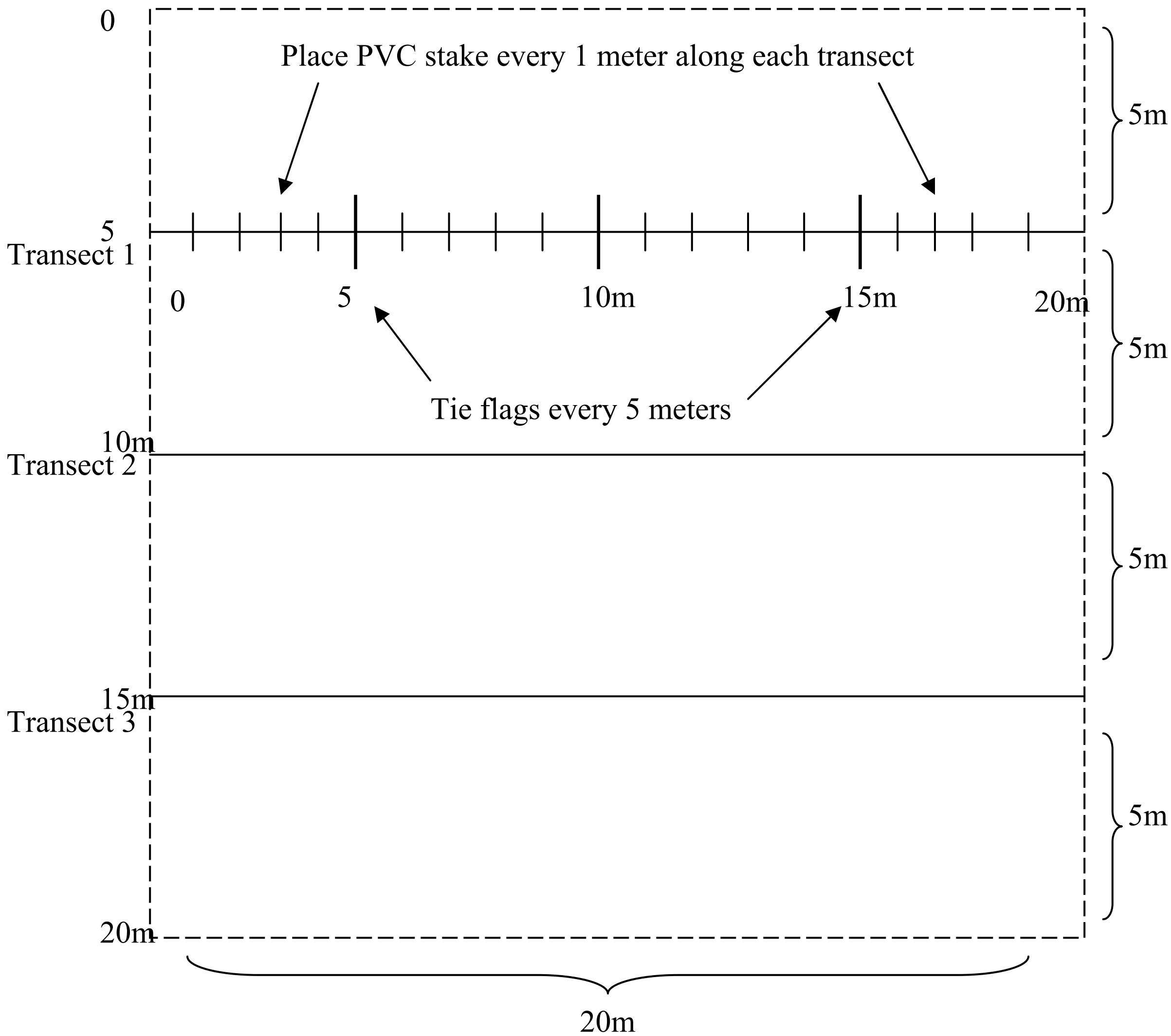
Methodology:

Long-term change plots:

Designate two areas with similar vegetation/aspect/characteristics that are 20x20m. One area will be used as a control plot and the second as a treatment plot. There will be three vegetation monitoring transects in each 20x20 meter area. These transects will be used for canopy surveys and understory surveys. Set up and re-read both plots at the same time as frequently as necessary (less damage is done if reads are conducted infrequently).

Transect design:

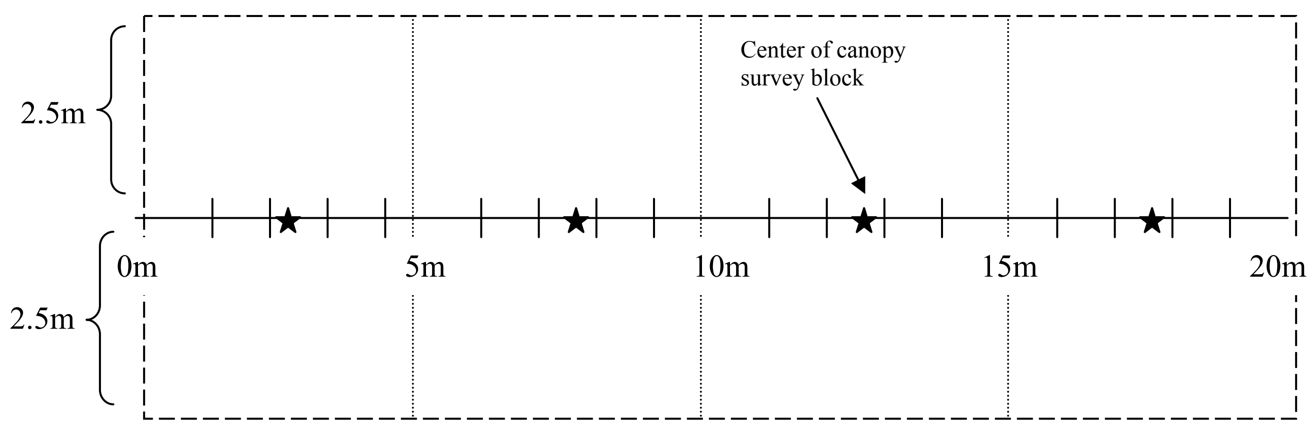
Lay transects out so that they run parallel to each other throughout the 20m survey area. Start points (0m) for each transect are spaced 5 meters apart. Each transect is 20 meters long. Place PVC stakes every meter along the entire transect (note: stakes should be placed so that the 1x1m quadrat fits snugly between stakes. Tie a flag at the 0m, 10m, 15m, and 20m stakes. Schematic of weed plot is as follows:



Each long-term change plot consists of three parts: Canopy Cover Estimates, Understory Survey, and Seedling Count. The forms for these three measures are attached at the end of this appendix; they are the Canopy Survey form, the Ground Survey/Control Test Plot form, and the Seedling Count form.

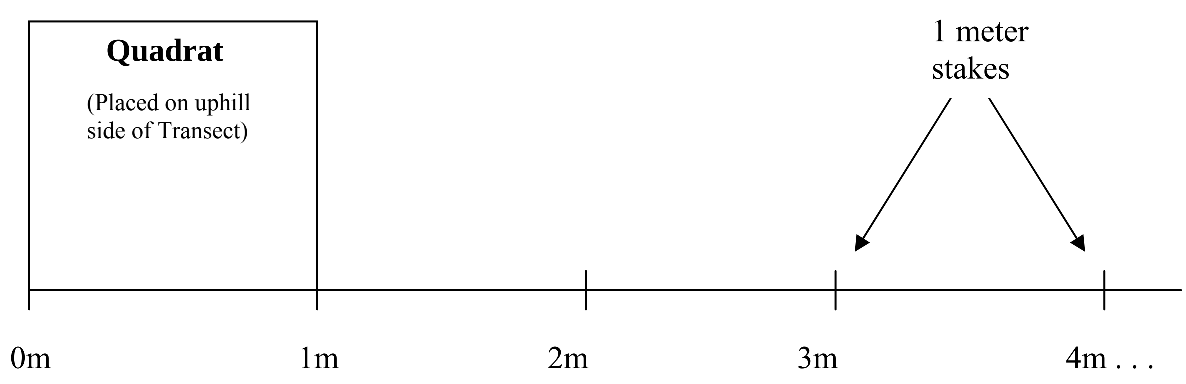
Canopy Cover Estimates

This measure looks at changes in canopy composition over time. Canopy survey blocks are spaced every 5 meters along each of the 20 meter transects and are 5x5m in area (5 meters along transect by 2.5 meters along either side of transect). Each transect has 4 canopy survey stations (4x5m = 20m). In each block, stand on the transect in the center of the block, and estimate canopy coverage using a 10% incremental scale for each species greater than 1 meter in height. Also obtain estimates for total native canopy cover, total non-native canopy cover, and total combined cover. Note that at one particular station, more than 1 species may have 100% (or any other arbitrary amount) canopy coverage, since each plant can occupy a different vertical space. Thus, if the forest structure included *Acacia koa* at 10m in height, *Metrosideros polymorpha* at 6m, and *Cibotium glaucum* at 3m, and each of these species provided dense cover, then each would have 100% canopy coverage. The total cover estimates are not necessarily the sum of all the individual species covers, but are separate observations recorded by looking at a set – native plants, or non-native plants, or all species of plants. Plot design is as follows: (note that the diagram below is a subset of the long-term change plot diagram)



Understory Survey

This measure looks at changes in the composition of herbaceous plants. Understory surveys are done in 1x1m plots along each of the 20m transects. All understory estimates are made on the uphill side of the transects. Place 1x1m quadrat so that it fits snugly between the 1 meter stakes. This ensures consistent placement of the quadrat. Estimate coverage for all species less than 1 meter in height whether they are rooted in the plot or not. Estimate total native, total non-native, and combined total cover for each plot. All estimates are done using 10% incremental scale. As described above in the Canopy Cover Estimates section, the total cover estimates are not necessarily the sums of each individual species cover, and in one quadrat, more than one species may have 100% coverage. Plot design is as follows: (note that the diagram below is a subset of the long-term change plot diagram)



Seedling Count

This measure looks at changes in woody seedling recruitment over time. Refer to above schematic for 1x1 meter plot design. In each 1x1m plot, obtain a count by size class for all woody species rooted in the plot that are less than 1 meter in height. Size classes for woody species are: 1 = <10cm, 2 = 10-25cm, 3 = 25cm-1m.

Weed control test plots

Designate an area containing both the weed species being targeted for control and non-target species (both weedy and native) that could potentially be impacted by treatment. Lay out a transect, marking it every 1 meter with PVC stakes. The length of the transect may be dependent on suitable area available, but should range between 5 and 10 meters. Distinguish the 0m stake from the end stake with flagging or paint. All estimates are made on the uphill side of the stakes. Starting at the 0m stake, place the quadrat between the first two stakes. To ensure consistent placement of the quadrat, fit it snugly between the stakes. Estimate coverage for all species in the plot less than 1 meter in height, whether rooted in the plot or not. Estimate total native, total non-native, and combined total cover for each plot. All estimates are done using a 10% incremental scale. Again, cover estimates do not necessarily sum to 100%, as described in the Long-term change plot methodology. Weed control test plots use the Ground Survey/Control Test Plot form. This methodology is the same as the Understory Survey component in the long-term ecological change methodology (see Understory Survey schematic). However, since the purpose of the plot is to gauge the efficiency of new control treatments, not monitor long-term change, these plots are categorized separately. The transect should be read prior to treatment, and at periodic intervals after treatment.

