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U. S. ARMY GARRISON HAWAII
OAHU TRAINING AREAS
NATURAL RESOURCE MANAGEMENT

FINAL REPORT

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For the U. S. Army Garrison, Hawaii

Contract: Scopes of Work for the Ecosystem Management Activities at Makua Military Reservation, Island of Oahu and Ecosystem Management Activities at Various Training Areas, Island of Oahu.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

INTRODUCTION

The Natural Resource Staff (NRS), employed by the Pacific Cooperative Studies Unit (PCSU), were charged with managing rare plants and animals and the ecosystems upon which they depend under the contract scopes of work entitled: Scope of Work for Ecosystem Management Activities at Makua Military Reservation, Island of Oahu and Scope of Work for Ecosystem Management Activities at Various Training Areas, Island of Oahu. 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 authorities to carry out programs for the conservation of federally listed species and to ensure that their actions are not likely to jeopardize the continued existence of any federally listed species.

O`ahu training areas include Makua Military Reservation, Schofield Barracks Military Reservation, Kawailoa Training Area, Kahuku Training Area and Dillingham Military Reservation (See Figure A). A total of sixty-eight endangered species, fifty-six plants and fifteen animals, have been reported from O`ahu Army Training Areas since 1970.

O`ahu training areas encompass 46,000 acres and range from intact native forests to completely alien dominated areas. To prioritize management, NRS have delineated management units (MUs) within each training area. These units are 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, which includes ungulate, and weed control in these areas. Two areas in Mākua have been designated as ungulate control areas because the forest in these regions is degraded in nature and does not warrant widespread weed control attention. The only threat control performed in these areas is ungulate control. Outside the MUs and ungulate control areas, NRS conduct primarily single species level management.

On O`ahu, the Army has two primary means of impacting threatened and endangered species, fires caused by live ammunition training, and weeds spread by training maneuvers. NRS assist in minimizing training impacts to threatened and endangered species by conducting road and landing zone surveys and addressing any weed problems that arise. NRS conduct post fire surveys to determine impacts to threatened and endangered species and make recommendations to improve training protocols. The aforementioned actions are a part of the minimization actions set out in the Section 7 Biological Opinion for Makua Military Reservation dated July 23, 1999.

Through the work performed under the Ecosystem Management Program contract, the Army has become a major player in conservation on the island of O`ahu. NRS have established cooperative relationships with neighboring land managers and landowners and have successfully promoted ecosystem project partnerships. This report summarizes the natural resource protection work conducted in this contract period (August 2000 to August 2001). The Chapters are as follows, Feral Ungulate Management (Chapter 1) and Weed Management (Chapter 2), Rare Plant Management (Chapter 3), Rare Vertebrate Management (Chapter 4), Invertebrate Management (Chapter 5), and Stream Management (Chapter 6). This report comes at the completion of the fourth year that PCSU contractors have been conducting natural resource management on Army training lands on O`ahu. NRS have used this report to critically analyze management approaches and efforts and to make recommendations for next year's work.

Table A: PCSU Line Items
Makua Military Reservation

Line Item	Chapter					
	1	2	3	4	5	6
1(a)	X					
1(b)	X					
1(c)	X					
1(d)	X					
1(e)		X				
1(f)		X				
1(g)			X			
1(h)			X			
1(i)				X		
1(j)				X		
1(k)					X	
1(l)		X				
1(m)		X				
1(n)		X	X	X		
1(o)			X			
1(p)			X			
1(q)			X			

Various Training Areas

Line Item	Chapter					
	1	2	3	4	5	6
1(a)	X					
1(b)	X					
1(c)	X					
1(d)	X					
1(e)		X				
1(f)		X				
1(g)			X			
1(h)		X				
1(i)			X			
1(j)			X			
1(k)				X		
1(l)					X	
1(m)					X	
1(n)						X
1(o)		X	X	X		
1(p)			X			
1(q)			X			

Makua Military Reservation (MMR)

MMR encompasses two valleys, Kahanahāiki and Mākua, which are the northern-most valleys in the Wai`anae Mountains. Encompassing approximately 4,190 acres, 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 intact dry and mesic forest. The terrain at MMR is extremely steep, exposed and rocky. There are five MUs and two ungulate control areas within MMR (See Figure B, Management Units Makua Military Reservation). There are a total of thirty-three endangered species in Mākua, thirty of which are plants.

Kahanahāiki Management Unit

Kahanahāiki MU is located on the northeast rim of Mākua Valley. At its boundary to the East, is the State of Hawaii's Pahole Natural Area Reserve. Kahanahāiki has an elevational range of 1,500 feet to 2,300 feet and an annual rainfall of 1,200 mm-3, 800 mm. Kahanahāiki MU is approximately 110 acres in size and is characterized as being a diverse mesic forest. Ridges and drainage's that feed into the northern half of MMR (Kahanahāiki Valley) dissect the Kahanahāiki MU. A feral pig exclosure fence surrounds 90 acres of the Kahanahāiki MU. This fence was completed in December of 1996. Kahanahāiki contains twelve endangered plant species and two endangered animal species and is the site of the first endangered species outplanting on military lands in Hawaii. 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 forty acres. The terrain is extremely steep and rocky and access to the upper portion of this management unit is by helicopter only. Large patches of `Ōhikilolo Ridge lack vegetation and erosion by wind and rain is severe. A large population of goats once exacerbated this problem by consuming most of the vegetation on the ridge. With intensive goat control measures and a perimeter fence installed, this MU is now very close to being ungulate free. `Ōhikilolo MU harbors a great deal of intact vertical cliff habitat and small patches of intact mesic forest. There is a goat-proof exclosure of approximately two and a half acres at the plateau where `Ōhikilolo ridge meets Kea`au ridge from the south. `Ōhikilolo contains thirteen endangered plant species and two endangered animal species. `Ōhikilolo is also home to the largest population of *Achatinella mustelina* known to NRS.

Kaluakauila Management Unit

Kaluakauila MU is approximately forty-five 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 made up primarily of dry forest on steep slopes and contains some intact native cliff habitat. Kaluakauila MU is very susceptible to fires because the habitat surrounding the intact native forest patches is comprised of introduced grasses and shrubs, which have very high fire potentials. There are a total of six endangered plants in Kaluakauila MU.

Lower Mākua Management Unit

The Lower Mākua MU is located at the base of the cliffs on the southern side 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 on O`ahu. The Lower Mākua MU contains eight endangered plant species and two endangered animal species.

C-Ridge Management Unit

The C-ridge MU is located on the north exposure of the large ridge, which 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 which limits the amount of time spent and number of trips made to the area. This MU is susceptible to fires from military live-fire training. There are a total of three endangered plant species known from this MU.

East Rim Ungulate Control Area

The East Rim Ungulate Control Area is situated at the headwall of the southern side of Mākua Valley, opposite Pahole Natural Area Reserve. It contains small native mesic forest patches but is dominated by non-native canopy and understory species. Christmas berry (*Schinus terebenthifolius*) dominates large portions of this area. The substrate character of this Ungulate Control Area varies from loose rocky soil to rocky cliff. This unit extends from 1,800 ft to 2,600 ft and is approximately one hundred acres in area. There are a total of three endangered plant species in the East Rim Ungulate Control Area.

Ko`iahi Ungulate Control Area

Ko`iahi Ungulate Control Area is centered on Ko`iahi gulch, which is the southernmost subgulch of MMR. The southern boundary ridge of Mākua, `Ōhikilolo, and a spur ridge off of `Ōhikilolo form Ko`iahi gulch. Alien scrubby vegetation and kukui (Aleurites moluccana) overstory dominate this area. The substrate character of Ko`iahi ranges from rocky talus, to rocky cliff and gulch substrates. This area extends from 400 ft to 2,200 ft in elevation and is approximately two hundred and thirty acres in area. There are a total of eight endangered plant species in Ko`iahi Ungulate Control Area.

Schofield Barracks Military Reservation (SBMR)

SBMR is located in central O`ahu on the west and east side of Wahiawā town. SBMR is approximately 9,676 acres and encompasses lands that stretch from the summit of the Ko`olau Mountains in the east to the summit of the Wai`anae Mountains in the west. The Army uses Schofield Barracks for live-fire and 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) Ranges (See Figure C, Management Units and Training Ranges Schofield Barracks Military Reservation). Hazards associated with unexploded ordnance (UXO) restrict ecosystem management possibilities in SBW. NRS will focus surveys this year in SBW to better identify MUs. The impacts of these limitations are discussed within each chapter. In both SBS and SBE, management units, which encompass the most intact portions of the training areas, have been designated. SBW, on the other hand, has not been adequately surveyed for areas that meet MU standards because of the UXO limitations. At present, management work is limited to the single species level. There are a total of three MUs within SBMR (See Figure C, Management Units and Training Ranges of Schofield Barracks Military Reservation). There is presently only one MU within SBW at Mt. Ka`ala. There are a total of forty endangered species in SBMR, eight of which are animals.

Ka`ala Management Unit

The Ka`ala MU encompasses approximately one half of the wetland atop the summit of Mt. Ka`ala at 4,100 ft. It also extends down the slopes of Mt. Ka`ala to approximately 3,200 feet in elevation. The total area within this MU is approximately eighty acres. The flat summit forest portion of the MU is characterized by drenched, mossy soils and is considered to be an immature bog. The sloped region of the MU contains both wet forests with very organic soils and native plant-dominated cliff habitat. There are three endangered plants within the Ka`ala MU. NRS have also detected `i`iwi on several occasions in the Ka`ala MU.

Pu`u Hāpapa Management Unit

The Pu`u Hāpapa MU is located at the top of Pu`u Hāpapa, the first peak to the south of Kolekole Pass. The MU is approximately nine acres. The elevation ranges from 2,400 ft to 2,900 ft. The forest within this MU 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 thus single species management is the focus. The Pu`u Hāpapa MU is home to a large population of *Achatinella mustelina* and a population of rare terrestrial snails, *Laminella sanguinea* and *Amastra micans*. There are also three endangered plants located within the MU

Schofield-Waikāne Management Unit

This MU encompasses 780 acres between 1,600 feet and 2,600 feet in elevation of the southern-most portion of the KLOA and the summit portion of SBE. The forest types within the Schofield-Waikāne MU include short stature wet forest near the Ko`olau summit region, and at lower elevations, taller-stature wet forest. 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 Hawaii. The State of Hawaii, Division of Forestry and Wildlife, has primary management responsibility and authority for this portion of the MU. The Schofield-Waikāne MU is home to thirteen endangered plants and five endangered animal species.

Kahuku Training Area (KTA)

The KTA is approximately 9,400 acres of land, which has been leased for years by the Army from Campbell Estate and was recently purchased by the Army. Elevation within KTA ranges from eighty feet to approximately 2,100 feet above sea level (See Figure E, Kahuku Training Area). The Army uses KTA for pyrotechnic training and foot maneuver training. Habitat within KTA is highly disturbed with some small, predominantly native pockets in upper elevations. The terrain consists of rolling hills dissected by broad drainages in lower elevations and relatively steep and windswept ridges in upper elevations. There are no MUs designated in KTA because surveys have not identified areas that meet the biological criteria. NRS will continue to search for areas that meet MU designation criteria. There are five endangered plants and two endangered animals found at KTA.

Dillingham Military Reservation (DMR)

DMR is approximately 665 acres. It is located near the northern tip of O`ahu, between Mokulē`ia and Ka`ena Point (See Figure F, Dillingham Military Reservation). The Army uses DMR for para-drop and night-vision goggle exercises. The elevation at DMR ranges from sea level to 400 feet. Habitat within DMR is highly disturbed with very little native flora surviving. However, small stands of native forest and shrub land 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 oahuensis* or Lonomea. This area could be classified as a MU but in this document is not treated as such. This area does not fulfill the necessary biological criteria to be considered a MU.

DMR also harbors a perennial spring seep habitat that begins at the uppermost portions of the reservation and has running water to about sixty feet in elevation. There are four endangered plants known from DMR.

CHAPTER 1 FERAL UNGULATE MANAGEMENT

1.1 PCSU Contract Requirements

The following is a list of PCSU contract requirements related to ungulate management followed by a brief discussion of NRS accomplishments.

Makua Military Reservation

Requirement (1a)

Monitoring established transects in Makua Military Reservation (9 transects) every quarter. Transects are 500 meters in length and 2.5 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." Based on ungulate findings and rare plant monitoring, recommendations shall be made for management actions.

Discussion

All nine transects in MMR are located in biologically sensitive areas or where ungulate control is in progress. Of these nine transects, eight are monitored quarterly and the last (MMR 4) is monitored twice per year. All transect data is recorded on DPW Environmental Ungulate Transect Data Sheets (Appendix 1-A) and analyzed to guide future management decisions.

Requirement (1b)

Implementing snaring/firearms use in MUs and Ungulate Control Areas to control feral pigs and goats and supporting U. S. Department of Agriculture ungulate control efforts, if necessary. Should snaring/firearms use be implemented, data shall be noted on Appendix 1-B. Firearms use shall be conducted as described in the US Army Garrison, Hawaii, Directorate of Public Works Standard Operating Procedure entitled, "DPW Standard Operating Procedure for the Safe Handling, Storage, Use and Transportation of Firearms." All data shall be analyzed and recommendations made for management actions.

Discussion

Snaring and firearms have proven to be highly effective for ungulate removal. Snares and firearms are being used for ungulate control in areas where these control measures are appropriate and feasible.

Snaring

NRS use snares to control ungulates in areas that are remote and difficult to access. To increase effectiveness, snares are generally placed in-groups along well-used game trails as they pass through narrow corridors and in areas where the terrain is steep. Snare locations and catches are documented on DPW Environmental Snare Report Forms (Appendix 1-G). All catches are sexed, sized and the feral pigs are given an approximate age utilizing a tooth eruption chart.

Firearms

Presently, NRS use firearms when checking snares or when entering areas that are known to have high numbers of feral ungulates. All NRS using firearms are certified by the State of Hawaii Hunter Education Program and as firearm safety instructors with the National Rifle Association. Personnel adhere to the procedures outlined in the "DPW Standard Operating Procedure for the Safe Handling, Storage, Use, and Transport of Firearms." All catches are recorded on Trip Report forms.

Aerial shooting by U. S. Department of Agriculture (USDA) Wildlife Service's staff has continued to be an effective tool for removing goats from remote, dangerously steep areas in MMR. Aerial shooting will be discussed in section 1.4. Wildlife Service's staff has continued to conduct ground hunts as well in MMR. Results from the hunts show a major decline in the catch rate as compared to last year.

Requirement 1(c)

Implementing recommended ungulate control for MMR as described in the 1999 PCSU report. This plan shall be re-evaluated and updated on an annual basis based on findings/data from items 1(a) and 1(b).

Discussion

NRS have developed a strategy, which address ungulate control for all Army training areas on O`ahu. The ungulate control plans in this report outline the basic goals for each MU as well as a quarterly timetable of actions that will accomplish these goals. They also contain a brief discussion of on-going ungulate management in each unit. The plan for each MU is based on a variety of factors including transect data, hunting and snaring effort/success, the type of on-going management in each MU, accessibility, safety, and resource/staff limitations. These plans are re-evaluated and updated annually by NRS.

See ungulate control plans, which are listed in each MU below.

Requirement 1(d)

Inspecting all fencing every quarter and performing repairs, if necessary.

Discussion

All fences in MMR were inspected quarterly and all repairs were completed as necessary. The Kahanahāiki fenced exclosure was vandalized again this year. Several of the holes previously cut in the fence last year were reopened. It is still unclear what purpose these holes may serve. NRS patched the holes before any animals were able to enter the exclosure. NRS will work with DLNR to try and improve enforcement in the area. Regulatory and informational signs have been installed.

NRS have been documenting rust along a 400 meter portion of fence below Transect 8 on `Ōhikilolo ridge. The corrosion had been limited to just one wire of the fence but has expanded to encompass an ever-increasing amount of the fence. A corrosion inhibitor was applied on two occasions but does not appear to be effective. NRS has discussed and shown the problem to the contractor. The contractor was going to inquire about a warranty and the supplier replacing the

corroding portion of fence. Corrosion has now also been found on the lowest portion of the fence, which another contractor installed. This portion of fence was completed in 1998 and is already showing signs of heavy corrosion. `Ōhikilolo ridge is a very exposed harsh environment, especially for metals exposed to the wind, sun and salt spray that is prevalent. The life expectancy of the fence may be severely reduced due to the harsher than usual conditions experienced in this environment.

Various Training Areas

Requirement 1(a)

Monitoring established ungulate transects in SB (3 transects) and KWTA (7 transects). Transects are 500 meters in length and 2 ½ m 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." Based on ungulate findings and rare plant monitoring, recommendations shall be made for management actions. To also support transect monitoring, incidental observations of ungulate activity shall be noted and included in management recommendations.

Discussion

All transects in SB and KLOA are located in biologically sensitive areas or where ungulate control is in progress. Of the eight transects in KLOA, three (KLOA 1, 2, and 3) have been removed due to their location outside biologically sensitive areas and outside of areas where ungulate management is in progress. All remaining transects in KLOA are monitored once or twice per year. Only two transects remain in SB due to the lack of large biologically sensitive areas in SBS and access restrictions imposed in SBW. One is monitored two times per year while the other is once a quarter. All transect data is recorded on DPW Environmental Ungulate Transect Data Sheets (Appendix 1-A) and analyzed to guide future management decisions.

Requirement (1b)

Implementing snaring/firearms use in MUs and Ungulate Control Areas to control feral pigs and goats and supporting U. S. Department of Agriculture ungulate control efforts, if necessary. Should snaring/firearm use be implemented, data shall be noted on Appendix 1-B. Firearms use shall be conducted as described in the US Army Garrison, Hawaii, Directorate of Public Works Standard Operating Procedure entitled, "DPW Standard Operating Procedure for the Safe Handling, Storage, Use and Transportation of Firearms." All data shall be analyzed and recommendations made for management actions.

Discussion

NRS continue to employ snares as a tool of management in SB. These devices are still proving to be effective in controlling ungulate numbers in the biologically sensitive areas located there. All but one snare group have been pulled from KLOA, as they appear to be less effective at controlling the ungulate numbers there.

NRS and the USDA Wildlife Services Program continue to conduct ungulate control hunts using high-powered rifles and shotguns in SBW.

Requirement 1(c)

Implementing the ungulate control plans developed for SB and KWTA. These plans shall be reevaluated and updated on an annual basis based on findings/data from items 1(a) and 1(b).

Discussion

The ungulate control plans in this report outline the basic goals for each MU as well as a quarterly timetable for each action toward accomplishing these goals. They also contain a brief discussion of on-going ungulate management in each unit. The plans for each MU are based on a variety of factors including transect data, hunting and snaring effort/success, the type of on-going management in each MU, land uses in adjacent parcels, accessibility, safety, and resource/staff limitations. These plans are re-evaluated and updated annually by NRS.

See ungulate control plans, which are listed in each MU below.

Requirement 1(d)

Inspecting the fence in the upper Pe`ahināi`a MU, KWTA every quarter and performing repairs, if necessary.

Discussion

All fencing in KLOA has been inspected and continues to be secure from any vandalism or corrosion. A new fence was constructed this year encircling approximately 150 acres of largely intact forest around the Pe`ahināi`a trail/summit area. The fencing project was a cooperative effort between the `Ōpae`ula Watershed Protection Project (OWPP), which include Kamehameha Schools, Department of Land and Natural Resources, the Army, and the USFWS.

1.2 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 most important ungulate threats to Army training lands on O`ahu are feral pigs (*Sus scrofa*) and goats (*Capra hircus*). Feral pigs can be found in all of the Army training areas on O`ahu. Pigs directly impact the flora of ecosystems through direct consumption of vegetation (Giffin 1972), (Tate 1984), (Kroll 1985). They have also been implicated with indirect impacts in response to rooting and digging activities such as changes in successional patterns, soil properties, accelerating erosion, and water infiltration rates (Spatz 1975), (Springer 1977), (Singer 1982 and 1984), (Tate 1984), (Kroll 1985). Feral pigs have been implicated as vectors of weed spread by transporting propagules in feces and by means of carrying seeds in their fur. These animals have been known to carry diseases such as brucellosis, psuedorabies, and leptospirosis that are transmittable to livestock and humans (Giffin 1972) (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 rilictum*). Presently, feral goats are known from MMR and 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 may have come from two goat ranches located in the Wai`anae Mountains. According to sources familiar with the Wai`anae Mountains, 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 NAR, Mākaha, Makaleha and other areas adjacent to the ranches.

Impacts and threats to resources from pigs and goats occur on all Army lands with 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 or remove the impacts of feral ungulates on endangered species and native habitats by excluding ungulates from biologically sensitive areas, reducing pig numbers and eradicating goats. 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 with helicopters. Ungulate monitoring is used to assess ungulate impacts and gauge the effectiveness of ungulate control efforts.

1.3 Feral Ungulate Monitoring

Monitoring for ungulates 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 being managed. In areas where habitat management is a priority, transects are located in the habitat being managed. Transect monitoring in SBW and MMR, which contain unexploded ordnance (UXO), is limited to areas that have been cleared by 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 in 10 meter sections 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 ten by five meter transect sections. All data is recorded on DPW Environmental Ungulate Transect Data Sheets (Appendix 1-A).

Monitoring transects do not provide information on ungulate population dynamics and densities. However, they help detect gross changes in ungulate presence and provide managers with a crude 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 gross changes expected in response to ungulate control efforts given limited staff.

Data collection and ungulate control have only recently begun in many of the MUs. Data sets for most of the transects are from three or four years of monitoring. While some data sets show a correlation between management efforts and ungulate sign, much of the data is preliminary. Trends and gross changes in ungulate movement patterns will become clearer as the ungulate control program expands and additional data sets are collected.

1.4 Feral Ungulate Control

Snaring

NRS utilize snares to control ungulates in areas that are remote and difficult to access by the public. To increase effectiveness, snares are generally placed in-groups along well-used game trails as they pass through narrow corridors and in areas where the terrain is steep. Snare locations and catches are documented on DPW Environmental Snare Report Forms (Appendix 1-G). Where possible, catches are sexed, sized and given an approximate age using an ungulate tooth eruption chart.

Shooting

Firearms are used to control ungulates wherever permissible. This year the USDA's Wildlife Services continued to conduct three ungulate control hunts per month in MMR. Wildlife Services has also been conducting bi-monthly hunts to eradicate a population of feral goats, which inhabits SBW.

Aerial Shooting

Aerial shooting only occurs at MMR. This year, Wildlife Services conducted eight aerial hunts in MMR during which twenty goats were removed. NRS have ceased assisting with the aerial hunts, as it is believed that flying the personnel into position disturbs the goats and hinders the hunt. Aerial hunting has so far proven to be very effective at removing a good portion of the goat population in remote portions of Mākua Valley.

Radio-tracking

Radio tracking has only occurred at MMR. NRS had attempted to use radio collars to track goat movements/locations and determine herd associations in MMR without much success. Four goats were given collars that emitted a unique radio signal that could be tracked from the ground or from a helicopter using an antenna/receiver. This "Judas goat" program was initiated as part of the original aerial hunting trial and was based on work done by Taylor and Katahira (1988). They found that Judas goats assist with locating wild goat herds for control and "have been proven to be effective for long term monitoring in areas thought to be free of goats". NRS have found radio-tracking goats in MMR to be somewhat difficult, as the signals tend to bounce off the cliffs, creating an echo, which in turn makes it very difficult to locate the targeted animal. NRS hope that the collared goats will be easier to track from some of the more remote portions of Mākua Valley, where topography is less likely to interfere with the signals. NRS do not plan on releasing any more Judas goats at the present time.

Additional ungulate control measures include the Department of Defense and the Division of Forestry and Wildlife's public hunting programs, which take place on portions of O`ahu Army training lands.

Wai`anae Mountains Feral Goat Management Group

In December 1999, NRS joined with other interested land managing agencies to form what has become the Wai`anae Mountains Feral Goat Management Group. The mission of the group is "to work together to cooperatively manage feral goat distribution to protect special Hawaiian plants, animals, watersheds, and ecosystems, while preserving important cultural, economic, and hunting

resources. The group will establish a working relationship that fulfills group members' interests, mandates, and jurisdictional responsibilities". NRS's interest in this project stems from the fact that goats not only directly impact native habitats and endangered species on Army lands but also threaten similar resources throughout the Wai'anae Mountains. Protection of these "off-site" resources is integral to the long-term health and stability of many Army species. The group met several times this year and includes representatives from the Army, Navy, Nature Conservancy, Board of Water Supply, Hawaiian Homelands, USDA, USFWS and Wai'anae Neighborhood Board. The group plans on working closely with local communities and community groups to cooperatively solve problems and better manage goat populations. Some goals of the group include increasing hunter access to public hunting areas, obtaining funds to erect goat-proof fences between domestic goat herds and natural areas, promoting responsible game management through enforcement and education, and controlling satellite feral goat herds before they become unmanageable. One major accomplishment of the Group involves an Army/DLNR cooperatively funded goat control project in SBW and Ka'ala NAR. DLNR and the Army have each provided funds to control a goat population, which inhabits both agencies' lands.

This year the Group was able to make marked strides in managing goats in a variety of areas. The Group has separated areas within in the Wai'anae's with feral goats into separate MUs each with their own set of management priorities. These MUs are defined as Schofield Barracks/Lower Ka'ala NAR, Wai'anae Kai (Hunting Area), Wai'anae Kai (Protected Watershed), Nānākuli, Lualualei, Kawiwi/Kamaile'unu, Mākaha, Makaleha/Mokulē'ia Forest Reserve and Mākua. Action is being taken to encourage appropriate management is carried out in each of the MUs. The first large ground hunt completed by Wildlife Services in Lualualei removed 47 goats. Personnel believe that this was roughly 70% of the population within the Naval Magazine. An aerial hunt is planned for later this year for the same area and may also include portions of Nānākuli.

1.5 Makua Military Reservation Ungulate Control Plan

In February 2000, Southwestern Fence Inc. completed fencing the remainder of 'Ōhikilolo ridge. NRS anticipate that goat populations within MMR will be eradicated because this fence effectively cuts off the ingress of goats from enormous source areas to the south. Several aerial hunting operations have been conducted this year resulting in the removal of twenty goats from MMR. Additional ungulate management activities within MMR include snaring, staff and volunteer shooting, and transect monitoring. There are two ungulate exclosures in MMR, which remain ungulate free. Browse Plot data within the 'Ōhikilolo exclosure indicates that native vegetation is recovering as a result of ungulate removal. Ungulate transect data indicates that ungulate sign is decreasing in all areas monitored within MMR. This is especially true for goats, which have been intensively controlled for several years. NRS hope that the combination of fencing and increased control efforts will eventually lead to total eradication of goats in MMR within the next few years.

Total eradication of pigs from MMR is not feasible at this time. Control of feral pigs in MMR is limited to those areas where NRS have access and actively manage. Pigs generally occur in small inconspicuous groups, which makes pig control in remote areas extremely difficult. Many areas within MMR, which contain pigs also contain high densities of UXO and are not actively managed (i.e. weed control, fire protection, out-planting, etc.) by NRS. Furthermore, according to the Army's Safety Office, access to certain extremely high hazard areas within MMR will be prohibited indefinitely, ruling out the possibility for on-the-ground management in these areas, including snaring and staff hunting. Because pigs have a tendency to hide in thick vegetation, aerial shooting for pigs in many areas in Mākua is impractical.

1.5.a Kahanahāiki MU

Goal

The overall goal of the ungulate program in Kahanahāiki MU is to maintain an ungulate free environment within the fenced exclosure, reduce feral pig populations outside the exclosure, and to maintain zero tolerance for goats in the entire unit.

Discussion

An ungulate exclosure surrounding approximately 90 acres of Kahanahāiki MU was completed in December 1996, and has remained ungulate-free since April 1998. The fence was vandalized again this year. Several of the holes previously cut in the fence last year were reopened. NRS patched the holes before any animals were able to enter the exclosure. It is unclear what purpose the holes served but NRS speculate that they were cut to let pigs in or hunting dogs out of the exclosure. NRS will work with DLNR to try and improve enforcement in the area. Regulatory and informational signs that detail the purpose of the fence and make it clear that there are no ungulates within have been installed

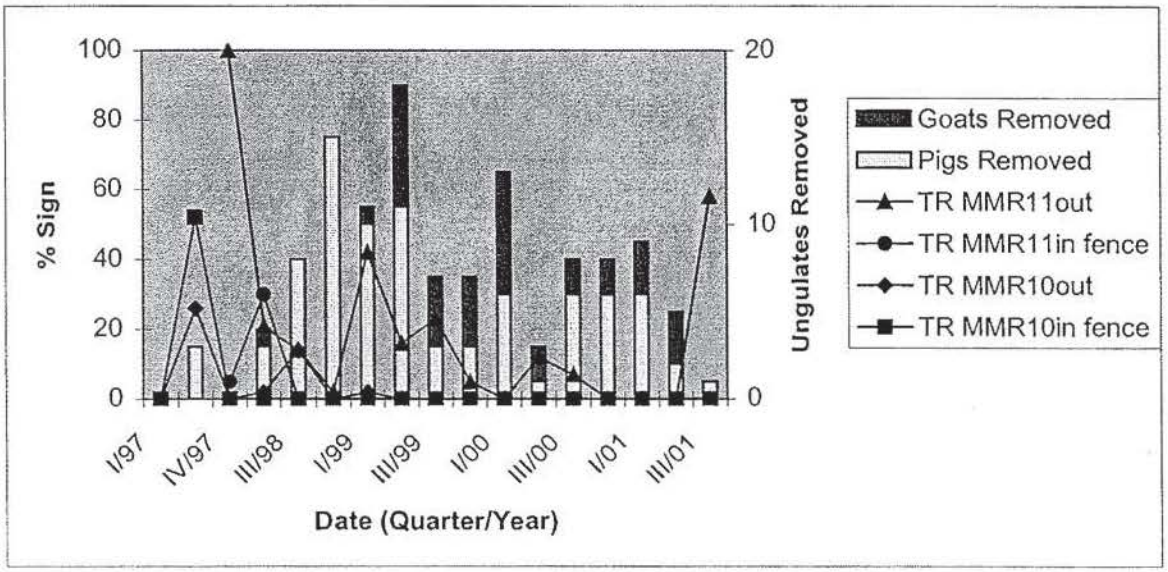
Ungulate sign has been closely monitored with two permanent ungulate transects (MMR 10 and MMR11) along the fence. Observations are made inside and outside the fence. Transects are monitored every three months and any incidental observations are documented. In June 1998, goat sign was observed on an ungulate monitoring transect in Kahanahāiki MU for the first time. Over the past couple of years goats have been observed on the cliffs just to the south of the MU. To meet the goal of zero goats in Kahanahāiki, NRS added one snare group to areas adjacent to this MU last year (for a total of five groups in and around Kahanahāiki MU). These groups have been very effective, removing 83 animals (7 goats and 76 pigs) since August of 1998. Wildlife Services also removed an additional two goats from the unit through aerial hunting. NRS will continue to search for goat sign in the area and increase snaring and hunting efforts if it becomes necessary. The downward trend in ungulate activity (Figure 1-1) indicates that control efforts for pigs and goats have been very effective at keeping these animals off of the fence.

No ungulates have gotten into the fenced exclosure. NRS speculate that the areas where active control is being implemented outside the exclosure are acting as an ungulate "sink" to that portion of MMR.

Table 1-1 Kahanahāiki MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor transects.	X	X	X	X
Check snares.	X	X	X	X
Inspect/maintain fences.	X	X	X	X
Improve enforcement during hunting season.	X	X	X	X
Aerial hunt six times this year.	X	X	X	X

Figure 1-1 Kahanahāiki Ungulate Management



1.5.b `Ōhikilolo MU

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 use 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 February 2000, Southwestern Fence Inc. completed fencing the remainder of `Ōhikilolo ridge. This has effectively eliminated the ingress of goats from the heavily infested areas to the south. A smaller goat exclosure, which was completed in 1999, enclosing several acres of high quality native forest and tree snail habitat remains ungulate free. Browse plot data (Figure 1-2, 1-3) indicates that vegetation is beginning to recover within the exclosure. Ie`ie (*Freycinetia arborea*) leaf hits were recorded using the Point/Intercept method for vegetation monitoring (Elzinga et al. 1998). NRS use ie`ie as an indicator of goat impact because it is a favored food for goats. An increase in the number of ie`ie leaf hits probably indicates a favorable response by vegetation to ungulate removal. Data from the inside the exclosure indicated a markedly favorable response to ungulate removal while the data from outside the exclosure showed very little change. Note that the number of hits in the "outside" plot was identical for both the .5 meter and 1 meter readings. Because the two lines overlap they appear as one line on the graph. Eight aerial hunts were conducted this year netting 22 goats. In addition, ground hunts are conducted three times per month in Mākua and Ko`iahi Valleys. Six snare groups are also maintained along `Ōhikilolo ridge.

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 densities that remain in Mākua.

Figure 1-2 Browse Plot Inside Fence

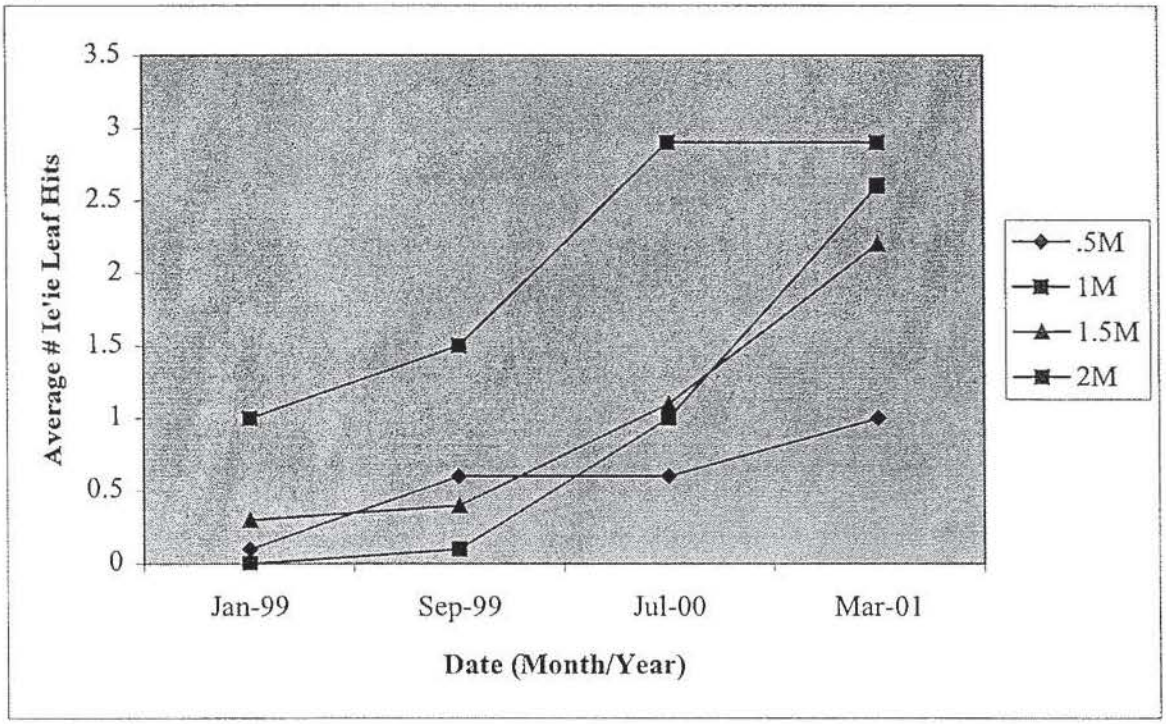
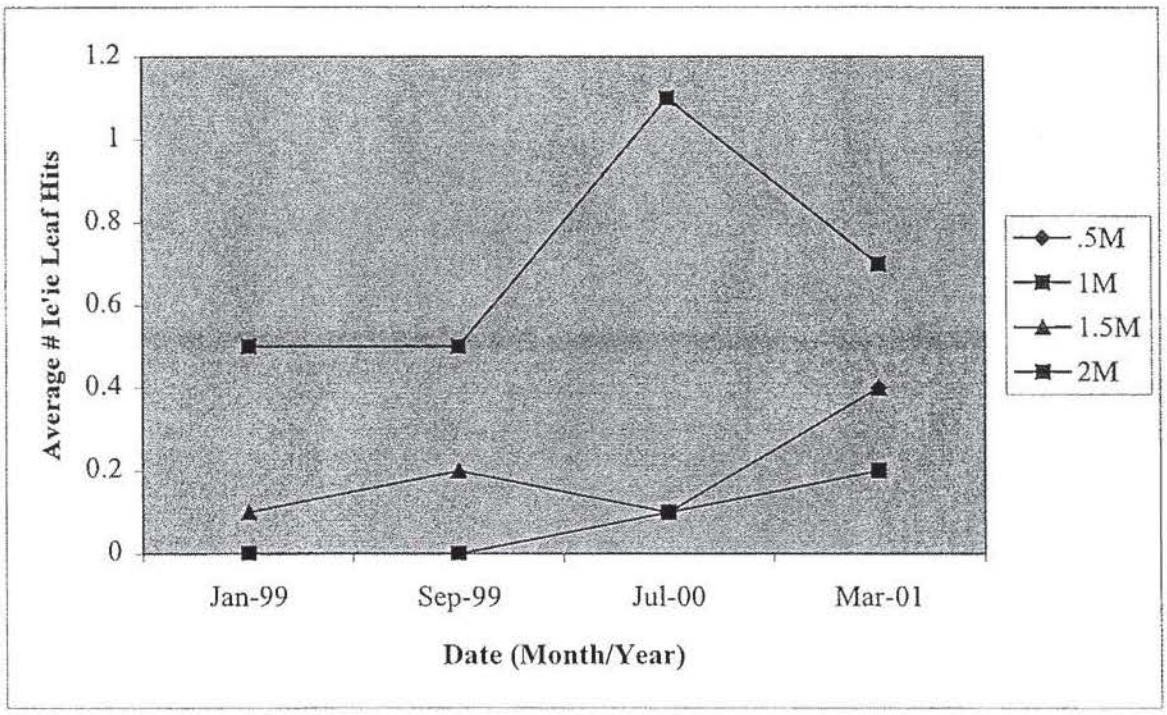
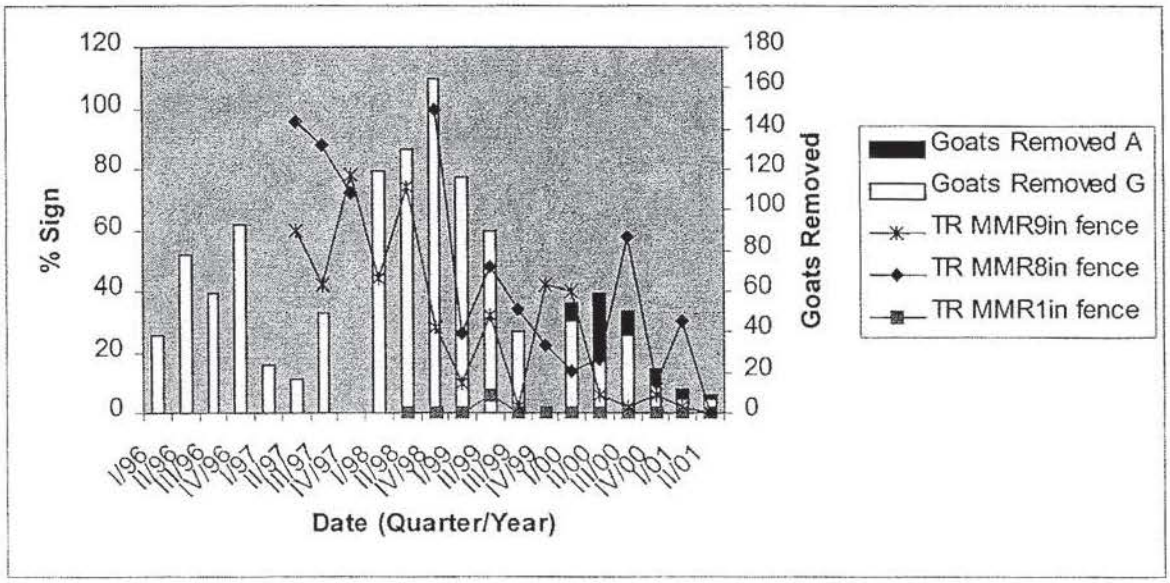


Figure 1-3 Browse Plot Outside Fence



Transect data (Figure 1-4) 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 this year. NRS anticipate that ungulate sign will continue to drop as ungulate control continues. However, NRS also recognize the potential for

Figure 1-4 `Ōhikilolo Ungulate Management



ungulate sign on transects to be relatively high, even when goat numbers are low, because transects are located along fence lines. Goat trails are prevalent along fence lines and a single goat may leave sign along an entire transect. Figure 1-4 also indicates that there is also a corresponding decline (in relation to ungulate activity) in the number of ungulates being removed. This is to be expected as goats become more wary and difficult to locate after being hunted so intensively. Ground hunting will continue until there is zero sign on transects for one year and aerial hunts will continue until no goats are removed for four consecutive trips.

As the numbers dwindle and goats become more wary, fewer animals are being taken so it may be time to utilize some other method of control to remove the last remaining goats. Wildlife Services has agreed to decrease the amount of aerial hunts to six times a year, the amount of ground hunts in either Lower Mākua or Ko`iahi to once a month, and to camp once a quarter with NRS. Aerial hunting utilizing Forward Looking Infrared (FLIR) technology has been proposed as an alternative solution. This tool has been used successfully on Maui to observe animals hidden in dense underbrush. NRS have agreed to attempt to track the three remaining radio-collard goats at MMR in order to establish if the collars are still functional. These Judas goats may still be of use for locating groups of goats during aerial hunts.

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Figure 1-4 `Ōhikilolo Ungulate Management

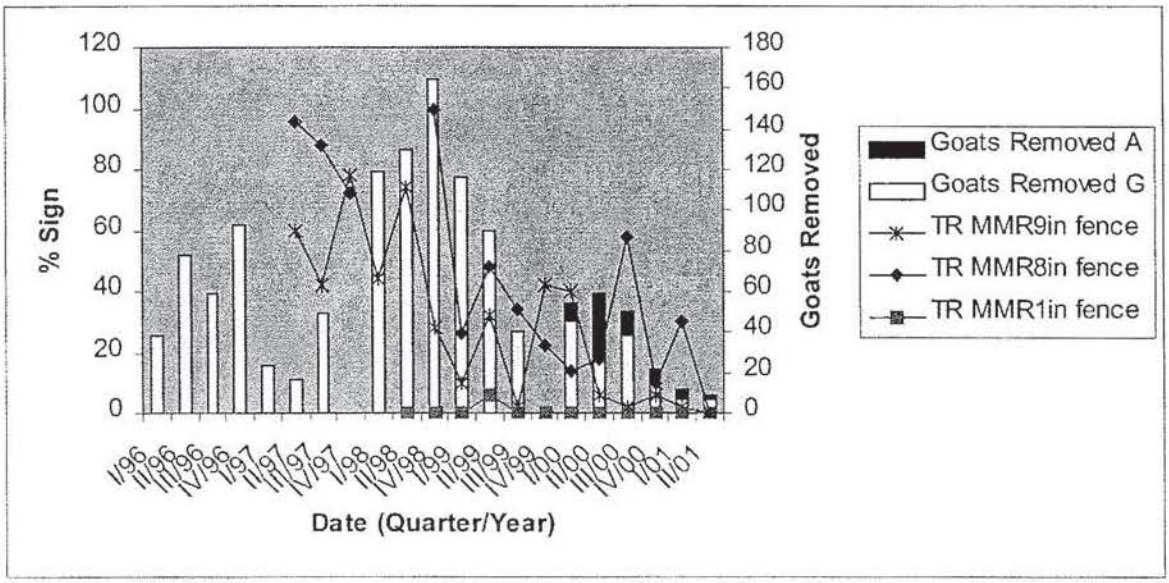

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Table 1-2 `Ōhikilolo MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Aerial hunt six times this year.	X	X	X	X
Monitor transects.	X	X	X	X
Inspect/maintain fences.	X	X	X	X
Check snares.	X	X	X	X
Track Judas goats.	X			
FLIR trial.	X	X		

1.5.c Kaluakauila MU

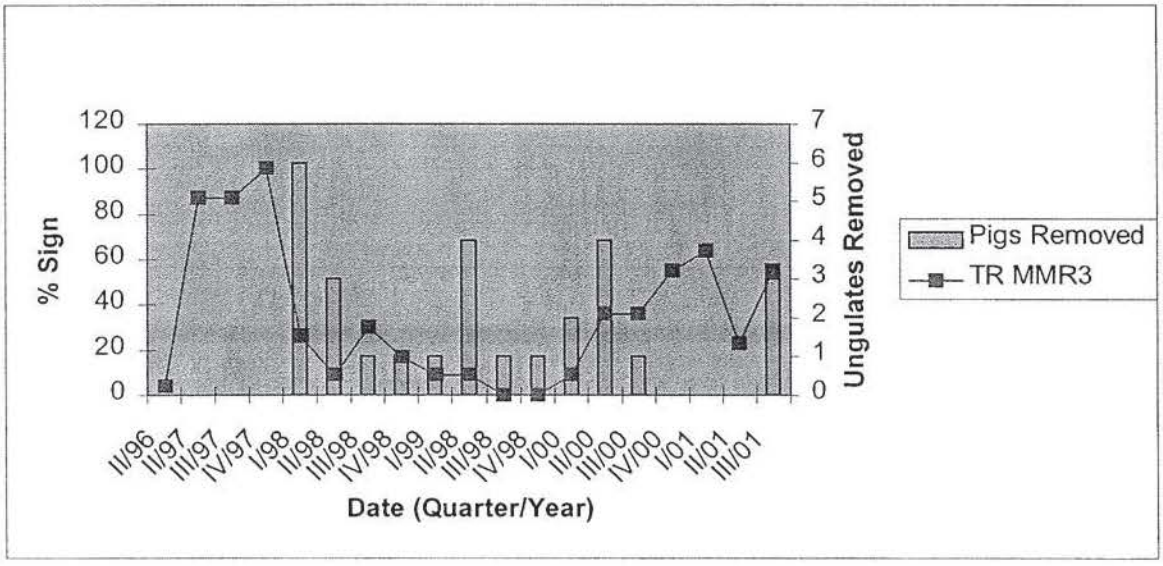
Goal

The overall goal is to eliminate impacts from feral pigs by erecting an exclosure fence and removing any pigs within while also reducing pig numbers in the overall area. Presently, feral pigs are the only ungulate threat to Kaluakauila.