Weedy tree control tests

Identify an area containing the tree weed species being targeted for control. Since large amounts of the canopy may be opened during control tests, this area should be degraded or low-value forest. If one treatment method is being tested, mark 20 trees with orange flagging. If more than one treatment method is being tested, designate sets of 20 trees, marking each with a different color of flagging. Create a map of test-tree placement for easy relocation. Perform control. Visit test area at regular intervals to determine whether or not the trees have succumbed to treatment, and if so, how long the treatment took to kill the trees.

If it is suspected that the target weed is clonal or allelopathic, treating individual trees in a greater patch of the species may not be effective. In this case, designate patches of the species to target for control. Clearly mark the edges of the patch with flagging. Treat all trees within the patch. Visit patch at regular intervals to determine whether or not the treatment is effective, and if so, how long the treatment took to kill the trees.

Qualitative change plots

The design of these plots is more flexible than that of either Long-term change plots or Weed control test plots. This is because qualitative plots are less rigorous and are installed to detect large scale change resultant to a particular treatment where non-target impacts are not as much of a concern. Typically, qualitative plots consist of 1 meter square plots, distributed throughout one or more populations of the target species. The corners of the plots are marked with orange-sprayed PVC poles and flagging. Qualitative observations are taken during plot installation, and at periodic intervals post treatment. Currently, NRS have two qualitative change plot sites. One is at Ka`ena point, and looks at the re-invasion rate of *Atriplex semibaccata* after manual hand-pulling. The other qualitative plot is in Kahanahāiki, and looks at the efficacy of 1% Garlon 4 spray on *Psidium cattleianum* seedling beds. At both sites, qualitative plots were used because there was little danger of non-target take, and NRS wanted to see response over several different site conditions and broad trends of change.

Range
Plot
Transect

Seedling Count (Kahanahaiki)

Observer
Weather
Date

SEEDLING COUNT--for seedlings <1m
(counts made by size class)

Species																																	
Size Class*	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
0-1m																																	
1-2m																																	
2-3m																																	
3-4m																																	
4-5m																																	
5-6m																																	
6-7m																																	
7-8m																																	
8-9m																																	
9-10m																																	
10-11m																																	
11-12m																																	
12-13m																																	
13-14m																																	
14-15m																																	
15-16m																																	
16-17m																																	
17-18m																																	
18-19m																																	
19-20m																																	

* Size Classes 1: <10cm, 2: 10-25cm, 3: 25-100cm

CANOPY SURVEY--for plants >1m (cover classes given for each species)

Species	Non-native canopy	Native canopy	Total canopy																																	
0-5m																																				
5-10m																																				
10-15m																																				
15-20m																																				

Cover Class Values

0=0-1%
1=1-10%
2=10-20%
3=20-30%
4=30-40%
5=40-50%
6=50-60%
7=60-70%
8=70-80%
9=80-90%
10=90=100%

Kahanahaiki Cover Classes

1=0-1%
2=1-5%
3=5-25%
4=25-50%
5=50-75%
6=75-90%
7=90-100%

*Circle the cover class scale used in survey

Appendix 2-B Weed Control Documentation

Weed Control Effort Form

Date _________ Weather ____________________ Crew
____

Range/MU or NAR/Specific Location ____
____
____
____

Ecosystem Scale Control or Incipient Invasive Control (circle one)

Managed Species ____

Target Weed Species ____
____

Photopoint? ________ Notes ____
____
____

GPS? ________ Notes ____
____

Methods:

Pesticide	Mix Rate	Quantity	Application Method	Area	People Hrs

Manual Control Technique (NO CHEMICALS)	Area	People Hrs

Manual & Chemical: Total Area Treated ______________ Total People Hours ______________

Comments
____
____
____
____

Next Time ______________________
____
____
____

Map

Weed Control Effort Form
Guidelines

Range/MU or NAR/Specific Location: Give a clear and complete description of the area, and directions to it, if necessary. List range first, then management unit, then specific work area. Refer reader to included map. For example: MMR, Kaluakauila, Lower Eup hae patch, D bait line (see map)

Ecosystem Scale Control or Incipient Invasive Control (circle one): Ecosystem scale control refers to management of established weeds for greater ecosystem health. Examples: Psidium cattleianum at Kahanahaiki; Panicum maximum at Lower Ohikilolo. Incipient invasive control refers to management, with the goal of complete eradication as quickly as possible, of a highly invasive weed species. Examples: Fountain grass at DMR; Tibouchina at Whitmore village.

Managed Species: Identify the specific native species which are prompting weed management. Some weed management does not focus on a specific native species; in this case, either leave this section blank, or write in ‘native forest’.

Target Weed Species: Identify the specific weed species controlled.

Photopoint?: Yes/No Notes: Record total number of photopoints taken, and how they are marked in the field (with PVC, flags, etc.). Describe view framed by each photopoint. For sites which have many photopoints, like Lower Ohikilolo, these descriptions can be recorded on the site’s Photopoint Form.

GPS?: Yes/No Notes: Give info which will help in downloading and sorting GPS data. Were waypoints or tracks (or both) taken? Names and symbols of waypoints?

Methods:

Record actions involving pesticides in the Pesticide Table. Record other, non-chemical actions in the Manual Control Table (for example: weedeating, weed pulling, girdling without herbicide).

Pesticide Table

1. Pesticide
   - Record the name of the pesticide used.
2. Mix Rate
   - Record the mix rate, or dilution, at which the pesticide was used. For example: 20% for Garlon 4 in FCO, 22mL/gal for Fusilade II with 19mL/gal surfactant.
3. Quantity
   - Report the amount of mixed pesticide used.
4. Application Method
   - Briefly describe method of pesticide application/weed control. For example: backpack sprayer, cut stump and drip, basal bark, etc.
5. Area
   - Approximate area treated with pesticide (in meters, feet, or acres).
6. People Hours
   - Effort/time spent working (do not include transport time).

Manual Control Table

1. Manual Control Technique
   - Briefly describe weed management actions completed.
2. Area
   - Approximate area managed (in meters, feet, or acres).
3. People Hours
   - Effort/time spent working (do not include transport time).

Totals: Sum the Area and People Hours columns from the two tables and record the total number of hours spent in the area. Note that one area may have been treated by more than one technique, so straight addition of the area column may result in over-reporting of the area treated.

Comments: Notes on the actions performed. Record location of any stashed equipment and water.
Next Time: Write specific action recommendations for future visits. List special supplies which will be needed for next action; for example, water.

Appendix 2-C Weed Surveys, Roads & Landing Zones: Makua Military

Appendix 2-D Weed Surveys, Roads & Landing Zones: Schofield Barracks Military Reservation

Appendix 2-E Weed Surveys, Roads & Landing Zones: Kawailoa Training Area

Appendix 2-F Weed Surveys, Roads & Landing Zones: Dillingham Military Reservation

Appendix 2-G Weed Surveys, Roads & Landing Zones: Kahuku Training Area

Appendix 2H: Weed Survey Form

Name:____ Range:____________________

circle one: Road Landing Zone Transect Camp site

Keys/Permission Required:____

Directions:____

Notes:____

Note all page numbers refer to the *Manual of Flowering Plants* or *Hawaii's Ferns and Fern Allies*

	Date and Observer			
Species Name, Alphabetical by genus				
Abutilon grandifolium (Hairy Abutilon, Ma'o, 872) Malvaceae, shrub				
Acacia confusa (Formosan koa, 641) Fabaceae, tree				
Acacia farnesiana (klu, popinac, 641) Fabaceae, shrub				
Acacia mangium (KTA Acacia) Fabaceae, tree				
Acacia mearnsii (black wattle, 642) Fabaceae, tree				
Achyranthes aspera (180) Amaranthaceae, herb				
Adiatum hispidulum (rough maiden hair fern, five-finger fern, 43) Pteridaceae, fern				
Agave sisalana (sisal, malina, sisal hemp, 1348) Agavaceae				
Ageratina adenophora (Maui pamakani, 254) Asteraceae, sub-shrub				
Ageratina riparia (Hamakua pamakani, 254) Asteraceae, sub-shrub				
Ageratum conzyoides (Maile honohono, 253) Asteraceae, herb				
Aleurites moluccana (Kukui, 598) Euphorbiaceae, tree				
Alocasia macrorrhiza ('ape, 1356) Araceae, herb				
Alternanthera sessilis (sessile joyweed, 185) Amaranthaceae, herb				
Amaranthus spinosus (spiny amaranth, pakai kuku,188) Amaranthaceae, herb				
Amaranthus viridis (slender amaranth, 189) Amaranthaceae, herb				
Ambrosia artemisiifolia (Common ragweed, 256) Asteraceae, herb				
Anagallis arvensis (Scarlet pimpernel, poor man's weather glass) Primulaceae, herb				
Andropogon virginicus (broomsedge, yellow bluestem, 1497) Poaceae, grass				
Angiopteris evecta (mules foot fern, giant fern, Madagascar tree fern, 48) Marattiaceae, fern				
Anthoxanthum odoratum (sweet vernalgrass, 1498) Poaceae, grass				
Araucaria columnaris (norfolk pine tree), tree				
Archontophoenix alexandrae (Date palm, 1362) Arecaceae, palm				
Archontophoenix alexandrae (king palm, 1362) Arecaceae, palm				
Ardesia cretica (hilo holly, hen's eyes, 932) Myrsinaceae, shrub				
Ardisia elliptica (shoebutton ardisia, 932) Myrsinaceae, shrub				
Arthrostemma ciliatum (905) Melastomataceae, herb				
Arundia gramminifolia (bamboo orchid, 1451) Orchidaceae				
Asclepias physocarpa (balloon plant, 240) Asclepiadaceae, sub-shrub				
Asystasia gangetica (Chinese violet, 168) Acanthaceae, herb				
Avena fatua (wild oat, 1499) Poaceae, grass				
Axonopus fissifolius (narrow-leaved carpetgrass, 1500) Poaceae, grass				