Discussion

Monitoring for ungulate activity takes place quarterly along one permanent ungulate transect (MMR03) within Kaluakauila MU. Any incidental observations are also documented. There is one snare group located within Kaluakauila MU. Last quarter NRS had discovered that someone had removed all of the snares, presumably a hunter. It appeared that a pig had been caught and was removed along with the snares and that all of the flagging had been discarded.

Figure 1-5 Kaluakauila Ungulate Management



Prior to ungulate control, ungulate sign in Kaluakauila MU was very high (Figure 1-5). It has remained at very low levels in response to ungulate control efforts. The peak in pig sign observed in Quarter I/01 is probably due to the fact that the snare group was in disrepair for two entire quarters. During this time there were only seven snares in the whole group, which is not enough

to cover the area and keep out pig ingress. Figure 1-5 also indicates that catch numbers have not markedly decreased in spite of several years of intensive snaring. Because of this NRS have investigated the possibility of fencing a major portion of this MU. At this time bids have been accepted from several fencing companies and NRS are waiting for the contract to be awarded before fence line clearing will begin.

Table 1-3 Kaluakauila MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor and extend transect.	X	X	X	X
Fence line clearing.	X	X		
Assist contractor with sling loading.			X	

1.5.d East Rim Ungulate Control Area

Goal

The overall goal is to minimize impacts from feral pigs and goats, prevent goats from moving to less goat-infested areas, and to help bring goat numbers in MMR to zero.

Discussion

Monitoring for ungulate activity within the East Rim Ungulate Control Area takes place along one permanent ungulate transect (MMR02A). Generally, aerial and ground hunting in this area are difficult because of thick vegetation so control of goats and pigs within the Ungulate Control Area is done primarily with snares. There are three snare groups within the Control Area and two immediately to the west. NRS are also working with Wildlife Services to access this area and hunt from the bottom. Wildlife Services has agreed to camp once a quarter with NRS in Lower Mākua, which shall make access into the Control Area much easier. In addition, NRS will increase ungulate control efforts in conjunction with camping expeditions.

NRS began ungulate control in January 1998, and have seen a decrease in ungulate sign along the transect (Figure 1-6). Catch rates remain constant but at low numbers (Figure 1-6), which is consistent with the goals of the Control Area. NRS will continue to conduct control to keep pig pressure off the fence and bring goat numbers down to zero.

Figure 1-6 East Rim Ungulate Management

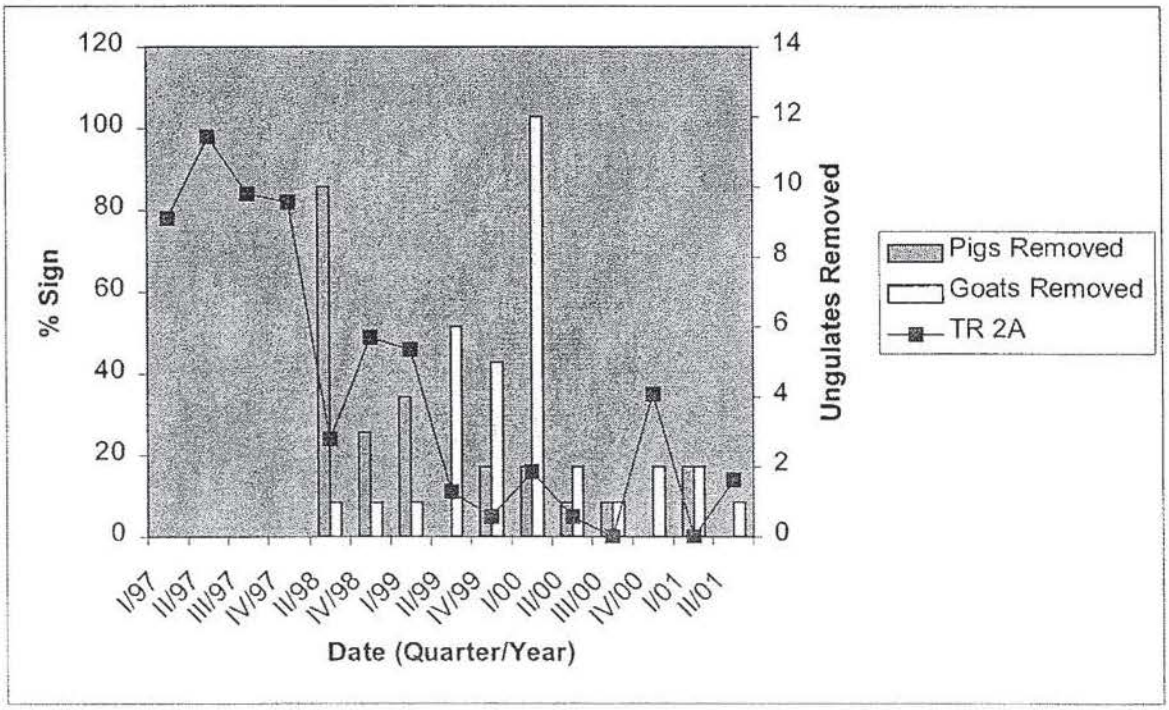


Table 1-4 East Rim Control Area Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Coordinate camping with Wildlife Services.	X	X	X	X
Aerial hunt six times this year.	X	X	X	X
Check snares.	X	X	X	X
Monitor transects.	X	X	X	X

1.5.e Lower Mākua MU

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 will allow NRS to expand ungulate management efforts in this unit.

Goal

The overall goal for the ungulate program in the Lower Mākua MU is to eradicate goats from MMR and to reduce pig populations in and around actively managed areas.

Discussion

Presently, there is one ungulate monitoring transect (MMR05) read quarterly to assess ungulate activity in this MU. A second transect was placed in the back of the valley but was abandoned because of the large amounts of UXO found in the area. As NRS become more familiar with the area one or more transects may be installed.

Ungulate control programs involving Wildlife Services, staff hunters and snares are on going. Eleven aerial hunts have been conducted this year and six additional aerial hunts and one FLIR trial will take place this year. In addition, Wildlife Services conducts ground hunts once a month in and around this unit and accompany NRS on quarterly camping trips. To compliment existing control efforts, NRS will initiate snaring in those difficult to access areas, which have been identified by Wildlife Services as having persistent goat activity.

While most ungulate control efforts have focused on goats, NRS have been discussing strategies for managing pigs on the valley floor. NRS are investigating the possibility of creating fenced MUs within the lower portions of MMR.

Transect data indicates that ungulate activity has declined since control was initiated (Figure 1-7). NRS anticipate that this trend will continue now that the `Ōhikilolo fence is complete and ungulate control efforts have been intensified. Figure 1-7 indicates that there is also a corresponding decline (in relation to ungulate activity) in the number of ungulates being removed. This is to be expected as goats become more wary and difficult to locate after being hunted so intensively. Ground hunting will continue until there is zero sign on transects for one year and aerial hunts will continue until no goats are removed for four consecutive trips.

Figure 1-7 Lower Mākua Ungulate Management

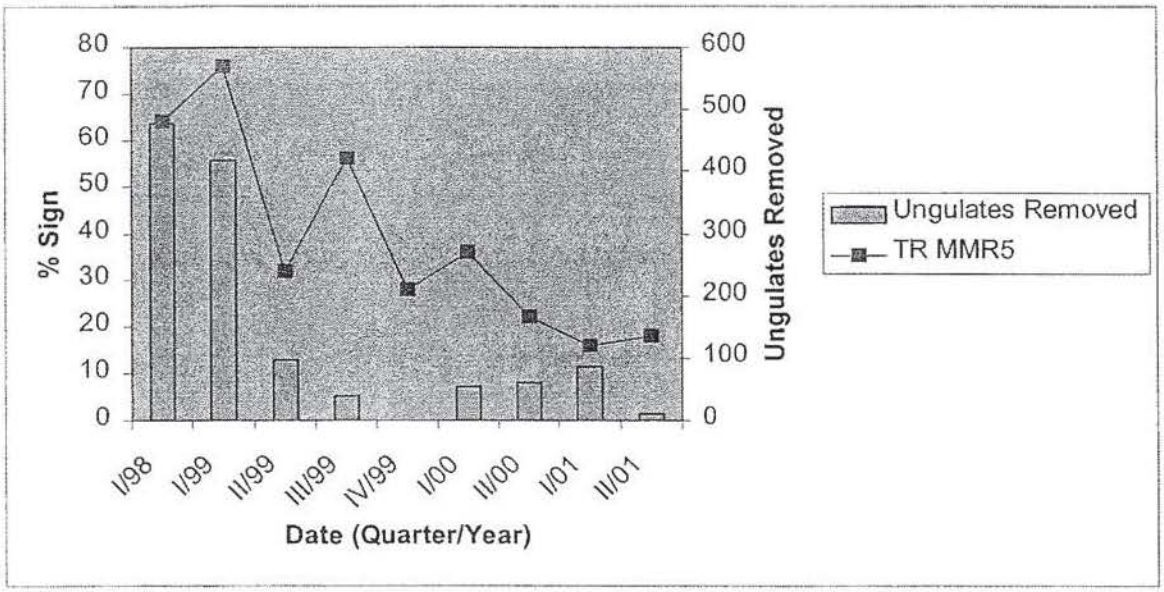


Table 1-5 Lower Mākua MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor ungulate transects.	X	X	X	X
Conduct aerial goat shooting six times this year.	X	X	X	X
Conduct Wildlife Services hunts once/month.	X	X	X	X
Investigate and implement pig-snaring program.	X	X	X	X
Investigate potential for fencing projects for portions of MU.		X	X	X
Coordinate camping with Wildlife Services in order to conduct control in remote portions of valley floor.	X	X	X	X
Install new transect if needed		X	X	

1.5.f C-Ridge MU

Goal

The overall goal is to minimize impacts from feral pigs by reducing pig numbers 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 has removed goats from areas adjacent to the MU.

Table 1-6 C Ridge Ungulate Control Area Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor ungulate sign around rare species.	X		X	

1.5.g Ko`iahi Ungulate Control Area

Goal

The overall goal is to eradicate goats from the area and to reduce the number of feral pigs near 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 on-going. This year goat

control efforts were intensified. Eleven aerial hunts were conducted this year and 6 additional aerial hunts will take place next year. In addition, Wildlife Services conducts ground hunts in this unit. To compliment existing control efforts, NRS will initiate snaring in those difficult to access areas, which have been identified by Wildlife Services as having persistent goat activity. Intensive pig control has not been deemed necessary in this area because of the lack of regular pig sign in the area. Figure 1-8 indicates a steady drop in ungulate activity in response to control.

Figure 1-8 Ko`iahi Ungulate Management

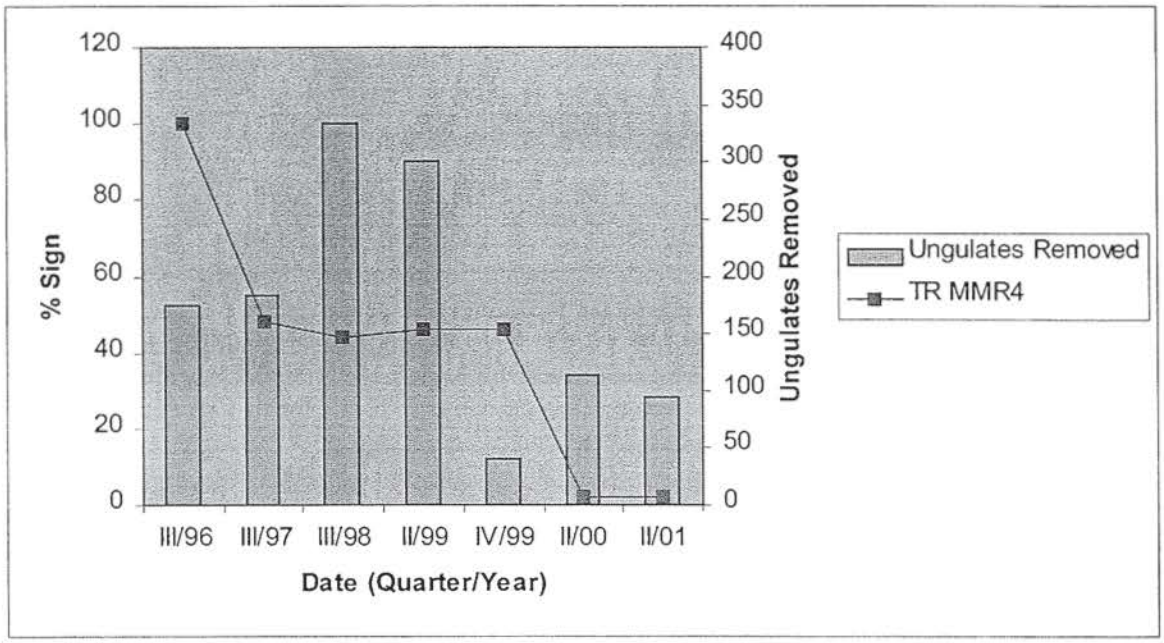


Table 1-7 Ko`iahi Ungulate Control Area Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Conduct ground hunts.	X	X	X	X
Monitor transect.	X	X		X
Conduct six aerial goat shoots.	X	X	X	X

1.5.h Three Points Pig Control

NRS, in cooperation with DLNR, had 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. The damage was amongst the worst ever observed in a natural area by NRS. Huge areas were plowed by pigs 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 nature of the area, to which pigs are well suited, and the fact that Three Points is very far

removed from any hunting pressure. Pig control was begun shortly after the discovery of a new population of *Cyanea grimesiana* ssp *obatae* and *Alsinidendron obovatum*, two extremely rare species, 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 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. Effects to pig movement patterns will have to be assessed before it is deemed necessary to erect further fencing. It is believed that the *A. obovatum* may not need fence protection due to the steepness of the terrain in which it is located.

1.6 Schofield Barracks Military Reservation

1.6.a Schofield Barracks SBW

Because of access problems in UXO areas, management of resources in SBW has been severely limited. Last year, PCSU granted NRS permission to access all areas in SBW outside the perimeter firebreak road. These previously off limit areas constitute the bulk of the forested lands within the training area. In addition, permission to use high-powered rifles for ungulate control was approved. 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 been focused on a population of goats that appears to be incipient in Schofield Barracks. In 1998, a Range Control employee at Schofield Barracks informed NRS that he had observed goats on SBW firebreak road for the first time. The population inhabits portions of Ka`ala NAR and the northern portion of SBW. NRS speculate that goats that escaped from a goat ranch adjacent to Ka`ala NAR may have founded the population. In September 1998, NRS flew a DLNR NARS crew to the summit of Pu`u Kama`ohanui, a prominent point, which borders SBW. This inter-agency cooperative effort resulted in the NARS crew removing 14 goats and two pigs from the area. In April 2000, NRS, DOFAW staff and volunteers installed several snare groups and conducted hunts in SBW. A total of 65 goats and four pigs have been removed since the intensive snaring effort was initiated in the area. At the moment, NRS are investigating the possibility of aerial shooting in SBW and preparing a Risk Assessment in order to get permission. Wildlife Services was also contracted to hunt the area. To date their efforts have removed 48 goats and one pig. Wildlife Services has also expressed a desire to alter the hunting schedule by alternating hunts once a month then twice a month for the next year. DLNR and the Army are currently working together to fund an expansion of the Wildlife Services contract for goat control. The Wai`anae Mountains Feral Goat Management Group is also working on long-term solutions to the goat problems in this area. Presently, the group is looking for funding sources to provide labor and materials for fencing a portion of Ka`ala NAR, which is adjacent to the privately owned goat ranch.

Table 1-8 Schofield Barracks SBW Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Scope other areas to determine extent of goat infestation.	X	X		
Conduct goat control efforts with Wildlife Services and NARS.	X	X	X	X
Check snares.	X	X	X	X

1.6.b Ka`ala MU

Goal

The goal within this MU is to maintain low levels of ungulate activity, protect the relatively intact forest located within the bog and protect rare and endangered species.

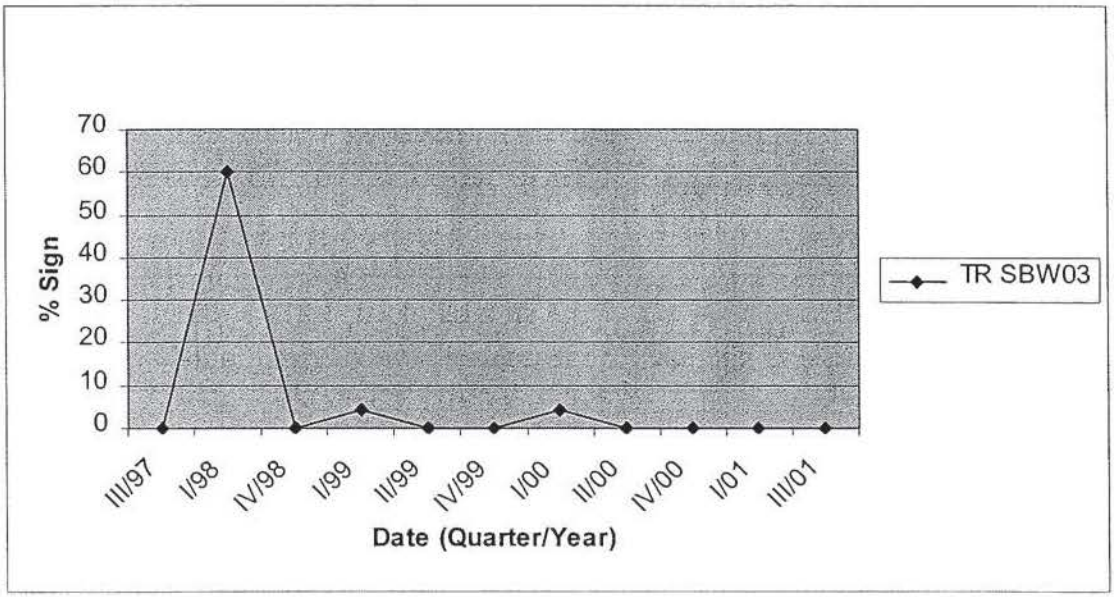
Discussion

The one ungulate transect (SBW03) located in this MU is read quarterly. Incidental observations and transect data (Figure 1-9) indicate that feral pig activity is low. Concern has been expressed about incidental observations of pig sign in the area around the MU. NRS are contemplating the idea of completing the fence around the rest of the MU. Presently, there is a fence that encircles half of the area of the bog that is controlled by DOFAW and in its current condition, offers no protection from encroachment by ungulates from the SBW side. Although goat populations occur nearby, habitat within this MU may be unsuitable for goats. Presently, no goats 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.

Table 1-9 Ka`ala MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor transect.	X	X	X	X
Scope area for fence construction.	X	X		

Figure 1-9 Ka`ala Ungulate Management



1.6.c Schofield Barracks SBS

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 the 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 vicinity. NRS have considered fencing existing wild populations of rare and endangered resources but consider it a low priority as these resources occur in areas unsuitable for fence construction or are not presently threatened by ungulates. However, small temporary fences were placed around several young *Urera kaalae*, which had been outplanted in February 1999. These will remain in place until NRS determine that pigs no longer pose a threat to these outplantings. NRS will consider installing additional small fences if ungulate threats arise or more plants are reintroduced.

NRS do not conduct any ungulate control in SBS. However, in the past, volunteer hunters have removed pigs from the area. Department of Defense recreational hunters may hunt in SBS but no records have been obtained by NRS.

Table 1-10 Schofield Barracks SBS Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor ungulate impacts around rare species.	X	X	X	X
Consider removing fences around outplantings	X	X		

1.6.d Schofield-Waikāne MU

Goal

The goal is to ensure that feral pigs are not impacting rare and endangered resources and to reduce pigs in areas, which are actively managed by NRS.

Discussion

This MU has one monitoring transect (SBE02) which is read twice per year (Figure 1-1O). NRS do not expect ungulate activity to correlate with ungulate control as no large-scale ungulate control has been conducted and transect reads have been infrequent due to adverse weather. Presently, ungulate control takes place in and around areas that are being actively managed for rare species protection. Large-scale fencing projects and snaring endeavors are not feasible to the area 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 eight pigs. 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.), given the limited staff.

Figure 1-10 Schofield-Waikāne Ungulate Management

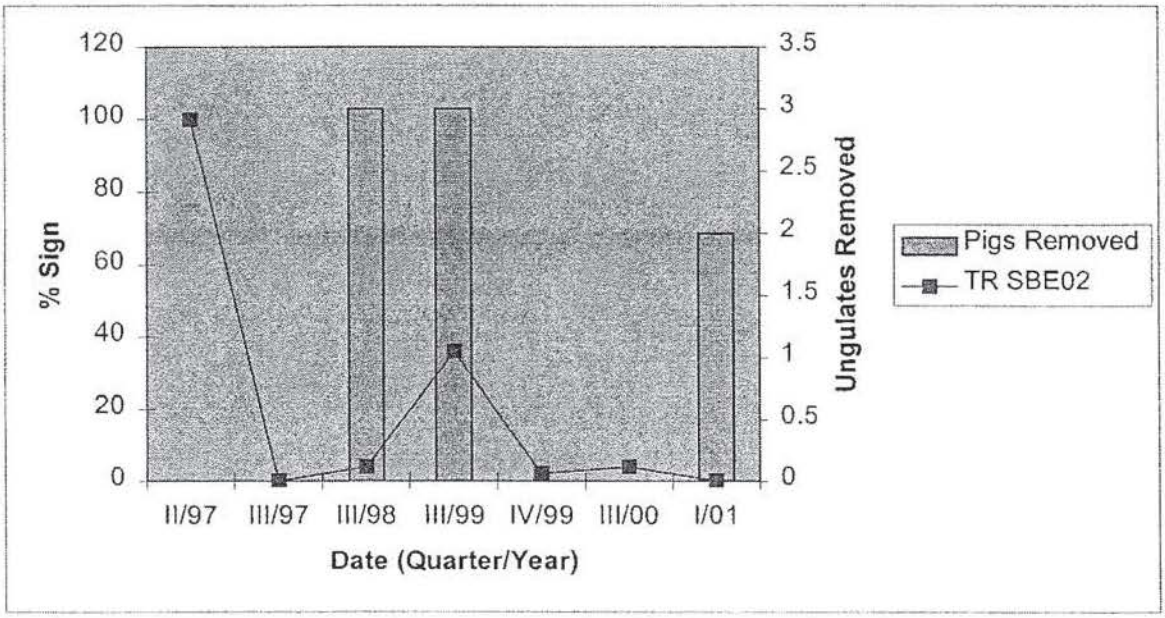


Table 1-11 Schofield-Waikāne MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor ungulate transects.		X		X
Monitor snare groups.		X		X

1.7 Kawailoa Training Area

Kamehameha Schools (KS), the State of Hawaii, Dole Foods, and Attractions Hawaii lease Kawailoa Training Area to the Army. In past years, NRS worked on a cooperative fencing project with KS and other land managing agencies. These are described in the 1999 PCSU report. This year another jointly funded exclosure, encompassing roughly 150 acres, was completed. 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. 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.

Pigs are the only ungulate threat in KLOA

1.7.a Poamoho MU

Goal

The overall goal is to ensure that feral pigs are not impacting rare and endangered resources within the MU.

Discussion

Presently, there is no ungulate control or monitoring 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 limit their management in this unit 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 Hawaii'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 Hawaii is responsible for making all management decisions in the area between Poamoho and Schofield-Waikāne trails. Presently, Dole restricts access to the trail due to the increase of vandalism on farming equipment and theft of product. It is not presently known how this has affected hunting access to the area.

1.7.b Upper Pe`ahināi`a MU

Goal

The overall goal is to minimize impacts from feral pigs by reducing pig numbers and excluding them from biologically sensitive areas.

Discussion

Monitoring of feral ungulates takes place along one permanent ungulate transect (KLO12) which has been monitored twice per year. Two snare groups have been established in this MU and have removed thirteen pigs since 1998.

In April 2001, Wellington Fence Inc. completed the construction of a pig exclosure surrounding approximately 150 acres of high quality native forest containing nine endangered species. The fencing project is a cooperative effort between the `Ōpae`ula Watershed Protection Partnership (OWPP), which includes KS, State DLNR, the U. S. Army, and the USFWS. The fence line was cleared by NRS with the support of staff from the Division of Forestry and Wildlife, The Nature Conservancy, and volunteers from the community. A Weather-Port rain shelter was purchased and erected to facilitate camping and management of the area. With completion of the fence, OWPP had considered using public hunters to remove pigs from inside the fence. As it turns out, all that effort may not be required, as it appears there is only one small pig trapped within the exclosure. FLIR technology has also been proposed as a useful tool to utilize for this area. An experimental trial will be attempted weather permitting. This trial will be completed before December 2001. If FLIR appears to be successful, NRS will staff a Risk Assessment to support KS in the operation. If the trial is unsuccessful, NRS will set up snares along the inside perimeter of the fence in order to catch the pig. Snaring efforts may be expanded as needed to the areas surrounding the fence. It may be deemed imperative to protect the integrity of the fence by installing snares in a strategic manner around the perimeter. It may also be useful to install wings along the fence in order to direct pigs to areas where snares are installed. OWPP is considering cooperatively funding another ungulate exclosure in the area. Two possible sites have been selected, the upper reaches of Helemano and Kaluanui/Kawaiiki Streams, and the USFWS has already committed $50,000 to the project.

There appears to be a direct correlation between transect data and ungulate control for this MU (Figure 1-11). NRS believe that this data is misleading. NRS don't believe that two snare groups would have a marked effect on pig activity over such a large area, nor is the transect an accurate representation of pig activity. NRS believe that a larger, more focused ungulate control project would decrease ungulate activity and would be reflected in transect data. At present, all of the snares within the MU have been removed in order to assess changes in ungulate movement patterns. Ungulate sign within the exclosure is expected to drop to zero.

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

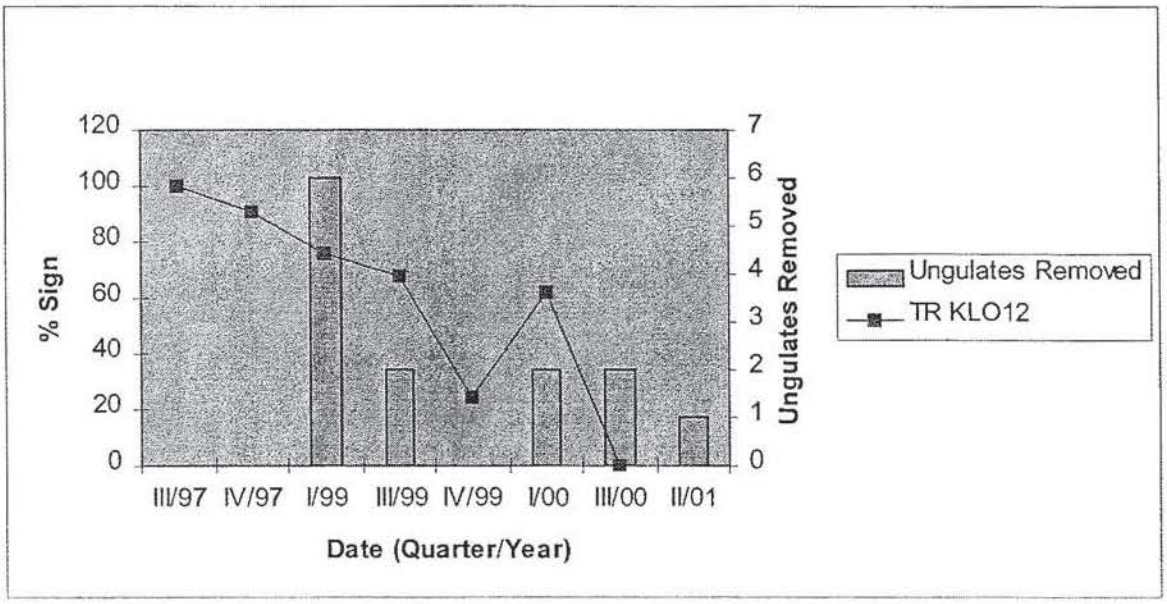


Table 1-12 Upper Pe`ahināi`a MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Install strategic wings.	X	X		
Install snares around perimeter as needed.		X	X	X
Reinstall monitoring transect.	X			
Conduct FLIR trial/staff Risk Assessment if prudent.	X	X		
Read ungulate transect.	X	X	X	X
Install snares on inside perimeter.		X		
Approach OWPP and Kamehameha Schools about funding additional fenced units.		X		
Scope additional fence lines and develop proposal for OWPP.	X	X	X	

1.7.c Lower Pe`ahināi`a MU

Goal

The overall goal is to minimize impacts to rare and endangered resources within the MU and in areas where NRS are conducting active management.

Discussion

Ungulate management takes place only in and around areas, which 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 dense, 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. Last year, five snare groups

were placed in and around this MU. Twenty-six pigs were removed. Monitoring for ungulate activity takes place along two ungulate transects (KLO05 and KLO13). The terrain dictates that monitoring transects be placed along ridge tops, where pig traffic is often focused, thereby biasing ungulate activity data. Data from transects (Figure 1-12) does not reflect any profound changes in ungulate activity in response to control and will need to be analyzed as management strategies evolve. NRS believe that the pig control efforts in this area were ineffective at protecting the area as a whole.

Public hunters are still illegally accessing this area from time to time and have removed several snares. As a result, NRS removed all of the snares and attempted a trial hunt utilizing public hunters. Overall, the hunt seemed to be very successful, with up to eight pigs removed in one day. It was hard to get a true number of all the pigs removed as the dogs came upon several baby pigs and killed them before the hunters could reach them. Logistically, it appears that more details need to be worked out before this sort of action is attempted again. Dogs were lost in the course of hunting and it took several days to retrieve them all. Access has been made difficult with all of the new gates that the landowners have installed. In the future, it would be more advantageous for the hunters to have access independent of NRS. That way the hunters would not have to rely on NRS to search for any dogs that may be lost. It may also be advantageous to speak with the hunters who utilize the area and find out how many pigs have been caught over the years and what, if any, patterns of movement are known. Their knowledge and dogs could prove to be useful for further management of the area. KS should be approached with the idea of utilizing public hunters, who have proper liability insurance coverage as a way of managing pig populations in areas such as this. It would also be advantageous to erect some fences in order to stop major movements and protect the ridgtops and Pu`u's in the area. No amount of control is going to be successful until fences are erected to protect areas from ingress.

Figure 1-12 Lower Pe`ahināi`a Ungulate Management

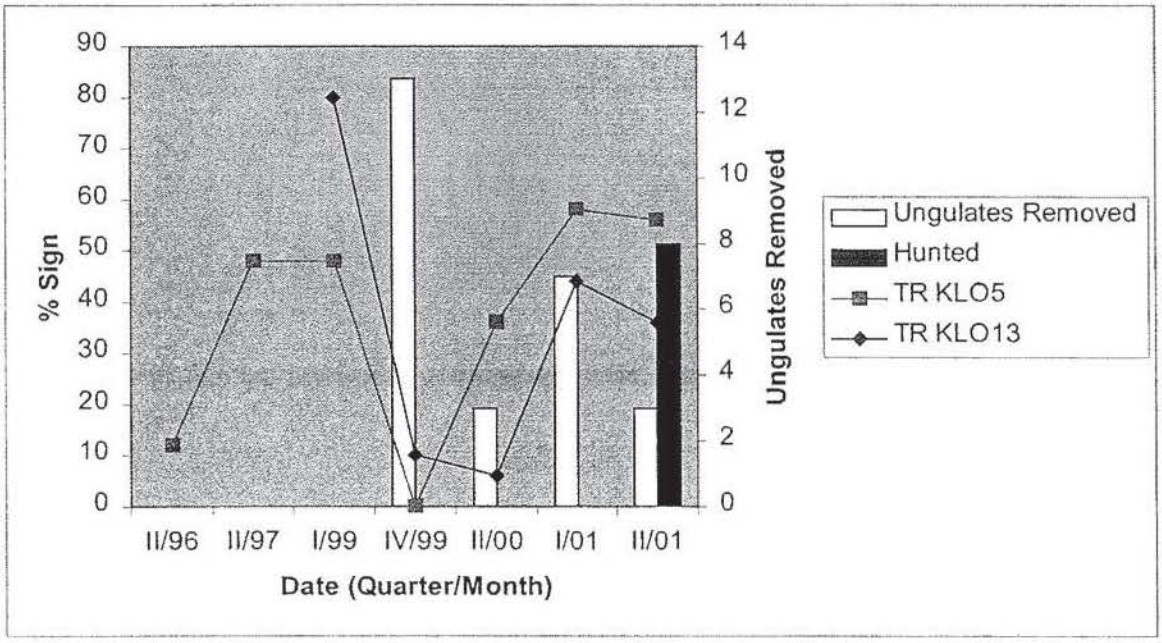


Table 1-13 Lower Pe`ahināi`a MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Monitor transect.	X		X	
Talk with hunters about numbers removed.	X			
Talk with KS about getting access for public hunters.		X		
Scope fence line and discuss with OWPP.				

1.7.d Castle MU

Goal

The overall goal is to minimize impacts from feral pigs by reducing pig numbers and excluding them from biologically sensitive areas.

Discussion

Monitoring for feral ungulates takes place along one permanent ungulate transect (KLO11) which is monitored twice per year. Two snare groups established in this MU have removed 32 pigs. If FLIR technology proves to be a successful animal control technique in Pe`ahināi`a MU, it may be utilized in this MU as well.

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 and contains many rare species as well as three endangered species. This project was a cooperative effort between the Army and Kamehameha Schools. 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 transect (Figure 1-13) does not reflect any profound changes in ungulate activity in response to ungulate control (Figure 1-13). Ungulate activity appears to fluctuate naturally 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 this year. The lack of productivity of these groups did not warrant the effort required in maintaining them. It seemed that these groups were acting as an ungulate "sink" for the area as a whole without actively reducing numbers overall. Without a fence to effectively exclude pigs from the area, any ungulate management actions imposed would appear to be unproductive. OWPP is considering fencing another portion of this MU. USFWS has already committed $50,000 to the potential fence.

Figure 1-13 Castle Ungulate Management

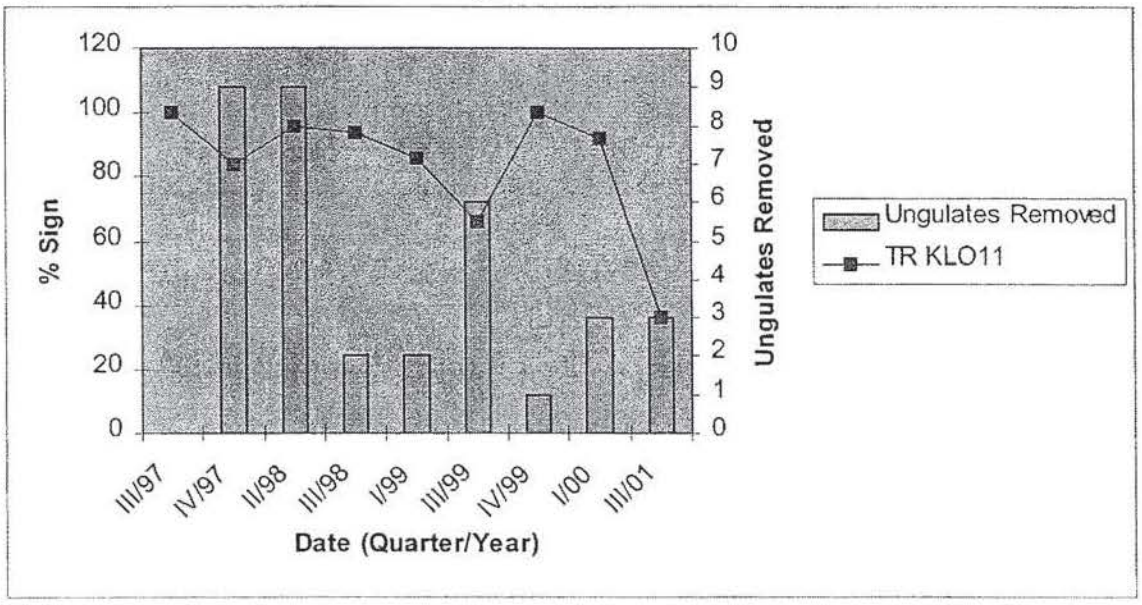


Table 1-14 Castle MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Investigate FLIR as an animal control measure.			X	
Inspect/Maintain Bog Fence.		X		X
Read ungulate transect.		X		X
Scope out possible fence route and make proposal to OWPP.	X	X		

1.7.e Kahuku Cabin MU

Goal

The overall goal is to minimize feral pig impacts to rare and endangered species by reducing pig numbers.

Discussion

Resource management in this unit is centered around rare plant and snail species. Ungulate transects KLO01, KLO02 and KLO10 were removed this year 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 MU and it has removed five pigs. However, the snare group has been removed because it is in a very remote area and has not been particularly productive. If FLIR technology proves to be a successful animal control technique in Pe`ahināi`a MU it may be utilized in this MU as well. NRS may consider fencing portions of this area as it contains a high density of rare species and

has topography, which is relatively easy to fence. NRS shall investigate the possibility of doing a cooperative project with the Zion's through the Ko'olau Watershed Partnership.

NRS do not expect to see a decrease in ungulate activity (Figure 1-14) along transects as very little ungulate control is being conducted in this MU.

Figure 1-14 Kahuku Cabin Ungulate Management

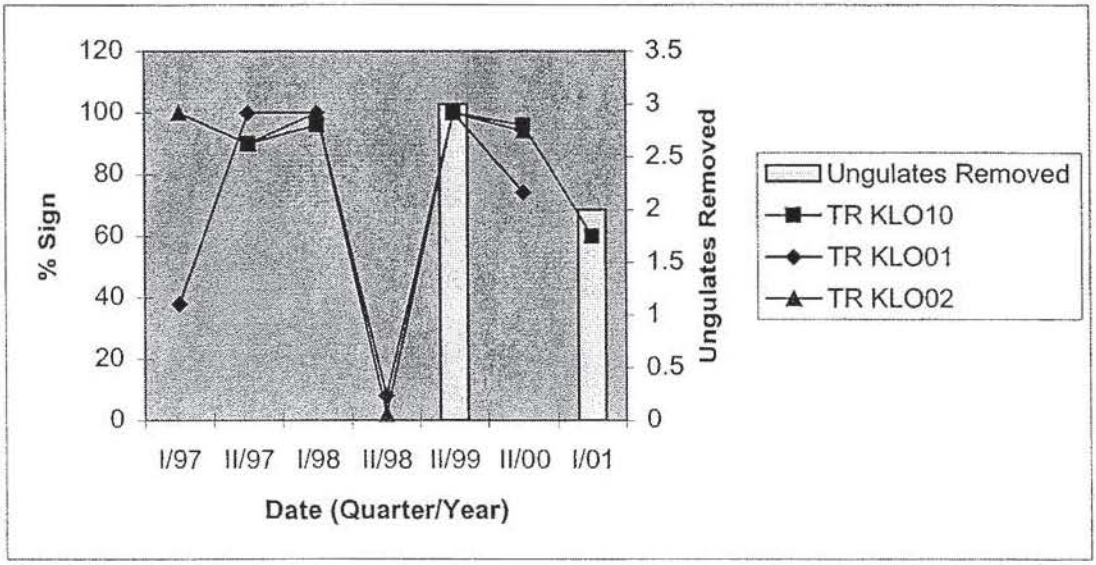


Table 1-15 Kahuku Cabin MU Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Investigate FLIR as an animal control measure.			X	
Investigate Zion partner's willingness to build cooperative fence.		X	X	

1.8 Kahuku Training Area

Goal

The overall goal is to minimize impacts from feral pigs. As the need arises, ungulate control will be administered around the rare plant species that are being monitored.

Discussion

Management in KTA is centered around rare species populations. Presently, there are no ungulate monitoring transects in KTA. NRS are still in the process of surveying KTA and ungulate sign and specific threats are noted whenever they are observed.

Presently in KTA, the only mechanism for ungulate control underway is the Division of Forestry and Wildlife's public hunting program, which is administered by the State of Hawaii'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.

Table 1-16 Kahuku Training Area Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Identify Biologically Significant Areas and determine and address ungulate threats.		X	X	X

1.9 Dillingham Military Reservation

Resource management in DMR occurs only around rare species and 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 invasive weedy 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 around rare species and stands of lonomea forest. NRS regularly observe ungulate sign in the area but have not observed any significant ungulate threats to DMR resources. Volunteer hunters would most likely be called upon to address any significant ungulate threats that arise.

Table 1-17 Dillingham Military Reservation Management Recommendations

Action	Quarter 4 Oct-Dec 2001	Quarter 1 Jan-Mar 2002	Quarter 2 Apr-Jun 2002	Quarter 3 Jul-Sep 2002
Implement ungulate control as need arises around rare species and lonomea (*Sapindus oahuensis*) stands.	X		X	

CHAPTER 2 WEED MANAGEMENT

2.1 PCSU Contract Requirements

The following is a list of PCSU contract requirements related to weed management followed by a brief discussion of Natural Resource Staff accomplishments.

Makua Military Reservation

Requirement (1e)

Developing and implementing a method to address weed spread during briefings for new troops.

Discussion

Natural Resource Staff (NRS) worked this year to construct a power-point brief that will be used to inform troops of the issues concerning natural resources in Mākua prior to their return to training. Training impacts to these resources mainly include fire and weed spread. Action has been halted on the brief until training resumes on the reservation. NRS have also worked with Integrated Training Area Management (ITAM) on the development of a solider card that would, like the brief, point out the impacts of training and give guidelines to minimize the impacts. Presently ITAM is pursuing the production of these cards. NRS will continue to coordinate actions with ITAM and encourage these types of proactive measures.

Requirement (1f)

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.

Discussion

Four native vegetation recovery plots (weed plots) were read this year in the ʻŌhikilolo MU (MU), and one was read in Kahanahāiki. A plot was also installed in the Lower Mākua MU. Data for these plots is presented and analyzed within the MU discussions. The data collection forms currently used are included in Appendix 2-A. In the future, NRS may not require the maintenance of as many vegetation plots because past plots have answered management questions. Past trials have identified which herbicides to use and the best application method. NRS are now able to spend less time monitoring and more time executing the management.

Requirement (1l)

Monitoring and controlling the ingress of incipient weeds on 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 MMR (Kuaokala Road). In addition, landing zones (two military and two natural resources) shall be monitored annually with weed control being performed, if necessary.

Discussion

Road and landing zone surveys have been conducted as discussed above. NRS survey the entire firebreak road as well as Kuaokala road. Landing zones in Mākua include three Army landing zones next to Range Control and one NRS landing zone on `Ōhikilolo. The military landing zones are monitored on the road survey route and NRS survey the `Ōhikilolo landing zone quarterly (See Appendix 2-B). Comparisons were made in the preparation of this document to determine patterns of weed spread along these survey routes. Results of these surveys and indications are presented below. NRS extensively surveyed the interior of the south firebreak road this year in response to the discovery of a past record of Fountain Grass in this area. Methods and results are discussed in section 2.7.

Requirement (1m)

Developing a prioritized plan for alien weed eradication at Kahanahāiki. The plan shall include rationale, method and effectiveness, results and discussion, and management recommendations. The plan will be consistent with the implementation plan being developed by the Army for biological actions at MMR in compliance with the Section 7 consultation on routine military training completed in July 1998.

Discussion

NRS are still in the process of developing a weed control plan for Kahanahāiki. NRS are working closely with the Mākua Implementation Team (IT) to develop a strategy and a monitoring approach that will link adaptively into the plan. NRS have been on two field trips with the IT to develop ideas and discuss options. The greatest challenge to the development of this plan is the high degree of habitat heterogeneity in the Kahanahāiki MU. There are areas in Kahanahāiki that are almost completely native, as well as areas that are completely dominated by weeds, and everything between these extremes. There also is great topographic heterogeneity; gulches, ridges, south-facing slopes, north-facing slopes, steep areas, and flat areas. As a result, there are many different community types present. NRS believe that an approach that combines weed control with out-planting of common native species is needed in the more degraded areas. It is hard to say what level of out-planting is needed to supplement weed control for restoration. Obviously, in those areas that are completely alien, natives will need to be inserted. Restoration techniques also must be developed for areas that are in between these extremes at 50% native. NRS need a good monitoring program. Current staffing levels are insufficient to institute the level of monitoring needed to accompany the implementation of this weed control plan. Regardless, NRS will continue to formulate the plan for Kahanahāiki but expect that it will be implemented when the Mākua Implementation Plan is approved and funded. NRS must implement this prioritized plan with monitoring efforts in place so that staff can learn from and adaptively manage this approach.

Requirement (1n)

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.

Discussion

Fortunately, many of the SEAs in Mākua are geographically removed from the areas that receive impacts from training activities. To mitigate any effects from training, NRS rely on a pro-active approach by frequently monitoring SEAs for the presence of military impacts. NRS also coordinate with ITAM in developing educational aids for trainers and monitor roads and landing zones. In MMR, fire, a potential side effect of training, has been observed to facilitate weed spread. NRS conducts fuel-load reduction and firebreak construction in high fire risk areas. NRS is constantly on the alert for impacts to SEAs.

Various Training Areas

Requirement (1e)

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.

Discussion

Four vegetation plots are being tracked on O`ahu Army training areas other than MMR. There are plots in Schofield-Waikāne and Ka`ala MUs to track efficacy of ginger control. In addition there are two plots in the Upper Pe`ahināi`a MU to track native vegetation recovery following pig control. Data for these plots is presented and analyzed within the MU discussions. The data collection forms used currently are included in Appendix 2-A. NRS shall eliminate unnecessary vegetation plots as past plots have sufficiently answered the questions posed. Past studies have identified which herbicides to use and the best application method. NRS are now able to spend less time monitoring and more time executing the management

Requirement (1f)

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.

Discussion

Weed control on the above listed species and additional ones has been conducted over a total of 75 acres within KTA, SB, KWTA, and DM. Generally, a combination of manual and chemical control is used. Details of weed control efforts are discussed in the training area and MU sections. Noteworthy projects include Manuka control in the Poamoho MU, Fountain Grass control in KTA and SB, and ginger control in SB.

Requirement (1h)

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 Pa'ala-Uka); KTA (Gate Access Roads A-D); DMR (unnamed roads south of the runway); and SB (Schofield-Waikāne, Schofield SBW Firebreak Road and SBS Roads). In addition, ten landing zone (six military and four natural resources shall be monitored annually with weed control being performed, if necessary.

Discussion

Road and landing zone surveys have been conducted as discussed above. NRS have surveyed roads in KWTA, KTA, DMR, and SB. Results of surveys are reported in the training area sections. NRS surveyed four natural resource and seven military landing zones in these training areas. No new habitat modifying weeds were found (See Appendix 2-C, 2-D, 2-E and 2-F). Comparisons were made in the preparation of this document to determine patterns of weed spread along these survey routes. Results of these surveys and indications are presented.

Requirement (1o)

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.

Discussion

Fortunately, many of the SEAs are geographically removed from the areas that receive impacts from training activities. To mitigate any effects from training, NRS rely on a pro-active approach by frequently monitoring SEAs for the presence of military impacts. NRS also coordinate with ITAM in developing educational aids for trainers and monitor roads and landing zones. In KTA and SBW, fire, a potential side effect of training, is a threat to the rare plants and critical habitat. Fires facilitate the establishment of invasive plant species and irreversibly damage native resources. During time spent in these training areas, NRS is constantly on the alert for impacts to SEAs.

2.2 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 therefore, are one of the primary focuses of all natural resource programs in Hawai'i.

NRS have been conducting weed control since the beginning of the Army's program. Management objectives have been developed following a four-step approach: surveying; prioritizing; controlling; and monitoring. 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.

2.3 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 where new weeds have a high potential for being introduced by military activities. Survey routes and results are presented within the discussion for each Training Area discussion. In addition to scheduled visits to roads and landing zones, incidental notes are taken of incipient or problematic weeds when they are observed anywhere on training areas during other field operations. For especially invasive species NRS perform helicopter surveying to identify the extent of infestations that cannot be mapped from the ground. In addition, while performing aerial survey a GPS is used to map individuals for removal from the ground. This mapping greatly facilitates ground control in dense and hard to navigate areas.

2.4 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. Weed species vary in their level of invasiveness and in their potential to dominate native areas. These inherent traits are taken into account when NRS prioritize weed projects. The species most successful at invading and dominating native ecosystems earn the highest priority for control.

Weeds are also classified as either incipient or widespread based on their abundance in a given area. Incipient weeds exist in a very small area and may not yet be established. These populations are a high priority 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 higher priority for control than those located far from intact forest. All of the above factors are used in combination to select the weed control projects that are worth tackling.

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

The goal of OSIC is similar to both the Maui and Big Island Invasive Species Committees, prevention of new invasive species from becoming established. This group is comprised of State, Federal, and private agencies, and interested individuals. NRS participation is key as the military controls a significant portion of the native forest remaining on O`ahu. In addition, the Army in its actions of moving large quantities of personnel and machinery to and from the State of Hawaii is a possible vector for introduction of new alien species. If the establishment of a weed species can be prevented through this pro-active approach, the costs of future control are avoided.

Over the past year NRS involvement in the OISC has been key to its development and success. NRS have contributed through coordinating and volunteering for various weed control projects as well as presenting weed species unfamiliar to others in the group. OISC has designated sub-groups related to detection of incipient alien species, control of these species, restoration of weed control areas and invasive species policy and legislation. NRS participate on the control sub-

group, which meets quarterly, and addressing the control status of target invasive species and developing action plans for each.

2.5 Weed Control

Control of weeds is conducted using a number of techniques, which include manual, chemical and biological control. Manual and chemical control are often combined. In most cases, a wound is cut on the target tree and herbicide is applied at the cut. All NRS undergo state certification for application of restricted use pesticides. The following are definitions of some control techniques used by NRS:

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

NRS have relied on either 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:

1. 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.
2. 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.
3. Garlon 4-a systemic herbicide applied generally as a basal bark treatment diluted in FCO. Active ingredient: 61.6% triclopyr.
4. Round-up-a non-specific, systemic herbicide applied generally in low concentrations diluted with water. Active Ingredient: 41.0% glyphosate.
5. Fusilade-a grass specific herbicide most frequently applied as a foliar spray diluted in water. Active ingredient: 24.5% fluazifor-P-butyl.
6. Escort-a systemic herbicide sprayed on the rhizomes of ginger diluted in water. Active ingredient: 60% metsulfuron methyl.
7. EZ-ject- a water-soluble systemic herbicide injected directly into stems or rhizomes. Active ingredient: 83.5% glyphosate

In general, control of canopy weeds is done using a basal bark application of 20% Garlon 4 in FCO. No more than 20% of the canopy is removed or opened during a treatment. Removing at a higher rate can change the light regime of the forest to a point where invasive understory species are favored. Unlike canopy weed control, where slow removal is the preferred approach, understory weed control is generally conducted to eliminate target weeds in a single treatment. 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.

2.6 Weed Monitoring

In order to assess the effectiveness of weed control in restoring and improving native ecosystems, NRS establish weed plots. In order to obtain reliable data from these plots, they must be monitored over long periods of time. Trends may be slow to surface due to the slow growth rate of native species. Appendix 2-A, Weed Plot Methodology, is the detailed scheme employed for basic monitoring and contains samples of field forms used to facilitate data collection. This methodology is sometimes applied in its entirety and other time's only parts are applied, depending on the plot purpose and available sites. The understory monitoring methodology is being used in the `Ōhikilolo MU. This methodology utilizes ten-percent cover classes. Weed plot data indicate patterns or trends related to the treatment employed in a given plot. Data may always be influenced by factors unrelated to the treatment including, seasonal fluctuations, observer bias, trampling and natural influences such as wind or senescence.

Weed plot data and discussion are presented within each training area monitoring section. Only data from plots that NRS have read twice or more are presented. Additional data plots have been analyzed in the 1998, 1999, and 2000 PCSU Reports and will not be contained in this report.

2.7 Makua Military Reservation

Surveys

No new incipient habitat modifying weeds were detected this year on either of the two road surveys in Mākua. Landing zone surveys have shown a stable set of weeds (See Appendix 2-B, Weed Surveys Roads and Landing Zones, MMR).

It was brought to the attention of NRS by Talbert Takahama (O`ahu NARS) that fountain grass (*Pennisetum setaceum*) had been reported from Mākua by John Obata and Rick Warshauer in 1977 (Biological Survey of the Makua Military Reservation Wai`anae, O`ahu, Hawaii). NRS contacted both Mr. Obata and Mr. Warshauer to discuss the report. Mr. Warshauer did not have notes on the observation but felt that it was probable that the species was present in the valley at the time of their surveys. Mr. Obata recalled that there had been a single plant in the middle of the southern half of the training area. Active training was occurring in the area. NRS extensively surveyed this entire area inside the firebreak road and found no fountain grass plants. Mr. Obata suggested that Range Control personnel may also have removed the plant as he had strongly suggested they do so at the time it was discovered. He had not heard whether or not any control had been done. Mr. Obata also suggested the fountain grass had probably come from PTA on a soldier's boots or in military equipment. When training resumes at Mākua, the threat of introductions such as this through training activities will continue. NRS will extensively survey the inside of the firebreak road again next year to be sure no plants still exist.

Control

In Mākua, NRS have controlled established weeds over a thirty-acre area. In all MUs the most common canopy species controlled are *Psidium cattelianum* (Strawberry guava) and *Schinus terebinthifolius* (Christmas berry). Understory weed species are controlled in areas where the native understory is particularly intact and where weed species do not have high densities. The most widely used canopy weed control technique in Mākua is basal bark application method using Garlon 4 at 20% in FCO.

Monitoring
The following is an overview of the weed plots in MMR. Results from these monitoring plots are used to measure efficacy of a single treatment and guide weed management.

Table 2-1 Weed Plot Summary Mākua Military Reservation

Area/Plot	Purpose	Treatment	Results
ʻŌhikilolo/16	Determine if treatment of *Erigeron karvinskianus* and *Blechnum occidentale* is effective	Foliar treatment with 3% Garlon 3A	Treatment effective, some native impact observed. See 2.7.b
ʻŌhikilolo/18	Determine if treatment of *Kalanchoe pinnata* is effective	Foliar treatment with 2% Garlon 3A	Treatment effective, some native impact observed. See 2.7.b.
ʻŌhikilolo/20	Determine if treatment of *Blechnum occidentale* is effective	Foliar treatment with 2% Garlon 3A	Inconclusive. See 2.7.b.
ʻŌhikilolo/21	Determine if treatment of *Thelypteris parasitica* is effective	Basal treatment with 20% Garlon 4 in FCO	Effective. See 2.7.b.
Kahanahāiki / Black Wattle	Determine if fertilizing is beneficial when out-planting	Fertilize half the plants outplanted	Inconclusive. See 2.7.a
Lower Mākua	Determine if native seed bank will respond to *Melinis minutiflora* grass control	Foliar treatment with Fusilade	Inconclusive - just installed

2.7.a Kahanahāiki MU

Control

In Kahanahāiki, volunteer groups play a large role in widespread weed control. Weeds have been controlled over approximately 15 acres of the MU this year alone. Species controlled thus far include, *Schinus terebinthifolius* (Christmas berry), *Psidium cattleianum* (Strawberry guava), *Acacia mearnsii* (Black wattle), *Clidemia hirta* (Koster's curse), *Montanoa hibiscifolia* (Tree daisy), *Cordyline fruticosa* (Ti leaf), *Grevillea robusta* (Silk oak), *Aleurites moluccana* (Kukui) and *Rubus argutus* (Blackberry).

The small population of blackberry present in the southeast portion of the exclosure has proven difficult to remove. Despite repeated treatments in the past year, plants are still present. NRS have seen a decline in the population since last year when quarterly visits were instituted. NRS will continue monitoring with quarterly visits again this year.

For the past three years, NRS have worked with volunteer groups to eradicate an incipient population of Black Wattle in Kahanahāiki. The goal of this project is to replace the Black Wattle with native species. Four common native species were planted in January and March of 1999; *Acacia koa, Psydrax odoratum, Hedyotis terminalis,* and *Dianella sandwichensis*. In an

effort to determine the effects of fertilizing in the field half the plants were fertilized and half were not. For all of these plants, growth and survivorship have been tracked. In July of 2001 the plants were counted and measured to identify treatment results. Survivorship data is summarized below in Figures 2-3 and 2-4. Growth for *Hedyotis* is presented in Figures 2-1 and 2-2 and *koa* growth is in Figures 2-5 and 2-6.

Dianella sandwichensis exhibited low survivorship, forty percent for fertilized plants and nine percent for unfertilized individuals. This may be attributed to the high level of light exposure that resulted from the clearing of the black wattle canopy. In the future, this species will not be inserted until the canopy is restored. Low numbers of *Psydrax odoratum* were planted and therefore conclusions could not be drawn from this species. The group of *Hedyotis terminalis* planted in January 1999 showed forty-seven percent survival for fertilized individuals and fifty-three percent for non-fertilized plants. The group of *Hedyotis terminalis* planted in March 1999 showed sixty percent survival for fertilized individuals and forty percent for non-fertilized plants. Both the January and March 1999 plantings show the same trend for growth. In the first few months, the fertilized plants grew faster than the non-fertilized plants. However, when the plots were next read, non-fertilized plants were growing faster. NRS discussed a theory that may explain the growth data. Fertilization initially resulted in high growth rates. However, once the time release fertilizer was gone (approximately three months) these plants may have suffered slightly from having to acclimate to the natural soil nutrient levels. The non-fertilized plants did not initially grow as fast as the fertilized individuals and showed almost no growth over the first months. Perhaps the plants were getting acclimated to the natural soil nutrient levels. Subsequently, this group has started growing at a comparatively rapid rate. NRS will collect data twice next year and analyze data for next year's report.

Figure 2-1 Hedyotis Growth: Fertilized vs. Not Fertilized

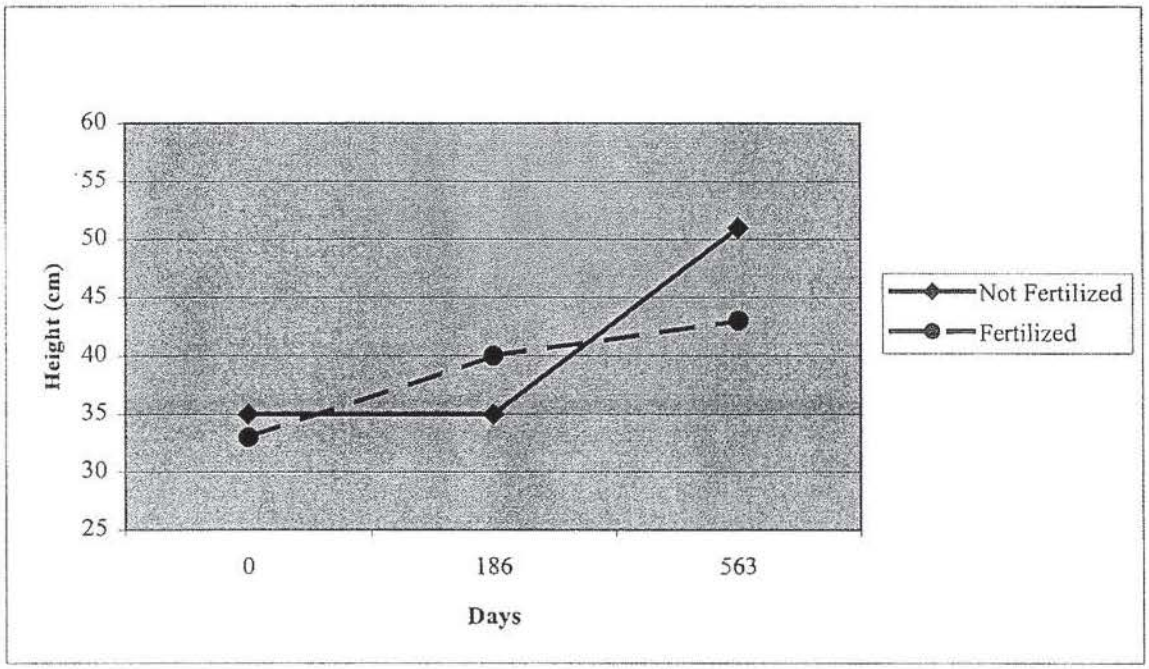
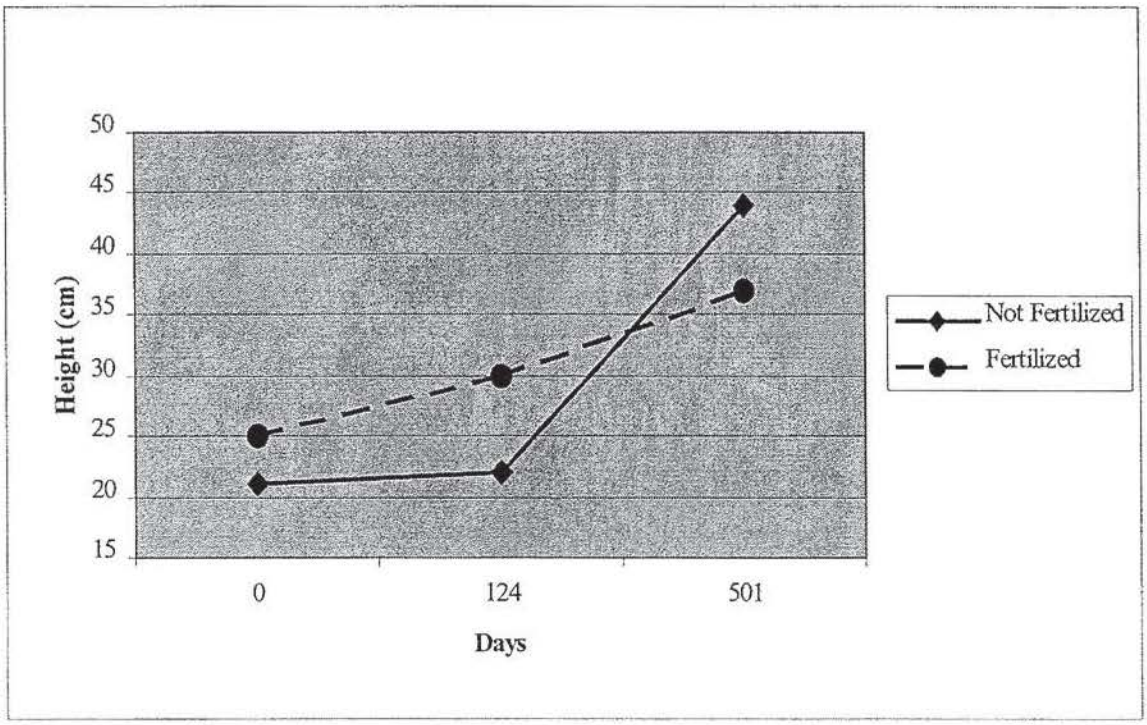


Figure 2-2 Hedyotis Growth: Fertilized vs. Not. Fertilized



Koa has showed the greatest amount of growth and highest survival for most groups. Koa planted in January of 1999 had a sixty-six percent survival rate for non-fertilized plants. Unfortunately, some of the flagging was lost on the fertilized plants in this group and survivorship could not be calculated. Koa planted in March of 1999 had a forty percent survival rate for fertilized individuals and a hundred percent rate for non-fertilized plants. Growth data is contradictory between the two groups. In the group of Koa planted in March fertilized individuals are growing faster than non-fertilized plants. Conversely, in the group of Koa planted in January fertilized individuals are growing slower than non-fertilized plants. It is hard to draw strong conclusions from these data.

Figure 2-3 Survivorship Summary, Black Wattle Control Project, March 1999

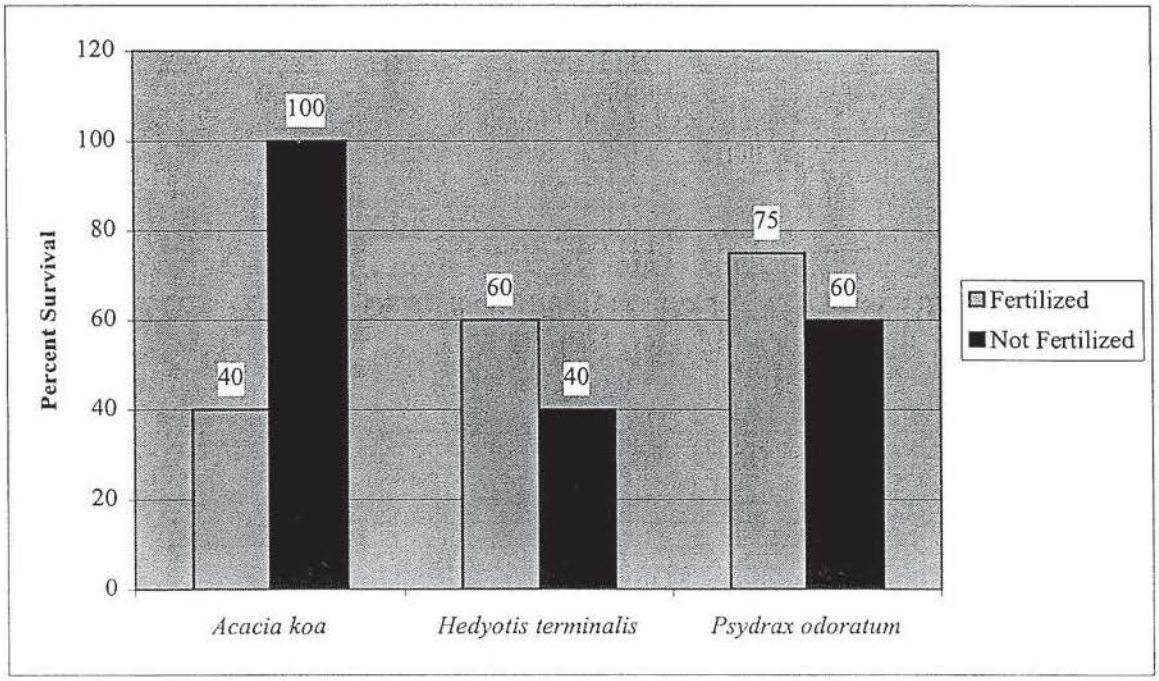


Figure 2-4 Survivorship Summary, Black Wattle Control Project, January 1999

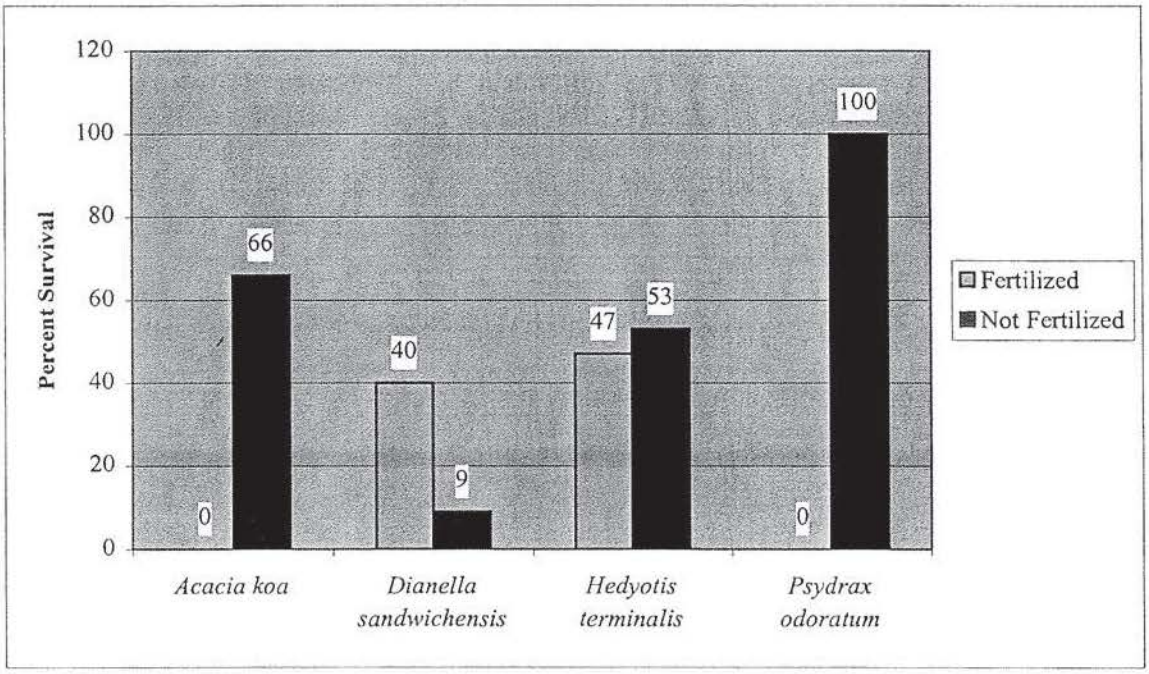


Figure 2-5 Koa Growth: Fertilized vs. Not Fertilized

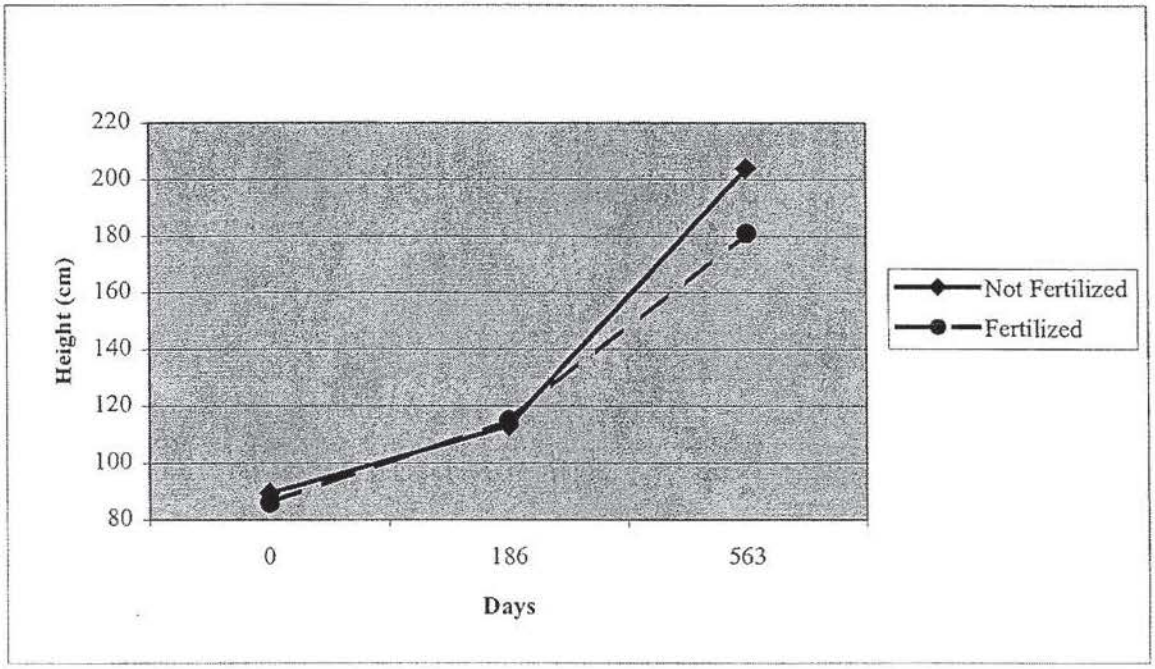
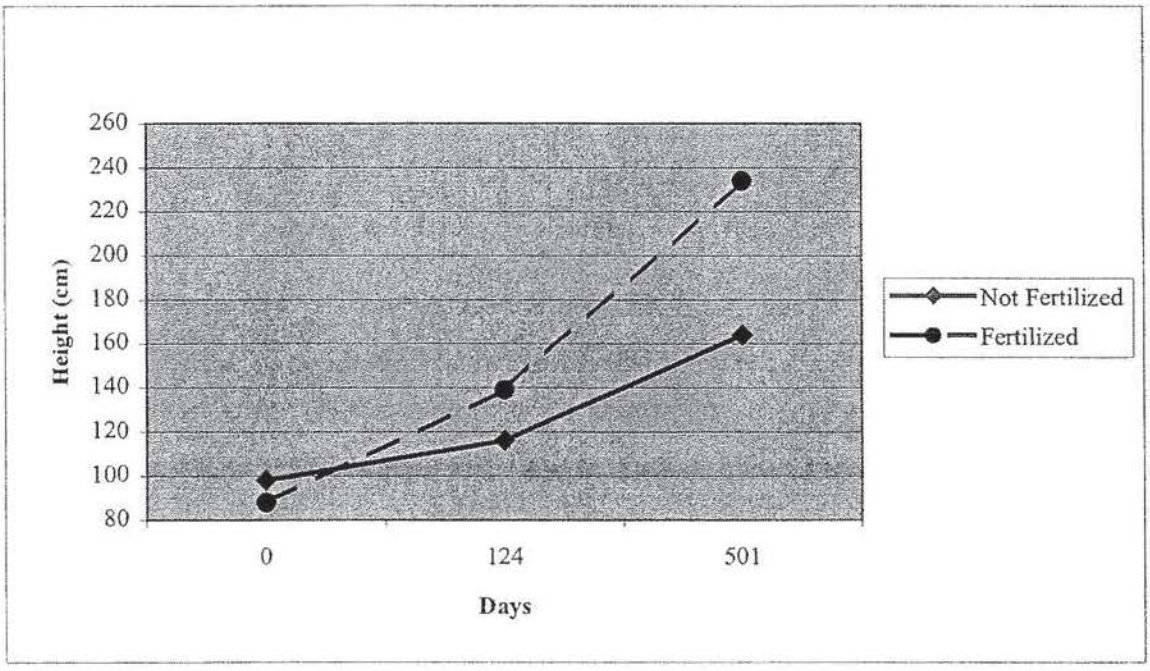


Figure 2.6: Koa Growth: Fertilized vs. Not Fertilized



During winter 2001-2002 NRS plan to resume planting efforts within areas already cleared of black wattle and expand into areas still dominated. Only Koa will be planted in hopes that this fast growing canopy species will build an environment suitable for native understory species as well as slower growing canopy species. The fertilization trials suggest that fertilization may not make a significant difference in the long-term and is not essential when outplanting native

Hawaiian species. Although NRS are interested in continuing fertilizer trials and collecting more data, these efforts may not be a vital part of future outplanting efforts.

Monitoring

The black wattle plot in Kahanahāiki continues to be monitored. Old vegetation monitoring plots will be permanently marked so they may be revisited in the future if the need arises. Past data collected from these plots is kept on file at the Natural Resource Center.

2.7.b `Ōhikilolo MU

Control

Widespread weed control has been conducted in the `Ōhikilolo forest patch between 2800 and 3000 feet in elevation. Controlling species such as *Schinus terebinthifolius* (Christmas berry), *Rubus rosifolius* (Thimbleberry), *Stachytarpheta dichotoma* and *Kalanchoe pinnata* (Air plant) have covered approximately 2.5 acres of area. NRS have expended extensive effort over the past four years to convert the `Ōhikilolo forest patch 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 quarterly and invasive plants do not have the opportunity to become established.

Monitoring

There are four active weed-control monitoring plots on `Ōhikilolo ridge. They were installed to monitor the effectiveness of treatments for invasive weeds.

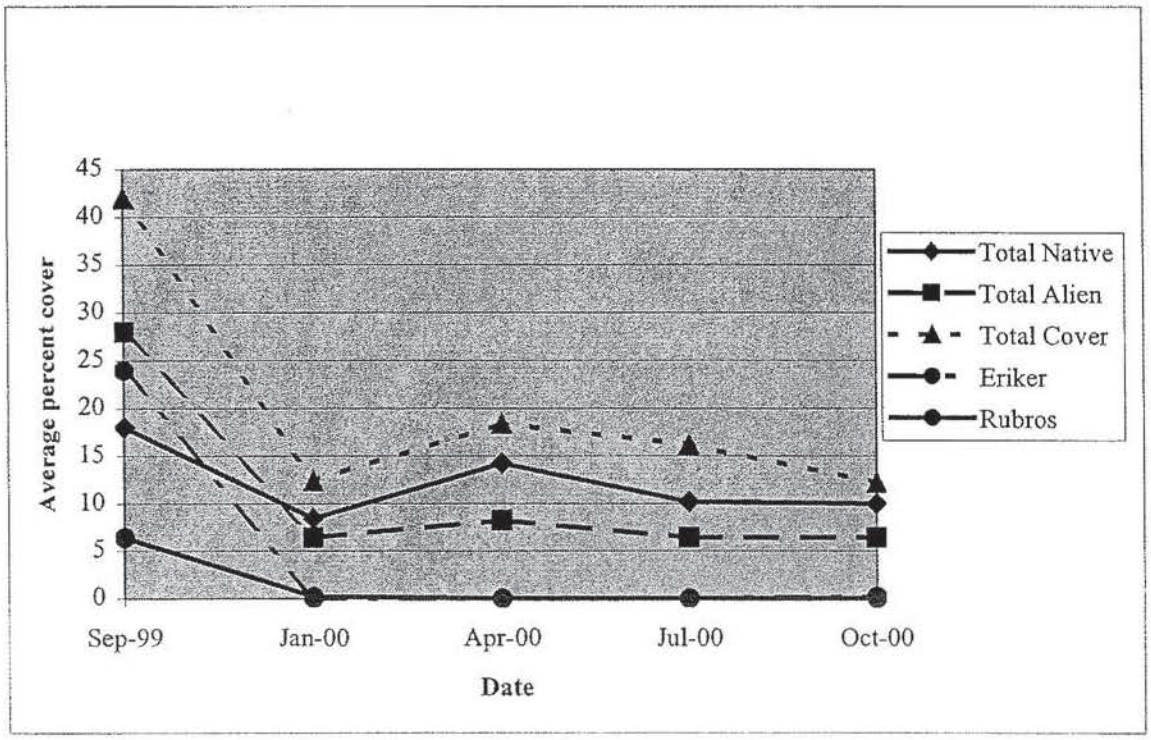
In general, most of the treatment methods were effective for controlling the target species. A percent cover was recorded for each species.

Plot #16 (Figure 2-7)

Plot #16 was installed to investigate the efficacy of a 3% foliar Garlon 3 treatment in controlling *Erigeron karvinskianus* and secondarily *Rubus rosifolius*. This treatment was very effective. *Erigeron* cover dropped from an average of 24% to less than 1% more than a year after treatment. Thus far this is the best technique identified to combat this species. However, there was some impact to native cover that dropped from an average of 18% to 10% over the same period. This cost to native vegetation from the herbicide Garlon is far less than the impact observed when Round-up was sprayed (PCSU report 2000). *Erigeron* is still incipient within the `Ōhikilolo MU and does pose a significant risk, therefore the damage caused by this type of treatment must be balanced against the potential risk this species poses to the ecosystem. Treatment may be employed on a small scale in areas with *Erigeron* infestation to prevent establishment.

Rubus cover averaged 6% at treatment and was completely removed from the plot. Initial *Rubus* cover was not high because plot placement was chosen to sample an area of high *Erigeron* cover. Although apparently effective, this treatment will not be applied to *Rubus* on a larger scale because basal treatment is as effective and it shows no non-target impacts (PCSU report 2000).

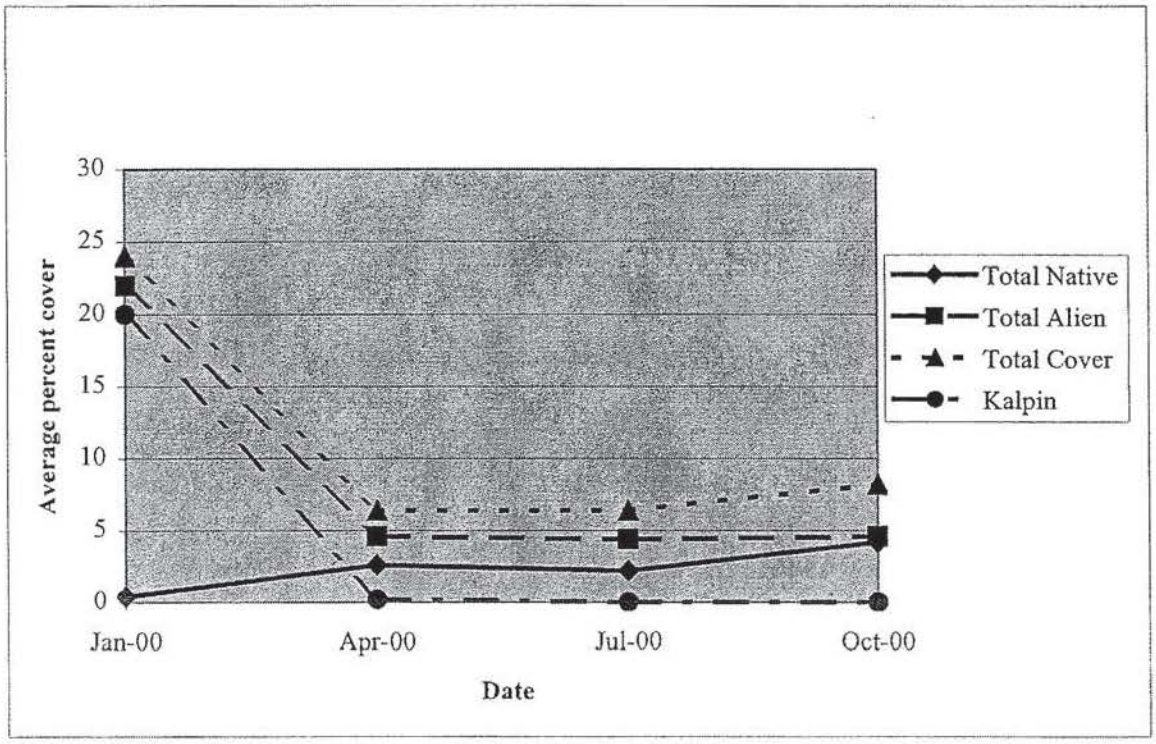
Figure 2-7 `Ōhikilolo Plot #16: Rubus and Erigeron Garlon 3 Foliar Treatment



Plot #18 (Figure 2-8)

Plot #18 was installed to investigate the efficacy of a 3% foliar Garlon 3 treatment in controlling *Kalanchoe pinnata*. This treatment was very effective. *Kalanchoe* averaged 20% cover prior to treatment and was completely removed from the plot ten months after treatment. This trial was performed in an alien dominated area and therefore the non-target impacts were not seen. Total native cover was less than 1% prior to treatment. This treatment may be an option in areas that are alien dominated, however the Garlon 4 basal treatment will be used in native areas to avoid non-target impacts. This treatment proved just as effective, without affecting native species (PCSU report 2000).

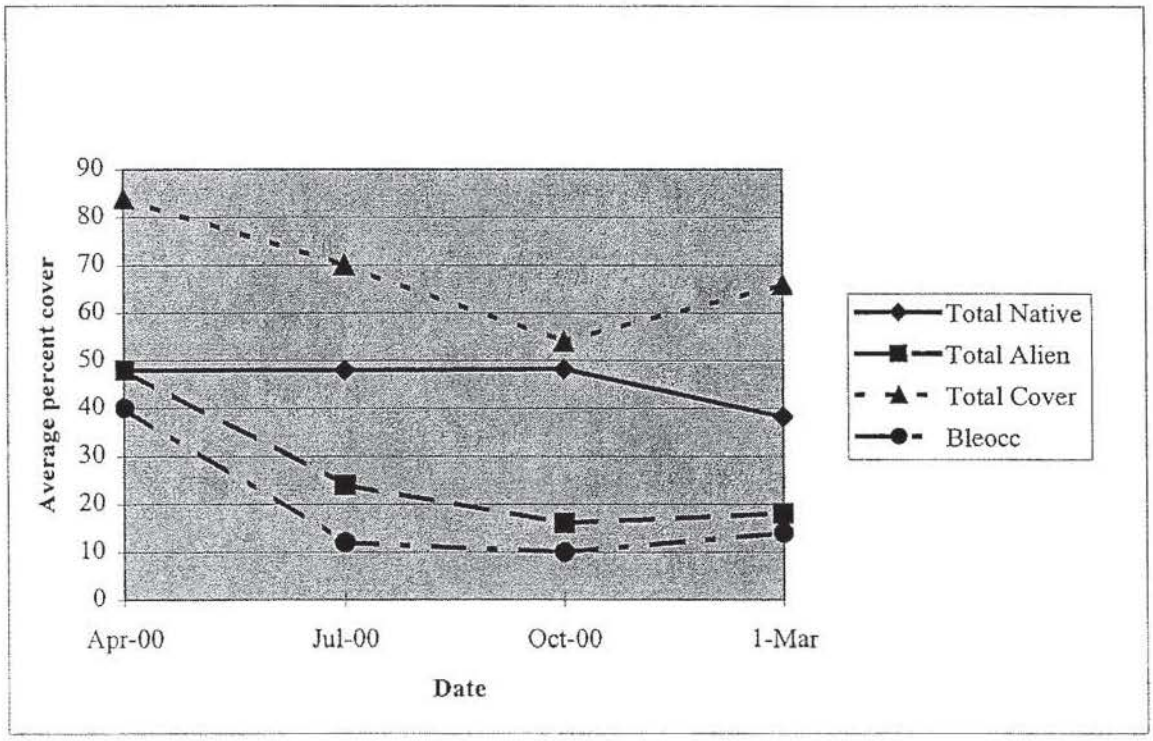
Figure 2-8 `Ōhikilolo Plot #18: Kalanchoe Garlon 3 Foliar Treatment Totals



Plot #20 (Figure 2-9)

Plot #20 was installed to investigate the efficacy of a 2% foliar Garlon 3A treatment in controlling *Blechnum occidentale*. *Blechnum* is the last remaining habitat altering invasive in the `Ōhikilolo MU for which NRS do not have an effective control strategy. This treatment was only marginally successful. *Blechnum* declined from 40% cover to 14% eleven months after treatment. There had been a slight increase in cover values since the initial treatment after which the *Blechnum* declined to 12%. NRS expect that *Blechnum* will continue to increase in cover in the plot. Due to high cover values of *Carex* species, native cover did not. As Garlon 3A at low concentration effects broad-leaf plants more than monocots, it was expected that the *Carex* would not be negatively impacted by this treatment. However, if in the future this treatment is applied, care must be taken to avoid non-target impacts to broad-leaf species seen with this type of treatment. A low Garlon 3A concentration was applied in an attempt to minimize the impact on non-target native species, however, a two-percent concentration may not be strong enough to affect any significant reduction of *Blechnum* within the plot. If extended results show an insufficient kill rate for *Blechnum* NRS may look at testing multiple treatments at two percent or increasing the percentage of Garlon 3A at application.

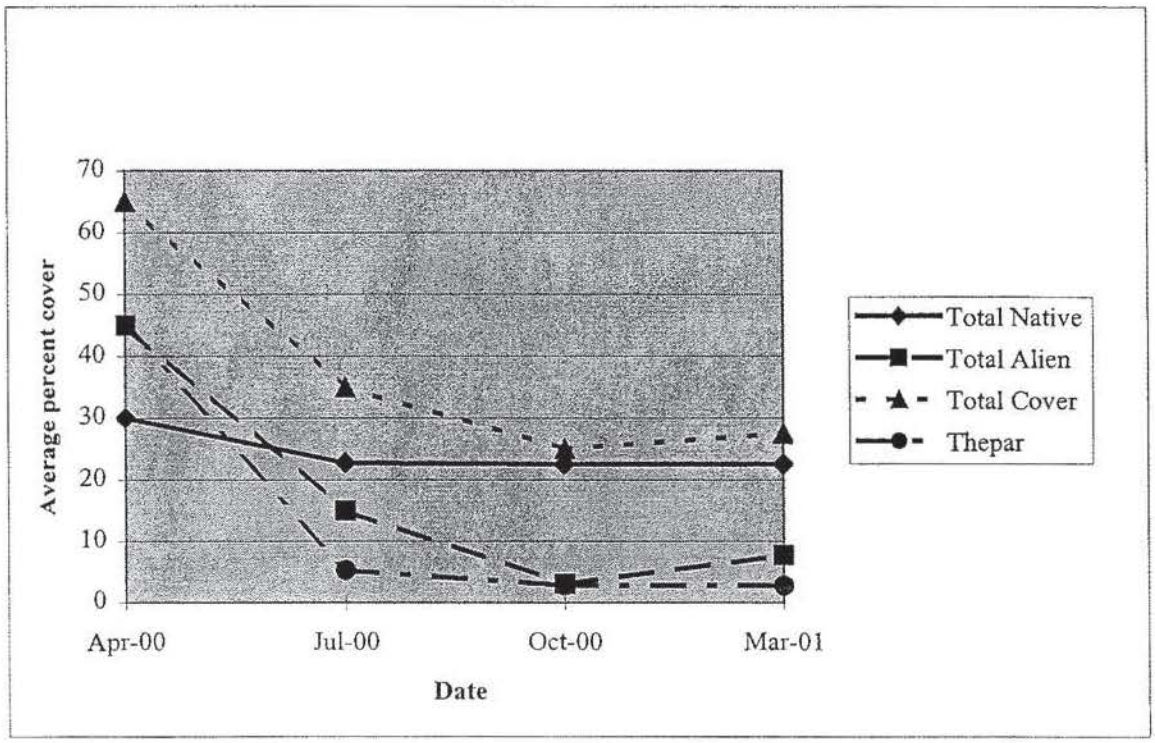
Figure 2-9 `Ōhikilolo Plot # 20: Blechnum Garlon 3 Foliar Treatment Totals



Plot #21 (Figure 2-10)

Plot #21 was installed to investigate the efficacy of a 20% Garlon 4 in FCO basal method in controlling *Thelypteris parasitica*. *Thelypteris* is a multi-stemmed fern. In order to treat all of these stems they were gathered into a tight bunch and treated as a single unit with Garlon 4. This approach minimizes herbicide waste and non-target impacts. This treatment was effective in controlling *Thelypteris*. Prior to treatment *Thelypteris* coverage averaged 45% and eleven months after treatment averaged less than 3 %. There was a slight decline in average native cover from 30% to 22%. This decline may have been due to some seasonal fluctuation in cover levels because non-target impacts have not been seen with this treatment technique.

Figure 2-10 `Ōhikilolo Plot #21 Thelypteris Garlon 4



2.7.c Kaluakauila MU

Control

Canopy weed control has been conducted in approximately five acres of the Kaluakauila MU. Most of this forest patch has minimal understory weed problems, thus canopy weed control has been the focus. Weeds controlled include *Psidium cattleianum, Schinus terebinthifolius, Aleurites moluccana, Cordyline fruticosa, Grevillea robusta, Melia azedararch, Lantana camara* and *Leucaena leucocephala*. *Panicum maximum* is the most threatening understory weed because of its association with fire. The extent of *Panicum* in the forest patch will be assessed and controlled as necessary.

Monitoring

There are no weed plots being actively monitored in Kaluakauila. Old vegetation monitoring plots will be permanently marked so they may be revisited in the future if the need arises. Past data collected from these plots is kept on file at the Natural Resource Center.