Appendix 2H: Weed Survey Form

Bidens alba (beggar's tick, 270) Asteraceae, herb				
Bidens pilosa (beggar's tick, Spanish needle, ki pipili, 279) Asteraceae, herb				
Blechnum appendiculatum (formerly B. occidentale, 79) Blechnaceae, fern				
Boerhavia coccinea (978) Nyctaginaceae, herb				
Bothriochloa pertusa (pitted beardgrass, 1503) Poaceae, grass				
Bouganvillea sp.(977) Nyctaginaceae, vine				
Brachiaria mutica (California grass, 1504) Poaceae, grass				
Brexia madagascariensis (KLOA LCTA plot)				
Bruguiera gymnorrhiza (oriental mangrove, kukunaokala, 1099) Rhizophoraceae, tree				
Buddleia asiatica (Dog tail, huelo, ilio, 415) Buddleiaceae, shrub/tree				
Buddleia madagascariensis (butterfly bush, smoke bush, 416) Buddleiaceae, shrub				
Caesalpinia decapetala (thorny cat's claw, Mysore thorn, wait-a-bit, 647) Fabaceae, vine				
Callitris sp. (gymnosperm, Australian cypress pine, SBW)				
Calyptocarpus vialis ("baby 5-petal wedelia", 284) Asteraceae, herb				
Canavalia cathartica (Maunaloa, 651) Fabaceae, vine				
Carica papaya (Papaya, 497) Caricaceae, tree				
Castilleja arvensis (Indian paintbrush, 1239) Scrophulariaceae, herb				
Castilloa elastica (Panama rubber tree, Mexican rubber tree,) Moraceae, tree				
Casuarina equisetifolia (common ironwood, paina, 529) Casuarinaceae, tree				
Casuarina glauca (swamp oak, saltmarsh, longleaf ironwood, 529) Casuarinaceae, tree				
Cecropia obtusifolia (trumpet tree, guarumo, 530) Cecropiaceae, tree				
Cenchrus ciliaris (buffelgrass, 1512) Poaceae, grass				
Cenchrus echinatus (common sandbur, \`ume\`alu, 1512) Poaceae, grass				
Centaurium erythraea (bitter herb,725) Gentinanaceae, herb				
Centella asiatica (Asiatic pennywort, pohekula, 201) Apiaceae, herb				
Cerastium fontanum subsp. triviale (common mouse-ear chickweed, 503) Caryophyllaceae, herb				
Cestrum nocturnum (night cestrum, \`ala aumoe, 1254) Solanaceae, shrub/tree				
Chamaecrista nictitans (Partridge pea, 655) Fabaceae, herb				
Chamaesyce hirta (garden spurge, koko kahiki, 609) Euphorbiaceae, herb				
Chamaesyce hypericifolia (Graceful spurge, 609) Euphorbiaceae, herb				
Chamaesyce prostrata (prostrate spurge, 613) Euphorbiaceae, herb				
Chenopodium murale (\`ahinahina, 538) Chenopodiaceae, herb				
Chloris barbata (swollen fingergrass, mau‘u lei, 1514) Poaceae, grass				
Chloris radiata (radiate fingergrass, plush grass, 1515) Poaceae, grass				
Chloris sp. (finger grass, 1513) Poaceae, grass				
Chloris virgata (feather fingergrass, 1515) Poaceae, grass				
Christella dentata (pai\`i\`iha, 88) Thelypteridaceae, fern				
Christella parasitica (90) Thelypteridaceae, fern				
Chrysophyllum oliviforme (satin leaf, caimitillo, 1231) Sapotaceae, tree				
Chrysopogon aciculatus (golden beardgrass, pili pili'ula, 1516) Poaceae, grass				
Ciclospermum leptophyllum (fir-leaved celery, 201) Apiaceae, herb				
Cinnamomum burmannii (padang cassia, 846) Lauraceae, tree				
Cirsium vulgare (bull thistle, pua kala, 287) Asteraceae, herb				
Citharexylum caudatum (juniper berry, 1317) Verbenaceae, shrub, tree				
Citharexylum spinosum (fiddlewood, 1317) Verbenaceae, shrub , tree				
Citrus sp. (Orange, Tangerine, 1174-1175) Rutaceae, tree				
Clidemia hirta (Koster's curse, 906) Melastomataceae, shrub				
Clusea rosea (autograph tree, 542) Clusiaceae, tree				
Coccinia grandis (ivy gourd, scarlet-fruited gourd, 569) Cucurbitaceae, vine				
Coffee arabica (Arabian coffee, 1120) Rubiaceae, shrub, tree				
Coix lachryma-jobi (Job's tears, Pu\`ohe\`ohe, 1517) Poaceae, grass				
Commelina diffusa (honohono, 1379) Commelinaceae, herb				
Conyza bonariensis (hairy horseweed, 288) Asteraceae, herb				

Appendix 2H: Weed Survey Form

Cordia glabra (broad-leaved cordia, kou) Boraginaceae, tree				
Cordyline fruticosa (ti, 1348) Agavaceae, shrub				
Coronopus didymus (swinecress, 403) Brassicaceae, herb				
Corynocarpus laevigatus (New Zealand laurel, karakaranut, 566) Corynocarpaceae, tree				
Crassocephalum crepidioides (291) Asteraceae, herb				
Crocosmia X crocosmiifolia (1446) Iridaceae, herb/shrub				
Crotalaria pallida (smooth rattle pod, pikakani, 661) Fabaceae, herb/sub-shrub				
Cuphea carthenagensis (tarweed, 866) Lythraceae, herb				
Cynodon dactylon (Bermuda grass, Manienie, 1520) Poaceae, grass				
Cyperus gracilis (McCoy grass, Mau`u hunehune, 1396) Cyperaceae, sedge				
Cyperus rotundus (nut grass, kili‘pi‘opu,1399) Cyperaceae, grass				
Datura stramonium (jimsen weed 1255) Solanaceae, herb				
Daucus pusillus (American carrot, 204) Apiaceae, herb				
Deparia petersenii (111) Athyriaceae, fern				
Desmanthus virgatus (slender or virgate mimosa, 665) Fabaceae, sub-shrub				
Desmodium incanum (spanish clover, 667) Fabaceae, shrub/sub-shrub				
Desmodium intortum (sticky spanish clover, 667) Fabaceae, herb				
Desmodium sandwicense (spanish or chili clover, 699) Fabaceae, herb/sub-shrub				
Desmodium tortuosum (Florida beggar weed, 669) Fabaceae, herb/sub-shrub				
Desmodium triflorum (670) Fabaceae, herb				
Digitaria ciliaris (Henry's crabgrass, kukae pua`a, 1530) Poaceae, grass				
Digitaria insularis (Sourgrass, 1531) Poaceae, grass				
Digitaria sp.(1529) Poaceae, grass				
Digitaria violascens (smooth or violet crabgrass, 1532) Poaceae, grass				
Dracaena (1351) Agavaceae				
Echinochloa sp. (Jungle rice grass or barnyard grass, 1534) Poaceae, grass				
Ehrharta stipoides (meadow ricegrass, 1536) Poaceae, grass				
Eleocharis geniculata (1402) Cyperaceae, sedge				
Eleocharis obtusa (1403) Cyperaceae, sedge				
Eleocharis radicans (1403) Cyperaceae, sedge				
Eleusine indica (wiregrass, manienie ali‘i, 1537) Poaceae, grass				
Emilia fosbergii (Flora's paintbrush red, Pua lele, 312) Asteraceae, herb				
Emilia sonchifolia (Flora's paintbrush purple, 312) Asteraceae, herb				
Eragrostis elongata (1538) Poaceae, grass				
Eragrostis tenella (lovegrass, 1545) Poaceae, grass				
Erichtites valerianifolia (fireweed, 314) Asteraceae, herb				
Erigeron karvinskianus (climbing daisy, daisy fleabane, 315) Asteraceae, herb				
Eriobotrya japonica (loquat, 1100) Rosaceae, tree				
Eucalyptus globulus; (blue gum, 954) Myrtaceae, tree				
Eucalyptus sp. (948) Myrtaceae, tree				
Euphorbia heterophylla (kaliko, 619) Euphorbiaceae, herb				
Euphorbia peplus (petty spurge, 619) Euphorbiaceae, herb				
Euphorbia sp. (Poinsettia, 618,619) Euphorbiaceae, shrub/tree				
Falcataria moluccana (formerly Albizia and Paraserianthes, 690) Fabaceae, tree				
Ficus microcarpa; Chinese banyon, Maylayan banyon; Moraceae, tree				
Ficus sp. (Banyan, 924) Moraceae, tree				
Fraxinus uhdei (Mexican ash, tropical ash, 990) Oleaceae, tree				
Glycine wightii (674) Fabaceae, herb/vine				
Gnaphalium purpureum (purple cudweed, 321) Asteraceae, herb				
Gomphrena globosa (globe amaranth, bozu, 192) Amaranthaceae, herb				
Gossypium hirsutum (upland cotton, 876) Malvaceae, shrub				
Grevillea banksii (kahili flower, 1086) Proteaceae, tree				
Grevillea robusta (silky oak, silver oak, 1086) Proteaceae, tree				

Appendix 2H: Weed Survey Form

Haematoxylum campechianum (logwood, bloodwood tree, 674) Caesalpiniaceae, tree				
Hedychium coronarium (white ginger, 1622) Zingiberaceae				
Hedychium flavescens (yellow ginger, awapuhi melemele, 1622) Zingiberaceae				
Hedychium gardnerianum (kahili ginger, 1623) Zingiberaceae				
Heliocarpus popayanensis (white moho, 1292) Tiliaceae, tree				
Heliotropium procumbens (grey heliotrope, 396) Boraginaceae, herb				
Hibiscus (ornamental, 881) tree/shrub				
Hibiscus tiliaceus (hau, 888) Malvaceae, tree/shrub				
Holcus lanatus (common velvet grass, Yorkshire fog, 1551) Poaceae, grass				
Hyparrhenia ruffa (thatching grass, 1554) Poaceae, grass				
Hypochoeris radicata (hairy cat's ear, gosmore, 327) Asteraceae, herb				
Hypochoeris species (cat's ear, 326-7) Asteraceae, herb				
Hyptis pectinata (comb hyptis, 802) Lamiaceae, herb/shrub				
Hyptis sp. (801) Lamiaceae, herb/shrub				
Indigofera spicata (creeping indigo, 675) Fabaceae, herb				
Indigofera suffruiticosa (indigo, kolu 676) Fabaceae, herb				
Ipomea cairica (koali`ai, ivy-leaf morning glory, 555) Convolvulaceae, vine				
Ipomea obscura (small white morning glory, 557) Convolvulaceae, vine				
Ipomea sp. (morning glory, 553) Convolvulaceae, vine				
Iris sp. (1444-1449) Iridaceae				
Jasminum fluminense (climbing jasmine, viney pikake, 990) Oleaceae, vine/shrub				
Juncus planifolius (junkus grass, bog rush 1453) Juncaceae, herb				
Justicia betonica (white shrimp flower, 172) Acanthaceae, herb/shrub				
Kalanchoe crenata (Lower Ohikilolo air plant) Crassulaceae, herb				
Kalanchoe pinnata (air plant, 568) Crassulaceae, herb				
Kyllinga brevifolia (kili`o`opu, Kaluha, 1411) Cyperaceae, sedge				
Kyllinga nemoralis kili‘o‘opu, 1413) Cyperaceae, sedge				
Lablab purpureus (Hyacinth bean, 676) Fabaceae, herb				
Lantana camara lantana, 1320) Verbenaceae, shrub				
Leonotis nepetifolia (lion's ear, spikey puff ball, 803) Lamiaceae, herb				
Lepidium hyssopifolium (pepperwort,407) Brassicaceae, herb				
Leptospermum flavescens (rare tree manuka, 961) Myrtaceae, tree				
Leptospermum scoparium (manuka, New Zealand tea, 963) Myrtaceae, shrub/tree				
Leucaena leucocephala (koa haole, 679) Mimosaceae, tree/shrub				
Linum trigynum (flax, 850) Linaceae, herb				
Livistona chinensis (chinese fan palm, spiney fan palm, 1364) Aracaceae, palm				
Lophostemon confertus (vinegar tree, 963) Myrtaceae, tree				
Ludwigia octovalis (primrose willow, 998) Onagraceae, herb/shrub				
Lychee sp. (planted) tree				
Lycopersicon esculentum (tomato, 1258) Solanaceae, herb				
Lycopersicon pimpinellifolium (currant tomato, baby wild tomato, 1258) Solanaceae, herb				
Macaranga mappa (Bingabing, 624) Euphorbiaceae, tree				
Macfadyena unguis-cati (climbing cat's claw, 388) Bighoniaceae, shrub/vine				
Macroptilium atropurpureum (trailing wild bean, 683) Fabaceae, herb				
Macroptilium lathyroides (erect wild bean, cow pea, 683) Fabaceae, herb				
Malva parviflora (cheesewood, 893) Malvaceae, herb				
Malvastrum coromandelianum (false mallow, 894) Malvaceae, herb				
Mangifera indica (mango) Anacardiaceae, tree				
Medicago lupulina (black medic, nonesuch, 684) Fabaceae, herb				
Medicago polymorpha (Bur clover,684) Fabaceae, herb				
Melaleuca quinquenervia (paper bark, 964) Myrtaceae, tree				
Melastoma candidum (Indian rhododendron, 910) Melastomataceae, shrub/tree				
Melia azedarach (Pride-of-India, 918) Meliaceae, tree				