2.7.d Lower Mākua MU

Control

The dry forest in the lower portions of Mākua Valley contains some of the most intact stands remaining on the island of O`ahu. UXO left by past military training hinders management in this forest. Access is only allowed with EOD escort a few days each month. Last year NRS were able to get a risk assessment approved that allows access to this MU with helicopter and camping

at an approved campsite. This has greatly increased the amount of management that NRS are able to perform in the MU. Four overnight trips were taken by NRS last year. More than 20 acres were weeded during these trips. A large proportion of the weeding has occurred in sites where there are relatively few weeds and thus a single pass-through conducting weed control results in the return to near-pristine state.

NRS initiated a new experimental grass control project this year in the Lower Mākua MU. Areas in Mākua Valley that have been burned in the past are dominated by alien grass. These grasses growth thick and prevent the germination of the native woody species that dominated before it was burned. NRS expect that these areas retain a rich seed bank built from the thousands of years that the area was native dominated. Thus, if the alien grasses are removed germination from the seed bank may begin the slow process of regenerating native forest. This was observed in areas on Haleakalā, Maui where invasive Kikuyu was removed. NRS treated two areas in Mākua with a grass specific herbicide. One area was adjacent to native forest and had some native woody species germinating through thin spots in the grass. The second plot was completely surrounded by grass and had no native species present.

Monitoring

NRS installed monitoring plots to better quantify the results of the alien grass control project discussed above. Prior to spraying, the areas were mapped and flagged. In addition, photo-points were established to visually display changes in vegetation. A comprehensive species list was also compiled before control began. NRS will monitor these areas quarterly and re-apply herbicide as needed to kill alien grass cover. NRS will also monitor the plot for germination of native species and consider removal of dead grass cover as a possible option.

2.7.e C-ridge MU

Control

This year NRS established a trail to the C-ridge MU via the north firebreak road. This new route greatly reduces the commute time required. NRS visits this MU twice a year for management work including weed control. Canopy weeds that include *Schinus terebinthifolius, Psidium cattelianum, Grevillea robusta, Cordyline fruticosa, Montanoa hibiscifolia, Leucaena leucocephala* and *Aleurites moluccana* have been controlled over approximately two acres. Understory weeds are not a significant problem in this MU.

Monitoring

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

2.8 Schofield Barracks Military Reservation

Surveys

Schofield Barracks is comprised of three separate ranges; West, South, and East. These ranges will be discussed separately.

In SBW, road surveys this year did not detect any habitat modifying weeds. Special care was taken to inspect the spot where NRS controlled *Rubus argutus* in 1999. It seems that this population has been eradicated. Other problematic species that appeared on the SBW survey

include, *Caesalpinia decapetala* (Cats claw), *Calliltris* sp., and *Pimenta dioica* (Allspice). *Caesalpinia* can grow into thick impenetrable thorny tangles. It colonizes sunny gap environments. This species is presently only found below the firebreak road. This area is inaccessible to NRS because of UXO threats. NRS set a zero tolerance goal for this species above the road in 2000. NRS mapped infestations below the road this year with GPS. No control actions were performed, as plants were not close to the road. In 2002, NRS will again map infestations and compare distribution. If plants are discovered on or near the road, control will be conducted. *Callitris* is only known from this single location on Army land and NRS does not have expertise in its potential impacts or manageability. NRS mapped this species extent in March of 2001. In 2002, land managers experienced with this species will be queried for recommended actions, and a literature search will be conducted to investigate its impacts. *Pimenta* is known to be invasive and habitat altering from other areas of the Wai`anae Mountains including such areas as Wai`anae Kai. In March 2001, NRS mapped the locations of this species but performed no control. Populations, which were thought to be incipient, are truly established, and NRS do not plan control in the near future.

In SBS, *Triumphetta semitriloba* was found for a second year on the road survey. NRS will keep this weed from becoming established within the MUs but believe it is impractical to try to control it across the entire range. In addition, an unidentified *Chloris* species was noted for the second year within an LRAM seed-sowing site. NRS will attempt to acquire a positive identification of this plant and monitor the site to determine if it has potential to naturalize.

In SBE no habitat modifying weeds were found on the road surveys. An aerial survey for ginger was performed this year and resulted in the identification of some satellite populations. NRS will perform more surveys in 2002 (See Schofield Waikāne MU for discussion).

There are two landing zones in SBMR and surveys of these indicate that each has a stable set of weeds. (See Appendix 2-C Weed Surveys Roads and Landing Zones, Schofield Barracks Military Reservation).

Control

Weed control in Schofield Barracks has not occurred on a large scale. In SBS, NRS perform control around rare species and remaining small patches of native forest. Most of the area is not worthy of habitat-scale weeding because it is heavily degraded. In SBE, NRS are focusing weed control efforts on incipient populations of White Ginger (*Hedychium coronarium*). In SBW, NRS are working with Rob Anderson, a research assistant at the University of Hawaii on applying a bacterial control agent to Kahili ginger (*Hedychium gardnerianum*) populations at Mt. Ka`ala.

Monitoring

Current monitoring will be discussed within the SBMR ranges or MUs.

2.8.a Ka`ala MU

To date, widespread weed control in SBW has been limited to the summit of Mt. Ka`ala, which has some of the most pristine forest in the Wai`anae Mountains. At Mt. Ka`ala, NRS control Strawberry Guava (*Psidium cattleianum*),and Kahili (*Hedychium gardnerianum*) and White ginger (*Hedychium coronarium*). In last year's report, NRS indicated that guava control within the bog at the summit of Mt. Ka`ala was not an option, as the only known herbicide labeled for

use in this type of environment was not effective. Fortunately, NRS recently discovered that this was not the case. In searching for an appropriate product NRS discovered that Garlon 4 was labeled for use in this type of environment, if scheduled during dry conditions. NRS was careful to confirm with experts at the Department of Agriculture that this treatment was safe. Armed with such an effective tool against guava, NRS plan to aggressively attack the small population of guava that exists in the otherwise pristine bog. NRS will institute a zero tolerance rule for guava on Mt. Ka`ala. Other than Strawberry Guava, Kahili ginger (*Hedychium gardnerianum*) has been invading native areas on Mt. Ka`ala. NRS have been working with Rob Anderson (a research assistant in the Department of Botany at the University of Hawaii) to apply a bacterial control he developed. This control technique is ideal in that it is completely non-toxic to all biota but the ginger to which it is specifically adapted. In theory, it infests the ginger clone to which it is applied, eventually killing its host. NRS have gone on four trips between October 2000 and June 2001 with Mr. Anderson to apply and monitor the applications of the bacterium. Unfortunately the treatment has had mixed results. Despite this, NRS and Mr. Anderson are still hopeful that by experimenting with application methods an effective technique will be found. Alternatively, NRS could perform treatment with EZ-ject herbicide. However, NRS will work with Rob for success before turning to EZ-ject. There is one small patch of White ginger (*Hedychium coronarium*) present on Army land on Mt. Ka`ala. Although this patch is not known to set seed, NRS will remove it through the use of EZ-ject because there is no known bacterial treatment for this species of ginger.

Monitoring

Currently all monitoring efforts center on control projects discussed above and are specifically designed to measure the efficacy of the tools applied.

2.8.b Pu`u Hāpapa MU

Control

NRS have not conducted control on widespread weeds at Pu`u Hāpapa. NRS re-visited TNCH weeding sites this year on Pu`u Hāpapa and determined that further canopy weed control was not appropriate. The understory is primarily alien grass. NRS will continue to monitor the area and may recommend weed control in the future.

Monitoring

Currently there are no monitoring plots in the Pu`u Hāpapa MU.

2.8.c Schofield-Waikāne MU

Control

Within this MU is a population of seeding white ginger (*Hedychium coronarium*). It appears to NRS that this population is spreading up from Kahana Valley where the species is widespread. Control of this population has been conducted to reduce its potential for spread beyond its current location. In 1999, NRS identified the summit trail as the boundary across which ginger will not be tolerated. This year an aerial survey was conducted by NRS and satellite populations above the trail were discovered. These populations were mapped using GPS. NRS followed up with a control trip. NRS and volunteers spent one day treating approximately 50-60 patches of ginger with EZ-ject. Treatment method was adopted from natural resource mangers on Maui. NRS will

return to the site to measure efficacy and continue control if effective. Additional surveys are needed both on the ground and from the air because small satellite populations are difficult to detect. NRS also plan to survey north of Pu`u Pauao to investigate an area which was reported to have ginger in the past. Small patches are relatively easy to eradicate and it is much more efficient to control them while they are still small. In addition, more control is needed to maintain a buffer on the Kahana side of the trail. NRS will employ the EZ-ject control technique in this area if it proves effective. Alternatively, NRS could employ a control technique developed by the National Park Service, which uses Escort herbicide sprayed on the rhizomes. Unfortunately, a low wind environment is necessary for this application and these conditions are rare in this area.

Monitoring

NRS is monitoring plots to determine efficacy of EZ-ject treatment on White ginger (*Hedychium coronarium*).

2.9 Kawailoa Training Area

Surveys

NRS cover more ground doing road surveys in KLOA than any other training area. There are five separate routes taken (Appendix 2-D). Last year, road surveys in KLOA detected *Triumphetta semitriloba*. This species was not seen this year. However, NRS suspect that this weed is on the rise in this area. In Kawailoa, NRS will keep this weed from becoming established within the MUs but feel it is impractical to try to control it across the entire range because of its effective dispersal mechanism. *Arthrostemma ciliatum* appeared again on KLOA-5, the road to Poamoho Trail. NRS have been battling with this species for some time. It was first detected in 1998. NRS went out a couple times that year in an attempt to eradicate the population. In 1999, NRS did not detect any *Arthrostemma* on the road survey and thought that the control had been effective. Unfortunately, in 2000 *Arthrostemma* was again found and NRS controlled it on one occasion that year. That effort was apparently not enough because it was still present on the road survey in 2001 and NRS have gone out on another control trip. Next year NRS will conduct at least two control trips in an effort to eliminate the population. NRS will also develop a more intense monitoring scheme such that individual plants will be marked and mapped.

Control

In KLOA, NRS have controlled weeds over a twenty-acre area. *Psidium cattelianum* is controlled on an ecosystem scale in both Upper and Lower Pe`ahināi`a and Castle MU. In this area, there are only small satellite populations present along pig trails. NRS use Garlon 4 basal treatment to control *Psidium cattleianum*. Large areas of *Leptospermum scoparium* have been controlled in KLOA and details are discussed within the MUs where applicable. The population of *Tibouchina urvilleana* above Whitmore Village in KLOA was visited four times by NRS in the last year. The area has been completely rid of reproductive plants and the number of seedlings found on each trip is declining. Communication with State personnel indicates that no seedlings have been found in *Tibouchina* populations on the Big Island or Kaua`i because its pollinator is lacking. It was thought that an appropriate pollinator was not present in Hawaii but the discovery of seedlings means that something is pollinating this species on O`ahu. NRS will notify other agencies on Kaua`i and the Big Island of this discovery. NRS will continue quarterly trips to remove seedling. In this same area, NRS discovered a population of *Ilex cassine*. Last year this population was mapped and determined feasible to control. Control occurred on this population

twice last year and NRS plan to perform *Ilex* control quarterly next year in combination with *Tibouchina* control. Trials were installed to determine if Garlon 4 thin line treatment is effective on this species. These will be read before control continues.

Monitoring

The following plots are being monitored in KLOA. Plot analyses are included in MU discussions.

Table 2-2 Weed Plot Summary Kawailoa Training Area

Area/Plot	Purpose	Treatment	Results
ITAM plots	Long term vegetation monitoring to determine trends and direct management	None	Inconclusive
Pe`ahināi`a/A	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.

2.9.a Poamoho MU

Control

Weed control in the Poamoho area has been focused on *Leptospermum scoparium* (Manuka). In 1995 this canopy tree was well established along the Poamoho Trail, stretching from the summit down the trail two miles and extending into the drainages on either side. NRS began control in 1996. NRS started control near the summit and have moved progressively down the trail, killing Manuka on both sides. Manuka has been controlled over approximately twelve acres. Control in this region is done using the cut-stump method without herbicide. The mature trees in the upper portion have been removed and today there are only seedlings present. Most of the mature trees in the lower portion have been removed with the help of volunteers. In February and August of 2000, NRS conducted overnight trips with volunteers to control Manuka. NRS will perform at least this level of control next year, and will re-take the photo point at the original core of the population to document progress. There are also small patches of Manuka present near the trailhead that need to be removed. A small patch of Manuka was seen in the Pu`u Pauao vicinity from the air. Unfortunately, when NRS returned to kill the trees the location could not be identified. NRS will continue to be on the lookout when in this area. In addition, NRS will strive to use GPS to record sightings in the future.

Monitoring

No plots have been established in the Poamoho MU.

2.9.b Upper Pe`ahināi`a MU

Control

Last year, NRS was busy working cooperatively with KS, the USFWS, and the State of Hawaii to build a pig exclosure fence within this MU. The project is now complete and is the first

ecosystem size exclosure in the Ko`olau Mountains. With the completion of the project, NRS can now return to previous management actions. The only widespread canopy weed in this area is *Psidium cattleianum*. Over the next year NRS will focus on controlling patches of *Psidium cattleianum* in the new exclosure. NRS discovered three small populations of palm grass (*Setaria palmifolia*) within this MU. Next year, NRS will again turn its attention to these patches and continue efforts to eradicate them. Additional problematic species in the area include *Axonopus fisifolius* and *Pterolepis glomerata*. These are opportunistic species that thrive in pig-disturbed areas. *Axonopus* is believed to be the worse 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. *Pterolepis* presents a greater challenge to control because species specific herbicides are not available for its control. NRS are hopeful, now that pigs are excluded from the area, that native species will be able to reclaim areas dominated by *Pterolepis*.

Monitoring

ITAM vegetation monitoring plots

ITAM personnel have accompanied NRS to the Pe`ahināi`a MU on two occasions, October of 1998 and August of 2000. On both these trips, random monitoring plots were installed. This monitoring 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 cooperatively work with NRS.

2.9.c Lower Pe`ahināi`a MU

Control

Weed control has been conducted in this vicinity around areas of valuable natural resources and along trails of heavy pig traffic. *Psidium cattleianum* is the species most actively controlled.

Monitoring

Weed plots are not established within the Lower Pe`ahināi`a MU.

2.9.d Castle MU

Control

Control has been focused on the only widespread canopy weed, *Psidium cattleianum*.

Monitoring

NRS have installed two *Pterolepis glomerata* plots designed to gauge the effect of pig control on its abundance. Plots were established in areas where NRS have initiated pig control. *Pterolepis* is a herbaceous *Melastome* spread by pigs and thrives in areas damaged by pigs. These plots were established to detect change in *Pterolepis* 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 complete ungulate control is achieved. NRS are considering proposing this area for fencing to the partners of the `Ōpae`ula Watershed Protection Project.

2.9.e Kahuku Cabin MU

Control

NRS have controlled over fifteen acres of a large population of Manuka, *(Leptospermum scoparium)* at Pu`u Kā`inapua`a. Cut-stump treatment without herbicide was used to kill Manuka. The next hotspot that remains in this area is approximately two miles down the Kawailoa trail. This is a large infestation that NRS feel is low priority because it is very large and in a somewhat degraded area. Of higher priority is the remaining Poamoho population because of its small size and close proximity to native forest. Once the Poamoho population is extirpated, NRS will shift control efforts back to Pu`u Kā`inapua`a.

In addition to Manuka, there was a population of white ginger at the old Kahuku cabin site and another approximately 500m north along the summit trail. The rhizomes of both populations were treated with Escort in 1997, 1998, and 1999. NRS revisited these sites in March 2001 and only found seedlings at the old cabin site. All seedlings were removed. There was nothing found at the trail site. These ginger sites will be monitored again next year.

Monitoring

Two weed plots have been established to gauge the effectiveness of cut-stump and girdle treatments on Manuka. These plots were concluded last year but are permanently marked. NRS will have the option of doing further reads in the future.

2.10 Kahuku Training Area

Surveys

This year, road surveys at KTA did not detect any new habitat altering weeds. In past years, road surveys identified two habitat altering weed species *(Melochia umbellata* and *Desmodium intortum*) (Appendix 2-E Weed Surveys Roads, Kahuku Training Area). In addition to these high priority species, two additional species were identified by ITAM and brought to the attention of NRS in July of 2000. These include Fountain grass (*Pennisetum setaceum*) and an unidentified *Acacia* species. NRS have been controlling these weeds over the past two years. A short discussion of each species follows.

Control

Control of widespread weeds in KTA has been done only in the vicinity of rare plants. *Psidium cattleianum*, *Passiflora suberosa*, and *Ardisia elliptica* have been controlled over a combined area of three acres around populations of *Eugenia koolauensis*. NRS are still investigating whether any areas are deserving of MU status. If MUs are defined NRS will begin widespread weed control within these units.

Melochia umbellata

Melochia umbellata was discovered at KTA in March of 1999. This is the only location on O`ahu from which it is known. It 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. Since its discovery by NRS, seven trips have been made to map and eradicate the population. Two trips were made between September and November of 1999 in which approximately 35 trees were treated with 20% Garlon 4. During the flowering season in February of 2000, NRS

surveyed the population from the air to map remaining individuals. Five individuals were seen. A few days later, NRS followed up on the ground to kill these trees. During the flowering season in March 2001, NRS again flew the area to map any plants and to search nearby areas for additional infestations. Six mature plants were mapped with GPS from the air in the forested area below the road. In addition, hundreds of seedlings were seen along the road. Out lying mature plants were not noted during aerial surveys. NRS produced a GPS track log that shows the area surveyed. Two additional trips were made to rid the area of these last individuals. The GPS proved effective in navigating to the waypoints taken from the helicopter. Seven mature trees were killed in the forested area below the road and hundreds of seedlings were removed from the road. NRS plan to return in 2002 to remove any additional seedlings and search for any remaining adults. NRS also will work with Range Control to prevent the further spread via roadways of this invasive species.

Desmodium intortum/tortuosum

In evaluating NRS's approach to this species it was discovered that this species was mis-identified in 1999. NRS have confirmed with the keys in the Manual of Flowering Plants as well as with Joel Lau that the *Desmodium* in KTA is actually *Desmodium tortuosum*. This species does not have an invasive reputation like *Desmodium intortum*. Therefore, NRS are terminating control operations for this species.

Acacia species

In March and April of 2001 NRS made three trips to map and control this species. A total of four sites were found and none of these were very extensive. NRS generated a GPS map of the survey area. NRS began control actions to remove this species. Treatments that were performed in July of 2000 showed that Garlon 4 basal for individuals less than approximately eight inches, and Garlon 4 girdle for larger individuals to be effective. Two trips were taken in April with volunteers to treat all four patches. NRS is uncertain as to the invasiveness of this species and will monitor the patches next year and treat any remaining individuals.

Pennisetum setaceum

The State of Hawaii lists fountain grass 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 has co-evolved with fire. Mature plants produce dense fuel loads. 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 of 2000. In the same month NRS accompanied ITAM to identify and map the infestation. Luckily, the population appeared small, with approximately 100 mature plants and fewer immature individuals. Four days later NRS treated the entire population with 20% Velpar in All-Flex. The following week the site was re-visited and treated a second time to ensure good coverage. NRS returned in August of 2000 to inspect treatment efficacy. At that time, the plants appeared to be responding favorably to the treatment. In April of 2001, NRS monitored the population, and unfortunately, many plants were still present. It seems as though treatment in July 2000 was not as effective as it first appeared. NRS re-treated the entire area in April. NRS will monitor the area every quarter and conduct treatment as needed. In August 2001, mature seeds were collected from fruiting plants and bagged. Approximately 100 plants, mostly small seedlings, were pulled from the ground and also bagged.

Monitoring

Weed plots are not established in the KTA.

2.11 Dillingham Military Reservation

Surveys

Road surveys are conducted at DMR on roads as indicated in Appendix 2-F entitled Weed Surveys Roads, DMR. In January 2001, the State Department of Agriculture reported fountain grass (*Pennisetum setaceum*) at DMR to NRS. Since that time NRS have taken three trips to DMR to map the population, search for additional plants, and control the population. In January 2001, NRS identified the reported population and removed all the seeds present. The seeds were taken to the University of Hawaii to be incinerated. A second trip was taken the same month to perform an extensive search for any other infestations in the area. NARS personnel accompanied NRS to help survey. No additional plants were found. On 4 February 2001 NRS and NARS treated the population with Round-up. A total of six to eight plants were treated, some of which were juvenile. NRS will return next year to survey and perform control as needed.

Control

Weed control in DMR has been limited to the large and intact *Sapindus oahuensis* forest. Species controlled include *Leucaena leucocephala, Syzigium cumini*, and *Schinus terebinthifolius*. In December 2000 and February 2001, NRS performed weed control at DMR with volunteer help. A small chainsaw was useful in quickly performing cut stump treatments to *Leucaena leucocephala*. This species must be deeply girdled or cut stump for Garlon to be effective. Control has been conducted over approximately three acres.

Monitoring

Weed plots have not been established in DMR.

Table 2-3 REVIEW OF 2000 WEED MANAGEMENT RECOMMENDATIONS

Range	MU	Completed	Action	Notes
DMR	DMR	x	Conduct annual road surveys	See MU discussion
DMR	DMR	x	Weed areas with >80% native cover	Two trips with volunteers
KLOA	Castle		Weed areas with >80% native cover - guava on summit trail	NRS focused on fencing project this year
KLOA	Kahuku Cabin	x	Follow up on ginger control	See MU discussion
KLOA	Kahuku Cabin		Weed areas with >80% native cover	NRS focused on fencing project this year
KLOA	KLOA	x	Conduct annual road (be ready to control *Arthrostema ciliatum* on the Poamoho road) and LZ surveys	See range discussion
KLOA	KLOA	x	Continue *Tibouchina urvilleana* control in Whitmore	See range discussion
KLOA	KLOA	x	Determine best methods for controlling *Ilex cassine*, survey the extent of the population and determine if necessary to control.	See range discussion

Table 2-3 REVIEW OF 2000 WEED MANAGEMENT RECOMMENDATIONS CONTINUED

KLOA	KLOA		Kill satellite manuka @ Poamoho trail head and Pu`u Pauao	See MU discussion
KLOA	Lower Pe`ahināi`a	x	Weed areas with >80% native cover	See MU discussion
KLOA	Pe`ahināi`a upper		Continue installing monitoring plots with ITAM	ITAM has not had staff available to work with NRS
KLOA	Pe`ahināi`a upper		Continue palm grass control	NRS focused on fencing project this year
KLOA	Pe`ahināi`a upper		Continue *Psidium cattleianum control* within MU	NRS focused on fencing project this year
KLOA	Pe`ahināi`a upper		Read Pe`ahināi`a Plot A following fence completion	Fence is just completed
KLOA	Pe`ahināi`a upper		Read veg. monitoring plots, retreat fusilade plot	Plots considered conclusive
KLOA	Poamoho	x	Work to eradicate Manuka from the MU	Two overnight trips with volunteers
KTA	KTA	x	Conduct annual road surveys	See range discussion
KTA	KTA	x	Conduct control recommended by survey data found for *Desmodium intortum* and *Acacia spp*	See range discussion
KTA	KTA	x	Continue efforts to eradicate *Melochia umbellata*	See range discussion
KTA	KTA	x	Control *Ardisia elliptica* around populations of *Eugenia koolauensis*	See range discussion
KTA	KTA	x	Control the *Melochia umbellata* and *Desmodium intortum* detected on recent road surveys in KTA	See range discussion
KTA	KTA		MU exploring to determine if there are areas of > 80% native vegetation deserving of weeding	NRS still working on this action
KTA	KTA	x	Survey and retreat *Pennisetum setaceum* population	See range discussion
KTA	KTA	x	Survey areas not covered by road survey for *Desmodium intortum* and *Acacia spp*, map any individuals found.	See range discussion
KTA	KTA	x	Survey *Melochia umbellata* area from the air to identify additional infestation	See range discussion
MMR	C-Ridge	x	Weed areas with >80% native cover	See MU discussion
MMR	Kahanahāiki		Develop weed control plan and begin implementation	NRS still working on this action
MMR	Kahanahāiki	x	Grow Koa for re-vegetating ironwoods	See MU discussion
MMR	Kahanahāiki		Permanently tag vegetation monitoring plots	NRS still needs to complete
MMR	Kahanahāiki	x	PO common natives (Koa)	Seeds have been delivered to the vender
MMR	Kahanahāiki	x	Pull Ethan's re-vegetation plots	

Table 2-3 REVIEW OF 2000 WEED MANAGEMENT RECOMMENDATIONS CONTINUED

MMR	Kahanahāiki	x	Read *Oplismenus* plots	Plots considered conclusive
MMR	Kahanahāiki	x	Retreat blackberry control site	See MU discussion
MMR	Kahanahāiki		Re-treat the *Oplismenus* Fusilade and Pull plots	NRS reconsidered this action
MMR	Kahanahāiki	x	Re-visit Blackwattle project and make plans for next year if out-planting is required seed collection may be necessary	See MU discussion
MMR	Kahanahāiki	x	Weed areas with >80% native cover	Approximately eight trips this year
MMR	Kaluakauila		Permanently tag vegetation monitoring plots	Pegs are onsite but NRS still needs to complete
MMR	Kaluakauila		Weed areas with >80% native cover	NRS did not do this year
MMR	Lower Mākua	x	Map and weed areas with >80% native cover	See MU discussion
MMR	MMR	x	Conduct annual road and LZ surveys	See range discussion
MMR	`Ōhikilolo	x	Map *Triumphetta semitriloba* infestation in MU and strategies control	See MU discussion
MMR	`Ōhikilolo	x	Read vegetation monitoring plots	See MU discussion
MMR	`Ōhikilolo	x	Weed areas with >80% native cover	See MU discussion
SBMR	Ka`ala		Aerial search for ginger	NRS investigated and found that FAA would not allow a flight
SBMR	Ka`ala	x	Conduct control of ginger using chemical and biological control methods	See MU discussion
SBMR	Ka`ala	x	Weed Strawberry guava from MU	See MU discussion
SBMR	Pu`u Hāpapa	x	Re-visit Nature Conservancy weed control area, strategize and begin new control efforts	See MU discussion
SBMR	SBMR	x	Conduct annual road and LZ surveys: Review specific goals in Schofield section	See range discussion
SBMR	SBMR	x	Revisit Blackberry control site along the firebreak road in SBW and retreat as necessary	See range discussion
SBMR	Schofield-Waikāne	x	Conduct an aerial survey for satellite populations of ginger in the Schofield-Waikāne MU	See MU discussion
SBMR	Schofield-Waikāne	x	Control White ginger population; day trip when weather allows	See MU discussion
SBMR	Schofield-Waikāne	x	Invite USFW refuges to SBE	Invite USFW but did not accompany
		x	Continue participation in OFGWG and OISC	Attended all meetings scheduling would allow
			Develop weed monitoring form	NRS still working on this action

Table 2-3 REVIEW OF 2000 WEED MANAGEMENT RECOMMENDATIONS CONTINUED

		x	Meet with ITAM and LRAM to communicate and coordinate projects, special attention to any LRAM planting projects	NRS meet with ITAM twice

2.13 Weed Management Recommendations/Schedule for 2001-2002

The following table lists recommendations that are not otherwise incorporated on a programmatic level during quarterly scheduling. This list does not reflect the total reach of NRS weed management.

Table 2-4 Weed Management Recommendations

Range	MU	Action	Q4	Q1	Q2	Q3
DMR	DMR	Conduct annual road surveys		X		
DMR	DMR	Weed areas with >80% native cover			X	
DMR	DMR	Survey and retreat Pennisetum setaceum population	X	X	X	X
KLOA	Castle	Weed areas with >80% native cover - guava on summit trail		X		X
KLOA	Castle	Treat guava patch along summit trail near bog			X	
KLOA	Kahuku Cabin	Follow up on ginger control	X			
KLOA	Kahuku Cabin	Weed areas with >80% native cover			X	
KLOA	KLOA	Conduct annual road and LZ surveys		X		
KLOA	KLOA	Control *Arthrostema ciliata* on the Poamoho road		X		X
KLOA	KLOA	Continue *Tibouchina urvilleana* and *Ilex cassine* control in Whitmore	X	X	X	X
KLOA	KLOA	Monitor Ilex cassine trials to determine if Garlon 4 treatment is effective	X			
KLOA	KLOA	Kill satellite manuka @ Poamoho trail head and Pu`u Pauao				
KLOA	Lower Pe`ahināi`a	Weed areas with >80% native cover	X		X	
KLOA	Upper Pe`ahināi`a	Continue palm grass control	X	X	X	X
KLOA	Upper Pe`ahināi`a	Continue Psidium cattleianum control within MU		X		X
KLOA	Upper Pe`ahināi`a	Read Pe`ahināi`a Plot A and Pterolepis glomerata on Alien Man	X		X	
KLOA	Poamoho	Work to eradicate Manuka from the MU		X		X
KTA	KTA	Conduct annual road surveys		X		
KTA	KTA	Revisit 4 Acacia spp infestation areas and perform control as needed			X	
KTA	KTA	Continue efforts to eradicate *Melochia umbellata*, search area near road and conduct a helicopter overflight		X		X
KTA	KTA	Control *Ardesia elliptica* around populations of *Eugenia koolauensis*		X		X

Table 2-4 WEED MANAGEMENT RECOMMENDATIONS CONTINUED

KTA	KTA	MU exploring to determine if there are areas of > 80% native vegetation deserving of weeding	X		X	
KTA	KTA	Investigate ways to prevent spreading of Melochia along road with Range Control				
KTA	KTA	Survey and retreat Pennisetum setaceum population	X	X	X	X
MMR	C-Ridge	Weed areas with >80% native cover		X		X
MMR	Kahanahāiki	Develop weed control plan and begin implementation	X	X	X	X
MMR	Kahanahāiki	Prep Black Wattle site for outplanting; clear more live and dead Black Wattle	X			
MMR	Kahanahāiki	Outplant Koa @ Black Wattle, *Schiedea nuttallii* @ MMR-A and Ironwoods		X		
MMR	Kahanahāiki	Record data on Black wattle trial		X		X
MMR	Kahanahāiki	Permanently tag vegetation monitoring plots	X			
MMR	Kahanahāiki	Retreat blackberry control site	X	X	X	X
MMR	Kahanahāiki	Weed areas with >80% native cover	X	X	X	X
MMR	Kaluakauila	Permanently tag vegetation monitoring plots	X			
MMR	Kaluakauila	Weed areas with >80% native cover			X	X
MMR	Kaluakauila	Consider and implement grass control if deemed necessary	X	X	X	X
MMR	Lower Mākua	Map and weed areas with >80% native cover	X	X	X	X
MMR	Lower Mākua	Monitor and continue grass control in plots, check for germination and consider removal of dead grass	X	X	X	X
MMR	MMR	Conduct annual road and LZ surveys		X		
MMR	MMR	Survey within South firebreak road for Obata Fountain Grass		X		
MMR	ʻŌhikilolo	Install vegetation monitoring plots to further investigate Blechnum occidentale control methods	X			
MMR	ʻŌhikilolo	Install vegetation monitoring plots to further investigate Blechnum occidentale control methods		X	X	X
MMR	ʻŌhikilolo	Weed areas with >80% native cover	X	X	X	X
SBMR	Kaʻala	Conduct control of white ginger using chemical methods and conduct control of Kahili ginger using biological/chemical (EZ-ject) control methods	X	X	X	X
SBMR	Kaʻala	Weed Strawberry guava from MU	X	X	X	X
SBMR	SBMR	Conduct annual road and LZ surveys		X		
SBMR	SBMR	Identify Chloris spp. present in LRAM outplantings in SBS; if invasive, consider control		X		

Table 2-4 WEED MANAGEMENT RECOMMENDATIONS CONTINUED

SBMR	SBMR	Maintain zero tolerance for Caesalpinia decapetala (Cats claw) above the firebreak road in SBW		X		
SBMR	SBMR	Investigate invasiveness of Calliltris sp. along the firebreak road in SBW and begin control if warranted		X		
SBMR	SBMR	Map infestation of Pimenta dioica (Allspice) along the firebreak road in SBW		X		
SBMR	SBMR	Revisit Blackberry control site along the firebreak road in SBW and retreat as necessary		X		
SBMR	Schofield-Waikāne	Conduct survey for satellite populations of ginger North of Pu`u Pauao (LZ ginger) in the Schofield-Waikāne MU		X		
SBMR	Schofield-Waikāne	Conduct an aerial survey for satellite populations of ginger in the Schofield-Waikāne MU		X		
SBMR	Schofield-Waikāne	Visit EZ-ject control area and determine efficacy of treatment, continue treatment if warranted		X		
SBMR	Schofield-Waikāne	Expand ginger free buffer below summit trail, employ EZ-ject technique if proven			X	
		Continue participation in OFGWG, OISC, and control sub-group	X	X		
		Develop weed monitoring form	X	X	X	X
		Meet with ITAM and LRAM to communicate and coordinate projects, special attention to any LRAM planting projects			X	X
		Obtain copy of all data from `Ōpae`ula LCTA plots in case of staffing changes				

CHAPTER 3: RARE PLANT MANAGEMENT

3.1 PCSU Contract Requirements

The following is a list of PCSU contract requirements related to rare plant management for the contract period 1 August 2000 through 31 July 2001, followed by a brief discussion of Natural Resource Staff (NRS) success in fulfilling those requirements. One set of line items is for work on Mākua Military Reservation (MMR). The other set of contract requirements covers work on Dillingham Military Reservation (DMR), Kawailoa Training Area (KLO), Schofield Barracks (SB) and the Kahuku Training Area (KTA).

Makua Military Reservation

Requirement (1g)

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 MMR to determine phenology. Propagules shall be collected, if possible. Conduct rat control on species fruiting if found susceptible. Determine the potential of pollination biology for plants while conducting rare plant monitoring. Parameters as described on Enclosure 3 shall be noted. All rare plant monitoring and collection will be conducted using the Hawaii Rare Plant Restoration Group (HRPRG) form. Based on the analysis of data, recommendations shall be made for management actions.

Discussion

MC1, MC2 and MC3 plant species were monitored quarterly by NRS on MMR. A detailed discussion of the monitoring and management accomplishments is included within the discussion of species on each training area. Propagules collected have been distributed to the propagators listed in the Rare Plant Propagation section below. Phenology and management suggestions are determined during visits to rare plant populations and are recorded on the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form (RPMF) (Appendix 3-A).

Requirement (1h)

Identifying the location of and/or obtaining Global Positioning System (GPS) coordinates for listed, rare and native taxa species while in the field during the monitoring of other projects. Parameters as described on Enclosure 3 shall be noted.

Discussion

NRS has been using hand held Garmin GPS units in the past year to help map and plan conservation of rare plants on MMR. When interfaced with our GIS software, this geographic data helps to guide surveys and conservation management. NRS are continuing to build our rare plant GIS database to guide future projects.

Requirement (1n)

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.

Discussion

NRS has documented impacts to rare and endangered plants on the Makua Military Reservation. During surveys with the Hawaii Natural Heritage Program (HINHP) and subsequent monitoring trips of two lowland species, NRS has documented fire damage to the habitat and the plants themselves. There is a population of *Chamaesyce celastroides* var. *kaenana* on lower `Ōhikilolo Ridge, the closest plants being on and around a rocky ledge about twenty meters above and fifty meters west of the fire break road. Several of the older plants were fire-scarred during two burns, which occurred after 1995. NRS has documented these two fires showing fire scars where the plants are now known. This population was not known at the time of the fires. The eldest plants are at least five years old and probably much older. There are seedlings and juveniles known from the population today. NRS recommends fuel control around this population and others highly threatened by fire.

Requirement (1p)

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

Discussion

NRS have continued to operate a facility on Wheeler Army Air Field (WAAF) for growing plants to be reintroduced onto Army training areas. Traditional propagation methods are used to germinate and grow wild collected stock for genetic storage (via seed or tissue), propagation trials, habitat restoration and rare plant reintroduction. Reintroductions have been coordinated with the Army Biologist, consulted experts and Natural Resource Manager.

Requirement (1q)

Reintroduce/out-plant rare plant species approved by the Army within MMR MUs. This task shall be consistent with the goals and actions in the implementation plan being developed by the Army for biological actions at MMR in compliance with the Section 7 consultation on routine military training completed in July 1998.

Discussion

NRS have continued to reintroduce rare plants into MMR MUs. Species reintroduced in the last year include: *Cyanea superba* ssp. *superba*, *Schiedea nuttalii* ssp. *nuttalii*, *Alsinidendron obovatum*, and *Cenchrus agrimonioides* var. *agrimonioides*. Sanitation standards reduce the chance of pathogens being carried into the field as specified by the Sanitation Guidelines. Where time and facilities allow, NRS strove to comply with the Mākua Implementation Team Sanitation Guidelines.

Requirement (2)

All information/data gathered on natural resources shall be entered and compatible with the US Army's Integrated Training Area Management (ITAM) GIS. An electronic copy of information/data gathered during the period of the contract shall also be submitted.

Discussion

Geographic data collected by NRS is submitted to our management database and made available in GIS format to ITAM. The provided data includes information on rare species locations and appropriate buffer zones, landmarks, training impacts and management boundaries.

Requirement (3)

The tasks may include work with Federally listed species or species of concern which will be covered under the permit issued to the US Army Garrison, Hawaii, Directorate of Public Works Environmental Division.

Discussion

NRS continue to work with Federally listed species under our permit (Appendix 3-C) from the USFWS. Work with listed species may include monitoring and management of wild populations, collection of propagules, propagation and reintroduction. The permit has been updated to include new species and staff.

Various Training Areas

Requirement (1g)

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 GIS databases that captures monitoring data and will interface with ARCVIEW software. All location data shall be noted on rare plant field data forms (Enclosure 3).

Discussion

NRS have been using hand held Garmin GPS units in the past year to help map and plan conservation of rare plants. When interfaced with our GIS software this geographic data helps to guide surveys and conservation management. NRS are continuing to build a rare plant database to guide future projects. NRS also use field mapping for those places where GPS units do not work. Geographic data is stored in the rare plant database and on the RPMFs for each population.

Requirement (1i)

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 Hawaii

Rare Plant Restoration Group (HRPRG) form. Based on the analysis of data, recommendations shall be made for management actions.

Discussion

MC1, MC2 and MC3 plant species were monitored quarterly by NRS. A detailed discussion of the monitoring and management accomplishments is included within the species discussion for each training area. Propagules have been distributed to the propagators listed in the Rare Plant Propagation section below. Phenology and management suggestions are determined during visits to rare plant populations and are recorded on the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form (RPMF) (Appendix 3-A). Notes on pollination biology are recorded and compiled on the RPMFs. Such observations are hard to verify without comprehensive study. NRS consider many such questions to be excellent topics for graduate study and would cooperate with researchers to allow access to these resources.

Requirement (1j)

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.

Discussion

NRS have been working with researchers at Lyon Arboretum to identify mycorrhizae from different native-dominated areas. The horticulturists at the Arboretum are testing different plants to determine their relationship with this fungus. So far, use of the fungus conflicts with sanitation concerns and so is not used on Army plants.

Requirement (1o)

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.

Discussion

NRS has been monitoring rare plants for impacts from military training in the last year. On 24 August 2000, NRS and representatives from the Army and their Cultural Resource office conducted a survey of the damage done by three fires in KTA. The purpose of the field visit was to map the extent of the fires and determine whether any damage had been done to federally listed species. The suspected cause of the fire of the fires was a hand flare and a grenade used by Marines training in the area. This was not an authorized use of KTA and use of these weapons is not permitted on any part of KTA. No federally listed species were detected in the burned area, though two populations of the endangered tree, *Eugenia koolauensis* are located within 200 meters of the fire.

Requirement (1q)

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, Range Division.

Discussion

NRS has continued to operate a facility on Wheeler Army Air Field (WAAF) for growing plants to be reintroduced onto Army training areas. Traditional propagation methods are used to germinate and grow wild collected stock for safe harbor, propagation trials, habitat restoration and rare plant reintroduction. Reintroductions have been coordinated with the Army Biologist, Natural Resource Manager and consulted experts. NRS are considering reintroducing two more species in the next year pending permission.

Requirement (2)

All information/data gathered on natural resources shall be entered and compatible with the US Army's Integrated Training Area Management GIS. An electronic copy of information/data gathered during the period of the contract shall also be submitted.

Discussion

Geographic data collected by NRS is submitted to the GIS database and made available to ITAM. The provided data includes information on rare species locations and appropriate buffer zones, landmarks, training impacts and management boundaries.

Requirement (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, Hawaii, Directorate of Public Works Environmental Division.

Discussion

NRS continue to work with Federally listed species under our permit (Appendix 3-C) from the USFWS. Work with listed species may include monitoring and management of wild populations, collection of propagules, propagation and reintroduction. The permit has been updated to include new species and staff.

3.2 Review of 2000-2001 Rare Plant Management Recommendations

Below is a list of recommendations made for 2000-2001 and a discussion of NRS actions for each:

- Monitor populations that have been difficult to visit due to ordnance restrictions. Collect propagules for propagation and storage.

PCSU employees were granted permission by PCSU to enter ordnance areas in the last year. This has allowed greater access into Lower Mākua MU, and SBW. This has greatly improved NRS's ability to access populations of several species that had not been adequately monitored or collected from including *Delissea subcordata, Phyllostegia mollis, Fluggea neowawraea, Alectryon macrococcus* var. *macrococcus, Neraudia angulata angulata* and *Gardenia mannii*. NRS has had access to Lower Mākua, but now are able to camp and spend enough time to access

and manage remote areas. While Mākua has not been used for training NRS has been able to access the resources frequently and without scheduling conflicts. However, access to SBW remains severely restricted due to nearly daily use of the Range. NRS often access the range during range maintenance every couple of months. Often access is restricted to a couple hours early in the morning before training begins.

- Conduct rare plant surveys with contracted assistance from the HINHP to determine suitable areas to conduct off-site mitigation for military impacts on threatened and endangered species.

Surveys have been conducted by NRS, and contracted botanists from the HINHP and the National Tropical Botanical Garden (NTBG). Many new species and locations were unveiled during these surveys. The results are discussed in the Rare Plant Survey Section.

- Work with other agencies and landowners to facilitate ecosystem management projects such as fencing and other ungulate control efforts.

A large-scale ecosystem project in the `Ōpae`ula watershed in the Ko`olau Mountains has been completed. The exclosure helps to protect over a hundred acres of native dominated watershed. This area is also known to have several listed species, which will benefit greatly from ungulate exclusion. Impacts to listed species are discussed in the KLOA section for each of the listed species. Partners in this effort include Kamehameha Schools, the State Division of Forestry and Wildlife, the Army and the USFWS. NRS will continue to represent the Army in these efforts. The partners involved in this project are enthusiastic about the success of the fence, and have expressed interest in continuing with this sort of conservation partnership. NRS have also participated in the construction of a fence in the Makaleha Forest Reserve. NRS cooperated with State Wildlife and NAR personnel to construct an ungulate exclosure around a population of *Cyanea grimesianna* ssp. *obatae*. When NRS first completed the fence around Mākua Valley, the movements of pigs in the surrounding area were affected. Pig sign became concentrated at the Mākua Rim fence in the area where a drainage of West Makaleha meets the Mākua Valley Rim. Pigs would have been able to get into Mākua this way but the fence prevented that and they stayed along the fence. Pig control proved ineffective and a new exclosure fence was put in around the *Cyanea* to stop ingress into this fragile area.

- Support the seed storage program at Lyon Arboretum by collecting propagules for which protocols have not yet been developed.

NRS have continued to support Alvin Yoshinaga's efforts to establish protocols for the storage of seeds from many native species and receive periodic updates on his results. There is now a small longer-term storage facility at Lyon, which is being used to harbor those species that are most threatened in the wild. NRS hopes to have complete genetic representation of all top priority plants stored in this facility. The Army will fund this facility in the coming year as part of the Urgent Actions identified by the Mākua Implementation Team.

- Work with State Horticulturist to interface database and encourage regular inventories. NRS continues to work with other agencies to establish a comprehensive system under which nurseries can better communicate.

At this time the databases have not been integrated. In the coming year, the NRS ex-situ database will be completed on the same operating system as Lyon Arboretum and the Pahole Nursery.

This will greatly improve tracking and make reintroduction projects easier to plan. A representative of NRS sits on the newly formed Pahole Steering Committee to identify priorities for the facility and express Army interests in the projects undertaken.

3.3 Introduction to Rare Plant Management

One hundred and two rare plant species with a federal status are known from Army training lands on O`ahu. There are 56 species with Endangered Status, 27 Species of Concern 18 Candidate species and 1 Threatened species. 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 with fencing and invasive plant control in MUs. Single species management incorporates fieldwork, careful planning and sometimes ex-situ propagation or storage and reintroduction. Our program utilizes a three tiered approach to rare plant management. First and foremost are surveys by contracted botanists, historical records, NRS surveys and monitoring of known populations. NRS and contracted botanists identify resources and provide a basis for prioritizing and recommending management/protection actions. Second, is an analysis of rarity and threats during which, NRS analyze species distribution, habitat restrictions, population demography and trends, and monitor threats to plants and management success. Third, are management recommendations and actions. Actions are focused on controlling threats to plants, improving conditions for recruitment, collection, propagation, and sometimes reintroduction. The following is a discussion of this process.

3.3a Surveys and Monitoring

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 survey reports stored in the GIS and RPMF databases. The U. S. Army Garrison Hawaii first contracted botanical inventories of their training areas in 1977. In 1993, the Nature Conservancy of Hawaii was contracted to conduct additional surveys, the results of which were used in writing Ecosystem Management Plan Reports. Ken Wood and Steve Perlman of the NTBG were contracted for 27 days in the winter of 1999-2000 to conduct surveys of areas off Army lands for federally listed species found in and around Mākua. 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 Reserve, 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.

Since 1998, Joel Lau of the HIHNP has been contracted to survey for certain critically endangered plant species and has assisted NRS with botanical orientation. In the last year, NRS has surveyed new areas in MMR and other training areas for unreported rare plant populations. Mr. Lau, accompanied by NRS, found a new species in MMR, *Hibiscus brakenridgei mokuleianus*. This extremely rare hibiscus was found on lower `Ōhikilolo Ridge and is highly threatened by fire and from competition with alien grasses. Significant populations of *Chamaesyce celastroides kaenana* were also located in the area. Mr. Lau will be contracted again in the coming year to continue surveying work.

NRS schedule time to survey for rare plants and in addition, incorporate surveys into other daily fieldwork. Many new populations have been found as a result of this extensive searching effort. New populations are recorded on the HRPRG Rare Plant Monitoring Form (RPMF) (Appendix 3-A). Once a population is discovered and mapped, it will be put on a monitoring schedule.

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. NRS have been working closely with the HRPRG to coordinate rare plant monitoring, standardize record keeping and collection efforts among agencies and to develop guidelines for the reintroduction of rare plants throughout the state. 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 and described on the form by the NRS visiting the population. The field form records individual plant information which 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. The population structure is recorded by defining the age classes and counting the 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 direct threat control for that species. The background form contains information that is unchanging, such land ownership and location. This information is to be reviewed before visiting the population and kept in the office. At the present time the RPMF are only on hard copy and have yet to be entered into a searchable database. The Army will contract the HINHP for database construction and maintenance. NRS will monitor all plants identified below as having a Threat Control Priority Level of 1, 2, or 3.

3.4 Analysis of Rarity and Threats

To effectively manage resources and threats identified in surveying and monitoring, given limited staff and funding, NRS must prioritize the most imperiled species and actions. NRS prioritizes management actions based on the Threat Control Priority Level (TCPL) assigned for each population. Each species is given a TCPL (1-5) based on the following three variables: Rarity, Conservation Potential, and Threat Level. To determine the TCPL for these species, data was gathered from surveys, RPMFs, the databases of the HRPRG, the HINHP and the USFWS. These databases give distribution, listing status, population size and threats for each of these species. There are 56 plants listed as Endangered, eighteen as Candidates for endangered status, five as Proposed Endangered, 27 as Species of Concern, and one as Threatened on Army Training Areas on O`ahu. NRS has analyzed the above data for the listed Endangered species and all other species having less than 250 individuals statewide. Those species with less than 250 individuals statewide are considered rare and threatened in this report, but are not yet federally listed as Endangered by the USFWS.

The process of determining the three variables and assigning a TCPL for each species in each training area is described below.

3.4a Rarity

To identify the most rare species, the list of rare plants found on Army lands was sorted by ranking the number of individuals known statewide. Species were separated into four categories. Species found on Army land are listed in order by the number of individuals known statewide. NRS uses the number of individuals rather than populations to determine rarity. This most effectively expresses the true population size without bias towards ambivalent population definitions. Many factors may go into determining what separates one population from another including, differing habitat characteristics, geographic boundaries, genetic differences (i.e. lack of gene flow), morphological differences and more. These parameters must be considered when defining a population and are the topic of much discussion. NRS has chosen to determine rarity based on the number of known individuals and not populations to avoid determining and defining populations for each of these species. The populations identified and discussed below are not meant to define genetically unique groups of plants, but are most often based on management or major geographic boundaries. These population sizes statewide range from one individual, to tens of thousands of known individuals. To determine a ranking scheme, four categories were assigned based on natural breaks in the ordered list of species. This scheme is meant only to determine the statewide rarity of a species found on Army land and falls under the jurisdiction of this program. This does not take into consideration other ranking schemes used by other programs. The four categories for number of individuals found statewide are as follows:

1= (<100) where there are less than 100 known individuals.
2= (101-250) more than 100 and less than 251.
3= (251-600) where there are more than 250 and less than 601
4= (>600) where there are more than 600 individuals.

Once these categories were defined, the species were assigned the appropriate ranking.

3.4b Conservation Potential

Some of the species found on Army lands have small, restricted ranges, or may be found in more than one mountain range or island. The Conservation Potential of a species is determined by dividing the number of individuals known from Army lands by the number known Statewide. The results are expressed as a percentage and show the Conservation Potential for the Army populations for each Training Area. This percentage reflects the relative abundance of a given species on Army lands compared with other lands. Determining the Conservation Potential is an attempt to express the relative distribution of a species for management purposes. It is important to account for the Conservation Potential, because a species with less than 10% of the known individuals on Army land will not benefit from Army management as much as a species with over 80% known from Army lands. The Army has the highest potential to be the major contributor to the conservation of those species with high Conservation Potential. Determining the Conservation Potential also identifies those species more vulnerable to extinction because of restricted ranges. For example, a species that occupies a small niche found mostly on Army lands would benefit greatly from Army management. Whereas a habitat generalist species found all over the island or state would not benefit as much from Army management. These species were ranked by their Conservation Potential and placed into four categories. Those categories are as follows:

1= (>75%) when more than 75% are found on Army lands.
2= (30-75%) where 30-75% are known from Army lands.
3= (20-30%) when 20-30% are found on Army lands.
4= (<20%) where less than 20% are found on O`ahu Army Training Areas.

3.4c Threat Levels

The isolation of the Hawaiian chain limited the number of successful colonizations. Due to the relatively stable species assemblage among which they evolved Hawaii's flora is extremely susceptible to rapid changes, in particular, the recent flood of invasive non-native species. NRS has identified eight threats to rare plants on Army training areas. Some are direct threats and others have a cumulative effect on the habitat of rare taxa: fire, alien invertebrates, weeds, ungulates, other introduced vertebrates, disease, loss of pollinators and small populations. Modern landscape altering actions such as ranching have led to habitat destruction and disturbance, which often facilitates and promotes the spread of alien species. These modern human caused threats have changed the landscape and promote fire. Introduced animals and plants take their toll on native plant communities through competition, consumption, and disease spread and habitat alteration. Introduced disease is considered a threat to rare plants and their habitats, but very little is known about them and the difficulty of getting good pathology data for wild plants has prevented NRS from assessing this threat. Although many introduced insects and birds may fill the role left by extinct fauna, the effect of the loss of pollinators on gene flow within and between plant populations is not well known, but must be considered. In addition, because of the small number of extant individuals and the fragmented or restricted distributions of these taxa, they have an increased chance of extinction due to stochastic events. While this is not considered in assigning Threat Levels, many taxa are faced with this additional threat.

NRS regularly tracks the threats to plants from fire, invertebrates, weeds, ungulates and rats. These are discussed below. The other identified threats are harder to track and are noted when monitoring. The Levels assigned for each species were based on monitoring and notes made on the RPMFs for those populations. The monitoring information captured on the RPMFs allow NRS to assign Threat Levels based on associated species lists when they include weeds, or frequency of rat, ungulate, invertebrate or fire damage. High, Medium, and Low Threat Levels were given for each of the following measurable threats: Fire, Invertebrates, Weeds, Ungulates and Rats.

3.4c-1 Fire Threat

The Fire Threat Levels were determined by NRS and the Wildland Fire Program Manager based on fire history and proximity of rare plant populations to light flashy fuels. The introduced grasses *Panicum maximum*, and *Melinus minutiflora* are identified as having the potential to stoke hot quick moving fires. When these grasses are found near or at rare plant populations, those populations were assigned High Fire Threat Levels. For those species with High Fire Threat Levels, long term genetic storage by tissue culture and seed storage will be recommended. For those taxa without known storage data, tissue will be stored ex-situ while seed storage potential is tested. This is to ensure that in the event of a catastrophic fire, a burned population or individual will be adequately represented in storage and could be reintroduced.

- High Fire Threat: based on a plants close proximity to previously burned areas or those with light flashy fuels.
- Medium Fire Threat: the plant is protected from previously burned areas by a natural boundary and absence of light flashy fuels.
- Low Fire Threat: there is little to no chance of a fire, (given to most Ko`olau taxa).

3.4c-2 Invertebrate Threat

Invertebrates threaten plant species by preying on mature plants, fruit, flowers and seedlings. The invertebrates that pose the highest threat are slugs (*Limax maximus*, *Milax gagates, and Veronicella* sp.), the Black Citrus Aphid (*Toxaptera aurantii)* and the Black Twig Borer (*Xylosandrus compactus*). Slugs consume fruit from native plants and prey directly on seedlings and mature plants. Seedlings are particularly susceptible due to their small size and nutritious foliage. The Black Citrus Aphid has been observed feeding on *Melicope lydgatei*. One individual was observed with an infestation and was found to be dead four months later. While the Black Citrus Aphid can not be solely implicated, the damage observed during monitoring was extensive. The Black Twig Borer burrows into branches and introduces a pathogenic fungus that can kill the plant. Other invertebrate threats are the Two-Spotted leafhopper (*Sofonia rufofacsia*) and the Chinese Rose Beetle (*Pseudonirvana rufofasciata*). The Threat Levels listed below are based on the susceptibility of a taxon to a certain invertebrate, and observed damage. There are certain families that are particularly susceptible to these Invertebrate threats, such as Campanulaceae. All species in that family received High Threat Levels. NRS has delineated three categories of Invertebrate Threat Levels.

- High Invertebrate Threat: based on the taxon's potential for lethal damage from slugs, the Black Twig Borer or observed potentially lethal damage from another invertebrate.
- Medium Invertebrate Threat: non-lethal damage is observed.
- Low Invertebrate Threat: no damage is observed and it is not considered a susceptible taxa.

3.4c-3 Weed Threat

Weeds threaten rare plant species by disrupting population structure and altering habitats. Introduced plants have an advantage over natives that have lost defenses. Weeds compete with natives for nutrient and water resources and change light regimes and soil chemistry. Weed invasions can also facilitate each other. For example, invasion by a Nitrogen fixing species may facilitate establishment of another weed species (Goergen et al 2001and Goergen et al 2001).

Weeds in the Hawaiian forests often take advantage of other introduced disturbance by following fire and ungulates. By smothering mature plants and prohibiting recruitment, alien plants can limit effective population size and alter demographics, leaving a species more vulnerable to extinction. The invasive nature of the weed species threatening the population and the percentage of alien cover at the plant determine the Weed Threat Level. There are three levels defined for weed threats.

- High Weed Threat: for those species threatened by a severely invasive weed such as *Rubus argutus*. Severely invasive species can be a substantial threat to the forest community and/or very difficult or impossible to control.
- Medium Weed Threat: for those species in a Training Area where habitat surrounding the plant(s) is greater than 50% non-native cover and there are no major threats from severely invasive weeds.
- Low Weed Threat: given to those species in a Training Area where habitat surrounding a plant(s) is less than 50% alien and there are no severely invasive weeds.

3.4c-4 Ungulate Threat

Ungulates threaten native ecosystems and rare species by trampling, preying directly on plants, accelerating the spread of invasive weeds and disrupting community structure. They are considered a threat to the rare species and to the surrounding habitat. There are two ungulate

- High Ungulate Threat: given to those species where a fence does not protect the known wild individuals and the species is known to be susceptible.
- Medium Ungulate Threat: given to those species where all of the known wild individuals are not protected by a fence, but the species is not known to be susceptible.
- Low Ungulate Threat Level: given to those species where all known individuals are protected with a fence. All other species received at least a Medium Threat Level.

3.4c-5 Rat/Other Vertebrate Threats

Introduced vertebrates such as rats and alien birds threaten rare plants. Introduced birds can spread the fruit of weeds and degrade habitats as well as feed directly causing damage by feeding on native fruits without successfully dispersing them. NRS know rats pose a great threat to plants by predating on fruit and destroying the seeds. Certain taxa are very susceptible to rat predation. Rat Threat Levels were assigned by NRS based on observations and the assumed susceptibility of a given species to rat predation such as the Campanulaceae.

- High Vertebrate threat: assigned to taxa that have exhibited some signs of predation from rats and members of the Campanulaceae whose fruit are large and fleshy and especially prone to predation. All members of this family got a High Threat Level. Other taxa given a High Threat Level showed some signs of predation from rats while being monitored.
- Medium Vertebrate threat: assigned to those taxa where susceptibility is suspected but predation is not yet observed.
- Low Vertebrate threat: for those species where a threat is not suspected or observed.

3.4d Threat Control Priority Level

The Threat Control Priority Level was determined by the variables described above to prioritize management actions. The TCPL is based on Rarity (1-4) and the Conservation Potential for those populations found on Army lands (1-4). These values are added together. Species scoring between 2 and 5, were then ranked based of the Threat Levels assigned for each Training Area. Those species that scored between 2 and 5 with High Threat Levels were assigned a TCPL of 1. Species that scored between 2 and 5 with only Medium of Low Threats, were assigned a TCPL of 2. Species scoring between 6 and 8 were further prioritized by Population Structure (whether or not they had seedlings and juveniles) for each Range. Species scoring between 6 and 8 with no seedlings or juveniles were assigned a TCPL of 3. Species scoring between 6 and 8 with seedlings or juveniles were assigned a TCPL of 4. Those exceptional species with large relatively stable populations, having seedlings or juveniles were assigned a TCPL of 5. The result was a scheme that identified those populations of the rarest plants found on Army lands that had the highest conservation potential and the highest threats. It is possible for the same taxon to have a First Priority Level in one area due to high threats and a Second Priority Level in another area where the threats are not as high. The TCPL is as follows:

- 1= First Priority Level: those species where the Rarity Index and the Conservation Potential Index add up to be between 2-5 and the population having High Threat Levels.
- 2= Second Priority Level: those species scoring 2-5 with Medium Threat Levels.
- 3= Third Priority Level: is for those species scoring 6-8 and having no population structure (see below for definition) indicating some High Threat Level. For example, a species, with a large population, may rank low overall but have no population structure. This would indicate a High Threat Level that is not allowing for recruitment. A species like this if left alone would have a sharp drop in population size once mature plants died leaving no younger plants to take their place.
- 4= Forth Priority Level: species that score 6-8 and have some population structure.

would have a sharp drop in population size once mature plants died leaving no younger plants to take their place.

- 4= Forth Priority Level: species that score 6-8 and have some population structure.
- 5= Fifth Priority Level: would include all other species. These species could be lower priority for a number of reasons such as: large semi-stable populations, all individuals are fenced, low Conservation Potential, and/or having all Low Threat Levels.

3.4e Population Structure

The Population Structure of a species for each Training Area is based on the presence or absence of juveniles and seedlings. If juveniles or seedlings are present, the population is considered to have structure. If not, there is no structure. Population Structure often illustrates the consequences of High Threat Levels and can be used to determine where management activities should be focused. Population size and the relative number of each size class found in the population determine the structure of a given population. NRS delineates three size classes on the RPMF (Seedling, Immature/Juvenile and Mature). Definitions are given, and tallies are made for each size class. Careful review of these forms gives an indication of the structure of each population. The presence/absence of seedlings and immature individuals was tallied giving an indication of structure. This is not meant to be a viability assessment of population health and recruitment levels, but a general indication of threats to recruitment and healthy population structure. In situations where no seedling or immature plants were noted, a high threat is assumed. This lack of structure may indicate any number and/or combination of threats. For a species where seedlings and juveniles have been observed, collection may not be necessary. A species with good population structure may not require ex-situ propagation and reintroduction.

3.5 Recommending Management Actions

Recommendations for threat management are based first on the Threat Control Priority Levels and on the Manageability Levels for each recognized threat. The recommendations for prioritized management must also take into consideration the Ex-situ status of each population.

3.5a Threat Manageability Levels

Manageability Levels are determined by NRS. There are four categories that indicate threat control potential for the threat, and feasibility of access to the threatened population. The Manageability Levels are as follows: Easy, Moderate, Difficult and Not Possible. The four Manageability Levels are described for each of the following categories: Fire, Invertebrates, Weeds, Ungulates, and Rats.

3.5a-1 Fire Manageability

There are no Threat Manageability Levels assigned by NRS for Fire. This responsibility lies with the Army and the Wildland Fire Program Manager.

3.5a-2 Rat Manageability

No Manageability Levels are given for Vertebrate threats. NRS has employed a vertebrate threat control method to protect snail, bird and plant populations with success. This method can be relied upon to control rats around rare plant populations to promote mature fruit production. While not considered easy, this time consuming method is effective. NRS is pursuing more efficient application methods through participation in the Toxicants Working Group. Any pest

management research project will require approval from the Command Consultant as stated in AR 200-5.

3.5a-3 Ungulate Manageability

Manageability Levels for Ungulate Threats were assigned by NRS based on the feasibility of fencing a species.

- Easy Manageability Level: given to those species for which an ungulate exclosure could be easily constructed with no major obstacles (stream crossings or cliffs).
- Moderate Manageability Level: for species in an area that could be fenced with only a few obstacles.
- Difficult Manageability Level: for an area dominated by cliff or with many stream crossings.
- Not Possible Manageability Level: In MMR and SBW, a history of live fire training has left unexploded ordnance (UXO). At this time, the presence of UXO prohibits fencing projects so species located in the Lower Mākua MU and SBW got a Not Possible for Ungulate Manageability.

3.5a-4 Invertebrate Manageability

The Invertebrate Manageability Levels are determined by whether or not a control method is available for the threat. There are no Easy or Moderate Manageability Levels described for any species due to the difficulty of controlling these threats in the field. There are no recognized sure fixes for any of the High or Medium Invertebrate threats discussed here.

- Difficult Manageability Level: given to a Medium Invertebrate Threat. Once a threat has been observed, NRS contact the State Department of Agriculture to help properly identify the pest and recommend management actions. The difficulty of identifying the Invertebrate threat, locating a legal treatment and administering it to a population or species makes this management option difficult.
- Not Possible Manageability Level: given if slugs or the Black Twig Borer is suspected or observed. At this time, NRS knows of no proven control method for slugs or the Black Twig Borer available for forestry use. NRS will recommend support for research on control methods for these Invertebrates and are currently experimenting with barriers. Any pest management research project will require approval from the Command Consultant as stated in AR 200-5.

3.5a-5 Weed Manageability

Manageability Levels for weed threats are assigned by NRS based on the Threat Level and accessibility. For example a species that grows only in a cliff habitat may be very difficult to protect against the threat of weeds due to the need to use ropes for access. There are four levels based on these criteria. A severely invasive weed may significantly alter habitats and may have no known control techniques.

- Easy Manageability Level: given to those species in a Training Area where habitat surrounding the plant/s is greater than 75% native and there are no major threats (see Weed Threat 3.4c-3) or steep terrain.
- Moderate Manageability Level: for those species in a community with greater than 50% native species and no severely invasive threats or steep terrain.
- Difficult Manageability Level: for those species where the habitat is less that 50% native and/or severely invasive weeds or steep terrain found.

- Not Possible: given to those species that are threatened by a weed species that can not be controlled at this time.

3.5b Ex-situ status

Ex-situ status shows the potential for reintroduction, the results of previous management, and provides guidelines for further collections. Recommendations for collection and propagation rely on the current ex-situ status. The ex-situ status of each species is determined by inventories that are taken twice a year at the nurseries where Army stock is being grown to ensure databases are up to date and accurate. The number of individuals is given for each of the following facilities: Pahole Nursery, Army Nursery, Botanical Gardens and the Lyon Arboretum Greenhouse and Micro-propagation Lab. With the exception of Botanical Garden collections, which are already planted on their grounds, the stock at the other Nurseries, is available for reintroduction projects. A seed-bank storage facility is now available to the Army at the Lyon Arboretum. This facility is designed to take deposits and give withdrawals when necessary unlike other long-term storage facilities. This facility is brand new and has only one accession from Army lands (*Alsinidendron obovatum*). This facility will play a much larger role in protecting a species' ex-situ status in the next year. NRS will recommend that all Priority 1, 2, and 3 species be stored ex-situ.

The percentage of known individuals represented ex-situ is expressed as Percentage Represented, and is shown next to the inventories. As more representatives of a population are collected from, the percentage of the known individuals protected ex-situ increases. For example, a species with five mature plants in MMR like the *Fluggea*, would be 20% represented, if plants from one mature tree are growing at any one of the listed nurseries. For the purposes of this report an individual with two or more progeny at any or a combination of the nurseries, is considered represented ex-situ. This is certainly not to say that it is adequately represented for mitigation or genetic storage. The Mākua Implementation Team is considering recommending that twenty-five individuals be stored for long-lived species and fifty for short-lived species.

3.6 Management Actions

Once the Threat Control Priority Levels have been assigned and the Population Structure and Ex-situ status considered, actions can be recommended. Below is a discussion of management actions.

3.6a Threat Control

Threats identified during surveys and monitoring visits are controlled 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 can be prioritized based on threat levels and manageability. When 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 at this time. There are no adequate controls for slugs or the Black Twig Borer. NRS has identified only one systemic insecticide that is approved for use in the field. Although the Black Twig Borer is not the target pest, the insecticide is being used at this time on *Fluggea* and *Alectryon* and will be discussed below. NRS is currently investigating methods to control the threat of slugs by using barriers and through involvement in the Toxicants Working Group, which hopes to improve access to effective threat control products. 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 will be discussed in detail in the Weed section (Chapter 2).

3.6b Propagation

For species that have 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 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 germination and storage. Alvin Yoshinaga is developing 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.

Other propagules that can be used right away or have poor storage records are brought to one or more facilities for germination. There are now five facilities where propagules from rare plants on Army land are brought: Lyon Arboretum, Pahole Nursery, Army Rare Plant Propagation Facility, and the Waimea and Wahiawa Botanical Gardens. The Lyon Arboretum in Manoa Valley practices both micropropagation and traditional greenhouse propagation. When NRS collect immature propagules, 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 Hawaii 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 now 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 Wahiawa Botanical Gardens for propagation. Both of these facilities receive funding from the 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.

3.6c 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 establish good population structure. NRS have reintroduced eight 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, Schiedea nuttalii var. nuttalii, Neraudia angulata var. dentata,* and *Euphorbia haeleeleana)* and one onto `Ōhikilolo Ridge (*Pritchardia kaalae)*. One species has been reintroduced into SBS (*Urera kaalae)*. These reintroduced populations are being monitored using the RPMF, noting the source of the population and the date they were planted. The success of these reintroductions will

Army's Rare Plant Propagation Facility, Lyon Arboretum, and at the State's Pahole Nursery). NRS have been coordinating with the HRPRG and also chairs the Reintroduction Sub-Committee. The Sub-Committee has developed guidelines to direct the reintroduction of rare plants into the wild. These guidelines have been developed with the help of experts on the propagation, genetics and distribution of rare plants on O`ahu and throughout the State and mainland. These guidelines suggest proper techniques and important considerations necessary for a successful reintroduction. They include considerations prior, during, and after a reintroduction. Prior to reintroducing a plant, the proper number of representatives must be selected to assure a balanced genetic stock. The site must be chosen carefully according to the associated species, aspect and light regimes. The threats must be properly identified and controlled.

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 has adopted these guidelines for their own program. The guidelines are currently in draft form and are attached, as Appendix 3-B. NRS will seek approval from appropriate landowners and range control for reintroduction projects.

Table 3-1 Makua Military Reservation Rare Plants

Mākua Military Reservation		Population Size and Distribution						Ex-situ Status									Structure		Threats and Manageability							
Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On O'ahu	Ind. On O'ahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroduction	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert. Manageability	Weed Threat	Weed Manageability	Ungulate Threat	Ung. Manageability	Rat Threat
Alectryon macrococcus	E	2	20	25	323-328	36	426	Y		10	0	0	2	N		N	N	N	M	H	N	M	M	M	N	H
Alsinidendron obovatum	E	0	0	3	3	3	3	Y		12	4	0	72	Y	100	Y	N	N	L	H	N	H	D	L	\	L
Bidens amplectens	C	1						N	0	0	0	0	0	N	0	N										
Bobea sandwicensis	SOC	2	25		<250		<250	N		0		0	P	N		Y	N	Y	H	L		H	D	M	E	M
Bobea timonioides	SOC	1	2		<250		<250	N	0	0	0	0	0	N	0	N	N	N	M	L		M	M	M	N	M
Bonamia menseziі	E	1	10			28	200-300	Y	0	0	0	0	2	N	10	N	N	N	H	L		M	M	M	E	L
Cenchrus agrimonioides agrimonioides	E	3	21	6	97	8	104	Y	0		0	2	P	Y		Y	Y	Y	M	L		M	M	M	E	H
Chamaesyce celastroides kaenana	E	4	105	7-12	516	7-12	516	Y	0	0	0	10	10	Y	12	N	N	Y	H	L		H	D	M	D	M
Ctenitis squamigera	E	1	4	5	110	16	333-339	Y	0	0	0	0	1/P	N	25	N	N	Y	M	L		M	M	M	N	L
Cyanea superba	E	1	1	1	1	1	1	Y		10	5	6	62	Y	100	Y	N	N	M	H	N	H	D	L	\	H
Cyrtandra dentata	E	1	97	4	3157	4	3157	N	0	0	0	0	0	N	0	N	Y	Y	L	H	N	M	M	L	\	M
Delissea subcordata	E	1	1	10	45	10	45	N	0	0	0	0	0	N	0	N	N	Y	L	H	N	M	M	L	\	H
Diellia falcata	E	1	150	21	5540-6540	21	5540-6540	N	0	0	0	0	0	N	0	N	Y	Y	L	L		M	M	M	\	L
Dubautia herbstobatae	E	1	1000s	4	1000s +26	4	1000s +26	N	0	0	0	1	1/P	Y	<1	N	Y	Y	M	L		M	D	H	D	L
Dubautia sherffiana	SOC	2	5	15-20	400	15-20	400	N	0	0	0	0	0	N	0	N	N	N	M	L		H	D	M	D	L
Euphorbia haeleeleana	E	1	120	3		16	550-675	N	0	8	19	5	0	N		Y	Y	Y	H	L		H	D	M	E	H
Fluggea neowawraea	E	4	5	10	31	19	118-142	Y	0	0				N		N	N	N	M	H	N	M	M	M	N	M
Hedyotis degeneri degeneri	E	1	11	5	278	5	278	N	0	0	0	0	0	N	0	N	N	N	M	L		L	E	M	E	L
Hedyotis parvula	E	3	101	4	165-180	4	165-180	N		40	0	0	16	N	<1	N	Y	Y	M	L		M	D	H	D	L
Hibiscus brakenridgei mokuleianus	E	1	4	6or7	14	6or7	14	Y	0	15	8	4	11/P	N	100	N	Y	Y	H	L		H	D	M	M	L
Lepidium arbuscula	E	1	3	10	1000	10	1000	N	0	0	0	0	0	N	0	N	N	Y	M	L		M	D	L	\	L
Lipochaeta tenuifolia	E	4	2000+	6	>4000	6	>4000	Y	0	0	0	0	9	N	<1	N	Y	Y	H	L		M	D	H	D	L
Lobelia niihauensis	E	1	430			33	3000-5000	N	0	0	0	0	0	N	0	N	N	Y	M	L		M	D	H	D	M
Melicope makahae	C	1	15-20	3	400	3	400	N	0	0	0	0	P	N	0	N	N	N	M	L		M	M	L	\	L
Neraudia angulata angulata	E	2	8	4	66	4	66	Y	0	0	0	0	0	N	0	N	N	Y	M	M	D	H	D	H	D	L
Neraudia angulata dentata	E	0	0	1	2	1	2	N	0	0	0	0	0	N	0	N	N	N	H	L		M	D	M	D	L
Nototrichium humile	E	4	460-681	14	1012-1362	14	1012-1362	N	0	0	0	0	0	Y	<1	N	Y	Y	H	L		H	D	M	N	L
Platydesma cornuta decurrens	C	1	207		251		251	N	0	0	0	0	0	N	0	N	N	N	M	L		M	M	H	D	M
Plantago princeps princeps	E	1	14	8	198-248	>8	198-248	N	0	0	0	0	3	N	14	N	N	N	M	L		H	D	M	D	L
Pleomele forbesii	C	3	110		<250		<250	N	0	0	0	0	0	N	0	N	N	Y	H	L		H	D	M	M	M
Pritchardia kaalae	E	4	76	7	222	7	222	N			4	4	4	N		Y	Y	Y	M	L		H	D	M	D	H
Pteralyxia macrocarpa	C	3	40	20	<500	20+	<500	N	0	0	0	0	0	N	0	N	Y	N	M	L		M	M	H	D	H
Sanicula mariversa	E	2	137	4	150	4	150	Y		50	0	0	0	Y	<1	Y	Y	Y	M	L		H	D	H	D	L

Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On O'ahu	Ind. On O'ahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroduction	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert.	Weed Threat	Weed	Ungulate Threat	Ung. Manageability	Rat Threat
Schiedea hookeri	E	1	5	11	<400	11	<400	N	0	0	0	0	0	Y	0	N	N	Y	H	L		M	M	M	E	L
Schiedea nuttallii nuttallii	E	1	17	3	50	3	60	Y	0	1	0	0	P	Y		Y	Y	Y	L	H	D	M	M	L	\	L
Silene lanceolata	E	1	11	5	<2000	5	<2000	N	0	0	0	0	21	Y		N	Y	Y	M	L		M	D	H	D	L
Spermolepis hawaiiensis	E	1	>1000			12	7,500	N	0	0	0	0	P	N	0	N	Y	Y	H	L		H	D	M	N	L
Tetramolopium filiforme	E	2	5000+	5	5100+	5	5100+	Y	0	1	0	0	0	Y	<1	N	Y	Y	H	L		M	D	H	D	L
Viola chamissoniana chamissoniana	E	1	350	2	375	2	375	N	0	0	0	0	0	Y	0	N	Y	Y	M	L		M	D	H	D	L

3.7 Makua Military Reservation

Alectryon macrococcus var. *macrococcus*

Species	Rarity Level	Conservation Potential	TCPL
ALEMAC	3	4	3

This species is known to be rare and found in mesic to dry forests on O'ahu, Moloka'i, Kaua'i and Maui (Wagner 1990). There are twenty individuals of this species known from MMR. Surveys in the last year found eleven more trees than were known in the Lower Mākua, Kahanahāiki and East Rim MUs. NRS deployed rat bait stations around the population in Lower Mākua to protect the maturing fruit. NRS collected from four individuals and now have representatives at the Pahole nursery, Army Nursery and at the Lyon Arboretum. NRS has also collected fruit for seed storage trials at the National Seed Storage Lab. High Threat Levels for this species are for rats and invertebrates. The Black Twig Borer heavily impacts this species. A systemic insecticide called Vivid II was tested on one individual in the Kahanahāiki MU. Results are inconclusive. The tree did not produce fruit and did not show any signs of flushing after treatment. Photo records are kept at the Natural Resource Center.

In the next year, NRS will monitor known individuals and protect any fruiting trees. With so few individuals represented ex-situ, (22%), NRS should strive to collect from the other trees though many are not healthy enough to produce fruit. NRS will recommend supporting research of control methods for the Black Twig Borer and the associated fungus. NRS will attempt again to propagate this species with cuttings, air layering and grafting in the next year. Last years vegetative propagation effort was not successful. A site must be found to cultivate these trees in the long-term so they can be managed for fruit production. The site must have the appropriate conditions and be accessible for regular Twig Borer control. Horticulturists on Kaua'i at the NTBG have successfully grown *Alectryon* on their grounds while treating them with systemic insecticides (Dave Bender, pers. comm. 2000). NRS will use another systemic insecticide this year to try and control the Black Twig Borer on *Fluggea*. If it proves effective, NRS will try it on *Alectryon*.

Alsinidendron obovatum

Species	Rarity Level	Conservation Potential	TCPL
ALSOBO	1	0	1

This species is reported from scattered ridges and gulches in mesic forest throughout the Wai'anaes (Wagner 1990). There are only three plants known to be extant at this time. Populations in Pahole NAR and Kahanahāiki MU have crashed, leaving just the Makaleha plants. There is a good chance plants may come up at the old locations in future rainy years (Joel Lau, pers. comm. 2001). There was one individual known from Kahanahāiki Gulch and it has been monitored and collected from for the last four years. However, when NRS went to monitor the plant on 28 of February 2001, it was dead. Dozens of fruit had been collected and brought to Lyon, Pahole and the Army facility over the years. At this time, there are representatives at all three nursery facilities. A reintroduction project in Kahanahāiki has put about 75 individuals into the Gulch. They are monitored frequently by NRS and have a high survival rate.

Slugs are suspected of devouring seedlings (Pers. comm., Weller, 2000). A copper/zinc barrier was erected around two reintroduced individuals in an attempt to exclude slugs and allow for

germination. NRS observed dozens of *Alsinidendron* seedlings within the copper exclosure but none survived the dry season. NRS will continue to monitor the slug exclosure for seedlings and will consider using this technique elsewhere. Since reintroduced populations are considered experimental in nature and are not counted as true populations, technically, the Conservation Potential for this species on Army land is now zero. The Army is still obligated to consult and work with this species as it was recently reported from Army lands. NRS is slowly weeding in the MU to promote native canopy and ground cover.

Bidens amplectens

Species	Rarity Level	Conservation Potential	TCPL
BIDAMP	?	?	?

This species is known to be fairly common on cliffs and talus in lowland shrublands (Wagner 1990). It is known from the windward side of the Wai`anae Mountains and from between Kawaihapai and Ka`ena Point on Oahu. According to the Manual of the Flowering Plants of Hawaii, "*Bidens amplectens* hybridizes and intergrades with *B. torta* from near Ka`ena Point to at least the head of Mākua Valley in the summit ridges of the Wai`anae Mountains. These plants are intermediate in ray floret number and head size, and recombine growth form and achene characters. Pure *Bidens amplectens* is restricted to the windward cliffs and crests." NRS has not surveyed for this species and is not able to define the TCPL for those plants found in Mākua. In the coming year NRS hope to define population size and better determine threats. This species benefits from ungulate management in Mākua.

Bobea sandwicensis

Species	Rarity Level	Conservation Potential	TCPL
BOBSAN	2	4	3

The *Bobea* is a tree up to 10 meters tall and was known from the Wai'anaes and Wailupe Valley on O`ahu, Maui, Moloka`i and Lāna`i (Wagner 1990). *Bobea* is presently known from Lower Mākua, `Ōhikilolo and Kaluakauila. There are no seedlings and some of the trees are in poor health. Fruit produced by these trees and has been collected and successfully propagated by the Army and Lyon Arboretum. Representatives are now growing at these two facilities and some have been outplanted around the Pahole facility. This species has High Threat Levels for Fire and Weeds and benefits from the large-scale weeding and rat control for the *Euphorbia*. The trees in Kaluakauila are more highly threatened than those in Lower Mākua and have drove the TCPL up. When threats are controlled with fencing and fuel reduction (grass removal) around the Kaluakauila trees, the TCPL will go down. There are estimated to be less than 250 individuals left statewide (Joel Lau, pers. comm., 2000). This species would benefit from a site where it could be grown for fruit production and be accessible for management of the invertebrate threats. NRS will fence off a portion of Kaluakauila in the next year providing an ungulate free habitat for those *Bobea*. Fuels will be controlled within the unit and will help to protect this area from fire.

Bobea timonioides

Species	Rarity Level	Conservation Potential	TCPL
BOBTIM	2	4	3

This species is known from dry to sometimes-mesic forests from Hawaii, Maui, O`ahu and Kaua`i (Wagner 1990). There is one known population with two mature trees in MMR. They are located in the Kahanahāiki MU, but are not fenced. There are no representatives of these trees in cultivation. This species benefits from ecosystem scale removal of weeds and ungulates but receives little single species management because of its low Conservation Potential (1.2%). In the next year, NRS hopes to collect from this species for seed storage. This species would benefit from a site where it could be grown for fruit production and be accessible for management. NRS will continue to monitor these trees during other fieldwork and note new locations on the GIS database. NRS will work with botanists familiar with the taxa in the coming year to better estimate population size.

Bonamia mensezii

Species	Rarity Level	Conservation Potential	TCPL
BONMEN	2	4	3

This species was known from Hawaii, Maui, Moloka`i, O`ahu and Kaua`i. It was rare and found in dry to wet forests (Wagner 1990). There is one occurrence of this species in MMR. There are fifteen known individuals in the Kaluakauila MU. This species, while rare throughout the state, has only 4% known from Army lands and would not benefit significantly from targeted Army Management. This species has a high fire threat and all other threats are medium or low. NRS will fence much of the Kaluakauila MU because of the high ungulate threat to other species found in Kaluakauila. The *Bonamia* will benefit from this action as well, having a medium Threat Level from ungulates. Because of the high fire threat, NRS will recommend collecting from this population for seed and tissue storage. NRS has collected for seed and tissue storage and will continue to do so and increase the diversity of ex-situ collections. Creating fuel breaks and reducing fuel loads in the forest would help control the fire threat.

Cenchrus agrimonioides* var. *agrimonioides

Species	Rarity Level	Conservation Potential	TCPL
CENAGRAGR	2	3	1

This endangered grass is known from Lāna`i, O`ahu and Maui. The other variety was known from the northwest Hawaiian Islands and is thought to be extinct (Wagner 1990). Twenty-one individuals are known from three sites in Kahanahāiki MU. Two of these sites are located inside a large-scale exclosure fence, and one with just one individual is just outside the fence. NRS has also reintroduced plants in to three sites. A High Threat Level was given for rats because one of the reintroduced plants was found with a rat damaged infructesence. The ungulate threat exists because of goats. Once goats are removed from Mākua, or the third population fenced, this threat will be low. Weeding in the MU will improve habitat for this species and address the medium weed threat. NRS have been collecting and propagating from these individuals and have about half (52%) represented ex-situ at the Army facility and one at Lyon. The reintroduction sites are monitored regularly and survivorship is high especially at two of the sites. There have been seedlings found at one of the reintroduction sites in the last year.

NRS has been monitoring these populations since they were fenced in December 1996, so have population data for these sites for nearly five years. The history of these populations may help NRS to identify remaining threats and suggest management actions. Of particular interest is the structure of these populations and at what stage mortality may be occurring. Trends may be

different at each site. Below is a graphical representation of the population structure for each time it was monitored, and a discussion for each figure.

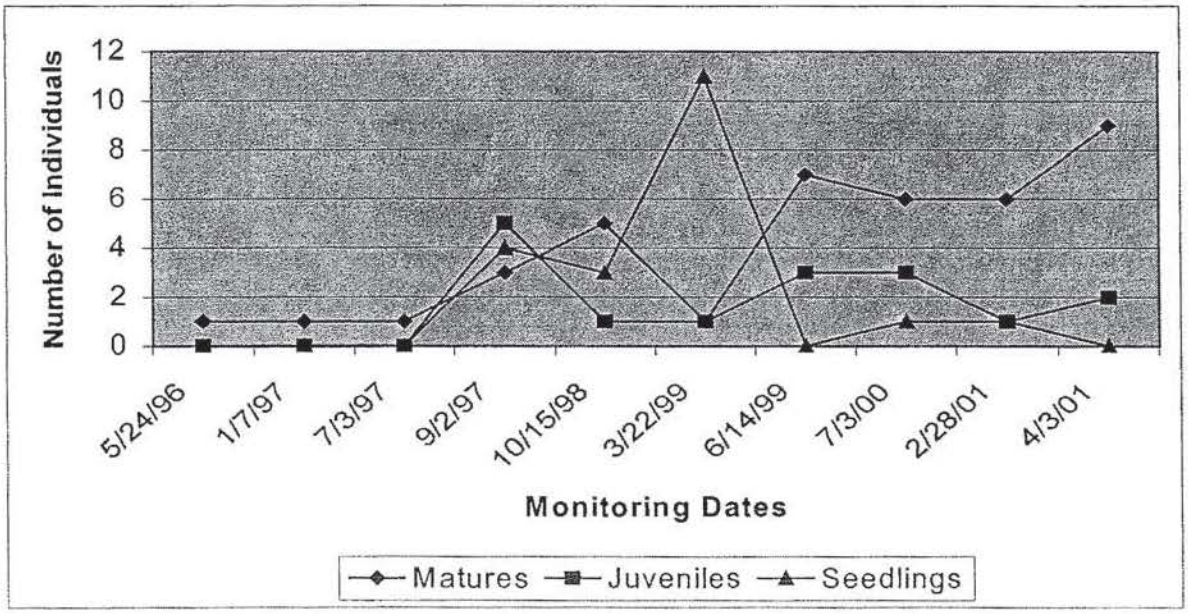
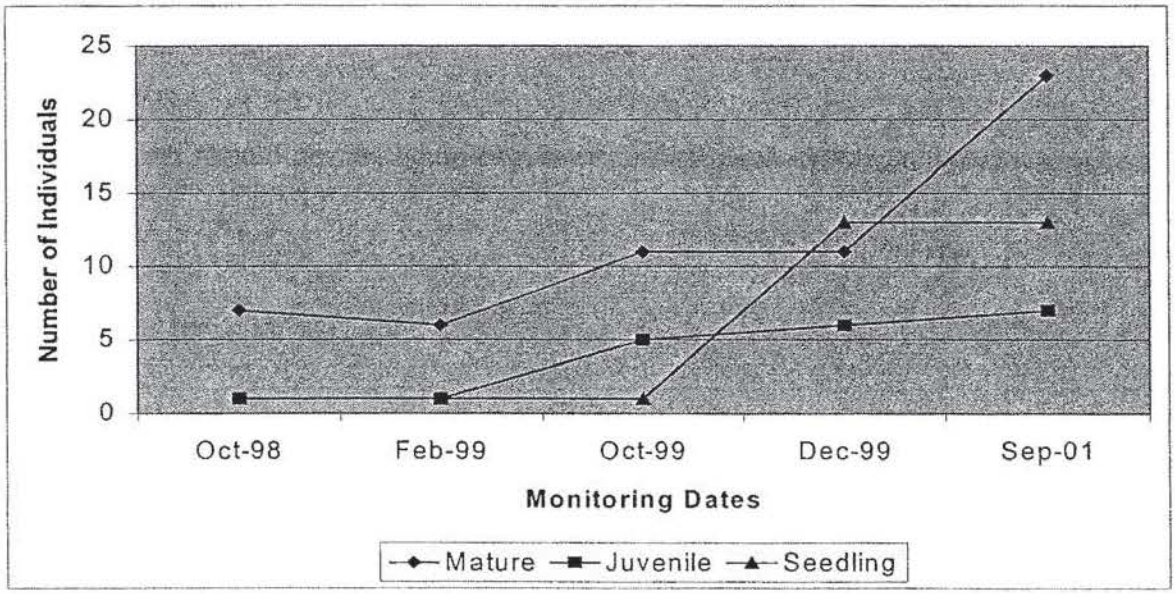


Figure 3-1 Population Trend *Cenchrus agrimonioides* var. *agrimonioide*s MMR-A

The population trend for MMR-A shows a general increase in all size classes since the fence was installed. The number of mature individuals has increased from one to nine and there are now seedlings and juveniles. It took over a year for seedlings and juveniles to show up at the site. In March of 1999, there were eleven seedlings at MMR-A and only one juvenile. The next time it was monitored, the population had three juveniles and no seedlings. This shows a natural change in size classes, as seedlings become juveniles. NRS is encouraged by this trend and will continue to monitor this population.

Figure 3-2 Population Trend *Cenchrus agrimonioides* var. *agrimonioides* MMR-C



MMR-C was found much later than MMR-A. It was also discovered to be twice its original size in October 1999. This is shown in the data when the number of individuals almost doubled. The number of seedlings known from this population increased from one to eleven from October to December 1999. This shows a natural seasonal increase in the number of seedlings in an ungulate free exclosure. NRS will continue to monitor this site for future trends and threats.

The MMR-B population of *Cenchrus* was not depicted graphically because it has one individual and a static population trend. It is not protected by fencing and may still be disturbed by ungulates. One seedling was observed at this site but has since died.

NRS reintroduced *Cenchrus* to two sites in Kahanahāiki. The first was in December 1999. This site was marginal and the plants did not respond well. Of five plants, four have survived but no seedlings have been observed. A second site ("Ironwoods") was selected and thirty-two plants were planted in December 2000. They are monitored regularly. All are alive and seedlings have been observed at the site (see discussion below). A third site was chosen and sixty-one plants were planted on "Sandalwood Ridge" in the Pahole NAR adjacent to Kahanahāiki MU. These plants are monitored regularly and only two have died. It was at this site that NRS observed rat damage to the infructesence of a reintroduced *Cenchrus*.

In August 2001, NRS visited the second reintroduced population of *Cenchrus* at the Ironwoods site. There was a seedling found below one of the reintroduced individuals. The seedling looked poor and was found to have ants crawling all over and around it and a then unidentified insect. The unknown insect was taken to Dick Tsuda at the Diagnostic Laboratory at the U.H. He identified it as the Rhodes Grass Mealybug. Very little is known about this mealybug by NRS. In the coming year we will rely on monitoring of these sites to determine the extent of this threat. Management of this threat would be very difficult if it was found to be established and widespread. It may be determined in the next year that this pest poses a High Invertebrate Threat to this species at it will have to be controlled.

Chamaesyce celastroides var. *kaenana*

Species	Rarity Level	Conservation Potential	TCPL
CHACELKAE	3	3	3

This species was known only from around Ka`ena Point on O`ahu. It is distinct in having cyathia on compact lateral branches (Wagner 1990). It was just found on MMR in the last year and is now known from four sites. It is known from the Ka`ena Point NAR and similar habitats. In Mākua it is found several hundred feet above sea level. MMR has 20% of the known population. Due to its preferred dry lowland habitat, this species is highly threatened by fire. NRS will recommend that these individuals be represented in seed and/or tissue storage. This species is being grown by the State from the Ka`ena population. NRS has collected extensively from the four populations in the last year. Collections of mature fruit were brought to Lyon for seed storage. Cuttings and immature fruit are at the tissue culture lab at Lyon as well. The collections were the first ever received by the lab and effective protocol had to be developed. Subsequent collections had much better survival and are currently growing. NRS will return to those underrepresented plants to collect again in the coming year. All plants are well tagged in the field and complete ex-situ representation is the goal. Seedlings and juveniles have been found in the bigger populations but not the smaller ones.