Appendix 2H: Weed Survey Form

Melinis minutiflora (molasses grass, 1562) Poaceae, grass				
Melochia umbellata (melochia, 1279) Sterculiaceae, tree/shrub				
Merremia aegyptia (hairy merremia, koali kua hulu, 563) Convovulaceae, vine				
Merremia tuberosa (wood rose, 563) Convolvulaceae, vine				
Mimosa pudica var. unijuga (sleeping grass, 687) Fabaceae				
Momordica charantia (bitter melon, 572) Cucurbitaceae, herb				
Monstera				
Montanoa hibiscifolia (tree daisy, montanoa) Asteraceae, shrub/tree				
Morinda citrifolia (noni, 1157) Rubiaceae, tree/shrub				
Musa sp. (banana, mai`a, 1465) Musaceae, tree				
Myrica faya (Morella faya) (firetree, fayatree, 931) Myricaceae, tree				
Nephrolepis multiflora (193) Nephrolepidaceae, fern				
Nicandra physalodes (Apple of Peru, 1260) Solanaceae, herb				
Oplismenus hirtellus (basket grass, honohono grass, 1565) Poaceae, grass				
Opuntia ficus-indica (prickly-pear cactus (yellow flwr), 419) Cactaceae, cactus tree				
Opuntia cochenillifera (prickly pear cactus (red flwr), 419) Cactaceae, cactus shrub				
Oxalis corniculata (yellow wood sorrel, 1002) Oxalidaceae, herb				
Oxalis corymbosa (pink wood sorrel, 1002) Oxalidaceae, herb				
Oxyspora paniculata (oxyspora, 912) Melastomataceae, shrub				
Panicum maximum (guinea grass, 1569) Poaceae, grass				
Paraserianthes falcataria (Moluccca albizia 690) Fabaceae, tree				
Paspalum conjugatum (Hilo grass, 1575) Poaceae, grass				
Paspalum dilatatum (Dallis grass, 1576) Poaceae, grass				
Paspalum fimbriatum (fimbriate/Panama paspalum, Colombia grass, 1576) Poaceae, grass				
Paspalum sp. (1574) Poaceae, grass				
Paspalum urvillei (Vasey grass, 1577) Poaceae, grass				
Passiflora edulis (passion fruit, liliko'i) Passifloraceae, vine				
Passiflora laurifolia (yellow granadilla, 1011) Passifloraceae, vine				
Passiflora ligularis (sweet granadilla, 1011) Passifloraceae, vine				
Passiflora mollissima (banana poka, 1012) Passifloraceae, vine				
Passiflora suberosa (huehue haole, 1014) Passifloraceae, vine				
Pennisetum clandestinum (kikuyu grass, 1578) Poaceae, grass				
Pennisetum polystachion (Feathery pennisetum, 1579) Poaceae, grass				
Pennisetum purpureum (elephant or napier grass, 1579) Poaceae, grass				
Pennisetum setaceum (fountain grass, 1581) Poaceae, grass				
Persea americana (Avocado, 847) Laureaceae, tree				
Phaius tankervilleae (Chinese ground orchid (brown/white/purple), 1473) Orchidaceae				
Philodendron (1355) Araceae, shrub				
Phlebodium aureum (laua`e haole, 203) Polypodiaceae, fern				
Phylanthus debilis (niruri, 627) Euphorbiaceae, herb				
Phyllanthus tenellus (629) Euphorbiaceae, herb				
Phyllostachys nigra (black bamboo, 1582) Poaceae, bamboo				
Phymatosorus grossus (laua`e) Polypodiaceae, fern				
Physallis peruviana (poha, 1265) Solanaceae, shrub				
Pilea microphylla (artillary plant, rockweed, 1306) Urticaceae, herb				
Pimenta dioica (allspice, 947) Myrtaceae, tree				
Pinus sp. (pine) Pinaceae, tree				
Pithecellobium dulce (opiuma, 691) Fabaceae, tree/shrub				
Pityrogramma austroamericana (gold fern, 207) Pteridaceae, fern				
Pityrogramma calomelanos (silver fern, 207) Pteridaceae, fern				
Plantago lanceolata (narrow leafed plantain, 1051) Plantaginaceae, herb				
Plantago major (broad leafed plantain, laukahi, 1051) Plantaginaceae, herb				
Pluchea indica (Indian fleabane, 351) Asteraceae, shrub				

Appendix 2H: Weed Survey Form

Pluchea symphytifolia (sourbush, 351) Asteraceae, shrub				
Plumeria sp. (213) Apocynaceae, tree				
Polygala paniculata (bubblegum/rootbeer plant, 1058) Polygalaceae, herb				
Portulaca oleracea (pigweed, akulikulikula, 1072) Portulacaceae, herb				
Portulaca pilosa (akulikuli, 1072) Portulacaceae, herb				
Prosopis pallida (kiawe, mesquite, algaroba, 692) Fabaceae, tree				
Psidium cattleianum (strawberry guava, waiawi, 971) Myrtaceae, tree				
Psidium guajava (guava, 972) Myrtaceae, tree				
Pterolepis glomerata (melastome, 912) Melastomataceae, herb/shrub				
Rhizophora mangle (red mangrove, american mangrove, 1099) Rhizophoraceae, shrub/tree				
Rhynchelytrum repens (Natal redtop, Natal grass, 1588) Poaceae, grass				
Ricinus communis (castor bean, 629) Euphorbiaceae, shrub/tree				
Rivina humilis (coral berry, 1016) Phytolaccaceae, herb/shrub				
Roystonea sp. (Royal palm, 1361) Arecaceae, palm				
Rubus argutus (Blackberry, 1107) Rosacea, shrub				
Rubus rosifolius (Thimbleberry, 1110) Rosaceae, shrub				
Rynchospora caduca (Beak-rush, 1428) Cyperaceae, sedge				
Saccharum spontaneum (Sugar cane, 1589) Poaceae, grass				
Sacciolepis indica (Glenwood grass, 1589) Poaceae, grass				
Salvia coccinea (Scarlet sage, 829) Lamiaceae, herb				
Salvia occidentalis (West Indian sage, 829) Lamiaceae, herb				
Salvia sp. (829) Lamiaceae, herb				
Samanea saman (monkeypod, 696) Fabaceae, tree				
Santalum album (white sandalwood, 1220) Santalaceae, tree				
Schefflera actinophylla (umbrella tree, octopus tree, 232) Araliaceae, tree/shrub				
Schinus terebinthifolius (Christmasberry, Brazilian pepper, 198) Anacardiaceae, tree				
Schizostachyum glaucifolium (`Ohe, Bamboo, 1590) Poaceae, bamboo				
Senecio madagascarensis (fireweed) Asteraceae, herb				
Senna surattensis (Kolomana, 702) Fabaceae, tree				
Setaria gracilis (yellow or perennial foxtail, 1592) Poaceae, grass				
Setaria palmifolia (palmgrass, 1592) Poaceae, grass				
Sida rhombifolia (898) Malvaceae, subshrub				
Sida spinosa (prickly sida, 899) Malvaceae, herb				
Solanum americanum (glossy nightshade, popolo berry, 1268) Solanaceae, herb				
Solanum sp. (1267) Solanaceae, herb				
Sonchus oleraceus (sow thistle, pua lele, 358) Asteracea, herb				
Spathodea campanulata (African tulip tree, 388) Bignoniaceae, tree				
Spathoglottis plicata (Philippine ground orchid (purple), 1476) Orchidaceae				
Spermacoce assurgens (button weed, 1173) Rubiaceae, herb				
Sphaeropteris cooperi (formerly Cyathea cooperi, Australian tree fern, 243) Cyatheaceae, fern				
Sporobolus indicus (West Indian dropseed, smutgrass, 1597) Poaceae, grass				
Stachys arvensis (staggerweed, 831) Lamiaceae, herb				
Stachytarpheta dichotoma (0i,1321) Verbenaceae, herb				
Stachytarpheta jamaicensis (Jamaica vervain,1322) Verbenaceae, herb				
Stachytarpheta sp. (1321) Verbenaceae, herb				
Stachytarpheta urticifolia (1322) Verbenaceae, herb				
Stapelia gigantea (carrion/starfish flower, in Lower Ohikilolo, 241) Asclepiadaceae, cactus				
Swietenia mahagoni (mahogany, 918) Meliaceae, tree				
Synedrella nodiflora (nodeweed, 360) Asteraceae, herb				
Syzygium cumini (Java plum, 975) Myrtaceae, tree				
Syzygium jambos (rose apple, 975) Myrtaceae, tree				
Syzygium malaccense (Mountain apple, 975) Myrtaceae, tree				
Terminalia catappa (tropical almond, false kamani, 547) Combretaceae, tree				

Appendix 2H: Weed Survey Form

Terminalia myriocarpa (jhalna, 548) Combretaceae, tree				
Thespesia populnea (milo, 902) Malvaceae, tree/shrub				
Thunbergia grandiflora (Bengal trumpet, blue trumpet vine, 175) Acanthaceae, vine				
Tibouchina urvilleana (lasiandra, 916) Melastomataceae, tree/shrub				
Toona ciliata (Australian red cedar, 920) Meliaceae, tree				
Trema orientalis (charcoal tree, gunpowder tree, 1296) Ulmaceae, tree				
Tridax procumbens (coat buttons, 370) Asteraceae, herb				
Trifolium arvense (rabbit-foot clover, 711) Fabaceae, herb				
Trifolium dubium (small hop-clover, 712) Fabaceae, herb				
Trifolium sp. (711) herb				
Triumfetta semitriloba (Sacramento bur,1294) Tiliaceae, herb/subshrub				
Verbena litoralis (oi, 1325)Verbenaceae, herb				
Verbesina encelioides (golden crown beard (yellowdaisy), 372) Asteraceae, herb				
Vernonia cinerea (little ironweed, 373) Asteraceae, herb				
Vulpia bromoides (brome fescue, 1603) Poaceae, grass				
Wedelia trilobata (wedelia, 373) Asteraceae, herb				
Xanthium strumarium (kikania, 376) Asteraceae, herb				
Youngia japonica (oriental hawksbeard, 377) Asteraceae, herb				

Appendix 3-A Hawaii Rare Plant Restoration Group Rare Plant Field Data

Scientific Name ______________________________ Date ______________

Agency ______________________________ Observers ______________________________

Agency Population Reference ______________ Island ____________ Elevation __________ft/m

Location/Directions/Flagging Scheme/GPS Notes ______________________________

____

____

Photo taken? Y/N ___ Notes ______________________________

Individual Plant Information

								Material Collected			
Plant #	Tag ? Y/N	Sex P or M/F Both or Unk	Ht. (m)	Basal Diam (cm) or N/A	Age Class: mature, immat, seedling	Reproduct. Status: veg, bud, flwr, imm frt, mat frt, dormant	Vigor: healthy mod, poor, dead	# Imm. Fruit or seed	# Mat. Fruit or seed	# Cut-tings	Propagule Destination & Purpose (i.e. Lyon for prop and reintro @ SB)

Population Structure

Age Class	Observer Definition of Age Class (Define criteria for seedling, immature, and mature, e.g. height, reproductive status, etc.)	Counted # of Individuals	Estimated # of Individuals
Seedling			
Immature			
Mature			
Total			

Population Information (If multiple categories chosen, explain in comments section below.)

Accuracy level (circle)	Phenology (for mature plants)	Indicate % or count	Condition	Indicate % or count	Light Level	Indicate % or actual
Actual count	Vegetative		Healthy		Full sun >95%	
Estimate	Bud		Moderate		Partial sun 50-95%	
	Flower		Poor		Partial shade 5-50%	
	Imm Fruit		Dead		Deep shade 0-5%	
	Mat Fruit					
	Dormant					

Habitat Characteristics (circle)

Overstory Closure >2m	Overstory height (All that apply)	Understory Closure <2m	Soil Drainage	Topography	Moisture Class	Slope (degrees)
Closed75-100%	2-5m	Closed 75-100%	Well	crest	Dry <25”/yr	flat 0-10°
Intermediate25-75%	5-10m	Intermediate 25-75%	Moderate	upper slope	Dry-Mesic 25-50”/yr	moderate 10-45°
Open 0-25%	>10m	Open 0-25%	Poor	mid slope	Mesic 50-75”/yr	steep 45-70°
			Hydric	lower slope	Wet-Mesic 75-100”/yr	vertical 70-90°
				gulch bottom	Wet >100”/yr	
				plateau-flat		

Aspect (eg. N,NNW,N/A)______________________

Associated species in order of abundance
Overstory >2m____

____

Understory/Ground Cover <2m(woody and herbaceous)____

____

Substrate (e.g. soil, pahoehoe, rock, sand, etc.) ____

Comments on threats (weeds, ungulates, arthropods), management suggestions and actions

____

____

____

Sketch Map

Appendix 3-B Hawaii Rare Plant Restoration Group Instructions and Guidelines

DRAFT April 99

This document, provided by Hawaii Rare Plant Restoration Group and the Center for Plant Conservation, Hawaii**,** serves as guidance when observing, inventorying, monitoring and collecting rare plant populations in Hawaii. Attached are two forms the HRPRG recommends for use: the *Rare Plant Background Data Form*, and the *Rare Plant Field Data Form*.

Rare Plant Background Data Form

This form is to be used in the office and does not need to be taken into the field. Information can be obtained from the Field Data Form or from other reference sources.

CPC Population Reference : This code is assigned by the CPC office staff to be consistent with national CPC standards. It is cross-referenced with individual agency population reference designations. For example, the first individual marked in the first population of Cenchrus agrimonioides agrimonioides would have the reference code Cenagragr-A-01.

All other requested information is self-explanatory.

Rare Plant Field Data Form

This form is designed for use in the field. It has an introductory section where general population tracking information can be recorded (i.e. Species, population #, observers, location, etc.). It has an *Individual Plants* section for use when conducting a detailed population inventory or monitoring, or when collecting material for taxonomic, genetic, or propagation purposes. It has a *Population Structure* section for tracking the age class within a population and a *Population Information* section for tracking phenology, vigor, and environmental characteristics such as canopy height and closure, topography, and edaphic conditions. Instructions for filling out each of these sections are listed below.

Scientific Name: Genus and species.

Agency Ref. Code: Provide the population number assigned by the observer, or the observer's agency. An abbreviation of the population location can be included in the code. For example a Cenchrus agrimonioides agrimonioides in Makua Military Reservation would have an Agency Reference Code of Cenagragr-MMR-A-01.

Observers: Name all observers present.

Agency: Identify the observer's agency affiliation.

Location/Directions/
Flagging scheme: Record any and all information that could assist in relocating the population, including geographical coordinates (UTM or Lat.-Long. or GPS coordinates). Also indicate if a GPS file exists, if it was sent to CPC and if it was entered into a GIS database. Further descriptive directions could be included which would help to locate the population such as landmarks, trails and transect stations.

Photo Taken (Y/N)
Notes: Record whether or not photographs were taken this visit. If so, record photo record number, type and speed of film and other pertinent information that could aide in tracking-down previously taken photographs. If fixed photo points were used, describe their location(s). A point of contact that is in possession of the negatives and other information about the photograph should be included.

Elevation: Record the elevation of the population in feet or meters (use the "~" symbol to indicate "approximate").

Date: Record date of field visit.

__Individual Plants__: This section must be completed when collecting fruit, optional when not.

Plant Number: Record existing plant number or assign one. Must sketch a map and/or use a tag to indicate plant number.

Tagged: Indicate whether or not the population is marked (including your own numbered tag, flagging or label).

Sex: For plants with perfect flowers indicate P (perfect). Indicate sex of only plants with imperfect flowers (having only male or female reproductive parts within a flower). Indicate in this column M (male); F (female), B (both) if male and female flowers exist on the same plant. Mark Unk (unknown) if sex can not be determined.

Height: Measure or estimate height or length of plant. Height is measured from the substrate to the point on the plant furthest from the substrate. Length is used for prostrate or climbing plants such as vines and grasses.

Basal Diameter: Record estimated diameter at 1 decimeter (dm) above root crown. If you choose to use diameter at breast height (DBH), then indicate so in the header of this column. Indicate N/A for plants with impossible situations such as Bunchy grass.

Age Class: Use definitions from the ***__Population Structure__*** section below.

Reproductive
Status: Indicate the reproductive status of the individual [i.e. In a vegetative state, in bud, in flower, possessing immature fruit, possessing mature fruit, or in a dormant (post reproduction) stage].

Vigor: Assess the vigor of the individual plant; use your best judgment.

Material Collected:
immature fruit/seed: Record number taken (indicate fruit or seed)
mature fruit/seed: Record number taken(indicate fruit or seed)
cuttings: Record number taken
Propagule destination: Identify where the propagules will be sent
Plan for Propagules Collected: Identify the intended fate of propagules collected

Population Structure: This table must be completed for all site visits. This table is designed to track the age structure of the population. If an actual count is performed, fill out column titled "counted number of individuals". If only an estimate is performed, fill out column titled "estimated number of individuals." Identify the age class of the individual and define your age classes (Examples of age class definitions could be: Mature = Indication that the plant has reproduced at some point in it's life, Immature = > 1 dm, but no indication of previous reproduction, Seedling = < 1 dm, no evidence of previous reproduction).

Population Information: These boxes are intended for use in *all* population visits.
Accuracy level: Indicate whether data is an actual count of all individuals or an estimate of the population. Circle % or actual count.

Phenology: Designate phenological state for all plants recorded as mature in population structure section. Record actual numbers of individuals in each category or estimate % of population that falls into each category by circling % or actual count. Could exceed 100% because any given plant could be fruiting and flowering at the same time.

Condition: Indicate the "health" condition of the population by recording the number of individuals in each category or by estimating the % of the population that falls into each category. Circle % or actual count.

Light level: Indicate the light level in the immediate environment of the plant. Full sun, >95% of the day in direct sunlight, partial sun 50-95% of the day in direct sun, partial shade 5-50% of the day in direct sun, deep shade 0-5% of the day in direct sun. Indicate % or actual count for each category.

Habitat Characteristics: These boxes are intended for use in *all* population visits. For the following categories, mark only one choice or indicate *why* more than one choice was marked.

Overstory Closure: Circle the appropriate overstory closure class, which defines the habitat of the plant. Overstory is defined as the vegetation above 2 meters.

Overstory height: Indicate overstory height, which defines the habitat of the plant. Choose all that apply.

Understory Closure: Circle the appropriate understory closure class which define the habitat of the plant. Understory is defined as the vegetation below 2 meters.

Soil Drainage: Circle the appropriate soil drainage descriptor. Well = No standing water high oxide content. Moderate = wet with medium oxide content. Poor = Reducing conditions show green or gray colored soils. Hydric = standing water at or just below surface.

Topography: Circle appropriate topographic position of plants.

Moisture class: Circle the appropriate estimated moisture regime. (This may not be possible from field observations and should be confirmed through weather station data or other sources.) If you mark more than one, explain.

Slope: Circle the estimated slope of the ground at the population.

Aspect: Indicate the aspect if there is a slope at the location (N, NW, NNW, etc.) Write in N/A for flat sites.

Associated Species:

Overstory: In order of abundance, record the most abundant associated overstory taxa (>2 meters) in the vicinity of the plant including those which define that type of habitat. Indicate genus/species, can use 6-letter abbreviations. If the rare plant population is very scattered and associated species vary over its distribution, list the associated species but indicate they are in no particular order.

Understory/
Ground Cover: In order of abundance, record the most abundant associated Understory taxa (<2 meters) in the vicinity of the plant including those which define the habitat of that plant.. Indicate genus/species, can use 6-letter abbreviations. If the rare plant population is very scattered and associated species vary over its distribution, list the associated species but indicate they are in no particular order.

Substrate: Identify the substrate (i.e. type of soil, cinder, sand, pahoehoe, etc.).

Threats and Management: Identify any observed or perceived threats (i.e. weed species, ungulates, rodents, invertebrates, disease, fire, erosion, poor health). Identify necessary or suggested management actions or list other comments. Also indicate any management actions taken on the visit.

Sketch map: Please draw, to the best of your ability, a map of the site that could be used to relocate the population by persons who have never been there. Indicate individual plant locations on map if fruit collected.

Appendix 3-C Reintroduction Guidelines

Hawaii Rare Plant Restoration Group
August, 1999

These guidelines deal with the reintroduction of rare plants. Reintroduction should be a supplement to habitat management not a substitute. The final goal is not the success of an individual plant, but the establishment of a viable reproducing population where cross-pollination can occur and in which genetic variation is maintained. An intermediate goal may be to establish a population for field stock or research reasons. It is expected that derivatives of the material in such field stocks will be outplanted more widely once appropriate habitat is secured and stabilized. These plants can be maintained as sources of seeds, cuttings or transplants for reintroduction efforts. Research activities may be intended to identify what factors are causing mortality/decline, to test methods to overcome these factors, or validate planting techniques. Ideally, successful research efforts will be permanent outplantings in their own right. Regardless of the intent of the planting, the process of reintroduction should consider the following guidelines. Many of the guidelines require coordination with other committees within the HRPRG as well as with agencies that may be collecting and propagating rare species. Included at the end of these guidelines is a list of contacts that may be contacted to consult on reintroductions. These guidelines have been broken into sections guiding actions before during and following the actual transplanting of a plant.