Rats are considered a Medium Threat to this species because of the fleshy nature of the fruit. It may be unlikely that rats considering the vertical habitat and small fruit size target this species,

but fruit will be examined for damage when populations are monitored. This species has Difficult Manageability Levels due to the cliff habitat it is found in. Any management, such as weeding and fence building, required for these plants must be done with ropes making it most difficult.

The population on Lower `Ōhikilolo is especially prone to fire started by military training and from the highway west of MMR. NRS will recommend that Guinea grass (*Panicum maximum*) be removed from around the population. It would also reduce the chance of fire reaching the population if firebreaks could be extended to further buffer these populations from ignition sources. For example, weed eaters are used to reduce fuel levels on the inside of the firebreak road. Both sides of the road could also be cleared in the vicinity of the population southwest side of the south firebreak. In addition, a firebreak should also be established on the highway side of lower `Ōhikilolo Ridge to reduce the chance that a roadside ignited fire would come onto MMR This lowest population has been burned in the past. Plants are fire-scarred the surrounding vegetation has been burned and charcoal can be found under the plants. NRS has photo-records of these burns covering the population. The C-Ridge population is thought to have been burned in the past as it is surrounded by grass. There are two plants here and both have a High Fire Threat Level. The Punapōhaku population has been burned in the past as well. NRS will recommend fuel breaks for all the populations especially lower `Ōhikilolo, which has juveniles and seedlings.

Ctenitis squamigera

Species	Rarity Level	Conservation Potential	TCPL
CTESQU	3	4	4

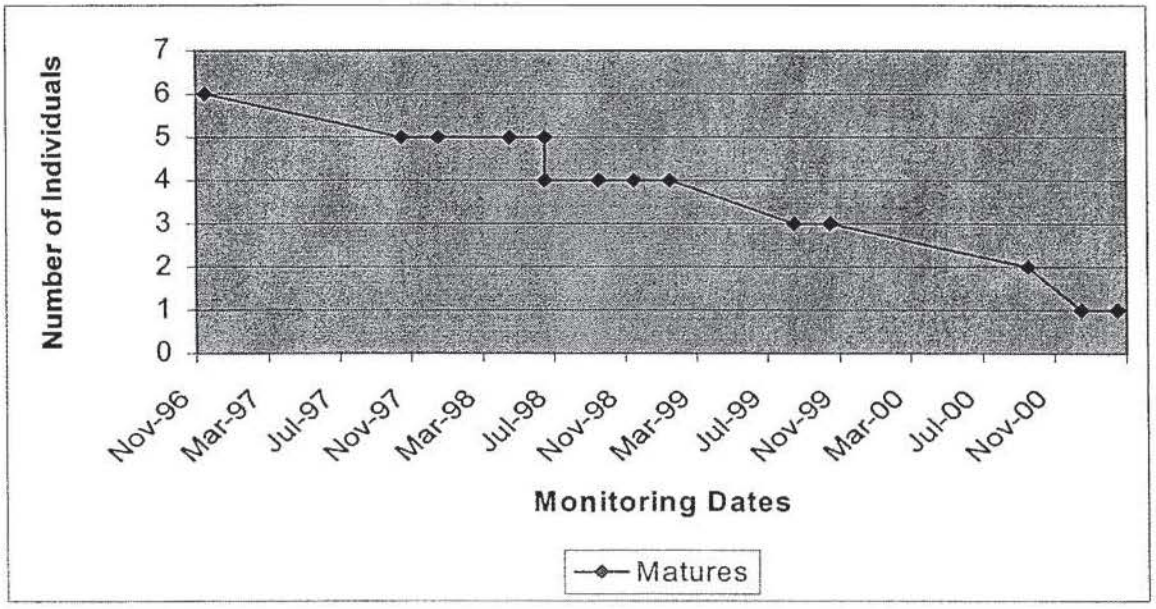
This is a fern with a short creeping rhizome and used to be found on Kaua`i, Moloka`i, Lāna`i, West and East Maui and both ranges on O`ahu (HINHP 2000). This species is known from Lower Mākua and this population is considered to have the lowest TCPL because it represents less than 2% of those known statewide. Large populations of this fern are located in Makaleha Forest Reserve and Lower Ka`ala NAR. NRS monitor this population but have not successfully collected from it. NRS collected again this past year but results are pending. In the last year, NRS also discovered that there are four plants at this site where only three were known. 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. NRS will continue to survey for this species while in Mākua and note locations on the GIS database.

Cyanea superba ssp. *superba*

Species	Rarity Level	Conservation Potential	TCPL
CYASUPSUP	1	1	1

This species was known only from the Northern Wai`anae Mountains. Plants can reach six meters in height and have long dangling inflorescences (Wagner 1990). There is now only one known wild individual of this species. It is located just outside of the Kahanahāiki Gulch fence inside another small exclosure. Six plants were known when NRS began monitoring in November 1996. The small fence was erected over ten years ago to protect the population from ungulates. There have been no observations of juveniles or seedlings at this population since NRS began monitoring in 1996. Below is a graph depicting the declining population trend for this site. This is meant to show the slow loss of individuals as the population crashed.

Figure 3-3 Population Trend *Cyanea superba* ssp. *superba* MMR-A



Since November 1996, five have died of unknown causes. The first to die was MMR-A-5. It was observed to be declining in November 1996 and was dead when monitored in October 1997. MMR-A-1 was observed to be declining in March 1998 and was dead when monitored in June 1998. MMR-A-6 was observed to be declining since summer 1998 and in November 1998 the apical meristem was collected and taken to the Lyon Arboretum. Horticulturists there were not able to save the tissue as it had already been invaded by rot. MMR-A-2 was observed to be in poor health in mid-September 2000. On 25 September 2000, the plants were visited by NRS, Nellie Sugii from the Lyon Arboretum and Desmond Ogata from the U.H. Plant Diagnostics Lab. MMR-A-2 was found to be in very poor shape and the apical bud was removed by Nellie and brought to Lyon in hopes of recovering some meristem tissue. No tissue could be recovered from this plant as rot had invaded the cambium up to the growing tip. The rest of the material was removed in an attempt to prevent further spread. Most recently, A-4 died after years of fruit production. The entire plant was removed by NRS and taken to Lyon and the plant diagnostics lab at UH. No single cause of death could be identified. The apical meristem was saved and remains alive in the tissue culture lab.

The Army has been protecting these plants from rat predation during the fruiting season and collecting the fruit from three individuals in the last five years (MMR-A-4, MMR-A-2, MMR-A-3). Snap traps and poison bait are used to reduce the chance of rat predation while fruiting. A shadecloth net is hung below the fruiting plants to catch the fruit and prevent further predation. The fruit has been brought to the Lyon Arboretum; the State's Pahole Nursery and the Army facility.

Hundreds of plants have been grown (mostly from A-4) and dozens reintroduced into the State's Pahole NAR. There have been reintroduction projects in Kahanahāiki Gulch as well. In 1996, six plants were reintroduced into two small exclosures inside the large-scale exclosure. All of these plants survived but have not flowered yet. Two other sites were selected and twenty plants each were reintroduced in January 1999 and 2000. These have had mixed success and are still being monitored frequently. NRS believes the small size classes used for these sites hindered

success. The threat from Invertebrates is High for slugs. Since then NRS has planted 75 larger and older plants into Kahanahāiki Gulch, and 120 into Pahole NAR. These sites are monitored twice a year by NRS and are doing well. The Pahole site and a couple of the sites in Kahanahāiki are doing especially well. Those site characteristics will be duplicated in future reintroduction sites. Since there is no control method in the field for slugs, fruit will continue to be collected and propagated ex-situ and outplanted when larger to avoid the slug threat. Rat control will continue around the population to ensure fruit matures and can be collected. This population will be monitored in the coming year and fruit will be protected with snap traps and rat bait stations. Reintroduced populations will be monitored and collected from in the coming year to increase the diversity of reintroduced stock. NRS has stored seed from two of the wild plants and will continue to do so with seed from wild and reintroduced plants.

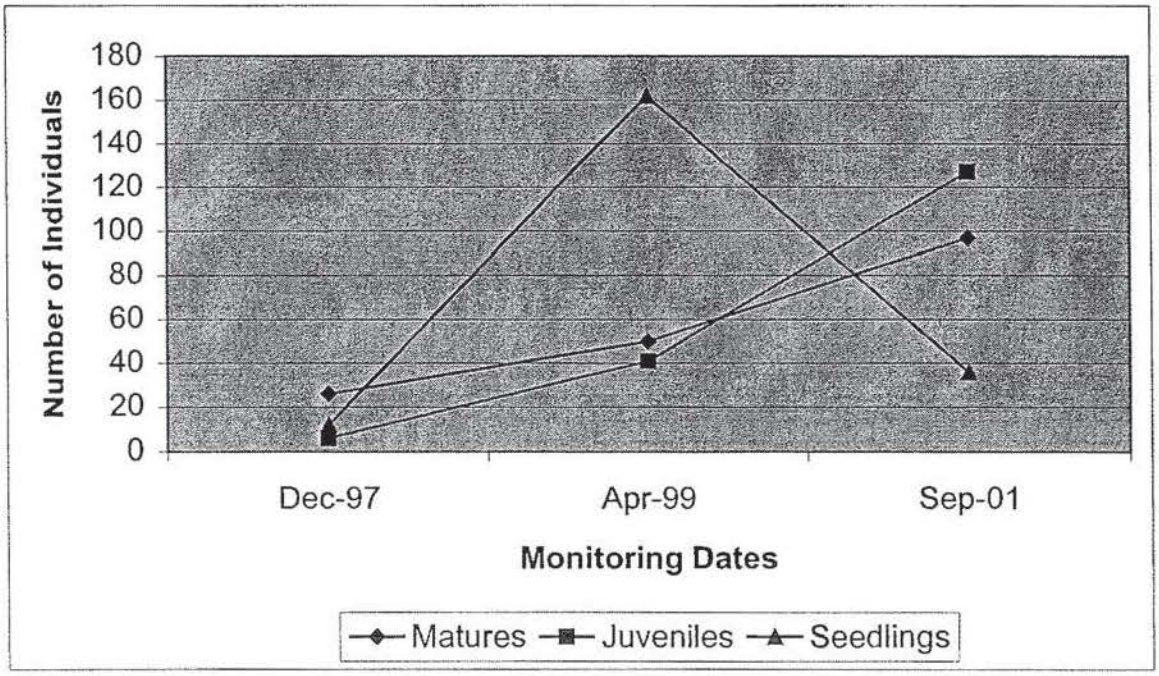
Cyrtandra dentata

Species	Rarity Level	Conservation Potential	TCPL
CYRDEN	4	4	5

This species of Gesneriaceae is known only from O`ahu. There are plants known from both the Northern Wai`anae and Ko`olau Mountains (Wagner 1990). In Mākua, one population of this species in Kahanahāiki Gulch and is surrounded by the fence. All the known individuals of this species on MMR are fenced. Pigs used to threaten this species by trampling and uprooting plants of all sizes. Since the fence was constructed and the pigs excluded, NRS has seen a rebound in this population. Now seedlings are plentiful and juveniles are present as well. The seedlings of this taxon seem highly susceptible to slugs but little impact has yet been observed. Weeding continues in this MU and will benefit this species which has a Medium Weed Threat Level. The weed *Clidemia hirta* in particular threatens this species and is slowly being removed from the MU. There are no representatives of this species ex-situ as there is natural recruitment and no observed High Threat Levels. This species is monitored by NRS; additional threats or changes in the population structure will be noted.

The population trend for this site is depicted below. There are only three reliable monitoring datasets for this site. One predates the fence and one after pigs were excluded since April 1998. This definitely shows an increase in all size-classes. There has been a steady increase in the amount of juvenile and mature plants at the site. The number of seedlings increased significantly after fencing. When the plants were monitored in September 2001, not as many seedlings were found. This is most likely due to seasonality and will be confirmed with future monitoring during the spring when more seedlings can be expected. NRS hope to be able to better define population structure and treats for other unprotected populations of *C. dentata* in the coming year for comparison. NRS will also continue to monitor the Kahanahāiki population for new trends and threats.

Figure 3-4 Population Trend *Cyrtandra dentata* MMR-A



Delissea subcordata

Species	Rarity Level	Conservation Potential	TCPL
DELSUB	1	4	1

This very rare member of the Campanulaceae family was known only from O'ahu, in the Wai'anae and Ko'olau Mountains. It is not known from the Ko'olaus today (Wagner 1990). One individual was found in Kahanahāiki Gulch this past year. This immature plan is only 20 cm tall. There are also two reintroduction sites in the MU. One site has four and the other seven individuals. They are from seeds collected from the nearby Pahole NAR population. This species is only known from 45 wild individuals in the State. This species received the first priority level for threat management given its overall rarity and High Threat Levels. The reintroduction sites are highly threatened by Invertebrates and Rats. A slug threat control method is being tested at a reintroduction site for *Alsinidendron obovatum*. A cooper/zinc barrier was erected around a plant to see if it would exclude slugs. It is not yet clear whether this control method works. If it does, it could be employed for *Delissea* as well. The threat of rats to this species is also High being in Campanulaceae with fleshy fruit. NRS can control rats around the reintroduced mature individuals if predation is observed.

The reintroductions were done in January of 1999 and have been observed flowering and with mature fruit though there is no recruitment yet. There are no representatives of the wild individual ex-situ because it is still immature. When this plant matures, fruit will be collected and propagated to represent that individual off-site. NRS is unsure of the source of the new immature plant. It could have come from either a seed bank still left from a historic population, or from the new reintroduced population. The Ungulate Threat Level for this species in MMR is Low because the wild and outplanted individuals are within the Kahanahāiki fenced exclosure. NRS will collect from the reintroduced population for storage in the coming year.

Diellia falcata

Species	Rarity Level	Conservation Potential	TCPL
DIEFAL	4	4	5

This listed fern is known from two sites on MMR. One site with lots of individuals is in Kahanahāiki and is protected within a fence. The other site is much smaller with less than ten individuals. It is on the East Rim of Mākua and has a Medium Ungulate Threat because goats or pigs do not target it. This species has one of the largest population sizes of all listed plants of Army lands. The Army has a small percentage (2%) of the total population. This gives this species a low priority for MMR. Goats are being removed from Mākua and this will benefit the *Diellia*. Weeds are indicated as having a Medium Threat Level to this species in MMR. Weeds are being controlled in the Kahanahāiki MU and will benefit this species. This species is not represented ex-situ and collections have recently been made to establish protocols for cultivating this species. NRS will relocate historic populations of *Diellia* with Joel Lau in the coming year.

Dubautia herbstobatae

Species	Rarity Level	Conservation Potential	TCPL
DUBHER	4	1	1

This Aster is known from a very restricted area in the Northern Wai`anae Mountains (Wagner 1990). Over 98% of the known individuals in the state are found on `Ōhikilolo ridge making the Army population very important. This species is also highly threatened by goats giving it a High Ungulate Threat Level. The cliff habitat of this species makes it very difficult to build fence around and gave it a Difficult Manageability Level. Fencing has been constructed on a large scale in Mākua and goats are being removed from the valley (see Feral Ungulate Management, Chapter 1). Once this is done, the Ungulate Threat Level will decrease to Low. There are only eight individual plants growing ex-situ. This represents less than 1% of the known population. NRS will collect from a larger subset of these plants for seed storage.

Dubautia sherffiana

Species	Rarity Level	Conservation Potential	TCPL
DUBSHE	2	4	3

This Aster is known only from the Wai`anae Mountains (Wagner 1990). It is found on the cliffs of `Ōhikilolo Ridge in MMR. About 11% of those known statewide are found in MMR. This species is still listed as a Species of Concern despite low and declining population numbers statewide. No collections have been made from the MMR plants. This species faces a High Weed Threat Level from *Melinis minutiflora*. Control of this threat is rated Difficult because of the cliff habitat preferred by this species. The Medium Ungulate Threat is being addressed by removing goats from the Valley. NRS will collect from this species for long-term storage.

Euphorbia haeleeleana

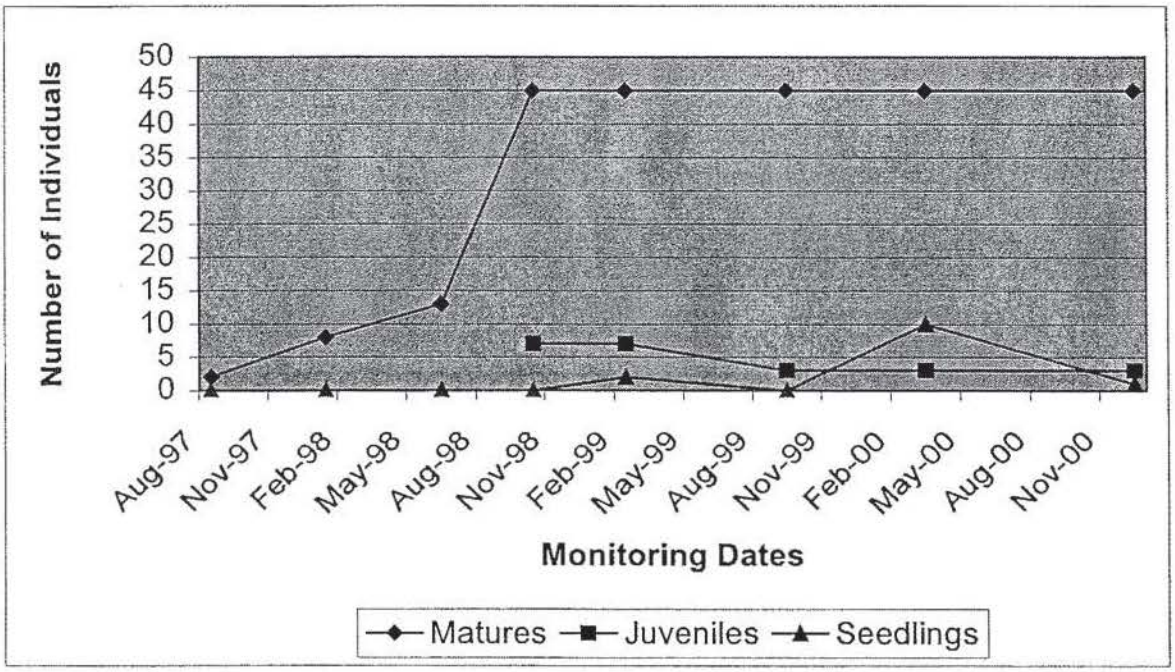
Species	Rarity Level	Conservation Potential	TCPL
EUPHAE	3	3	4

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 1990). The *Euphorbia* on MMR are found only in Kaluakauila Gulch. There is one population of about 120 trees with seedlings and juveniles. These trees were first discovered in 1985 and were the only known occurrence on O`ahu until recently when it was discovered above Waialua. This species is highly threatened by fire, rats and weeds. NRS have been controlling rats around the *Euphorbia* for three years. There is a huge amount of Guinea grass (*Panicum maximum*) around and in the population. NRS may recommend spraying this grass to reduce the fire and weed threat. The MU will be fenced due to the ungulate threat and density of rare species. This would decrease the Ungulate Threat Level to this species and many others.

The population on in Kaluakauila was broken into two groups, which are geographically separate. A large grassy area separates the forest patches where the trees are found. Gene flow may occur across this divide making them one population but it is not known whether this occurs. NRS have been tracking the populations separately for five years. The population trends are depicted below.

The trees in MMR-A were known since 1985 and have been monitored by NRS since 1997, when only a few trees were known. As the graph depicts, surveys found more trees and by the fall of 1998 all known trees were found. Rat control began in June 1999. The graph for MMR-A below does show an increase in the number of observed seedlings after rat baiting. Many of these seedlings died during the next dry season and this is shown in the graph. NRS does not expect to see a dramatic increase in the number of trees in larger size classes. This species is a long-lived perennial that may take years to mature. NRS hope to see a large increase in the number of seedlings and a slow increase in juveniles as the population is relieved of threats.

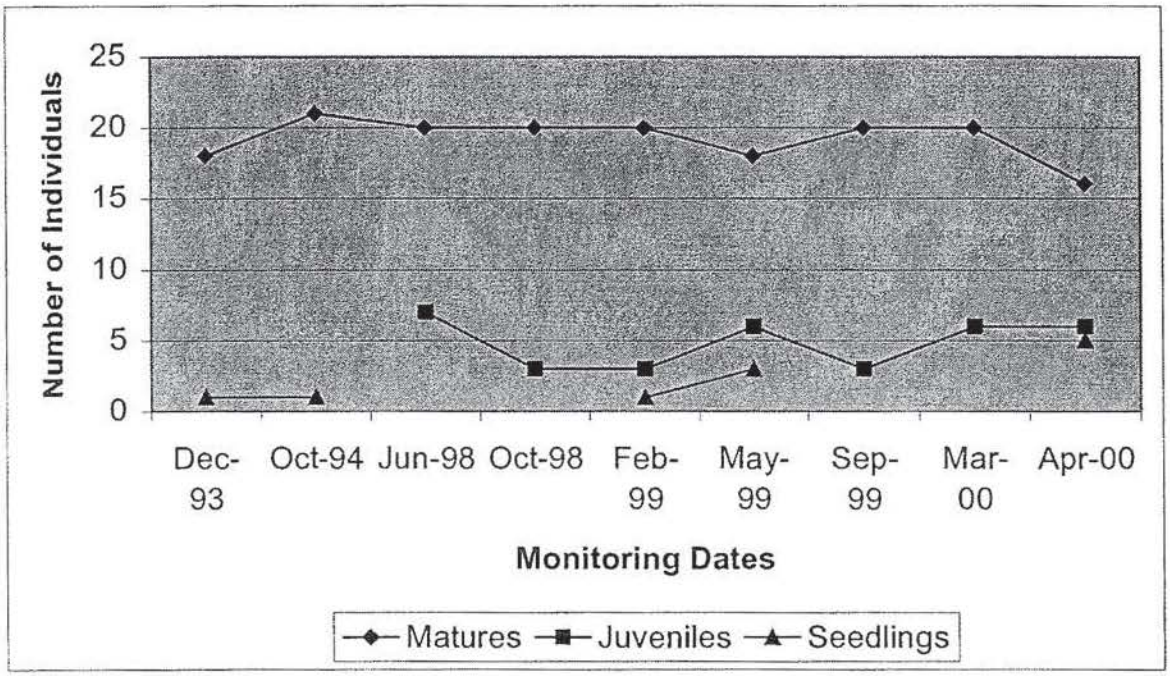
Figure 3-5 Population Trend *Euphorbia haeleeleana* MMR-A



The trees in MMR-B were monitored a few times by a State NARS technician between 1993 and 1997, when NRS began monitoring so the graph for MMR-B covers a much longer period then the MMR-A graph. There are a steady number of mature individuals, but unfortunately, the

number of plants in smaller size classes is fluctuating greatly over time and does not illustrate an increasing trend. Rat baiting began in June 1999 in this patch. Again the highest number of recorded seedlings was found after rat baiting but many may have died during the dry season. NRS will continue to manage this population for fruit production and monitor for population trends.

Figure 3-6 Population Trend *Euphorbia haeleeleana* MMR-B



NRS will continue to monitor for new threats and population trends. NRS will continue rat control at the population and a fence will be installed in the next year. Fuel loads will be reduced in the MU and seeds will be collected for storage.

Fluggea neowawraea

Species	Rarity Level	Conservation Potential	TCPL
FLUNEO	2	4	3

This species is one of the rarest trees in Hawaii. It was known from all the major islands. On O`ahu it is known from the Wai`anae Mountains (Wagner 1990). There are five individuals of this rare tree known from MMR. Threats from invertebrates and ungulates, no recruitment, and very low numbers heavily impact the *Flueggea*. This species is highly impacted by the Black Twig Borer.

There are two trees in the Kahanahāiki MU, one in the gulch inside the fence and one outside the fence. Both these trees have flowered and produced fruit. The gulch tree produced only a few fruit and they were aborted. NRS have applied a systemic insecticide to this tree three times between June 1999 and July 2000. The product was called Vivid II and the active ingredient is 1% Abamectin and the target pest is the Elm leaf beetle. It is installed with microinjection units. At this point, there is no indication that the treatments are helping. Pictures have been taken at every application and show no significant change. The tree outside the exclosure produced fruit

that had no embryos. NRS have been working with Dr. Richard Criley, a horticulturist at the UH to root cutting and graft Mākua material onto a tree from Kaua`i. Attempts to grow cuttings from this tree have been unsuccessful, but intriguing. Cuttings have stayed alive for months without rooting under his mist system. Grafts have not taken at the Pahole nursery.

Two trees are located within a couple hundred feet from each other in the Lower Mākua MU. Access to portions of this MU is restricted due to UXO and requires permission from the Range Control office and EOD escorts. NRS now has permission to camp in Lower Mākua and will be better able to access these trees. They both flowered and one produced fruit (MMR-C-2) in January 2000. The other tree (MMR-C-1) has not produced fruit and is assumed to be a male. MMR-C-2 was visited on two occasions to collect and monitor while fruit was maturing. A total of 87 fruit was collected from the tree in and the ground below in January 2000 and brought to the Lyon Arboretum Micro-propagation Lab. One seed germinated and lived for some time before dying. NRS collected from the MMR-C plants again in August 2001 and have sent cuttings to the Volcano Nursery in Hilo where cuttings have been rooted from Big Island plants. NRS will attempt to hand-pollinate the Mākua and Fluggea Gulch females in the next season. This may increase the number of fertile fruit produced.

The fifth individual is also in Lower Mākua and has very little vegetative material left. NRS will attempt to collect from this tree in the coming year and get material to the Volcano Nursery for propagation. A Medium Weed Threat Level was given for this species in MMR. There are no major weed threats in the area and it is more than half-native. While this species is not thought to be targeted, ungulates are still in the area and so the Ungulate Threat Level is Medium. Since, fencing at this time is not allowed in the MU, because of UXO, the Manageability Level for Ungulates is Not Possible. The Threat Level for rats is a Medium due to the partially fleshy nature and rarity of fruit. NRS will continue to attempt to represent these trees ex-situ in the coming year. NRS has observed goat damage to one of the trees and has raised the ungulate Threat Level for this species to High. NRS will continue to control goats around these trees.

Hedyotis degeneri var. *degeneri*

Species	Rarity Level	Conservation Potential	TCPL
HEDDEGDEG	3	4	3

This species is known from diverse mesic forests in the Wai`anae Mountains of O`ahu. The other variety is known also from the Wai'anaes. This variety is distinguished by having glabrous stipules (Wagner 1990). *H. degeneri* var. *degeneri* is known from one population of eleven individuals in Mākua , which represents less than 5% of those known statewide. The population is located within the Kahanahāiki MU but is not fenced. This population was collected from to determine propagation protocols and progeny are still at the Army facility. No seedlings or juveniles have been observed in this population. An appropriate ex-situ site should be found where these plants may be grown for fruit production and research. NRS will work in the coming year to identify such an area. A botanical garden would be an appropriate place where the plants could be both managed and enjoyed by the public. There are no High Threat Levels identified for this species and only one Medium. The Ungulate Threat Level is a Medium with an Easy Manageability Level. A small fence could easily be built around the population but has the lowest priority because it would only protect a small portion of the known statewide population. This species benefits from ongoing ungulate control in the area. NRS will continue ungulate control in the are and seek a good ex-situ site for this species.

Hedyotis parvula

Species	Rarity Level	Conservation Potential	TCPL
HEDPAR	2	2	1

This rare *Hedyotis* was known only from rock ledges, cliff and outcrops in the Wai'anae Mountains (Wagner 1990). Today, there are two sites with *H. parvula* in MMR totaling more than 100 individuals. These plants represent 44% of those known statewide. Because the Conservation Potential is so high and there are High Threat Levels recognized for this species, threat control is a high priority. The High Threat Level for this species is for Ungulates. Goats threaten these populations and are being removed from the valley. Completion of this action would reduce the overall threat to a Medium. A Medium Fire Threat Level is identified for this species. Weeds also have a Medium Threat Level for this species because of Molasses Grass. The Manageability Level for Weeds is a Difficult because of the cliff habitat this species prefers. Any weed management would have to be done using ropes. A small percentage (<5%) of the MMR plants are represented ex-situ at the Army Nursery and at Lyon. NRS monitored a population with Steve Perlman of the NTBG and found many more plants in the last year. A third location for this species was documented in 1993 on `Ōhikilolo and NRS will relocate and monitor this population. NRS will store seeds from these plants in the coming year.

Hibiscus brakenridgei ssp. *mokuleianus*

Species	Rarity Level	Conservation Potential	TCPL
HIBBRAMOK	1	2	1

This species of *Hibiscus* was 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 ten meters tall. There are two subspecies. The *mokuleianus* subspecies occurs on Lāna`i and O`ahu (Wagner 1990). There are three slightly different types 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.

In November 2000, NRS accompanied Joel Lau of the HINHP onto the North facing slopes of lower `Ōhikilolo Ridge. On the way to the ridgetop, Mr. Lau found four mature, two juveniles and three seedlings of *Hibiscus*. This is the first record of *brakenridgei* on the leeward side of the Wai`anaes. These plants are very distinct and display a growth form very different from the other plants on O`ahu. The low-branching sprawling growth is well suited to these dry windy slopes. Cuttings were taken from four of the plants and mature and immature fruit was later collected. The cuttings were propagated by Joel and are growing at his house. NRS has collected cuttings from these plants and are growing them at the Army nursery. Vegetative material and the fruit were brought to the Lyon Arboretum. There are plants in tissue culture as well as in the nursery. NRS will seek many places for growing and storing this stock.

The wild plants are scattered throughout the highly disturbed Guinea grass dominated shrubland. The plants are at around 460 feet in elevation and are about 150 meters from the firebreak road. They are highly threatened by weeds and fire. These plants along with the *Chamaesyce celastroides* var. *kaenana,* which is nearby, are the most threatened by military training. This slope has burned more than five years ago. The large fires of 1998 burned both inside and outside the firebreak road and were stopped just before burning any known plants. NRS believe that the firebreak road is not enough to stop a fire from spreading from inside to outside the road in this area. NRS will recommend that Guinea grass (*Panicum maximum*) be removed from

around the population. It would also reduce the chance of fire reaching the population if firebreaks could be extended to further buffer these populations from ignition sources. For example, weed eaters are used to reduce fuel levels on the inside of the firebreak road. Both sides of the road could also be cleared in the vicinity of the population southwest side of the south firebreak. In addition, a firebreak should also be established on the highway side of lower `Ōhikilolo Ridge to reduce the chance that a roadside ignited fire would come onto the Reservation. NRS will monitor these plants frequently in the coming year and most likely collect again to increase ex-situ stock.

Lepidium arbuscula

Species	Rarity Level	Conservation Potential	TCPL
LEPARB	4	4	5

This species is known from open dry ridges and cliffs in the Wai'anae Mountains on O`ahu(Wagner 1990). This species falls into the last priority due to the very small Conservation Potential Index (.3%). *Lepidium* is known from two sites on MMR. One site is surrounded by fence in the Kahanahāiki MU and the other in the `Ōhikilolo MU is not fenced. This species has a Medium Weed Threat Level and will benefit from the removal of weeds from the MUs. There are no ex-situ representatives of these populations.

Lipochaeta tenuifolia

Species	Rarity Level	Conservation Potential	TCPL
LIPTEN	4	2	4

This species is known from diverse mesic forest and cliffs from the Central and Northern Wai'anae Mountains (Wagner 1990). It is known from four locations on MMR. There are estimated to be over 2000 individuals on MMR. This represents half of those in the state. *L. tenuifolia* is a common component on the cliffs of upper `Ōhikilolo Ridge. In addition there is one small patch with plants much lower on `Ōhikilolo. This low population will be fenced in the coming year. There is also a population in Kaluakauila and one on C-Ridge. Those represented ex-situ are less than 1% of the individuals known statewide. This species has a High Fire Threat Level and will be recommended to be stored. *Lipochaeta* also has a High Ungulate Threat Level. Goats have been observed eating this species and are being removed from the Valley. Kaluakauila MU will also be fenced in the coming year. Rats are not considered at threat. This species grows on cliffs making management actions like weeding and fencing difficult. The Army plans on fencing the lowest plants on `Ōhikilolo in the coming year.

Lobelia niihauensis

Species	Rarity Level	Conservation Potential	TCPL
LOBNII	4	4	4

This species of *Lobelia* is only found on dry cliff faces, and was known from Niihau, Kaua`i and the Northern Wai'anae Mountains on O`ahu (Wagner 1990). In Mākua, there is a population of about 430 individuals, and possibly many more. About 10% of the known individuals are found on MMR. This plant likes mid-elevation, very exposed cliffs making monitoring difficult even with ropes. These plants may be found hundreds of feet below the ridge crest and hundreds of feet above the valley floor, making them hard to count. The Fire Threat Level for this species is

Medium. The Ungulate Threat Level is a High because of goats. This Threat Level will be reduced when goats are removed from the Valley. There is no representation of this species ex-situ at this time. NRS expects this species to do very well as goats are removed from the valley. There is still a fairly large population in Mākua capable of rebounding well once the ungulate threat is removed.

Melicope makahae

Species	Rarity Level	Conservation Potential	TCPL
MELMAK	2	4	3

This species is known only from the Wai'anae Mountains (Wagner 1990). There are no High Threat Levels identified for this species in MMR. Most known individuals on `Ōhikilolo are located within the fence. Weeding inside the fenced exclosure benefits this species. There have been no collections of this species so none are in cultivation ex-situ. This population represents only 5% of those known statewide. Because of the Low Conservation Potential, this species is not a high priority.

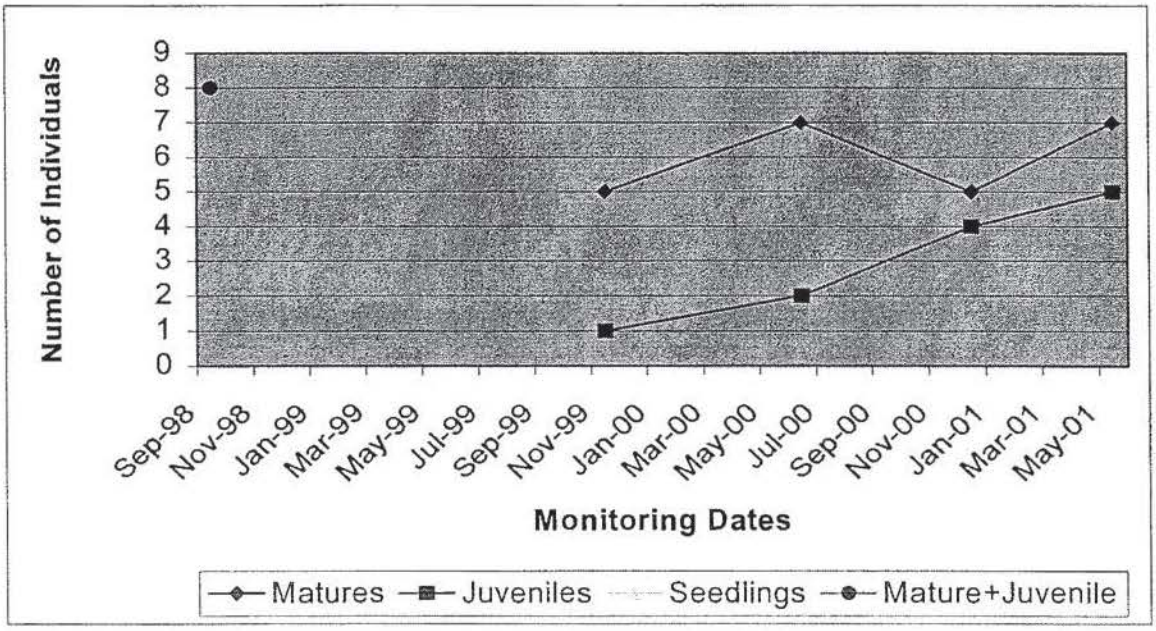
Neraudia angulata* var. *angulata

Species	Rarity Level	Conservation Potential	TCPL
NERANGANG	1	4	1

This variety is known to be rare in the diverse mesic forests of the Wai'anae Mountains (Wagner 1990). There are two sites where this species can be found on MMR. There are no seedlings but there are juveniles. This species has High Threat Levels for Weeds and Ungulates. The Threat Manageability Levels reflect the difficulty of controlling weeds around the population and removing ungulates from Mākua. The plants are on a cliff in an area frequented by goats though sign has been declining as goats are removed from the Valley. The weed threat is difficult to control given the vertical terrain. Perhaps a reintroduction into a more native habitat would help to stabilize this species in a less threatened area. There is no representation of these plants ex-situ. NRS have been monitoring two different groups of plants separated geographically and topographically so that there is probably no gene flow between populations. Other locations have been reported to have *N. angulata* var. *angulata* and were searched in the last year. No additional plants were found. NRS will attempt to relocate these populations with the botanists who reported them in the coming year. The two populations monitored by NRS are depicted graphically below as A and B.

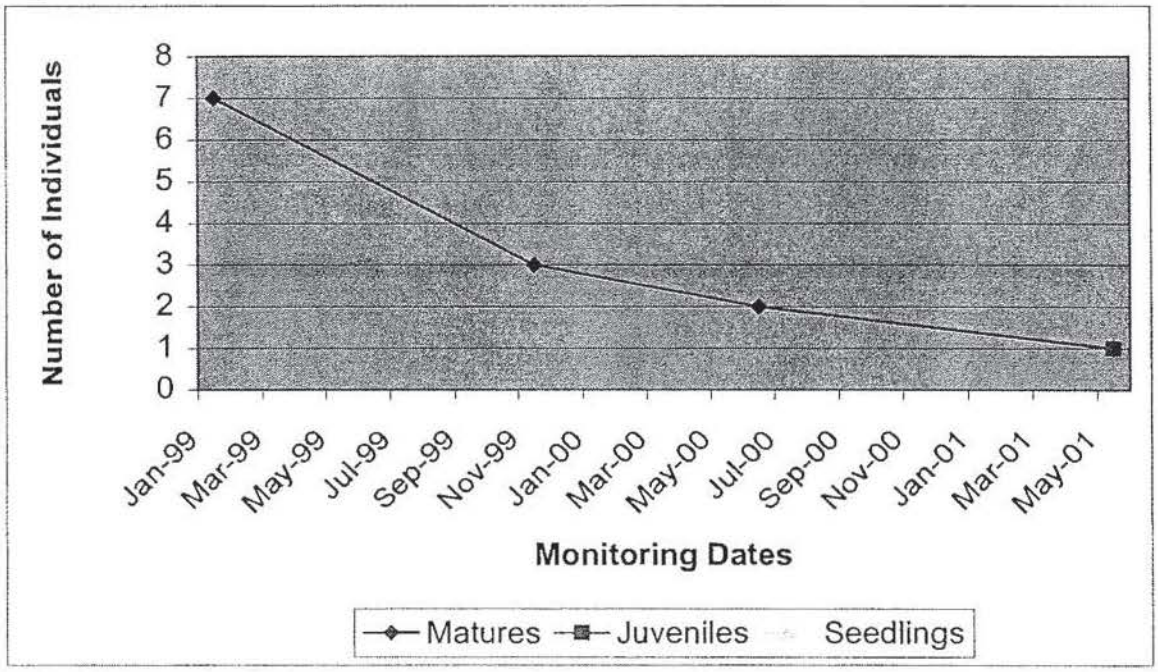
The plants at MMR-A have been monitored by NRS since 1998. They are visited at least twice a year to determine phenology, assess threats and collect. When first visited in September 1998, the number of mature and juvenile plants were lumped and not distinguished from each other. When the plants were monitored again the next year, there were five matures and one juvenile. The number of individuals has since increased. Most likely, this is due to the large numbers of goats that were removed from Ko`iahi Gulch. Ungulate sign in the area has gone from 100% to zero in the last few years (see Feral Ungulate Management, Chapter 1). NRS has collected from this species in the last year. Two of the cuttings were successfully rooted and the fruit is still in the lab pending results. NRS will continue to monitor these plants and collect for ex-situ storage.

Figure 3-7 Population Trend *Neraudia angulata* var. *angulata* MMR-A



NRS have been monitoring the plants in MMR-B since January of 1999. They have been in steady decline ever since. They were highly threatened by goats until recently. There are no juveniles or seedlings, and only one plant is left. Joel Lau of HIHNP believes that the population may be restricted during drought years and more plants may come up during wetter years. Goat sign has been significantly reduced but not eliminated in the area. NRS have collected from this plant in the last year and will again at least once in the coming year.

Figure 3-8 Population Trend *Neraudia angulata* var. *angulata* MMR-B



Neraudia angulata* var. *dentata

Species	Rarity Level	Conservation Potential	TCPL
NERANGDEN	1	4	1

This variety is known from the Wai'anae Mountains of O`ahu (Wagner 1990). It was reported from the C-ridge area and Lower Mākua and is thought to still be there, though none are known today. NRS will survey for this species when monitoring other projects in the area. HIHNP has been contracted again this year and will search for this species. A reintroduction with stock from Wai`anae Kai was put into the fence exclosure in Kahanahāiki Gulch. These plants were from the hybrid stock found in Wai`anae Kai and were removed as recommended by botanists familiar with the taxon. If indeed there are true *angulata dentata* plants near C-ridge, the reintroduced population might have mixed and altered the wild stock. NRS will continue to work with botanists familiar with the taxa to identify appropriate survey areas. NRS searched a historical location for this species on MMR but was not successful in finding any. The Medium Threat Levels for this species are addressed with large-scale weeding and ungulate removal. NRS will continue to search for this extremely rare variety.

Nototrichium humile

Species	Rarity Level	Conservation Potential	TCPL
NOTHUM	4	2	4

This species is found in the Wai'anaes and recently was found on East Maui (Wagner 1990). It is found in at least five locations in Mākua with over 400 individuals. This represents over 55% of those known statewide. Seedlings and juveniles have been found in the populations despite High Threat Levels. High Threat Levels were identified for Fire and Weeds. The fire-threatened site is in Kaluakauila where many *Nototrichium* can be found. Weeds also threaten these populations especially the Kaluakauila site. NRS continue to locate more of this species and documents the locations in the GIS database. NRS is working with Alvin Yoshinaga to store seeds from this species for future reintroductions. A proposed fence in Kaluakauila would reduce the ungulate threat. Once a fence is complete, NRS would recommend removal of the Guinea grass from the exclosure. This would reduce both the fire and weed threats.

Plantago princeps* var. *princeps

Species	Rarity Level	Conservation Potential	TCPL
PLAPRIPRI	2	4	3

This cliff species was known from Kaua`i, Maui, Moloka`i, Hawaii and O`ahu. However, the *princeps* variety is known only from O`ahu (Wagner 1990). There is one site with 14 individuals on MMR. This population represents 14% of the individuals known statewide. Weeds have the only High Threat Level for this population. They would be very difficult to control on a cliff. This population will benefit from the removal of goats from the Valley. There are ex-situ representatives of 7% of this population at Lyon Arboretum. NRS has collected from Schofield populations to test for storage potential. So far seeds stored for a few months are still viable. If testing indicates a positive long-term storage potential, the Mākua plants should be well represented in seed storage in the future.

Platydesma cornuta var. *decurrens*

Species	Rarity Level	Conservation Potential	TCPL
PLACORDEC	?	?	?

This variety is known only from the Wai`anae Mountains. The other variety *cornuta* is known only from the Ko`olau Mountains (Wagner 1990). *P. cornuta* var. *decurens* is now considered a Candidate species. NRS sought to determine the population statewide and on Army lands in the last year. Botanists familiar with the taxa estimated there may be less than 250 individuals left on the island. During surveys in the last year, NRS found 207 plants on `Ōhikilolo. This should raise the number of estimated individuals for this species statewide. During surveys, NRS found most plants with damage from aphids and other arthropods. These threats were not yet fatal to the plants, but will be monitored. Because the statewide rarity can not be determined at this time, a TCPL can not be assigned for this species. NRS will work in the coming year to better determine the statewide population size and prioritize management accordingly.

Pleomele forbesii

Species	Rarity Level	Conservation Potential	TCPL
PLEFOS	?	?	?

This species was known only from dry areas on O`ahu (Wagner 1990). Almost half of the known individuals are found in Mākua. This species has High Threat Levels for Fire and Weeds. This species does benefit from canopy weeding and ungulate removal in the MU. This species has the potential for rat predation on its fruit and will be monitored by NRS. It does benefit from rat control that targets more rare species such as *Pritchardia* and *Euphorbia*. NRS sought to determine the population statewide and on Army lands in the last year. Botanists familiar with the taxa estimated there may be less than 250 individuals left on the island. NRS has counted about a hundred plants in Mākua in the last year. This is not significant enough to change the number estimated statewide. Because the statewide rarity can not be determined at this time, a TCPL can not be assigned for this species. NRS will work in the coming year to better determine the statewide population size and prioritize management accordingly.

Pritchardia kaalae

Species	Rarity Level	Conservation Potential	TCPL
PRIKAA	2	2	1

This *Pritchardia* species was and is known only from the Wai`anae Mountains. They are found in mesic to dry gulches and cliffs from Mt. Ka`ala and Mākua (Wagner 1990). There are at least 76 individuals in Mākua. One dense patch is located just outside the fenced exclosure and has about fifty trees. Rats are known to eat the fruit of this species as it ripens and when NRS first visited this patch five years ago no ripe fruit could be found. NRS has been baiting ever since and now find ripe fruit on the ground. Seedlings have been found in the last year. Twenty-eight were found in July of 2000 and fifty estimated in June 2001. Goats have browsed these seedlings and small fences have been erected to protect them. This species has a High Threat Level for Ungulates, Rats, and Weeds. This species will benefit greatly from the removal of goats from the Valley. The forest patch on `Ōhikilolo, in which the *Pritchardia* is found, is dominated by *Schinus terebinthifolius*. This threat is being addressed by removing this weed species at a slow rate and planting of common native species. NRS has been collecting fruit from these trees for

propagation at the Army Nursery, Pahole and Lyon Arboretum. Of the 76 trees in Mākua , 44% are represented ex-situ. There are currently over 260 plants in ex-situ at this time. There has been one reintroduction project with this species on `Ōhikilolo. Twenty-one plants were put into two sites within the fenced exclosure. These plants are monitored by NRS and are doing well. NRS has lots of individuals at the Pahole nursery ready for reintroduction. A site will be prepared on `Ōhikilolo Ridge and plants may be reintroduced this year.