Prior

1.Prior to the reintroduction of a plant, there are some issues that must be considered to ensure the health of the species, the individual transplanted plant and the surrounding habitat. This must include considerations of the reproductive biology of the species to be reintroduced.

a) Genetic Stock: The agency or individual that is reintroducing a plant must coordinate with the agencies or individuals responsible for the collection, and propagation of the plant. This must be done to ensure a healthy and balanced genetic composition. In addition a population geneticist may be consulted about strategies and alternatives when dealing with especially rare species or those with specific reproductive qualities. This is of course of special concern when dealing with depleted wild populations with remnant genetic stock. It should be the shared responsibility of all agencies and individuals involved to leave an easy-to-follow paper trail back to the source plant. (i.e. Rare Plant Monitoring Form, greenhouse accession numbers) Reintroduction is the last chance to make sure what we are propagating and planting represents a sufficient amount of the genetic composition of the species. Recalcitrant seed-producing plants may be taken as cuttings and helped into seeding in a greenhouse to increase the overall genetic base of the outplantings. Plants used in reintroduction should be as close to the collected field stock as possible. Plants that have been in the greenhouse for multiple generations may have been selected for different conditions than the reintroduction site and may have high attrition rates when planted. The pollination biology of each species must be researched and considered before reintroduction. Of special concern are pollen dispersal, autogamous (capable of self-pollination on a regular basis) and dioecious species, using propagules or plants from multiple year collections and mixing populations.

- When reintroducing a species that is an outcrosser, one must consider the method of pollen dispersal. For example, wind pollinated species need to be planted close enough to ensure successful cross-pollination and species which require a pollinator must be planted in an area where an appropriate pollinator is known to exist. In a situation where one needs to keep a reintroduced population distinct from a wild population the site must be far enough to not allow cross-pollination. How far is enough depends on the method of pollination (i.e. wind, insects, and birds).
- One needs to determine if the species they intend to reintroduce is obligatively autogamous. Obligatively autogamous species tend to have genetically similar individuals due to their inability to outcross within a population. When collecting propagules for reintroducing an obligatively autogamous species, it is important to collect representatives from as many distinct populations as possible as opposed to getting representation from many individuals in one population as you would for an outcrossing species. If one intends to reintroduce an autogamous species it is important to maintain those distinct populations and not mix them when reintroducing. When reintroducing dioecious species one should plant equal numbers of male and female plants. If the plants are not yet mature and cannot be sexed, one should plant larger numbers of individuals to increase the effective population size.
- When selecting the plants to be used in reintroduction, one must consider the age and year the stock was collected. Using propagules or plants from multiple years ensures better age class representation and possible genetic variety of stock.
- Care should be taken not to mix gene pools that may be distinct and have local or microhabitat adaptations. A site with mixed stock should not be close to a population in which you seek to preserve representatives of geographically isolated subsets.

b) Maps: Prior to the reintroduction of a species, the area should be precisely mapped. Maps should include the historical and present range of the species, locations of known populations and proposed outplanting sites. A GIS database can also be used as a permanent record of the source of a particular population and to track the propagules. This will help ensure a genetic balance throughout the historical range.

c) Threat Abatement: Threats to a population should be noted on the Rare Plant Monitoring Forms used to monitor rare species. An entity involved with reintroduction must obtain copies of the Rare Plant Monitoring Forms to track the genetic composition of their plants. As always, consulting with anyone associated with the monitoring, collection and propagation of the species is necessary to get any other information. A management strategy addressing the threats compiled from the Monitoring Forms should be in place before plants are reintroduced. Strategies should include measures to control the most likely threats of ungulates and competition with non-native plants. Management activities must be conducted carefully as to not further degrade the habitat for reintroduction. All threat control techniques can be pathways for pathogens and other contaminants and must be executed properly. Weeding around an outplanting site may only proceed after careful considerations of the intent. Changing light regimes and soil composition can negatively impact the habitat for reintroduced plants. Also threats to a outplanted population may be different from those affecting the wild populations. For example, a wild population from which propagules are collected may be fenced and weeded but an ideal outplanting site existing off site within historical range may not have any management. Reintroduction should only proceed once a management strategy for the site has been established.

d) Site Selection: Once the historical range of the species is known and a management strategy is established, a suitable site for outplanting within the range must be selected. Again coordination with the collectors and propagators is essential. A site should be chosen according to the biotic and abiotic elements that comprise the habitat for the newly transplanted population. A careful review of the Rare Plant Monitoring Forms may provide all the information available on the source population. However, before outplanting, an agency or individuals should seek any additional information from anyone associated with the monitoring, collection, and propagation of the species. When interpreting historical range, one must consider that recent alterations of the habitats may have left the sites inhospitable for reintroduction. Invasion by alien species and other threats may have left the habitat within historical range unsuitable due to changes in moisture regimes and soil composition. In such cases reintroduction may be most successful in sites outside known historical locations that have maintained the critical biotic and abiotic elements necessary for successful reintroduction.

e) Reintroduction scenario: Sites for reintroduction can be placed in at least three categories each having special considerations.

    i) Reintroduction of a species within historical range: Agencies must consider what distinguishes populations from one another for each species that is to be outplanted. The site must be able to support a distinct population or one is only augmenting the adjacent population, which may have different ramifications. Specific information about the habitat characteristics of the source population must be matched as close as possible with the outplanting site to provide the best chance for survival. This should be done by consulting anyone associated with the collection and propagation of the species and referring to the RPMFs.

    ii) Augmentations: This involves introducing propagules or plants into existing wild populations. This type of reintroduction must be considered on a case by case basis for each species. This reintroduction must be done carefully as to not harm the existing population with contaminants or physically altering the soil structure or existing roots. Augmentation may negatively alter the genetic composition of the population with propagules or plants from a single source or ones that have been raised through multiple generations in the greenhouse if not carried out strategically. Alternative scenarios are preferred due to the difficulty in ensuring a successful reintroduction. The complex problems involved with preventing pathogens from invading the wild population lowers the desirability of this option. It is especially important to contact as many individuals or agencies as possible for comments before augmenting a population.

iii) Introduction of a species to a site outside the known historical range: Agencies or individuals considering this type of introduction need also to consider the possible negative effects on the species. Establishment of a healthy viable population may be hindered by loss of genetic variation being at a site away from other populations. Possible hybridization may occur when bringing a species outside its historical range and into the range of another related species. A site outside the known historical range may lack the habitat characteristics necessary for establishing a healthy population. Contrarily a site outside of the known historical range of the species may be the only place safe from the threats that brought the species to the remnant state we find them in today. In some cases, these sites may also offer the best management option for a particular species. It is also possible that the historical range is incomplete or no longer contain the most appropriate habitat including suitable moisture and soil composition.

f) Site Preparation: Once a proper site has been selected there are steps the agency or individuals can take to prepare it for reintroduction. In accordance with the management strategy for the species and site, it may be initially necessary to construct a small scale exclosure and/or weed non-native competitors around the site. These actions should be taken in concurrence with protection of the greater habitat, which is critical to the success of an established population. The season in which to plant must be considered. Generally mesic and dry plant species would face less challenges if planted during a wet season. If drought conditions persist for more than a year, it may be beneficial to wait for a better year if storage conditions allow. Techniques for preparing the soil to receive and support a new plant differ depending on the species. One should consider digging holes in advance and composting material on site to provide a favorable substrate. Composting materials should come from on-site and ideally be from native material. Soils may also be tested to guide soil preparation and future fertilization schemes. Coordination with the propagators is essential to ensure the fertilization and pesticide application schemes used in the greenhouse are adopted in the field. A catchment and watering system may also be considered.

During

2. The successful reintroduction from the greenhouse to the ground requires several issues to be taken into account.

a) Sanitation: Coordination with the propagator and collector is necessary to ensure that all aspects of rare plant handling is done with attention to sanitation. Collection should be done with sanitized tools and proper propagation techniques practiced to eliminate possible contaminants. Agencies and individuals involved with reintroduction need to coordinate with the propagator before the date of planting to make sure the propagules are prepared to go out. This may entail use of pesticides to ensure no foreign contaminants are transported to the site. The risk of spreading aliens via reintroduction activities must be adequately addressed and effectively eliminated. Seeds, slugs, disease, parasites, flatworms and other unintended inoculates must be prevented from being transported to the site by any aspect of the operation: protective management activities, materials, personnel and the plants themselves must all be completely free of contaminants. Care should be taken to clean all gear (boots, packs, planting tools, etc.) prior to arrival at the site to assure no contaminants are spread unknowingly.

b) Transport: Use caution when transporting fragile plants. Some species may need water or protection from the sun and wind during the transport. The most secure place in a vehicle for transporting plants is directly in back of the driver's seat.

c) Planting: Those involved in the planting of rare plants should be briefed before heading out to the site. Agencies and individuals directing reintroduction need to consider the techniques to be used in getting the plant from the container to the ground. Of special consideration is the decision to use a fertilizer in addition to any on site composting. In areas of low rainfall initial watering may be essential in easing the shock for the new plantings. Building up a pile of mulch around the base of a new plant can help to slow evaporation and keep water near the roots. A layer of cinder an inch thick placed around the base of a new planting can prevent slugs from reaching the plant.

Post

3. Following the reintroduction, monitoring is essential to maintain the health of the plant and the surrounding habitat.

a) Monitoring: Coordination with the agency or individual responsible for monitoring the existing populations may be necessary to see that a reintroduced population gets on a regular monitoring schedule. It is recommended that the site be monitored daily for a week after reintroduction. This close monitoring will insure that if there are problems with pests or other unforeseen threats such as drought, they can be addressed before they affect the plants. Use of the Rare Plant Monitoring Form (RPMF) will give important information pertaining to the location, phenology, population structure, habitat characteristics and threats to the new population. Individual plants may be labeled or tagged and tracked using the RPMF. The goal of a successful reintroduction is the establishment of a viable population that maintains the genetic variability of the species and produces successful offspring. Recruitment in the wild is necessary for the reintroduction to be deemed successful. Monitoring a new population is essential to tracking the lineage of the population and to maintain local genotypes. A consistent monitoring schedule will also reduce the chance of a contaminant affecting the population or surrounding habitat. Recording the watering, fertilization and pesticide application schemes will help guide future reintroductions. CPC is currently working on a database to track safety net species including outplantings. Information on reintroduced populations should be transferred into the database.

b) Maintenance: Watering, fertilization and pesticide application may be necessary to ensure success. Supplemental watering especially in dry areas will greatly improve chances for a successful reintroduction.

c) Management: Actions after reintroduction must be taken in concurrence with a habitat management strategy. Reducing competition for resources with non-native plants by weeding may be necessary. A necessary ungulate exclosure may require maintenance.

List of Contacts

Marie Bruegmann USFW--541-3441--marie_bruegmann@mail.fws.gov
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Kapua Kawelo USAG-ENV--656-7641--kawelok@schofield-emh.army.mil
Steve Weller UC Irvine--sgweller@uci.edu
Cliff Morden UH Manoa--cmorden@hawaii.edu
Vickie Caraway CPC--cpchinet@lava.net

Appendix 4-A Rat Monitoring Form

RAT MONITORING

DPW Environmental Predator Control Report Form

Date:____________ Range/Location:______________________________________ Observers:_____________

Total Traps, Stations, and Amount of Bait Left for Restock:

S = Snap Trap: _________ B = Bait Station:________ L = Live Trap:_________ □ = Bait Bucket_________

Directions/Flagging Scheme/Location of Restock Bait Bucket: ___________________________________

____

____

________________*BAIT RESTOCK INFO*

Bait Station #	# of Bait Gone	# of Bait Left	# of New Bait Put Out	Total Bait In Station

Bait Station #	# of Bait Gone	# of Bait Left	# of New Bait Put Out	Total Bait In Station

Total Bait Available:____________ Total Take:____________ Total New Bait:____________

Notes:

Appendix 4-B Snap Trap Catch Report

Number of Trap Nights:_______________ Total Rats Snapped:________________

Indicate date change in Notes section if traps are checked for 2 consecutive nights

For Trap Status: S = Sprung w/o hair H = Snapped w/ Hair R = Snapped w/ Rat U = Unsprung

Trap #	Trap Status	Predator	Sex	Species	Notes

****Reminder: Clean hair off snaps before resetting****

Notes:____

____

____

____

____

LIVE TRAP CATCH REPORT

Trap #	Predator	Sex	Notes

Number of Trap Nights:___________

New Population? Y / N
_____Entered into GIS?

Rare Snail Observation Form

Scientific Name: ____ Date: _________________
Pop Ref Code: _______________________ Range: _______________________________
Elevation: ____________ft/m Observers: _________________________ Aspect: ___________

Location/Flagging Scheme (orange/blue):
____
____
____
____
____

Weather: _________________________ *Effort (people hours):* _______________________________________

GPS? Y / N Coordinates: __________________ Photo Y / N?

Predation: Ground search conducted for fresh shells? Y / N Area searched: ________________m^2
People Hours: ______________ # intact___________ #rat damaged_____________
Empty shells collected for reference? Y / N

Population Structure:

Small	Medium	Large

Achatinella mustelina: small ≤ 8 mm, medium 8-18 mm, large ≥ 18 mm
Koolau *Achatinella*: small ≤ 7 mm, medium 7-15 mm large ≥15 mm

Threats/Management Recommendations/Actions Taken/Notes:
____
____
____
____
____

Count/Density: ___________SNAILS __________________SNAIL HOURS

SKETCH MAP OF SITE (indicate area ground searched):

Snail meeting agenda

Kewalo Marine Laboratory library
May 12, 2004
8 a.m. – 10 a.m.

8:00-8:15	Update on status of captive snails
8:15-8:30	Summary of upcoming Oahu IP proposed snail management recommendations
8:30-8:45	Funding status
8:45-9:15	Discuss Army responsibility to do genetic testing on captive snails
9:15-10:00	In situ management (snail management handout)

- Exclosure construction
- New ESU designations, and management of 8 vs. 10 populations
- *Euglandina* research possibilities?

Attendees:
Patrice Ashfield, Michelle Mansker, Mike Hadfield, Lorena Wada, Dan Sailer, Kapua Kawelo, Vince Costello, Leilani Durand, Steve Miller

Meeting notes:

Kapua summarized the Army's new snail binders organization system.

Snail status update:
Mike had been concerned about flatlines in growth for captive snails. Took some *A. fuscobasis* and removed 5 adults from terraria and moved them to other terraria, numbers immediately jumped. Source populations also jumped. Apparently there is a density factor, even in the largest terraria. They were separated on Nov. 20th, and between then and April 26th, from *A. partulina*, 5 separate adults produced keiki, which is an 80% reproductive rate, which is very high. The 5 adult *A. fuscobasis* produced 5 keiki, while the source population 26 adults had 12 keiki. There are apparently some density factors at work, which is generally an easy problem to solve. Currently space is limited in the environmental chambers. One of the chambers has been down for the last 6 months. The company the chamber was purchased from won't help because the chambers are 6 years old or more, so Mike's lab is trying to fix them in-house. Hopefully they will get broken one back in operation soon. Originally it was thought that population numbers were declining due to high mortality, but it was a low birth rate.

Vince: some of the populations we brought in last year, it looks like some of those populations have doubled over the year.

Mike: we don't like to start with low numbers, 7 or more seems to be working. Terraria with 25 or more adults seem to have overcrowding problems.

Tap: this just underscores what we've already said, we need to secure some outside places to reintroduce these snails.

Vince: there are more than 300 *fuscobasis* now.

Tap: and it's not great that they're all in one place, that has its own inherent risks. We're working hard to figure out funding sources to get snails out of the lab. We'd like to look at the Army's funding sources and look at partnering to do things like that.

Mike: the State said they were purchasing materials for exclosures, but I'm not sure what the status is.

Vince: the materials are up at the Nike site, but we're not sure when they'll build.

Tap: (Steve Miller just entered) Do you know what the state will do with their recycled plastic planks that are supposed to be used for an exclosure?

Steve: I don't know.

Tap: I haven't seen anything from Brent, section 6 related, for the new fiscal year yet.

<u>Oahu Implementation Plan:</u>

Kapua: Michelle's going to be the Oahu IP point of contact, and Patrice will be involved, too. After having learned a lot about plan writing from the Makua IP, we wanted to streamline the process and have subcommittees. So pretty much for snails, it's mainly Koolau species. We'd like to have Mike, Vince, Talbert, USFWS, and whoever else from our team has specific knowledge. In terms of developing SPs, we have our digital information organized. We expect to have someone on the Oahu IP job at the end of the month. The person writing it will be an RCUH employee.

Dan: it'll include the expanded South Range area to be used for transformation?

Kapua: yes, but there won't be much impact from that.

Dan: well, the firing range is potentially pretty close to Puu Hapapa, and there are potential fire impacts.

Kapua: probably what we'd be doing initially is developing species background information, and asking Mike for information on the snails.

Mike: so that's already started?

Kapua: once the person is hired we'll start, but we've got a lot of the associated data organized. And we'll hopefully be doing less off-site management for snails, because the threat from training is so low to Koolau snails, we'll be focusing on on-site management. So we'd want to review the genetics information.

Mike: I hired someone who started the first day of March. Bjorn Erickson, he's got a background in molecular biology, so he's now working on building the microsatellite library, and it's about ¾ of the way along.

Steve: is that per species?

Mike: no, it should be useful across species. These are snails that died in the lab and are well preserved, so we have the larger tissue samples that we need for this research.

Funding update:
Leilani: the $78k we requested for this year should be in Mike's RCUH account right now. The cost estimates for the next 33 years were recently completed, and we included $50k/year to cover the cost of supplies and one person to raise snails in the lab.

Tap: does this also cover the Oahu IP?

Kapua: no, this is just Makua. Until the Oahu IP is written we don't know how much money we'll ask for.

Tap: right now we're doing all the funding of the captive facility, and it's getting harder for us to secure funds. Right now we're funding Mike at $83k for the captive facility, but when you're funding the Oahu IP we'd like to look at potentially sharing that cost. I know that you guys need to know way in advance what you may need.

Steve: do have any idea when you'll get money into your budget for the Oahu implementation stuff?

Kapua: We need to find out from the USFWS if we are supposed to develop urgent actions.

Michelle: I'm not sure. Maybe for *Eugenia*.

Kapua: unless the team identifies that money is needed right away I don't see us getting money before the plan is finalized. That should be in December 2005, so money would be available for '06.

Tap: so you'd put in your request for funds in '05?

Kapua: yes, and we'd put in money earlier for *Eugenia* and things that are high priority. Because snails are so far removed from training, they weren't put in the list of things that need funding right away.

Dan: Training will have consequences for Ekahanui snails. Is there any more immediate money for more 'elepaio baiting that will also affect the snails?

Kapua: we can do baiting in Ekahanui as part of the Makua funding, that's one of the ESUs. 'Elepaio baiting will be more intensive so won't be funded until the plan is. We may be doing management of 'elepaio offsite, so in the next 3 years we'd be supporting you guys in larger-scale rat baiting.

Tap: so after 2006?

Kapua: USFWS could ask Joel if there are things we could fund sooner.

Steve: I asked because 5 of the non-*mustelina* species are in the Oahu BO. I think you guys need to plan right now for getting funding into the captive propagation component because the program is already going. What we need to get from Mike is what are the costs associated with the 5 species we currently have in captive propagation. It's critical because by 2006 we're looking at as much as a 20% budget cut in our own budget, so it's going to fall to the Army more and more to make sure that the captive propagation program is sustained.

Michelle: I can talk to Joel and let him know we need to make sure there's no gap in Mike's funding.

Kapua: at our last IT meeting we discussed funding, and the Army isn't happy with the money we requested as part of the full IP. So we asked the USFWS to scale down and focus on 3 populations/species. We cut the requested funds in half, but so far we've never received full funding from the Army, and we're not sure if we will next year. So maybe we should ask the State if they can contribute.

Mike: we used to get section 6 money from the state, but not anymore.

Tap: we need to get ahold of someone from the State; we need permission to collect snails for propagation from Waianae Kai, and to find places to put snails from the lab back out into the wild. I'm just having a really difficult time getting a response from anyone from the State. But we'll keep trying, and we'll try to get funding from other places. If we partner and look for multiple sources we should be able to cover Mike's propagation needs.

Kapua: I just need to talk to Joel about funding what we can for the Oahu IP, and funding things up front.

<u>Genetic testing:</u>

Kapua: we haven't yet talked about the Army's responsibility to do genetic testing on captive snails. And the change in ESUs hasn't been discussed. I wanted to bring this to the USFWS representatives. We were originally going to manage 10 populations from 8 ESUs, two populations from the two larger ESUs and one population from each of the smaller ESUs. Now that there 6 ESUs should we manage 8 populations?

Mike: I still agree with the logic of our original discussions. Managing 8 populations makes sense.

Kapua: old ESUs C, D, and E are now one. So how do we treat those? Another issue to discuss is that at Schofield West Range, our access has been terrible. I'd like to think that the Army would give us more access and we could manage that population, but I don't know. It seems like with the Oahu BO it should have changed, but it didn't.

Steve: does that affect all of the C sites?

Kapua: no, the other C sites are really steep. There's another option, Manuwai gulch is one gulch west from Palikea Gulch, and we haven't really looked for snails there, but I was going to suggest that we maybe have Vince do some surveys out there and try to find an area with a high density of snails where we could do management. But I don't know if we need to do more genetics on any new population we might find there?

Mike: doing genetics would be the best thing to do.

Kapua: okay, we'll plan on doing that. I guess we need to still answer the question of how many populations to manage in ESU C. The management options in that ESU aren't really great.

Mike: I thought we were ending up with 8 managed populations. B and D in the new scheme would be the only ESUs duplicated.

Kapua: that's what we have here in our proposal right now.

Mike: I think that's totally reasonable.

Kapua: anyone here is welcome to join us in the field for our snail searches or to help with management.

Mike: Shaun would like to go, but he's leaving to go to grad school. He'll only be here through July.

Kapua: and then the issue of genetics testing for captive snails. It's not in the IP, but Mike thinks it's an important component of managing the captive snails.

Mike: our concern is inbreeding. Since they're all hermaphrodites it makes the situation better. This year we've noticed that *apexfulva* is reproducing from only 1 adult. I've been worried for a long time about all the species where the populations are very small.