Below is the population trend for MMR-A. The population has been monitored regularly since 1997. In January 2000, the first seedlings were found. The most recent monitoring found over two-hundred seedlings. NRS will continue to monitor this population in the coming year to track population structure and size. NRS would like to compare the structure of this population to other populations of *Prichardia* around the State. NRS will be working with the NTBG in the coming year to compare the population structure of the Mākua trees to those in less degraded habitats, such as the one on Huelo Rock near Moloka`i.

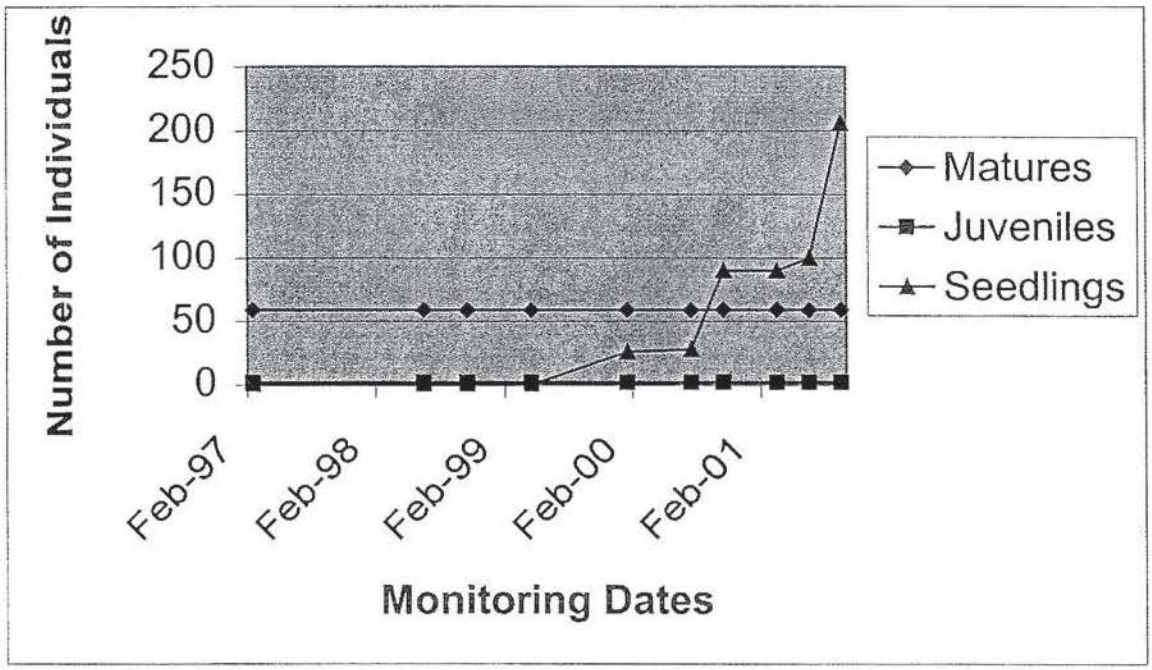


Figure 3-9 Population Trend *Pritchardia kaalae* MMR-A

Pteralyxia macrocarpa

Species	Rarity Level	Conservation Potential	TCPL
PTEMAC	3	4	4

This species was found in diverse mesic forest in the Ko`olau and Wai'anae Mountains on O`ahu (Wagner 1990). It is found throughout Mākua. Over 25% of the known individuals in the state are found in MMR. The High Threat Levels identified for this species are Ungulates and Rats. Since January 1999, NRS have controlled rats in the patch for protection of *Achatinella* snails. The Ungulate Threat Level will be reduced as goats are removed from the Valley. Lyon Arboretum made collections from the `Ōhikilolo population for germination trials. This species would benefit from large-scale protection from rats by a broader dispersal of bait. For the first time in five years on `Ōhikilolo, seedlings were seen in the patch. Rat control may be helping

more of the fruit reach maturity. NRS will continue baiting in the area and monitoring the population for seedlings.

Sanicula mariversa

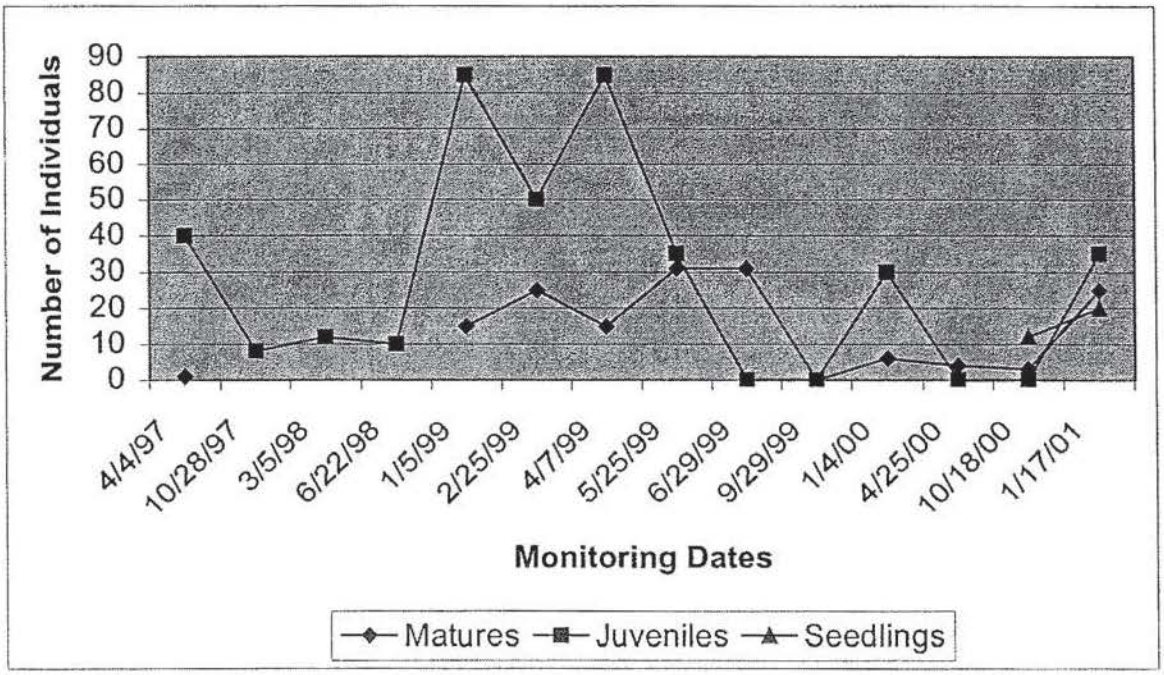
Species	Rarity Level	Conservation Potential	TCPL
SANMAR	3	2	1

This rare Apiaceae was known only from the leeward Wai'anae Mountains (Wagner 1990). It is now known from two sites on ʻŌhikilolo and one in Kea'au Valley adjacent to Mākua. This species comes up every winter-spring with the rains and is known from only two other sites in the Wai'anae Mountains. There were 137 mature and juvenile individuals known from this site on a good wet year and fewer during drier years. In January 1999, NRS attempted to slow the erosion around this population by back filling an area supported with fencing. A jute mat and chain-link fence was laid down to stabilize more habitat. The plants did emerge from these areas to flower and produce fruit.

During the summer of 1999, NRS collected fruit from all known individuals. From each individual, a third of the fruit was brought to the Army facility for propagation; a third to the Lyon Arboretum for storage trials and a third was sown into two sites on ʻŌhikilolo. These sites were marked and were monitored in January 2000 and three seedlings were found. The fruit collected from the wild population did germinate and is now growing at the Army Nursery.

In the last year NRS accompanied Joel Lau to a smaller population just up the ridge from the known population. This site has about a dozen plants and none were flowering at the time. These populations received High Threat Levels for Weeds and Ungulates. The ungulate threat is being addressed by removing goats from the Valley. NRS is considering controlling *Melinis minutiflora* at the site but is concerned about the potential impact on native grasses. The following graph shows the seasonality of these plants and the difficulty of determining true population trends. Determining a juvenile from a mature plant can also be difficult as the main difference in size may be below ground. NRS will continue to closely monitor these populations in hopes of better determining population trends and species biology.

Figure 3-10 Population Trend *Sanicula mariversa* MMR-A



Schiedea hookeri

Species	Rarity Level	Conservation Potential	TCPL
SCHHOO	3	4	4

This species is known from the Central and Northern Wai'anaes. It is described as being scattered and locally common in diverse mesic forests (Wagner 1990). There is one site with *S. hookeri* in Mākua in Kaluakauila Gulch. It has a High Threat Level for Fire only. This population represents only 1% of the more than 400 known individuals and is not considered critical. No collections have been made for propagation. NRS will recommend that this population be preserved ex-situ in seed storage due to the High Fire Threat Level. This species would benefit from the removal of weeds and ungulates from the Kaluakauila MU. A proposed fence in the Kaluakauila MU will enclose the only known population in the coming year.

Schiedea nuttallii

Species	Rarity Level	Conservation Potential	TCPL
SCHNUT	1	3	1

This rare species of *Schidea* is found on Maui, Kaua`i and in the Wai`anae Mountains of O`ahu (Wagner 1990). It is known from one population in Mākua. There are 17 mature individuals in Kahanahāiki with seedlings and juveniles. This represents 41% of the sixty individuals known statewide. Invertebrate damage has been noted in the wild population and samples were taken to the Plant Pathologists at the University's College of Tropical Agriculture and Human Resources. They noted the presence of scolytid beetles and the two-spotted leafhopper. Desmond Ogata confirmed this in the field. They are known to attack branches and twigs of trees and shrubs. This damage is not thought to be lethal and no control is planned for this threat. All other threats

have been identified as Medium and Low. This species will benefit from the weeding being done in the Kahanahāiki MU.

Collections have been made from this population. A reintroduced population planted in January 2000 in Kahanahāiki has eight individuals. Half of them have flowered in the last year. Eight more plants were added to the reintroduction site in the last year and all 16 are doing well.

NRS has been monitoring the wild population since September 1998 and has fairly accurate population data. This data shows a fairly stable trend with a slight recent increase. This is encouraging, as ungulates have been removed and the number of both juveniles and mature plants has increased in the last year. NRS hopes to plant some common native species to improve the cover in this population. NRS will continue to closely monitor this population for additional threats and population trends.

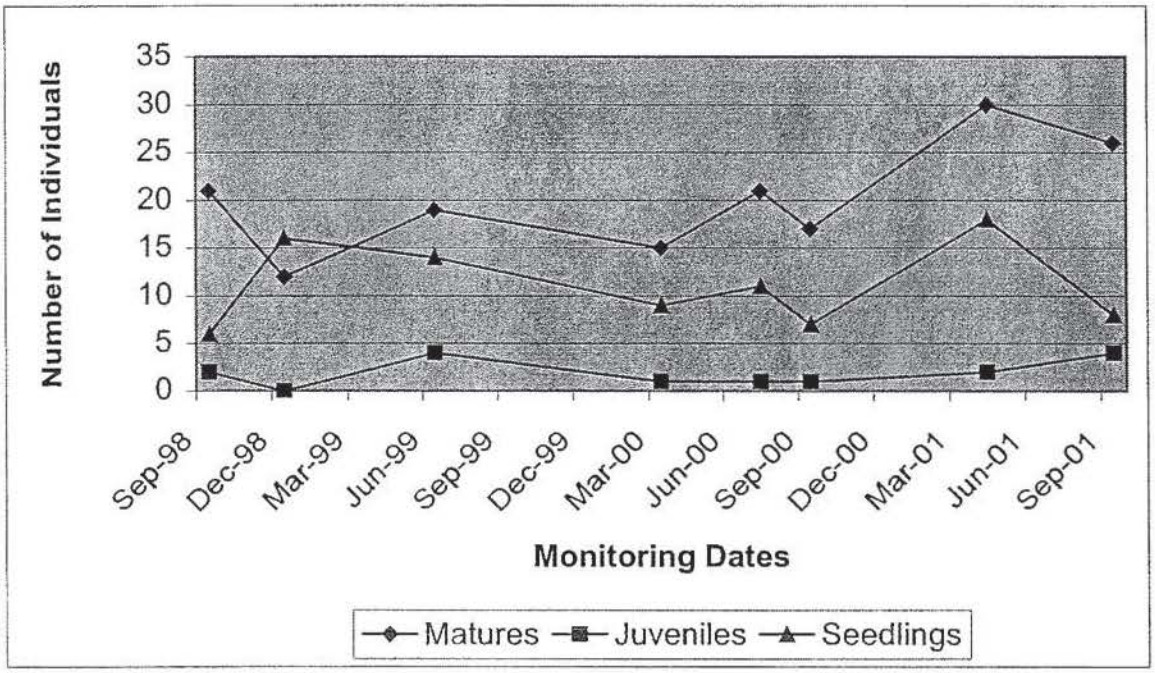


Figure 3-11 Population Trend *Schidea nuttallii* MMR-B

Silene lanceolata

Species	Rarity Level	Conservation Potential	TCPL
SILLAN	4	4	4

This species was known from nearly all the islands (Wagner 1990). There are 12 individuals known of this species from MMR. This represents less than 1% of the known population throughout the State (<2000). Fruit was collected from this population in September of 1999 and 8% are now represented ex-situ at Lyon. There is a High Ungulate Threat for this species. This will decrease once goats are removed from the Valley. NRS accompanied Steve Perlman from NTBG to this population in the last year. Eleven mature plants and six seedlings were counted. NRS has collected from these plants for seed storage and will again in the coming year.

Spermolepis hawaiiensis

Species	Rarity Level	Conservation Potential	TCPL
SPEHAW	4	4	5

This species was known from all the major islands (Wagner 1990). There is a population of this species located on the lower portions of `Ōhikilolo Ridge. There are about 250 plants have been documented from this location. Because this population occurs at such a low elevation on `Ōhikilolo it has a High Fire Threat Level. NRS will collect from these plants in the coming year to store. NRS recommends that fuel breaks be extended on both sides of the road adjacent to this area to reduce the chance of fire reaching the plants. Fire has burned through areas now occupied by the plant.

Tetramolopium filiforme

Species	Rarity Level	Conservation Potential	TCPL
TETFIL	4	1	1

This species is known only from the Northern Wai'anae Mountains. It is found on dry ridge crests, cliffs and ledges mostly on `Ōhikilolo Ridge (Wagner 1900). About 5,100 individuals are known of this species. However, its range is quite restricted and the species is relatively rare. It is thought to number over 5000 from MMR. This species is highly threatened by Fire and Ungulates. Because of the High Fire Threat, NRS will recommend that adequate representation be established ex-situ in seed storage. The `Ōhikilolo Ridge Fence was just completed in the last year separating the mauka half of the Valley from Mākaha Valley to the South. This will stop the ingress of goats into the Valley and decrease grazing pressure and trampling. The Pu'u with the highest density of *Tetramolopium* on the ridge has been included inside the fence and the plants will benefit greatly from the fence. The C-Ridge population has been collected from for seed storage in the last year. NRS will 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.

Viola chamissoniana ssp. *chamissoniana*

Species	Rarity Level	Conservation Potential	TCPL
VIOCHACHA	3	1	1

This rare violet sub-species was known from dry cliffs in the Wai'anae Mountains (Wagner 1990). The `Ōhikilolo population of *Viola* represents more than 80% of those known throughout the State. This species has a High Ungulate Threat Level and will benefit from the removal of goats from the Valley. There are representatives of this species ex-situ but not an adequate amount. NRS will collect from this species to bolster ex-situ representatives at Lyon Arboretum in seed storage. The seed storage potential for this species must be better determined. NRS will work with Alvin on this in the coming year.

Table 3-2 Rare Plants Kawailoa Training Area

Kawailoa Training Area		Population Size and Distribution						Ex-situ Status									Structure		Threats and Manageability						
Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On Oahu	Ind. On Oahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroduction	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert. Manageability	Weed Threat	Weed Manageability	Ungulate Threat	Ung. Manageability	Rat Threat
Chamaesyce rockii	E	4	38	11	>600	11	>600	Y	0	5	0	0	P	N	<1	N	N	Y	L	L		L	E	M	E	M
Cyanea acuminata	E	1	7	15	>1000	15	>1000	N	0	0	0	0	10	N	<1	N	N	N	L	H	N	M	M	H	M	H
Cyanea crispa	E	1	5	5	40	5	40	N	0	0	0	0	25	N	20	N	N	N	L	H	N	H	D	H	M	H
Cyanea humboldtiana	E	3	9	4+	100-220	4+	100-220	N	0	0	0	0	0	N	0	N	N	Y	L	H	N	L	E	H	M	H
Cyanea koolauensis	E	13+	50+	15	>1000	15	>1000	N	0	0	0	0	0	N	0	N	Y	Y	L	H	N	L	M	H	M	H
Cyanea stjohnii	E	1	5	5	25-30	5	25-30	N	0	0	0	0	0	N	0	N	N	Y	L	H	N	L	E	H	M	H
Cyrtandra dentata	E	3	125+	5	3157	5	3157	N	0	0	0	0	0	N	0	N	Y	Y	L	H	N	M	M	H	M	M
Cyrtandra viridiflora	E	3	38	4	38+	4	38+	Y	0	0	0	0	31	N	5	N	Y	Y	L	H	N	M	M	L	M	M
Exocarpus gaudichaudii	SOC	5	9	>5	<250	>5	<250	N	0	0	0	0	0	N	0	N	N	N	L	L		L	E	M	M	M
Gardenia mannii	E	3	25	27	>300	27	>300	N			8	0	23	N	5	N	Y	N	L	L		M	M	M	M	M
Hesperomannia arborescens	E	12	160	13+	>1000	13+	>1000	Y	0	0	0	0	6	N	0	N	Y	Y	L	L		M	M	M	M	L
Lobelia gaudichaudii ssp. gaudichaudii	SOC	3+	65+	<15	200-250	<15	200-250	N	0	0	0	0	0	N	0	N	N	Y	L	H		L	M	H	M	H
Melicope hiiakae	C	4	6	6	90	6	90	N	0	0	0	0	6	N	50	N	N	N	L	L		L	E	M	M	L
Melicope lydgatei	E	11	34	11	34	11	34	N	0	0	0	0	10/P	N	0	N	N	Y	L	H	D	M	M	M	M	L
Myrsine fosbergii	C				150-175		150-175	N	0	0	0	0	0	N	0	N	N	N	L	L		L	E	M	M	L
Phlegmariarus nutans	E	3	3	6+	12	6+	12	Y	0	0	0	0	P	N	0	N	N	N	L	L		L	E	M	M	L
Phyllostegia hirsuta	E	5	10	16	>400	16	>400	N		0	0	0	P	N	0	N	N	Y	L	M	D	M	M	M	E	L
Platydesma cornuta var. cornuta	E	3	27	4+	<200	<5	<200	N	0	0	0	0	P	N	0	N	N	N	L	L		M	M	M	E	L
Psychotria hexandra ssp. oahuensis	C	1	1	4+	<20	4+	<20	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	M	M
Pteris lydgatei	E	1	3		<200	<5	<200	N	0	0	0	0	0	N	0	N	N	N	L	L		L	E	M	D	L
Sanicula purpurea	E	3	40		250	7	250	N	0	5	0	0	0	N	<1	N	Y	Y	L	L		H	D	M	E	L
Stenogyne sherffii	SOC	0	0	0	0	0	0		20	0	9	25+	13	N	100	N	N	N								
Tetraplasandra gymnocarpa	E	5	5	15	<200	15	<200	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	M	L
Viola kauaensis	E							Y	0	0	0	0	0	N	0	N	Y	Y	L	L		L	E	M	M	L
Viola oahuensis	E	<10	<200	>10	>200	>10	>200	N	0	0	0	0	P	N	0	N	N	Y	L	L		M	M	H	M	L
Zanthoxylum oahuense	C	1	10+		<250		<250	N	0	0	0	0	0	N	0	N	N	Y	L	L		M	M	M	M	L

3.8 Kawailoa Training Area

Chamaesyce rockii

Species	Rarity Level	Conservation Potential	TCPL
CHAROC	4	4	4

This rare species of *Chamaesyce* is known only from the upper crest and cloudswept summit ridges in the Ko`olau Mountains. The large red fruit of this species are unique in the genus (Wagner 1990). It is now also known from the windward side in deep wet gulches. Only 6% of the more than 600 known individuals of this species are found in KLOA. This species has no High Threat Levels, though ungulates are not controlled around the plants. There are a few individuals represented ex-situ at the Army nursery. The propagules were taken for germination trials. The proposed Helemano fence will protect many individuals from ungulates.

Cyanea acuminata

Species	Rarity Level	Conservation Potential	TCPL
CYAACU	4	4	5

This species is known from mesic to wet forest in the Ko`olau and Wai'anaes on O`ahu, Lāna`i, Moloka`i and West Maui (Wagner 1990). High Threat Levels are indicated for this species for Invertebrates, Rats, and Ungulates. All members of the Campanulaceae were recognized as being prone to damage from pigs, slugs and rats and were given corresponding High Threat Levels. Since those plants found in KLOA represent only 1.4% of the known individuals, Army management can make little impact for the species as a whole. There are representatives of this species at Lyon Arboretum's Micropropagation Lab. There are currently no *C. acuminata* in KLOA that are protected from ungulates.

Cyanea crispa

Species	Rarity Level	Conservation Potential	TCPL
CYACRI	1	4	1

This species formally known as *Rollandia crispa* was and still is known from mesic to wet forest in the Ko`olau Mountains (Wagner 1990). There is one population of five *Cyanea crispa* known from KLOA. These five plants represent 16% of the known population and are in decline. There were 14 individuals last year, but nine have died. The site has High Threat Levels for Invertebrates, Weeds, Rats, and Ungulates. Slugs can not be controlled at this time. There have been collections made from this population and 7% are represented ex-situ. NRS will recommend a more adequate ex-situ stock be established due to the many High Threat Levels. Rat control may be necessary at the population in order to collect mature fruit, given the susceptibility of this taxon to predation of the fruit by rats. This site has many *Achatinella* tree snails and is monitored often. Rat bait stations meant to protect snails in the area may be adequate to protect fruiting plants. Reintroduction sites will be scoped and propagules replicated at Lyon for future reintroduction of this rare species. Permission will be sought for any future reintroductions in KLOA.

Cyanea humboldtiana

Species	Rarity Level	Conservation Potential	TCPL
CYAHUM	2	4	4

This *Cyanea* species was and is found throughout the Ko`olau Mountains (Wagner 1990). A small percentage (5.6%) is found KLOA. As a member of the Campanulaceae, this species has High Threat Levels for Invertebrates, Ungulates and Rats. It is found at three sites in KLOA with nine known individuals. There are no representatives of this species ex-situ. Because of the high TCPL score, this species will not be the target of management actions in KLOA.

Cyanea koolauensis

Species	Rarity Level	Conservation Potential	TCPL
CYAKOO	4	4	4

There are greater than a thousand individuals known from the Ko`olau Mountains, with only 5% found in KLOA. As a Campanulaceae it has High Threat Levels for Invertebrates, Rats, and Ungulates. Seedlings and juveniles have been found in these populations, even though slugs are a major threat to seedlings of plants in the Campanulaceae family. There are no representatives of this species ex-situ. There are no management actions targeted for this species because of the high TCPL score.

Cyanea stjohnii

Species	Rarity Level	Conservation Potential	TCPL
CYASTJ	1	4	1

This species is known only from the windy cloudswept ridges and gulches of the central Ko`olau Mountains on the windward side (Wagner 1990). This species was first found on Army land in 2000, in the Helemano drainage of the KLOA. Five individuals were found, including a juvenile. There are High Threat Levels, like other Campanulaceae, for Rats, Ungulates and Invertebrates. This population represents 11% of those known statewide and the northernmost population known in the Ko`olau Mountains. NRS will recommend that these plants be better-represented ex-situ. This population is in a very intact native area and will be monitored carefully. NRS has not visited this population in the last year to prevent further disturbance. Propagules will be collected in the next year for genetic storage and propagation.

Cyrtandra dentata

Species	Rarity Level	Conservation Potential	TCPL
CYRDEN	4	4	5

This species was known from both the Wai'anae and Ko`olau Mountains (Wagner 1990). In KLOA this *Cyrtandra* is known from three sites with over a hundred individuals. This represents a small fraction of those known statewide. This species has High Threat Levels for slugs, which can not be controlled at this time. Fortunately though, there are seedlings and juveniles in these populations. The population of *C. dentata* in the Kahanahāiki MU on MMR has been fenced for about four years and has responded well, having many seedlings and juveniles, where there were once very few. None of the Ko'olau plants are protected from ungulates. There are no

collections in ex-situ and no management actions are targeted for this species. The Kawaiiki population may benefit from construction of an exclosure for the reintroduction of *Stenogyne sherfii*.

Cyrtandra viridiflora

Species	Rarity Level	Conservation Potential	TCPL
CYRVIR	1	1	1

This species is known only from scattered windy cloudswept ridge tops in the Ko`olau Mountains on O`ahu. Over 95% of the 38 known individuals of this species are found in KLOA. The High Threat Level for Invertebrates identified for this species is due to the potential for seedlings to be consumed by slugs. However, seedlings and juveniles have been found in these populations. Collections have been made from these plants and are at the Lyon Arboretum. These represent 5% of the wild individuals. This species will benefit greatly from the `Ōpae`ula Watershed Protection Project Fence, which surrounds nearly all the known individuals of this species in KLOA. Once pigs are removed from the area, these plants will have a protected habitat. The Ungulate Threat for this species was changed to a Low now that close to 90% of the KLOA plants are within a fence. NRS will monitor these plants further to determine other threats and address them as necessary.

Exocarpus gaudichaudii

Species	Rarity Level	Conservation Potential	TCPL
EXOGAU	2	4	3

This species is known to be uncommon and scattered from mesic to wet forest on all the major islands except Kaua`i (Wagner 1990). There are five individuals of this species known from KLOA. This is a small percentage of the 250 known statewide. This Species of Concern deserves more protection given the small number of wild individuals and observed threats. More surveys are needed to determine the population size and range. These trees are found as lone individuals scattered across KLOA in wet areas dominated by uluhe fern. Because of this distribution pattern, this species is difficult to manage. There have been no seedlings or juveniles found during surveys, but the scattered distribution pattern makes it hard to monitor for population structure. There are no High Threat Levels for this species and none are in cultivation. More time must be spent determining population range and size. When the distribution and structure of these plants are better known, threats can be better recognized and managed.

Gardenia mannii

Species	Rarity Level	Conservation Potential	TCPL
GARMAN	3	4	4

This *Gardenia* species is known to be uncommon from mesic to wet forest on O`ahu (Wagner 1990). There are 25 known trees in the KLOA. This is 5% of those known statewide. There are no High Threat Levels recognized for this species. This species benefited from ungulate removal from the Lower Pe`ahināi`a MU where the majority of known trees are found. However, ungulate control has ceased around these trees due to conflicts with illegal hunting. Weed control efforts in the MU will also decrease the Medium Threat Levels. Collections have been made from this population and 8% are represented ex-situ by about 25 individuals. A place must be

found to hold ex-situ collections so they are close to appropriate habitat and accessible to managers.

Hesperomannia arborescens

Species	Rarity Level	Conservation Potential	TCPL
HESARB	4	4	4

This species is known from O`ahu, Moloka`i and Lāna`i. It is apparently extinct on Lāna`i and now rare on other islands (Wagner 1990). This species has a low TCPL Level due to the large population size and no High Threat Levels. NRS are working with Susan Ching, a graduate student from the Botany Department at UH Manoa, to provide samples of this species for pollen viability and genetic studies. Preliminary data suggests that pollen from these populations has a high viability. Ms. Ching has observed better germination rates with the *arbuscula* species after hand pollination. There are more than six groups of individuals in the KLOA area on several different ridges. Seedlings have been found in these populations, but they are disturbed by ungulates, as there are few juvenile trees within known populations. There are representatives from this species at the Lyon Micropropagation Lab. `I`iwi are thought to be able to pollinate this species and have been seen in the area.

Lobelia gaudichaudii ssp. *gaudichaudii*

Species	Rarity Level	Conservation Potential	TCPL
LOBGAUGAU	2	2	1

This species is known from cloudswept summit forest in the Ko`olau Mountains (Wagner 1990). This rare member of the Campanulaceae has High Threat Levels for Invertebrates (slugs), Rats and Ungulates. This species is known from the Lehua Maka Noe Bog, a fenced area in KLOA, and along the summit on the windward side. It can also be found in the central Ko`olaus in the Kōnāhuanui area. The `Ōpae`ula Watershed Project Fence protects more plants. Now, 46 of 66 known plants in KLOA are inside that fence. There are no representatives of these plants in cultivation. Juveniles have been found but no seedlings. Seedlings are hard to find given the steep and dense terrain. Slugs are thought to be a major threat to seedlings. About 25% of those known statewide are found in KLOA. Surveys in the last year have brought the estimated number of individuals from 250 to 150. This makes the plants found on Army lands a more significant part of the known population and increases their conservation potential which, has changed from last year. There is much more habitat to be surveyed for this species, and these numbers may not present an accurate assessment of the populations. NRS will collect from this species for seed storage trials. This subspecies is still more prevalent than the variety *koolauensis*.

Melicope hiikae

Species	Rarity Level	Conservation Potential	TCPL
MELHII	1	2	2

There are six individuals of this rare *Melicope* in the KLOA. There are no High Threat Levels identified, only Medium for Weeds and Ungulates. Collections of this species have been made and plants are growing ex-situ at Lyon. These represent 50% of the known plants from 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 hundred 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.

Melicope lydgatei

Species	Rarity Level	Conservation Potential	TCPL
MELLYD	1	1	1

This *Melicope* was known from scattered populations in the Ko`olau Mountains (Wagner 1990). In KLOA it can be found in the Lower Pe`ahināi`a MU and from the Poamoho Trail area. There are less than 50 known wild individuals and all are known from within the KLOA. No seedlings have been observed in the populations but juveniles are present. Arthropod damage has been noted on one wild individual. Aphids and ants covered all of the growing tips and the plant was doing poorly. A collection of the damaged material and unidentified aphids were taken to the Plant Diagnostics Lab at the College of Tropical Agriculture and Human Resources. They were identified as Black Citrus Aphids (*Toxaptera aurantii*). The aphid is described by Zimmerman, E. (1945), as being principally a species of the mountains and cultivated areas at higher elevations. It has been in the islands since the early 1900's. When this plant was revisited a year later, it was dead. Therefore, this invertebrate species has been identified by NRS as having potentially lethal impacts and is given a High Threat Level. NRS continues to monitor this population for signs of further aphid damage. There are no known control methods for this pest. This pest has the potential to do major damage if it is capable of killing plants in the *Rutaceae* family. NRS will monitor these plants closely and address any new threats. The *M. lydgatei* benefited from ungulate and weed removal in the area. NRS has discontinued ungulate control in this area due to conflicts with illegal hunting. Collections have been made from these plants for five years but none had successfully germinated until this last year. There are now two plants represented by ten individuals at Lyon. Collection and reintroduction will be pursued by NRS in the coming year once a suitable site is identified and we have landowner approval. This species would benefit from large-scale ecosystem protection from fencing and more weed control.

Myrsine fosbergii

Species	Rarity Level	Conservation Potential	TCPL
MYRFOS	2	?	2

This species is known to be uncommon on ridges of cloudswept forest in the Ko`olau Mountains (Wagner 1990). There has been no management for this species despite small population size. No RPMFs have been filled out and it is difficult to estimate the number found on Army lands. A second priority was given to this species to indicate a need for surveys. There are no representatives in cultivation. A large-scale ecosystem fence would address the Medium Ungulate Threat once surveys better determine distribution and threats. There are a significant number of *M. fosbergii* in the Southern Ko`olau Mountains, along the summit ridge. They occur in higher densities there than in the North.

Phlegmariarus nutans

Species	Rarity Level	Conservation Potential	TCPL
PHLNUT	1	1	2

This endangered member of the *Lycopodiaceae* is known only from the Ko`olau Mountains. A new wild individual was found by NRS in KLOA this last year. Medium Threat Levels are recognized and so the species has a Threat Control Priority Level of 2. NRS is surveying for more of these and has collected in an attempt to propagate this species at Lyon. There are gametophytes from these collections at the Lyon Micropropagation Lab. NRS will continue to survey for this species in the coming year. This species has a scattered distribution around the Ko`olau Mountains including several known plants from the windward side. Though few are now known, other botanists estimate many more are undiscovered. NRS will continue collections to better understand cultivation techniques. Joel Lau of HIHNP believes that this species is under-reported and surveys would better determine the population size. This species is difficult to find and will not be the target of many surveys. When found, new locations will be noted on the GIS database.

Phyllostegia hirsuta

Species	Rarity Level	Conservation Potential	TCPL
PHYHIR	3	4	4

P. hirsuta is known from diverse mesic to wet forest in the Ko`olau and Central Wai'anaes (Wagner 1990). This mint is known from 5 sites with 10 individuals in KLOA. There are no High Threat Levels identified for this species, only Medium Threat Levels. Juveniles have been noted in the populations. The Medium Threat Levels are addressed by ecosystem scale removal of pigs and weeds. NRS will continue ecosystem level threat control. There are representatives of the Ko`olau plants at the Pahole nursery. An appropriate ex-situ site should be found to hold mature collections. The proposed Helemano fence would protect several individuals.

Phyllostegia parviflora* var. *parviflora

Species	Rarity Level	Conservation Potential	TCPL
PHYPAR	1	?	2

This variety of *Phyllostegia* was known only from the Ko`olau Mountains (Wagner 1990). Hank Oppenheimer reported a single plant of this species from a survey a few years ago. It was found along the Ko`olau Summit Trail and has not been relocated since. NRS accompanied NTBG botanist Steve Perlman to a population of this species on the windward cliffs of the Ko`olaus just east of the KLOA. About a hundred individuals were found and collections were taken to the Lyon Arboretum for cultivation. NRS will continue to survey for this species, but most of the appropriate habitat may be east of KLOA on the cliffs of the windward side. There are many appropriate areas that remain un-surveyed and a good chance more plants may be found.

Platydesma cornuta* var. *cornuta

Species	Rarity Level	Conservation Potential	TCPL
PLACORCOR	2	4	3

This variety of *Platydesma* was known only from the Ko`olaus (Wagner 1990). This species was considered only a Species of Concern by the USFWS despite estimates of fewer than 200 individuals remaining in the wild. It is now recognized as a Candidate species. NRS will continue to note plant locations in the GIS database and hope to better determine the size, status and threats to this population. Pigs and invertebrates likely threaten this species. NRS has collected from these plants in the past, but none have germinated.

Psychotria hexandra ssp. *oahuensis*

Species	Rarity Level	Conservation Potential	TCPL
PSYHEXOAH	1	4	2

This *Psychotria* sub-species is known only from the Ko`olau Mountains (Wagner 1990). Less than 20 plants are known of this species and it is a Candidate for Endangered Status. One plant is known from KLOA. It was found in March of 1999, and NRS has monitored it twice in the last year. In December 1999, mature fruit was collected and brought to Lyon Arboretum, but none successfully germinated. There are only Medium Threat Levels identified for this species. Ungulate removal in the Lower Pe`ahināi`a MU has benefited this species, but NRS have discontinued control because of conflicts with illegal hunting. Surveying may identify other individuals in KLOA. NRS will continue to collect from this species survey for more and identify any new threats.

Pteris lidgatii

Species	Rarity Level	Conservation Potential	TCPL
PTELYD	2	4	4

This rare fern is known from one site in KLOA. They grow on a stream side cliff next to a waterfall and they have been collected from but no representatives survived. There is much more habitat for this species in the Ko`olau Mountains and surveys would likely turn up more plants. NRS will continue to monitor this population and continue to collect for Lyon. This population is fairly safe from ungulate impacts but other appropriate habitat continues to be degraded by pigs. This species is not targeted for management actions given its high TCPL score. NRS will revisit historic locations for this species in the coming year.

Sanicula purpurea

Species	Rarity Level	Conservation Potential	TCPL
SANPUR	2	3	1

This member of the Apiaceae family is known from wet forest of Maui and O`ahu (Wagner 1990). There are three sites with about 40 individuals in KLOA and less than 200 are known statewide form O`ahu and Maui. There is a High Weed Threat for this species because *Axonopus fisifolius* smothers appropriate habitat in the Ko`olaus. This Threat was assigned a Difficult Threat Manageability Level because of wet weather conditions on the Ko'olau summit and the difficulty of controlling this weed without killing native grasses. Seedlings and juveniles have been found and mature fruit has been germinated easily by NRS. The Medium Ungulate Threat could easily be managed by fencing the populations, however the recommended first priority action is weeding. NRS will continue to collect. Several successful collections have resulted in

an ex-situ stock ready for reintroduction. NRS is considering reintroducing this species with landowner approval if appropriate habitat can be found within the `Ōpae`ula fence.

Stenogyne sherfii

Species	Rarity Level	Conservation Potential	TCPL
STEKAASHE	1	0	1

This species is no longer known from the wild. It was known from mesic forest in the Ko`olau Mountains (Wagner 1990). The one population that NRS monitored was from the Pe`ahināi`a Trail. This population was crashing and material was salvaged from the site by Nellie Sugii from Lyon Arboretum, NRS and Desmond Ogata of the UH Plant Diagnostics Lab. The only known representatives of this species are at the Pahole nursery, Lyon Arboretum and UC Irvine with Steve Weller. Clones have been made of these plants and are growing fast. A reintroduction site will be located and protected so this species can be reintroduced in the winter of 2001-2002. Habitat loss and degradation have limited its distribution, but it is not clear what caused the recent extirpation. NRS believes that Invertebrates were primarily responsible for its demise in the wild and NRS will monitor any reintroductions closely.

Tetraplasandra gymnocarpa

Species	Rarity Level	Conservation Potential	TCPL
TETGYM	2	4	3

This species is known from scattered locations in mesic to wet forest in the Ko`olau Mountains (Wagner 1990). During monitoring, this species showed no High Threat Levels and only 2.5% (5 individuals) of the known trees is found on KLOA. The majority of this species are known from the windward side. They can be found in wet summit and sometimes in mid-elevation mesic forests. These five trees are monitored regularly by NRS. The sites where these trees are found are marginal and the trees have been assigned Medium Ungulate and Weed Threats. This species has a wide and scattered distribution and there are likely more trees to be found. There is no adequate ex-situ stock and these trees are declining throughout their range. *T. gymnocarpa* is not the target for much management given its limited occurrence on Army lands.

Viola kauaensis

Species	Rarity Level	Conservation Potential	TCPL
VIOKAU	?	?	?

The Oahu populations of this *Viola sp.* are found on the summit of the Ko`olau Mountains. They occur in boggy windswept areas around Kaipapa`u. According to the Manual of the Flowering Plants of Hawaii, "The Oahu populations may represent a distinct taxon, but specimens were not available for study." NRS monitored one population of this species in the last year and collected one immature fruit, which was brought to the Lyon Arboretum. NRS will survey for this species when in the area for other management. These populations may be recognized as a distinct species and should be managed as so. In the coming year, NRS hope to better determine population size and range so a TCPL can be defined for those plants on Army land.

Viola oahuensis

Species	Rarity Level	Conservation Potential	TCPL
VIOOAH	2	1	1

This rare species is known from cloudswept summits in wet forest in the Ko`olau Mountains (Wagner 1990). This species is known from 10 sites, all in KLOA. One additional individual was found by NRS in the Poamoho area in the last year. Medium Threat Levels identified for Rats and a High Threat Level for Ungulates. The `Ōpae`ula Watershed Protection Project fence encloses and protects some of these plants. Those plants that were found along the fenceline during surveys have been monitored throughout the fence construction and remain alive. This species is expected to benefit greatly from protection within the fence due to the susceptibility of its habitat to ungulate damage. Weed control focused within the fence will benefit the *Viola* along with other rare species. The proposed Helemano fence would surround and protect many more plants.

Zanthoxylum oahuense

Species	Rarity Level	Conservation Potential	TCPL
ZANOAH	2	4	4

This species was known from mesic to sometimes-wet forest in the Ko`olaus Mountains (Wagner 1990). About 5% of this species, which is only found on O`ahu, are known from KLOA. There are more that ten trees scattered throughout the Training Area and there are estimated to be less than 250 island-wide. It is found in mesic and sometimes up into wet forests. There are no representatives of this species in cultivation. NRS maps locations of this species but it is not targeted for management action due to the low Conservation Potential and lack of High Threat Levels. This species is a Candidate for Endangered Status. This species benefits from ecosystem scale weeding and ungulate removal. The highest density of trees observed by NRS has five mature trees and one juvenile. NRS know of only two sites where more than one tree can be found. Given the scattered distribution of this species, NRS does not expect to see high numbers of seedlings and juveniles in proximity to mature trees.

Table 3-3 Rare Plants Schofield Barracks Military Reservation

Schofield Barracks		Population Size and Distribution						Ex-situ Status									Structure		Threats and Manageability						
Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On Oahu	Ind. On Oahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroduction	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert. Manageability	Weed Threat	Weed Manageability	Ungulate Threat	Ung. Manageability	Rat Threat
Alectryon macrococcus	E	2	28	25	323-328	36	426	Y	0	0	0	0	P	N	0	N	N	N	M	H	N	H	D	M	N	H
Alsinidendron trinerve	E	3	44	3	44	3	44	Y		0	11	1	79	Y	7	Y	Y	Y	L	L		H	D	M	M	L
Cyanea acuminata	E	1	24	15	>1000	15	>1000	N	0	0	0	0	0	N	0	N	N	N	L	H	N	M	D	H	N	H
Cyanea koolauensis	E	3	3	15	>1000	15	>1000	N	0	0	0	0	0	N	0	N	N	N	L	H	N	L	M	H	M	H
Cyrtandra subumbellata	E	2	30	4	<200	4	<200	N	0	0	0	0	3	N	3	N	Y	Y	L	H	N	M	M	M	D	M
Delissea subcordata	E	1	2	10	45	10	45	Y	0	12	0	1	0	Y	100	N	N	N	M	M	D	H	D	H	N	H
Diellia falcata	E	1	50	21	5540-6540	21	5540-6540	N	0	0	0	0	0	N	0	N	N	Y	M	L		H	D	M	E	L
Dubautia sherffiana	SOC	3	10-100	15-20	<250	15-20	<250	N	0	0	0	0	0	N	0	N	N	Y	M	L		H	D	M	N	L
Exocarpus gaudichaudii	SOC	1	1		<250		<250	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	E	L
Fluggea neowawraea	E	1	1	10	31	19	118-142	Y	0	0	0	0	6	N	100	N	N	N	M	H	N	H	D	M	N	M
Gardenia mannii	E	1	3	27	>300	27	>300	N	0	0	0		11	N	33	N	Y	N	M	L		M	M	H	N	M
Hesperomannia arborescens	E	4	55	13+	>1000	13+	>1000	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	H	M	L
Labordia cyrtandrae	E	5	9	7	18	7	18	N	0	0	0	2	199	N	33	Y	N	Y	L	M	D	H	D	M	N	M
Lepidium arbuscula	E	2	20	10	1000	10	1000	N	0	0	0	0	0	N	0	N	N	N	M	L		M	D	M	N	L
Lobelia gaudichaudii koolauensis	E	1	40	4	<150	4	<150	N	0	0	0	0	1	N	2	N	Y	Y	L	H	N	L	E	H	E	H
Lobelia sp.	None	1	2	?	?	?	?	Y	0	0	0	0	0	N	0	N	Y	Y	M	H	N	M	D	H	D	H
Melicope christopherseni	C	1	150		<250		<250	N	0	0	0	0	0	N	0	N	N	Y	M	L		M	M	M	M	L
Melicope cinerea	SOC	2	4		<250		<250	N	0	0	0	0	0	N	0	N	N	N	M	L		M	M	M	N	L
Phlegmariarus nutans	E	1	1	6+	12	6+	12	N	0	0	0	0	P	N	0	N	N	N	L	L		L	E	M	M	L
Phyllostegia hirsuta	E	2	43	16	>400	16	>400	N	0	0	0	0	18	N	2	N	Y	Y	M	L		M	M	M	N	L
Phyllostegia mollis	E	2	2	5	<40	5	<40	Y	0	0	0	4	19/P	N	100	N	N	Y	M	M	D	H	D	M	N	L
Plantago princeps princeps	E	1	20	8	198-248	>8	198-248	Y	0	0	0	0	0	N	0	N	Y	N	M	L		M	D	M	D	L
Platydesma cornuta cornuta	C	1	1	4+	400	<5	400	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	E	L
Platydesma cornuta decurrens	C	3	20		<250		<250	N	0	0	0	0	0	N	0	N	Y	Y	L	L		M	M	H	D	M
Pleomele forbesii	C	1	16		<250		<250	N	0	0	0	0	0	N	0	N	Y	Y	M	L		M	M	M	D	M
Prichardia kaalae	E	1	4	7	222	7	222	Y	9	6	0	0	19	N	50	N	N	N	M	L		H	D	M	M	H
Pteralyxia macrocarpa	C	3	25		<500		<500	N	0	0	0	0	P	N	0	N	N	N	M	L		M	M	M	M	M

Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On Oahu	Ind. On Oahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroduction	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert. Manageability	Weed Threat	Weed Manageability	Ungulate Threat	Ung. Manageability	Rat Threat
Pteris lydgatei	E	1	6	<5	<200	<5	<200	N	0	0	0	0	P	N	0	N	Y	Y	L	L		M	M	M	D	L
Schiedea hookeri	E	1	100	11	<400	11	<400	N	0	0	0	0	0	N	0	N	N	N	M	L		M	M	M	M	L
Sicyos lanceoloidea	SOC	3	4		<50	5	<50	N	0	0	0	0	0	N	0	N	N	Y	M	L		M	M	M	N	L
Tetraplasandra gymnocarpa	E	3	3	15	<200	15	<200	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	M	L
Urera kaalae	E	1	3	9	<25	9	<25	N	0	14	16	0	8	Y	66	Y	N	N	M	M	D	H	D	M	M	L
Viola chamissoniana chamissoniana	E	2	25	6	>350	6	>350	N	0	0	0	0	5	N	3	N	Y	Y	M	L		M	D	M	D	L
Zanthoxylum oahuense	C	1	4		<250		<250	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	M	L

3.9 Schofield Barracks Military Reservation

Alectryon macrococcus

Species	Rarity Level	Conservation Potential	TCPL
ALEMAC	3	4	3

This species was known to be rare and found from mesic to dry forests on O`ahu, Moloka`i, Kaua`i and Maui (Wagner 1990). There are two sites with *Alectryon* in Schofield Barracks. There are around thirty trees in Schofield and no seedlings or juveniles. Recent surveys estimate between 323 and 328 trees on O`ahu and 424 Statewide. Live fire in the SBW has left UXO. Access to the range is restricted to days where no firing is scheduled and certified Ordnance personnel must accompany NRS. Rats are known to predate on the fruit. Controlling rats with bait requires frequent re-stocking and this is not feasible given access restrictions. All trees in the wild are in very poor condition and heavily damaged by the Black Twig Borer. A tree in SBW was collected from and fruit was brought to the Lyon Arboretum. The SBS does not have these access restrictions, however only one tree has been observed fruiting. There are no representatives of Schofield stock ex-situ. The Black Twig Borer can not be controlled at this time and is the largest threat to this species. Weeds are also given a High Threat Level for this species. Range Restrictions prohibit NRS from adequately addressing this threat in SBW. The Ungulate Threat is a Medium for this species. However, due to the presence of UXO fencing is not an option at this time. NRS attempted unsuccessfully to represent this species with vegetative cuttings in the last year. Dr. Richard Criley of the University of Hawaii has been working with NRS to attempt vegetative propagation. Once ex-situ stock is available an appropriate site must be located and prepared for long-term genetic storage of these living ex-situ collections. NRS recommends a site where habitat conditions are met and access for management is relatively easy. An ex-situ collection managed for fruit production would help to ensure the viability of these collections.