Kapua: should we worry about that then for the Oahu IP?

Mike: I'm sure there are still more pockets of snails out there that we haven't found. But genetics testing should be part of the management scheme.

Kapua: I could see doing genetics on those populations every 5 years.

Mike: it's not a big expense, so I don't think it requires more money than you have right now for the Makua IP.

Kapua: we'll work on the estimate for maintaining the snails and doing the genetics work.

Steve: the new Koolau snails opens up a whole new arena of questions. What do we need in terms of genetic analysis to determine if these are all legitimate species? The next thing would be, within a species do we need to assess for any ESUs? This could affect how many populations should be managed. Even if we end up with things that look like the same ESUs, if they're covering a large enough range, we're going to want to stabilize something that represents the extremes of the range. We're also basing all our determinations on just one gene, so managing 8 populations for the Makua IP seems reasonable, and we're going to want to do the same type of assessment for the Koolau snails.

Mike: *A. livida* and *A. byronii* are the two we really need to look at.

Kapua: we need to start working on this soon.

Mike: we don't have as many samples for the Koolau snails, so more sampling needs to be done. The one thing we know about *livida* and *sowyerbyana* is that all *livida* is senestral and all *sowyerbyana* is dextral.

Kapua: I wonder if the ESU discussion is moot for the Koolau snails because there are so few sites.

Steve: for now it is. For now preserving the field populations that are out there are the two critical things that need to be done right away, and then considering where we want to reintroduce snails. Where we have large populations in the lab, getting them back into the field.

Mike: and the problem with the Koolau locations is that most of the populations have gone way down since we first started looking at them.

Steve: the other thing I'd try to do for the areas where we used to see snails and aren't seeing them anymore is do a lot of surveys and get any snails we find into the lab.

Kapua: this leads into struggles we've been having with field management of *Achatinella*. Unfortunately a lot of these ESUs are in really steep habitat, and the snails are scattered, so they don't lend themselves to exclosure construction. We wanted to ask you guys what you think we should do for *Euglandina*. We want to manage snail populations that will be in larger-scale ungulate exclosures and conduct weed control on a large scale. We'll monitor them regularly and do rat baiting, but we don't know what to do about *Euglandina*. We have money to fund research for *Euglandina* attractants or baits.

Mike: I developed a bait, but we couldn't use it. *Euglandina* is so spotty, and the bait doesn't hold up on the field. Are you seeing lots of *Euglandina* in the Koolaus?

Vince: we don't see a lot. We're in the field often, and you may go months without seeing a live one, and then you may see several.

Mike: it might be that you if you get rats under control *Euglandina* is less of a problem.

Kapua: and then having a good backup population in the lab is really important.

Tap: I would say right now mechanically killing them may be your best option. Maybe we could wait and see, if we have bait and it isn't working.

Kapua: do you know anybody who would want to do more research on Euglandina and developing a bait?

Mike: we worked with the capsaisin guy, but when it didn't work for us we didn't hear from him again.

Kapua: one thing we've been thinking of is trying to develop a screen or something to cover an area so *Euglandina* couldn't get in. But we're not sure how big the *Euglandina* babies are.

Mike: there are areas on the north summit of the Koolaus that are flat enough to put up exclosures. Maybe thinking about small exclosures is the way to go.

Dan: maybe we should do some releases in areas where we're controlling rats and monitoring them to see what happens. Do periodic searches for *Euglandina* and continue controlling the rats.

Mike: I haven't seen an area where anyone has successfully controlled the rats.

Dan: at Puu Hapapa we have about 15 stations in the area, but we haven't had time to do the monitoring to see if the populations of snails have decreased or not, but we're still going to keep on baiting in these areas. We could then look at doing releases.

Kapua: at Makaha the snails are widely scattered, so baiting across the whole area would be difficult. It may work better to move the snails to one area and bait in that area.

Mike: yes, but remember, snails don't like to get moved.

Kapua: well maybe we could move snails from the lab into those areas.

Mike: we created a net with nylon window screen to protect the snails, but we couldn't keep the snails in. I think it created a microclimate they didn't like.

Kapua: it's good to hear from you guys that our proposal to put snails in ungulate exclosures and weed and rat bait in those areas is a good start. And we'll see how it goes with the State and their new exclosure.

Mike: have you met Jenny Davidson? She just moved out here, and she's an expert on the fungus killing oak trees on the mainland. She's a good tree pathologist who may be interested in black twig borer. She's in the zoology department.

Dan: TNC recently received funding for a small fence at Puu Hapapa, so hopefully we'll be building toward the end of this year. There are many snails up there.

Kapua: and we did fence the South Range population, and the 'ie'ie is looking better and mamaki is coming up. The exclosure is about one acre.

Vince: we did a snail count in the Kahanahaiki exclosure last week, and we found 68 snails inside the exclosure, and we're starting to look outside the exclosure and mark them. We're wondering if you're interested in going sometime to Pahole?

Mike: yes, and I'd like to get both of my assistants out there.

Michelle: I'd like to go too.

Mike: the next 3 weeks are a good time to do this.

Mike: I have accepted a new grad student, Kevin Gill, and he really wants to do field ecology with the tree snails. I'd like to get him working with you guys in the northern Koolaus. When Kevin gets here and gets started I'll let you know. I'll be supporting him on the USFWS grant.

Mike: what about the *concavospiras*?

Dan: they're pretty far out there, and there's very little management being done for them. North Palawai may also have some live ones, but I haven't seen them. That's another project that would require help. We're trying to get money to build a fence in North Pualii, so that would help.

Appendix 7 MMR Keawaula Post Fire Survey

MMR Keawa`ula Post Fire Survey
September 11, 2003

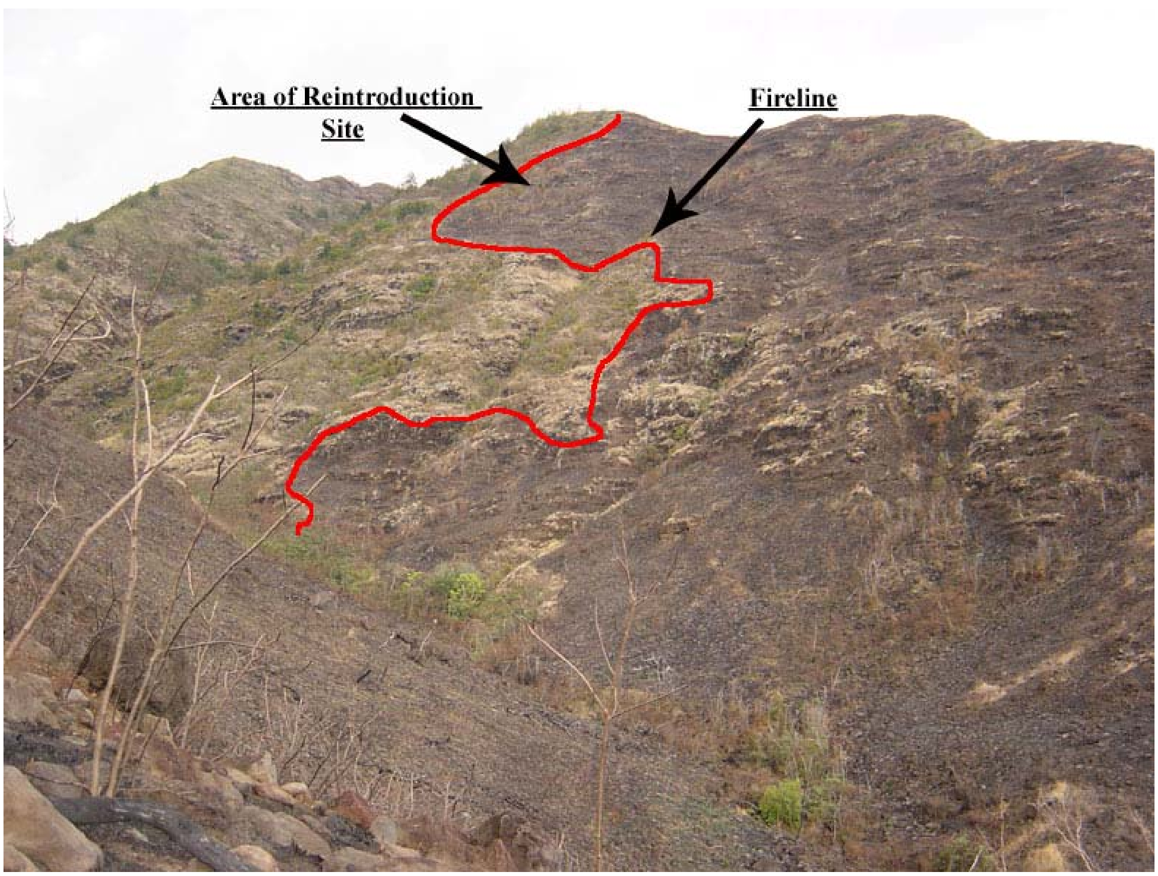
APVG-GWV (200-3) 15 September 2003

MEMORANDUM FOR RECORD

SUBJECT: Reconnaissance for Fire burning into Makua Military Reservation, started on 8/15/03 in the Keawa`ula area, north of Makua Valley.

1. On 11 September 2003, Naomi Arcand and Lasha-Lynn Salbosa surveyed an area damaged by a fire that burned into Makua Military Reservation (MMR) on 15 August 2003. The purpose of the follow up survey was to generate an exact map of the fires' extent and to assess impacts to a reintroduction site of federally listed plant species.

2. A map showing the extent of the fire is attached. A total of 675 acres burned (enclosure 1.) The fire started near the entrance to Keawa'ula Beach Park on Farrington Highway. The cause of the fire was determined to be arson.



View from Keawa'ula Beach Park looking up at Puaakanoa Ridge, which borders Makua Valley Military Reservation. The reintroduction site of *H. brackenridgei* subsp. *mokuleianus* lies just within the fireline.

4.

Outplanting site of *H. brackenridgei*, marked with a flagged pole. Although the fire did not engulf the entire reintroduction site, at least 90 percent of the site suffered from considerable heat damage.

Reintroduction site near Kaluakauila fenceline damaged by fire. Approximately 250 meters of fenceline was damaged in the fire and may subsequently need to be replaced.

5. In addition to impacting the reintroduction site of *H. brackenridgei* subsp. *mokuleianus*, planted 10 December 2002, a number of other native plant species were also burned. See below for a partial list of native and alien species surveyed. In addition, under-story species were burned but not documented due to unidentifiable charred remains.

Native Plant Species	**Alien Plant Species**
Diospyros sandwicensis	*Leucaena leucocephala*
Santalum ellipticum	*Panicum maximum*
Hibscus brackenridgei subsp. *mokuleianus*	*Grevillia robusta*
Dodonaea viscosa	*Melinus minutiflora*
Erythrina sandwicensis	
Sida fallax	
Bydrax odoratum	

5.

View looking down at Keawa'ula Beach Park from the reintroduction site outside the fire line. *P. maximum* and *L. leucocephala* dominate much of this area through which the Kuaokala Road bisects. The fire line burned down to the beach stopping only by the roads' edge.

6. POC is the undersigned, 656-7641/7741.

Encl

KAPUA KAWELO
Biologist, Environmental Division