Alsinidendron trinerve

Species	Rarity Level	Conservation Potential	TCPL
ALSTRI	1	1	1

There are 44 plants known from Army land in the Mt. Ka`ala area. These plants have High Threat Levels for Weeds and a Medium for Ungulates. Seedlings and juveniles have been found at these sites and 7% are represented ex-situ. The High Weed Threat Level was given because of the presence of blackberry (*Rubus argutus*). These plants are monitored by NRS and threats will be watched carefully. NRS has helped the State NARS staff reintroduce ten plants into the Mt. Ka`ala NAR in the last year. The Lyon Micropropagation Lab has about 80 individuals and they will eventually be reintroduced into a protected area on Mt. Ka`ala. The plants located between Ka`ala and Pu'u Kalena are more threatened by goats and may have to be fenced if goat control in the area does not significantly lessen the threat to this species. There is more appropriate habitat for this species and more may be found in surveys. NRS has been storing populations with Alvin Yoshinaga at Lyon for long-term seed storage. Alvin has had positive results with storing this species frozen as has representatives from several wild plants. NRS will continue to collect from these plants to ensure complete ex-situ representation from all known mature wild individuals.

Cyanea acuminata

Species	Rarity Level	Conservation Potential	TCPL
CYAACU	4	4	4

There are twenty-four plants with no seedlings or juveniles found in Schofield Barracks. This is a fraction of the greater than a thousand plants found statewide and this population will not be the target of prioritized management. As a member of the Campanulaceae, this species is thought to be highly susceptible to ungulate and slug damage and was given High Threat Levels for both Invertebrates and Ungulates. This species has a lower priority due to the high number of individuals found off Army lands.

Cyanea koolauensis

Species	Rarity Level	Conservation Potential	TCPL
CYAKOO	4	4	4

This member of the Campanulaceae is known from SBE. There are two individuals known and they have High Threat Levels for Ungulates, Rats and Invertebrates. These populations are not being intensively managed because they represent such a small amount of those known statewide. They benefit from ungulate and weed removal in the area and are monitored by NRS.

Cyrtandra subumbellata

Species	Rarity Level	Conservation Potential	TCPL
CYRSUB	2	4	4

This *Cyrtandra* species was and still is known only from the North and Central Ko`olau Mountains. It is rare in moist, gulch bottoms and ridges near the summit and the leeward and windward side (Wagner 1990).There are thirty known plants in Schofield with seedlings and juveniles. There are representatives of 15% of this population ex-situ at Lyon. With a Threat Control Priority Level 4, there will be little management action for this species. NRS recently accompanied botanists from the NTBG and HINHP to a large population of *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 Army's portion of plants less significant.

Delissea subcordata

Species	Rarity Level	Conservation Potential	TCPL
DELSUB	1	4	1

This very rare member of the Bellflower family was known only from O`ahu, in the Wai`anae and Ko`olau Mountains. It is not known from the Ko`olaus today (Wagner 1990). It is found in SBW and has High Threat Levels from Rats, Weeds and Ungulates. There are two individuals in this population and no seedlings or juveniles. There are 44 of these plants known statewide. Restricted Access limits the management options available to NRS. NRS has visited this population four times in the last year and had recommended fencing it due to the high incidence of pig sign in the area. There were three individuals known as recently as 15 March 2001 when

NRS was scoping a proposed pig exclosure around the *Phyllostegia mollis* and the *Delissea subcordata*. When NRS monitored both species again in July 2001, one plant of both species had been uprooted and trampled by pigs. The *Delissea* had been toppled over and decapitated. This is most likely pig damage as there was lots of fresh tracks and feces all around the plants. The trunk of the plant was found a few meters down-slope and was collected and brought to the Micropropagation Lab at Lyon. At this time the plant is sending out shoots from several of the cuttings. No fencing can be built to decrease the Ungulate Threat Level. Limited access restricts the weed control that could be done. NRS expects to be able to fence this population within the coming year pending approval from the Range Division and Safety office. Damage from mites and other arthropods has been observed by NRS and confirmed by U.H. Plant Diagnostics. This poses a non-lethal and therefore Medium threat and would be difficult to control with insecticides. NRS will monitor this population for fruit and attempt rat control to promote mature fruit production if permitted by access restrictions. If fruit matures it will be collected to protect against slugs and propagated and stored ex-situ. If this population is fenced, NRS may try to augment it with ex-situ stock. A couple dozen individuals at the Army nursery and Lyon represent both of the remaining wild plants.

Diellia falcata

Species	Rarity Level	Conservation Potential	TCPL
DIEFAL	4	4	5

This rare fern species is known from one population in SBS. Only 6 individuals are known from this site, which very small percentage of the over 6000 known statewide. There is a High Weed Threat Level indicated for this species in SBS. Weed control will not be prioritized for this species because of the very low Conservation Potential Index (2.5%). Ungulate control would help to stabilize this population and prevent further habitat degradation but is not prioritized for now.

Dubautia sherffiana

Species	Rarity Level	Conservation Potential	TCPL
DUBSHE	2	4	4

This Aster is known only from the Wai'anae Mountains Wagner 1990). This species is known from SBW. There are 24 plants known from two locations. There is a High Weed Threat identified for this species. Goats are not yet a threat to this population but would be if they got there. Goats are currently being controlled along the northern boundary of the SBW in an effort to stop their ingress onto Army property. Goats also threaten the SBW from the southwest side and are proposed for control within the next year. Since it has a low priority it will not be the target of management actions, however benefits from large-scale removal of ungulates and weeds.

Exocarpus gaudichaudii

Species	Rarity Level	Conservation Potential	TCPL
EXOGAU	2	4	3

This species is known to be uncommon and scattered from mesic to wet forest on all the major island except Kaua'i (Wagner 1990). This species received the lowest priority level for

Schofield. There is only one individual known from SBE. There are no High Threat Levels identified for this species, and there are none in cultivation. This tree has a scattered distribution making it hard to accurately estimate population size, range and biology. More must be understood about this species for better management. NRS will monitor this species more closely in the coming year.

Fluggea neowawraea

Species	Rarity Level	Conservation Potential	TCPL
FLUNEO	2	4	3

This species is one of the rarest trees in Hawaii. It was known from all the major islands. On O'ahu it is known from the Wai'anae Mountains (Wagner 1990). One tree is known from SBW. Throughout their range *Fluggea* are heavily damaged and in very poor condition due to the Black Twig Borer. Most trees are actually mature root suckers from very old trees. This plant is very damaged by the Black Twig Borer and carries a High Invertebrate Threat. Weeds also have a High Threat Level in SBW for this species. The Medium Invertebrate Threat can not be decreased because fencing can not be done in SBW at this time. NRS took eight cuttings from this tree and they are still alive but have not developed roots at the Lyon Arboretum. NRS will work with researchers and horticulturists from the University to develop vegetative propagation methods. This individual is in very poor condition and may be getting close to its last days. It has fallen down and new suckers are available for collection. NRS will likely continue to collect from this individual for cultivation trials.

Gardenia mannii

Species	Rarity Level	Conservation Potential	TCPL
GARMAN	3	4	5

This *Gardenia* species is known to be uncommon from mesic to wet forest on O'ahu (Wagner 1990). There are three *Gardenia* known from SBW. There are about 300 known from O'ahu total. The plants in SBW are the only known from the Wai'anae Mountains. A High Threat Level was identified for Ungulates though juveniles and seedlings have been found in the patch. The ungulate threat can not be decreased due to UXO restrictions against fencing. NRS may be able to fence in SBW in the coming year. Ex-situ collections from these trees are doing well at Lyon and Pahole. NRS may augment this population with ex-situ stock with Army approval.

Hesperomannia arborescens

Species	Rarity Level	Conservation Potential	TCPL
HESARB	4	4	4

This species was known from O'ahu, Moloka'i and Lāna'i. It is apparently extinct on Lāna'i and now rare on other islands (Wagner 1990). There are 46 known plants from Schofield. They are found in three sites and High Ungulate Threat Levels have been identified. This species benefits from ungulate removal in the area. There are juveniles and seedlings in these populations with a relatively large number of mature plants. Since these populations are relatively stable, they have low management priority.

size and distribution and tell NRS how much Army conservation efforts will help the species as a whole.

Pleomele forbesii

Species	Rarity Level	Conservation Potential	TCPL
PLEFOR	2	2	1

There are a few individuals of this species found in SBS. There are no High Threat Levels identified for this species and it will not be the target of management. This species does benefit from weeding in the MU. There has been no collection of this species for ex-situ cultivation. In an effort to better estimate population size and range NRS has been surveying for this species in the last year. Surveys indicate that there may be as little as 250 individuals left in the wild. NRS will continue to note locations in the GIS database.

Pritchardia kaalae

Species	Rarity Level	Conservation Potential	TCPL
PRIKAA	2	2	1

This species is known only from the Wai`anaes having an estimated 222 individuals. There are trees in Mākua, Makaleha, Lower Ka`ala and these trees located on the boundary of SBW and Wai`anae Kai Watershed Protection Area. NRS has been monitoring these trees and collections have been made and brought to Lyon and the Army facility. There were thought to be only three trees at this location. In May 2001, NRS rappelled below the known trees and located another seven individuals including six juveniles. Collections were again taken to Lyon where there are two representatives from two of the trees. Both Weeds and Rats are identified as having High Threat Levels for this species in SBW. NRS may consider rat control around these trees to promote recruitment. The Mākua population of this species is well-represented ex-situ and will be reintroduced in the next year. NRS will consider securing a location for reintroduction of stock from SBW as well.

Pteralyxia macrocarpa

Species	Rarity Level	Conservation Potential	TCPL
PTEMAC	3	4	4

This species is found scattered in diverse mesic forest on O`ahu. There are a couple dozen trees in SBW and SBS. There is a Medium Ungulate and Vertebrate threat identified for this species. Ecosystem scale removal of goats in this area will benefit this species. Fencing is not an option at this time given the UXO in SBW. Fencing for SBS is not yet being considered, as goats have not been seen in the area. Large-scale rat control would benefit this species. NRS is participating in a Toxicant Working Group to encourage legal methods of broadcasting bait to control rats on an ecosystem level. NRS has been monitoring a group of trees in Mākua for years as there are many tree snails nearby. In the last year, seedlings have been found below the patch. NRS suspects that rat control aimed at reducing the rat threat to snails may have benefited the *Pteralyxia*. NRS will monitor these trees to better determine threats and possible control methods.

Pteris lydgatei

Species	Rarity Level	Conservation Potential	TCPL
PTELYD	2	4	5

There is one population of this rare fern in SBE. Since it represents such a small percentage of those known statewide, it is not the target of any management actions. There is much more habitat for this species in the Ko'olau Mountains and surveys would likely turn up more plants. NRS will continue to monitor this population and continue to collect for Lyon. This population is fairly safe from ungulate impacts but other appropriate habitat continues to be degraded by pigs.

Sicyos lanceoloidea

Species	Rarity Level	Conservation Potential	TCPL
SICLAN	1	4	2

This species is known from three sites in SBW and there are none in cultivation from this area. This species would benefit from ecosystem management such as weeding and fencing. However, restrictions in SBW limit management options. This species is increasingly rare, there are estimated to be less than fifty individuals in the wild. NRS will try to monitor these plants as access allows. This species is only a Species of Concern, but should receive more protection. NRS will attempt to collect for seed storage in the next year.

Schiedea hookeri

Species	Rarity Level	Conservation Potential	TCPL
SCHHOO	3	3	4

This species was known from the Central and Northern Wai'anaes. It is described as being scattered and locally common in diverse mesic forests (Wagner 1990). This species is found in SBW and there are no High Threat Levels. There are estimated to be about 400 individuals on O'ahu. There is no management prioritized for this species and UXO restricts the large-scale management options available to NRS. Ungulates are being controlled in SBW and weeds are controlled on a small scale when possible. Goat control will be expanded next year offering more protection for these plants. Surveys in the last year by NRS indicated that there were a hundred more plants that previously known from that area. This significantly raised the Conservation Potential for that population, where those plants represent about a quarter of the known individuals in the wild.

Tetraplasandra gymnocarpa

Species	Rarity Level	Conservation Potential	TCPL
TETGYM	2	4	3

This species was known from scattered locations in mesic to wet forest in the Ko'olaus (Wagner 1990). There are three known individuals of this species and no High Threat Levels. This species is not the target of management actions given its low Conservation Potential and having only Medium Threats. Large-scale ecosystem level removal of pigs and weeds will benefit this species in SBE. The majority of this species are known from the windward side. They can be found in wet summit to sometimes mid-elevation mesic forests. The trees are monitored

Medium Ungulate and Weed Threats. This species has a wide and scattered distribution and there are likely more trees to be found. There is no adequate ex-situ stock and these trees are declining throughout their range.

Urera kaalae

Species	Rarity Level	Conservation Potential	TCPL
UREKAA	1	4	1

This species was known to be rare on slopes gulches in the south and central windward Wai'anaes (Wagner 1990). It is found on SBS. There are three trees and they have been monitored by NRS for nearly six years. Mature fruit have been collected from two of the three trees and Lyon and the Army are growing representatives of 66% of the population. Three plants were introduced into SBS and are doing well. The wild trees are declining rapidly in the wild and must be monitored closely. Over 150 plants are being grown ex-situ and will provide the stock for reintroduction, once suitable sites are found and protected. This species has a High Weed Threat in SBS. The Nature Conservancy's Honouliuli Preserve is just south of Army land on the windward side of the Wai'anae s. The *Urera* found on Army land is part of a larger population that crosses the boundary and exists on the Preserve. NRS has cooperated with them to reintroduce plants collected from Army lands onto their Preserve to encourage gene flow between these fragmented populations. More individuals collected from the Army plants are being held ex-situ. NRS recommends that a suitable reintroduction site be found where the habitat is appropriate and access for management easy. A population should be managed for seed production to conserve the lingering diversity represented by these last wild individuals. An accessible population where threats could be controlled with fencing and insect control would help to recover this crashing species.

Viola chamissoniana chamissoniana

Species	Rarity Level	Conservation Potential	TCPL
VIOCHACHA	3	1	1

This rare violet sub-species was known to be rare on dry cliffs in the Wai'anaes (Wagner 1990). Plants were relocated in SBS in 2000. On SBW, the population on Pu'u Kumakali'i has been monitored by NRS. These only represent a fraction of those known statewide. Most are known from Mākua. There are seedlings and juveniles in this population. Six plants representing one plant from the population are ex-situ at Lyon. There are no High Threat Levels identified for this population. The Medium Ungulate Threat is being addressed by participating in an inter-agency working group targeting goat populations in the Wai'anae Mountains. Other landowners are being encouraged to assess and control goat populations. Goats have not yet been observed where the *Viola* is found.

Zanthoxylum oahuense

Species	Rarity Level	Conservation Potential	TCPL
ZANOAH	2	4	3

This species was known from mesic to sometimes-wet forest in the Ko'olaus(Wagner 1990). This species is known from the Schofield-Waikāne Trail in SBE. There are three trees known from Schofield and probably more out there. There are no High Threat Levels identified for this

species on SBE and it is not the target of management actions. It does benefit from ecosystem level management of pigs and weeds. There are estimated to be less than 250 island-wide. It is found in mesic and sometimes up into wet forest. There are no representatives of this species in cultivation. NRS maps locations of this species but it is not targeted for management action due to the low Conservation Potential and lack of High Threat Levels. Also, this species is only a Candidate for Endangered Status. This species benefits from ecosystem scale weeding and ungulate removal. There are no juveniles or seedlings found around these trees. These trees have scattered distributions and may disperse most of their seeds far from the mother plant. This also may indicate some ubiquitous threat affecting all trees preventing recruitment around the mother trees.

Table 3-4 Kahuku Training Area

Kahuku Training Area	Status	Population Size and Distribution						Ex-situ Status									Structure		Threats and Manageability							
Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On Oahu	Ind. On Oahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroductions	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert. Manageability	Weed Threat	Weed Manageability	Ungulate Threat	Ung. Manageability	Rat Threat
Bobea timonioides	SOC	1	1	15+	<250	15+	<250	N	0	0	0	0	0	N	0	N	?	?	M	L		M	M	M	E	M
Eugenia koolauensis	E	6	200+	>6	350	>6	350	Y	0	0	3	0	P	Y	0.5	N	Y	Y	H	L		H	M	M	E	M
Tetraplasandra gymnocarpa	E	5	4	15	<200	15	<200	N	0	0	0	0	0	N	0	N	N	N	L	L		M	M	M	M	L

3.10 Kahuku Training Area

Bobea timonioides

Species	Rarity Level	Conservation Potential	TCPL
BOBTIM	2	4	3

This species is known from dry to sometimes-mesic forests from Hawaii, Maui, O`ahu and Kaua`i (Wagner 1990). There is one known individual in KTA, so this species has a low Conservation Potential (1.2%). This species is a Species of Concern, but warrants more surveys and perhaps protection given the threats and known population size. There are no juveniles or seedlings known in KTA. NRS will map this species when found to better assess population size and structure. MUs must be surveyed and defined in KTA.

Eugenia koolauensis

Species	Rarity Level	Conservation Potential	TCPL
EUGKOO	3	2	1

This species was known from dry gulches and slopes on O`ahu and Moloka`i (Wagner 1990). Over 65% of the *Eugenia* known statewide are found in KTA. There are seedlings and juveniles found in the population and there are two High Threat Levels identified for this species in KTA for Fire and Weeds. The High Fire Threat is due to military and public use of the range. In the last year, 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. Native trees and shrubs burned in the fire including koa (*Acacia koa*), iliahi (*Santalum frecinetianum*), and ohi'a (*Metrosideros polymorpha*). The proximity of the fire to the *Eugenia* was alarming. The High Weed Threat is from the presence of *Ardisia elliptica* in the populations. NRS have spent hours weeding in these populations to promote in-situ recruitment. The Medium Ungulate Threat could be easily controlled with small fences around the populations. This species may be susceptible to rat predation. NRS will monitor these populations, collect seed for long-term storage and note any new threats. MUs must be surveyed and defined in KTA.

Tetraplasandra gymnocarpa

Species	Rarity Level	Conservation Potential	TCPL
TETGYM	2	4	3

This species was known from scattered locations in mesic to wet forest in the Ko`olaus (Wagner 1990). The majority of this species are known from the windward side. They can be found in wet summit to sometimes mid-elevation mesic forests(Wagner 1990). There are a few individuals known from the summit region of KTA. Joel Lau of the HINHP from reported these trees before 1995. NRS has yet to monitor them. NRS familiar with the area and Mr. Lau defined the threat levels. This species has a wide and scattered distribution and there are likely more trees to be found. There is no adequate ex-situ stock and these trees are declining throughout their range. NRS will monitor these trees in the coming year and collect for storage. MUs must be surveyed and defined in KTA.

Table 3-5 Dillingham Military Reservation

Dillingham Military Reservation		Population Size and Distribution						Ex-situ Status									Structure		Threats and Manageability							
Species	Federal Status	Pop. On T.A.	Ind. On T.A.	Pop. On Oahu	Ind. On Oahu	Pop. In State	Ind. In State	Coll LFY	#Pahole	#Army	# Botanical Gardens	Lyon Greenhouse	Lyon Micropropagation	Seed Storage	% Represented Ex-situ	Reintroductions	Seedlings	Juveniles	Fire	Invertebrate Threat	Invert. Manageability	Weed Threat	Weed Manageability	Ungulate Threat	Ung. Manageability	Rat Threat
Schiedea kealiae	E	1	10	4	200-300	4	200-300	N	0	0	0	0	0	N	0	N	Y	Y	M	L		H	D	M	D	L

3.11 Dillingham Military Reservation

Schiedea kealiae

Species	Rarity Level	Conservation Potential	TCPL
SCHKEA	2	4	4

This species was found only in the Wai`anae Mountains in *Sapindus* forest on steep cliffs and ledges (Wagner 1990). There is one population with about 10 mature individuals in DMR. There were seedlings and juveniles found in the population in February 2001, but there is a High Weed Threat. The weeds would be difficult to control being on a cliff. Ex-situ collections of this species exist at Waimea Botanical Garden but none from this population. Even though this population has a TCPL of 4, NRS hopes to collect for seed storage this year.

3.12 Omitted Species

Hibiscus kokio ssp. *kokio*

This subspecies is known from O`ahu, Moloka`i, Maui, Kaua`i and Hawaii (Wagner 1990). One tree of this subspecies is found just on the boundary between DMR and the Mokulē`ia Forest Reserve. No juveniles or seedlings have been found at this population. There is a High Threat from Weeds. This species benefits from the large-scale removal of weeds from the area. NRS has collected cuttings from this tree in the last year. Plants are now growing at Pahole and Lyon. NRS will work with State NARS staff and Lyon Arboretum to cultivate this species and secure an appropriate site to keep stock. NRS has omitted this species from analyses this year because it is not a listed Endangered species and has more than 250 known individuals. Most of the individuals are on Kaua`i. There are also two trees known from KLOA. These plants may have been planted as no more are known from O`ahu.

3.13 Schedule of Recommended Actions

For those species with Threat Control Priority Levels of 1,2, and 3, management actions have been identified to address the High Threats. Below is a schedule of management actions to address the High Threats identified for those species and other scheduled management.

Table 3-6 Recommended Actions

Range	MU	Action	Q4	Q1	Q2	Q3	RP P
DMR	DMR	Schkea- Collect/Store	X				P4
KLOA	Kahuku Cabin	Cyacri- Collect/Store	X	X	X		P1
KLOA	Kahuku Cabin	Cyacri- Contact Kam. Schools re: Reintroduction	X	X	X		P1
KLOA	Kahuku Cabin	Cyacri- Monitor	X	X	X	X	P1
KLOA	Kahuku Cabin	Cyacri- Scope reintroduction site			X		P1
KLOA	KLOA	Sanpur- Monitor/Collect/Store	X				P1
KLOA	KLOA	Melhii- Survey/Map		X		X	P2
KLOA	KLOA	Myrfos- Survey/Map		X		X	P2
KLOA	KLOA	Phlnut- Monitor/Collect			X	X	P2
KLOA	KLOA	Phlnut- Survey/Map	X	X	X	X	P2
KLOA	KLOA	Placorcor- Survey/Map	X	X	X	X	P3

Table 3-6 Recommended Actions Continued

KLOA	KLOA	Tetgym- Survey/Map	X	X	X	X	P3
KLOA	KLOA	Tetgym- Monitor for structure	X	X	X	X	P3
KLOA	Lower Pe`ahināi`a	Mellyd- Monitor/Collect/Store	X	X	X	X	P1
KLOA	Lower Peahinaia	Mellyd- Monitor for Invertebrate Threat	X	X	X	X	P1
KLOA	Lower Pe`ahināi`a	Mellyd- Scope fencing		X	X		P1
KLOA	Lower Pe`ahināi`a	Stekaashe- Contact Kam. Sch. Re: reintroduction	X				P1
KLOA	Lower Pe`ahināi`a	Stekaashe- Scope site for Winter 2001 reintroduction	X				P1
KLOA	Lower Pe`ahināi`a	Stekaashe- Survey		X		X	P1
KLOA	Lower Pe`ahināi`a	Stekaashe- Reintroduce	X				P1
KLOA	Lower Pe`ahināi`a	Stekaashe- Monitor old wild site	X	X			P1
KLOA	Lower Pe`ahināi`a	Stekaashe- Monitor Reintroductions	X	X	X	X	P1
KLOA	Lower Pe`ahināi`a	Psyhexoah- Monitor/Survey/Collect/Store	X	X	X	X	P2
KLOA	Upper Pe`ahināi`a	Cyastj- Monitor for fruit/collect/store/propagate			X		P1
KLOA	Upper Pe`ahināi`a	Cyrvir- Collect for Storage trials			X	X	P1
KLOA	Upper Pe`ahināi`a	Cyrvir- Monitor		X		X	P1
KLOA	Upper Pe`ahināi`a	Lobgaugau- Monitor/Collect/Store	X	X		X	P1
KLOA	Upper Pe`ahināi`a	Sanpur- Get #'s from Maui population	X				P1
KLOA	Upper Pe`ahināi`a	Sanpur- Scope Reintroduction site	X	X			P1
KLOA	Upper Pe`ahināi`a	Sanpur- Collect/Store	X			X	P1
KLOA	Upper Pe`ahināi`a	Sanpur- Reintroduce into `Ōpae`ula fence		X			P1
KLOA	Upper Pe`ahināi`a	Viooah- Monitor/Collect/ Store	X			X	P1
KLOA	Upper Pe`ahināi`a	Viooah- Scope Helemano fence	X	X			P1
KLOA	Upper Pe`ahināi`a	Phypar- Revisit Hanks area/Survey/Map	X		X		P2
KLOA	Upper Pe`ahināi`a	Exogau- Survey/Map	X	X	X	X	P3
KLOA	Upper Pe`ahināi`a	Zanoah- Survey/Map	X	X	X	X	P3
KTA	KTA	Eugkoo- Collect/Store		X		X	P1
KTA	KTA	Eugkoo- Monitor for rat damage				X	P1
KTA	KTA	Eugkoo- Define MUs		X	X		P1
KTA	KTA	Eugkoo- Discuss Training Restrictions with ITAM		X	X		P1
KTA	KTA	Eugkoo- Weed control				X	P1
KTA	KTA	Bobtim- Define MUs		X	X		P3
KTA	KTA	Tetgym- Survey/Map		X		X	P3
MMR	Kahanahāiki	Alsobo- Monitor/Collect/Store Reintroductions			X	X	P1
MMR	Kahanahāiki	Alsobo- Monitor/Expand Slug control trials		X		X	P1
MMR	Kahanahāiki	Alsobo- Work with NARS to Reintroduce Pahole stock	X	X			P1
MMR	Kahanahāiki	Alsobo- Monitor Makaleha population	X	X	X	X	P1
MMR	Kahanahāiki	Alsobo- Supplement Reintroductions with new stock	X	X			P1
MMR	Kahanahāiki	Cenagragr- Monitor/Weed control	X	X	X	X	P1
MMR	Kahanahāiki	Cenagragr- Determine Rat/Invert Threat	X	X	X	X	P1
MMR	Kahanahāiki	Cenagragr- Weed Ironwoods/Plant Koa	X	X			P1
MMR	Kahanahāiki	Cenagragr- Monitor Reintroductions		X		X	P1
MMR	Kahanahāiki	Cyasup- Collect MMR-A-3 for storage/propagation	X	X			P1
MMR	Kahanahāiki	Cyasup- Seed sow with slug control		X	X		P1
MMR	Kahanahāiki	Cyasup- Monitor wild population		X		X	P1
MMR	Kahanahāiki	Cyasup- Monitor Reintroduced populations	X		X		P1

Table 3-6 Recommended Actions Continued

MMR	Kahanahāiki	Cyasup- Rat control at MMR-A-3	X	X			P1
MMR	Kahanahāiki	Cyasup- Determine site for older stock	X	X			P1
MMR	Kahanahāiki	Cyasup- Assist NARS with rat control and Collection for Storage	X	X			P1
MMR	Kahanahāiki	Cyasup- Retag NARS Reintroductions	X	X			P1
MMR	Kahanahāiki	Cyasup- Replicate stock for Lyon and Pahole	X	X			P1
MMR	Kahanahāiki	Delsub- Experimental Use Permit for slug control	X	X	X	X	P1
MMR	Kahanahāiki	Delsub- Monitor Reintroductions and wild	X		X		P1
MMR	Kahanahāiki	Delsub- Collect for genetic study			X	X	P1
MMR	Kahanahāiki	Delsub- Collect/Store Reintroductions		X			P1
MMR	Kahanahāiki	Schnutnut- Contact Steve Weller re: Invert. Threat	X	X			P1
MMR	Kahanahāiki	Schnutnut- Investigate Arthropod control	X	X			P1
MMR	Kahanahāiki	Schnutnut- Monitor/Collect/Store/Propagate		X	X	X	P1
MMR	Kahanahāiki	Schnutnut- Rehabilitate wild population with Koa		X		X	P1
MMR	Kahanahāiki	Schnutnut- Monitor/Collect/Store Reintroduced	X	X	X	X	P1
MMR	Kahanahāiki	Alemac- Monitor	X	X	X	X	P3
MMR	Kahanahāiki	Bobtim- Monitor/Collect/Store		X		X	P3
MMR	Kahanahāiki	Bobtim- Get Pop. Estimates from Joel		X	X		P3
MMR	Kaluakauila	Bobsan- Collect/Store			X	X	P3
MMR	Kaluakauila	Bonmen- Collect/Store	X		X	X	P3
MMR	Kaluakauila	Bonmen- Weed Control			X	X	P3
MMR	Kaluakauila	Euphae- Collect/Store	X			X	P4
MMR	Kaluakauila	Euphae- Monitor for Seedlings	X	X	X	X	P4
MMR	Kaluakauila	Euphae- Retag	X				P4
MMR	Kaluakauila	Euphae- Rat control	X	X	X	X	P4
MMR	Kaluakauila	Euphae- Monitor Reintroduced		X		X	P4
MMR	Kaluakauila	Euphae- Augment Reintroduction	X	X			P4
MMR	Kaluakauila	Euphae- Grass control			X	X	P4
MMR	Kaluakauila	Euphae- Cut fenceline	X				P4
MMR	Kaluakauila	Lipten- Collect/Store			X	X	P4
MMR	Kaluakauila	Nothum- Collect/Store			X	X	P4
MMR	Kaluakauila	Plefor- Survey/Map	X	X	X	X	P4
MMR	Kaluakauila	Schhoo- Collect/Store			X		P4
MMR	Lower Mākua	Nerangden- Survey with Ken Wood		X	X	X	P1
MMR	Lower Mākua	Alemac- Monitor/Collect/Propagate/Storage Trials		X	X	X	P3
MMR	Lower Mākua	Alemac- Rat control	X	X	X	X	P3
MMR	Lower Mākua	Bobsan- Survey/Map		X	X		P3
MMR	Lower Mākua	Fluneo- Monitor/Collect/Investigate Hort. Techniques		X	X	X	P3
MMR	Lower Mākua	Fluneo- Invertebrate Threat Control		X		X	P3
MMR	Lower Mākua	Fluneo- Collect Pollen from Makaleha	X			X	P3
MMR	Lower Mākua	Fluneo- Hand Pollinate	X				P3
MMR	MMR	Hibbramok- Monitor/Collect/Store	X	X	X	X	P1
MMR	MMR	Hibbramok- Weed Control	X	X	X	X	P1
MMR	MMR	Hibbramok- Work with Range to extend grass cutting area					P1
MMR	MMR	Hibbramok- Redefine Biologically Significant Areas	X	X			P1

Table 3-6 Recommended Actions Continued

MMR	MMR	Hibbramok- Reintroduce	X	X			P1
MMR	MMR	Lipten- Monitor/Collect/Store/Propagate	X	X			P1
MMR	MMR	Nerangang- Monitor/Collect/Store	X	X	X	X	P1
MMR	MMR	Nerangang- Survey		X		X	P1
MMR	MMR	Chacelkae- Weed Control	X	X	X	X	P3
MMR	MMR	Chacelkae- Survey	X	X	X	X	P3
MMR	MMR	Chacelkae- Collect/Store	X	X	X	X	P3
MMR	`Ōhikilolo	Dubher- Monitor/Collect/Store		X	X		P1
MMR	`Ōhikilolo	Hedpar- Locate new population	X	X			P1
MMR	`Ōhikilolo	Hedpar- Monitor/Collect/Store		X		X	P1
MMR	`Ōhikilolo	Hedpar- Kill Blackberry	X	X			P1
MMR	`Ōhikilolo	Prikaa- Rat control	X	X	X	X	P1
MMR	`Ōhikilolo	Prikaa- Scope reintroduction site	X				P1
MMR	`Ōhikilolo	Prikaa- Reintroduce	X	X			P1
MMR	`Ōhikilolo	Prikaa- Track Seedlings	X	X	X	X	P1
MMR	`Ōhikilolo	Prikaa- Monitor/Collect from Underrepresented	X	X	X	X	P1
MMR	`Ōhikilolo	Prikaa- Weed	X	X	X	X	P1
MMR	`Ōhikilolo	Sanmar- Monitor/Collect/Store	X	X			P1
MMR	`Ōhikilolo	Sanmar- Monitor Seed Sow	X	X			P1
MMR	`Ōhikilolo	Sanmar- Plan for Ex-situ stock	X				P1
MMR	`Ōhikilolo	Sanmar- Monitor Weed control	X	X	X		P1
MMR	`Ōhikilolo	Tetfil- Collect/Store	X	X		X	P1
MMR	`Ōhikilolo	Viochacha- Monitor/Collect/Store	X	X	X	X	P1
MMR	`Ōhikilolo	Melmak- Survey/Map/Collect for Germination trial		X	X		P3
MMR	`Ōhikilolo	Alemac- Monitor	X	X	X		P3
MMR	`Ōhikilolo	Dubshe- Monitor	X	X			P3
MMR	`Ōhikilolo	Plapripri- Monitor/Collect/Store	X		X		P3
MMR	`Ōhikilolo	Plefor- Survey/Map		X			P?
MMR	`Ōhikilolo	Sillan- Collect/Store				X	P4
MMR	`Ōhikilolo	Spehaw- Collect/Store		X			P5
SBMR	Banana/Water	Labcyr- Monitor/Collect/Store		X	X		P1
SBMR	Banana/Water	Labcyr- Survey				X	P1
SBMR	Banana/Water	Labcyr- Weed Control			X	X	P1
SBMR	Banana/Water	Labcyr- Monitor Reintroduced		X		X	P1
SBMR	Banana/Water	Lobelia sp.- Collect/Store/ Propagate for taxonomy	X				P1
SBMR	Banana/Water	Lobelia sp.- Survey	X	X			P1
SBMR	Banana/Water	Lobelia sp.- Scope Weed Control	X	X			P1
SBMR	Banana/Water	Lobelia sp.- Contact Lammers	X				P1
SBMR	Banana/Water	Placordec- Survey/Map	X	X	X	X	P1
SBMR	Banana/Water	Siclan- Survey/Map	X	X	X	X	P2
SBMR	Banana/Water	Siclan- Consider fencing	X	X	X	X	P2
SBMR	Banana/Water	Siclan- Monitor/Collect/Store	X	X	X	X	P2
SBMR	Banana/Water	Melcin- Survey/Map/Collect for Germination Trials				X	P4
SBMR	Banana/Water	Plapripri- Monitor/Collect/Store	X				P4
SBMR	Hāpapa	Phymol- Monitor/Collect/Store			X		P1

Table 3-6 Recommended Actions Continued

SBMR	Hāpapa	Phymol- Consider Augmentation	X	X			P1
SBMR	Hāpapa	Urekaa- Monitor/Collect/Store	X			X	P1
SBMR	Hāpapa	Urekaa- Reintroduce with TNCH	X	X			P1
SBMR	Hāpapa	Urekaa- Monitor reintroductions/Remove fences?	X	X			P1
SBMR	Hāpapa	Alemac- Invertebrate Control Trials	X				P3
SBMR	Hāpapa	Alemac- Monitor/Collect for propagation trials	X	X			P3
SBMR	Kalena/Ka`ala	Alstri- Collect/Store		X	X		P1
SBMR	Kalena/Ka`ala	Alstri- Monitor wild populations(Kalena)for Ung. Threats		X	X		P1
SBMR	Kalena/Ka`ala	Alstri- Monitor Reintroductions/Rat control?		X		X	P1
SBMR	Kalena/Ka`ala	Alstri- Reintroduce on State land		X			P1
SBMR	Kalena/Ka`ala	Labcyr- Monitor/Collect/Store		X	X		P1
SBMR	Kalena/Ka`ala	Labcyr- Monitor Reintroductions		X		X	P1
SBMR	Kalena/Ka`ala	Labcyr- Survey	X		X		P1
SBMR	Kalena/Ka`ala	Melchr- Survey/Map/Collect for propagation trials				X	P2
SBMR	Kalena/Ka`ala	Prikaa- Monitor/Collect/Store/Restock bait	X	X	X	X	P4
SBMR	Kalena/Ka`ala	Prikaa- Survey below for more		X			P4
SBMR	Kalena/Ka`ala	Viochacha- Monitor/Collect/Store	X		X	X	P4
SBMR	Kamaohanui	Lobelia sp.- Collect/Store/Propagate for Taxonomy	X				P1
SBMR	Kamaohanui	Lobelia sp.- Survey	X	X			P1
SBMR	Kamaohanui	Lobelia sp.- Scope Weed Control	X	X			P1
SBMR	Kamaohanui	Lobelia sp.- Contact Lammers	X				P1
SBMR	Kamaohanui	Garman- Monitor/Scope fence?		X		X	P5
SBMR	Kumakalii	Viochacha- Collect/Monitor/Store	X			X	P2
SBMR	Mohiākea	Delsub- Collect/Store			X	X	P1
SBMR	Mohiākea	Delsub- Fence construction	X				P1
SBMR	Mohiākea	Delsub-Monitor and Investigate need for rat control	X	X	X	X	P1
SBMR	Mohiākea	Delsub- Determine need to augment population	X	X			P1
SBMR	Mohiākea	Delsub- Weed control		X			P1
SBMR	Mohiākea	Phymol- Monitor Invert. Damage	X	X			P1
SBMR	Mohiākea	Phymol- Monitor/Collect/Store underrepresented	X	X	X	X	P1
SBMR	Mohiākea	Phymol- Fence	X				P1
SBMR	Mohiākea	Phymol- Determine need to augment population	X				P1
SBMR	Mohiākea	Siclan- Monitor/Collect/Scope fence?	X	X	X	X	P2
SBMR	Mohiākea	Alemac- Collect/Store		X	X		P3
SBMR	Mohiākea	Alemac- Monitor/Scope rat control		X			P3
SBMR	Mohiākea	Alemac- Determine good Ex-situ site	X	X			P3
SBMR	Mohiākea	Fluneo- Monitor/Collect vegetative material		X		X	P3
SBMR	Schofield-Waikāne	Lobgaukoo- Monitor/Collect/Store	X			X	P1
SBMR	Schofield-Waikāne	Phlnut- Monitor/Survey Collect from unrepresented				X	P2
SBMR	Schofield-Waikāne	Tetgym- Monitor for Seedlings	X		X		P2
SBMR	Schofield-Waikāne	Tetgym- Survey/Map	X		X		P2
SBMR	Schofield-Waikāne	Exogau- Survey and map	X		X		P3
SBMR	Schofield-Waikāne	Placorcor- Determine status of historically reported plant	X	X			P5
Admin.		Biannual meeting with Alvin, Nellie, Bill	X		X		
Admin.		Develop Rare Plant Monitoring Database	X	X			

Table 3-6 Recommended Actions Continued

Admin.		Develop Ex-situ Database	X	X			
Admin.		Scope Helemano fence	X	X			
Admin.		Investigate BTB control options with Curtis Daehler			X	X	
Admin.		Develop Protocols/Inventory for Collection of Stored seed	X	X			
G.H.		Greenhouse work weekly	X	X	X	X	
G.H.		Select site for long lived ex-situ collections	X	X			
G.H.		Alsobo- Joel ID Pahole Nursery Stock for Outplanting	X				
G.H.		Cyasup- Replicate stock from nurseries and reintroduced	X	X			
G.H.		Cyasup- Plant on grounds at Lyon with Army stock	X				
G.H.		Cyacri- Harden for Outplanting				X	
G.H.		Delsub- Determine appropriate site	X				
G.H.		Fluneo/Alemac- Research Hort. Techniques	X	X	X	X	
G.H.		Lobelia sp.- Propagate for taxonomy	X				
G.H.		Sanpur- Harden for Outplanting	X				
G.H.		Stekaashe- Replicate Stock	X				
G.H.		Collect Koa for Picies Pacifica		X	X	X	

CHAPTER 4 RARE VERTEBRATE MANAGEMENT

4.1 PCSU Contract Requirements

The following is a list of PCSU contract requirements related to vertebrate management followed by a brief discussion of NRS accomplishments.

Makua Military Reservation

Requirement (1i)

Monitoring a discrete population (approximately 4 individuals) of O`ahu `elepaio in MMR. Identification of individual birds shall be accomplished by banding, as appropriate and morphological measurements taken of bill, tarsus and wing length and color using Munsel color charts. Predator control shall be conducted where there are breeding pairs.

Discussion

All known birds were monitored this year. Predator control efforts were employed in both known territories where there are breeding pairs.

Requirement (1j)

Surveying other suspected areas of MMR for additional O`ahu `elepaio and O`ahu creeper by January 1, 2001.

Discussion

Further areas of MMR were surveyed and six new O`ahu `elepaio were discovered, including one pair. NRS still believe that there may be a few more birds still undiscovered in the valley and hope that at least a few are paired. No `alauahio (O`ahu creeper) have been seen nor heard in MMR at anytime. NRS believe that this bird is most likely extinct island-wide or extremely rare and found only in the most remote areas of the central Ko`olau Mountains.

Requirement (1n)

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.

Discussion

Since 1998, MMR has been closed to all training. As a result of this there have been no further impacts to SEAs due to military training activities.

Various Training Areas

Requirement (1k)

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, and 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.

Discussion

All banded O`ahu `elepaio in both SBS and SBW were monitored for survival. Results are discussed below. NRS were unable to attempt to catch or monitor the `i`iwi this year in SBE due to logistical troubles and scheduling conflicts.

Requirement (1o)

Monitoring 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.

Discussion

From February to May 2000, Dr. Eric VanderWerf, Y. Ebisu and Associates, and Wil Chee-Planning, Inc. worked in conjunction with NRS to conduct a study to determine if artillery blast sounds had any deleterious effects upon existing populations of O`ahu `elepaio located at SBW and MMR. Video surveillance cameras with videocassette recorders and precision sound meters were synchronized in order to obtain a simultaneous record of sound levels and any response by the birds to each blast noise. Impacts to the birds were based on three regulatory decision criteria outlined in the Endangered Species Act: (1) Any proximate response or immediate change in behavior such as flying from the nest or alarm calling due to artillery blasts, (2) Whether any of these changes in behavior had any "adverse affects on individual fitness" or overall behavior, and (3) Whether any disturbance "caused a population-level effect on nesting success or the number of individuals that could jeopardize the continued existence of the population". It was determined from this study that the `elepaio were not adversely affected by artillery training at the recorded intensities, which are typical of training at SBW (VanderWerf et al. 2000).

To date, NRS have not documented any impacts to rare vertebrate fauna, within any of the other training areas, which could be attributed to military activities.

`Elepaio Critical Habitat

Critical habitat for O`ahu `elepaio was proposed by the USFWS in July 2001. This proposal is currently being finalized and is scheduled for completion by 31 October 2001. (E VanderWerf pers. com. 2001). Figures 4-1 and 4-2 illustrate the extent of the critical habitat on Army lands on O`ahu. Approximately 9,775 acres of Army land on O`ahu are proposed as critical habitat. These areas lie within MMR, SBS and SBW in the Wai`anae Mountains and the southernmost portion of the KLOA and SBE in the Ko`olau Mountains. `Elepaio occur in a scattered fashion across the area designated in MMR but the entire area is not occupied. In SBW and SBS, most of the area designated is occupied by `elepaio while in KLOA and SBE none of the habitat is currently occupied. The known locations of O`ahu `elepaio within these critical habitat units are also indicated on Figure 4-3. This designation has significant implications for the Army. It means that the Army must consult on not only potential endangered species impacts but also any potential adverse modification to `elepaio critical habitat. The largest potential impact to this critical habitat is from fires started by military live-fire exercises at Schofield and Mākua. This

Figure 4-1

PROPOSED `ELEPAIO CRITICAL HABITAT

KAWAILOA TRAINING AREA AND SCHOFIELD BARRACKS EAST RANGE

N

400 0 400 800 Meters

`Elepaio Critical Habitat

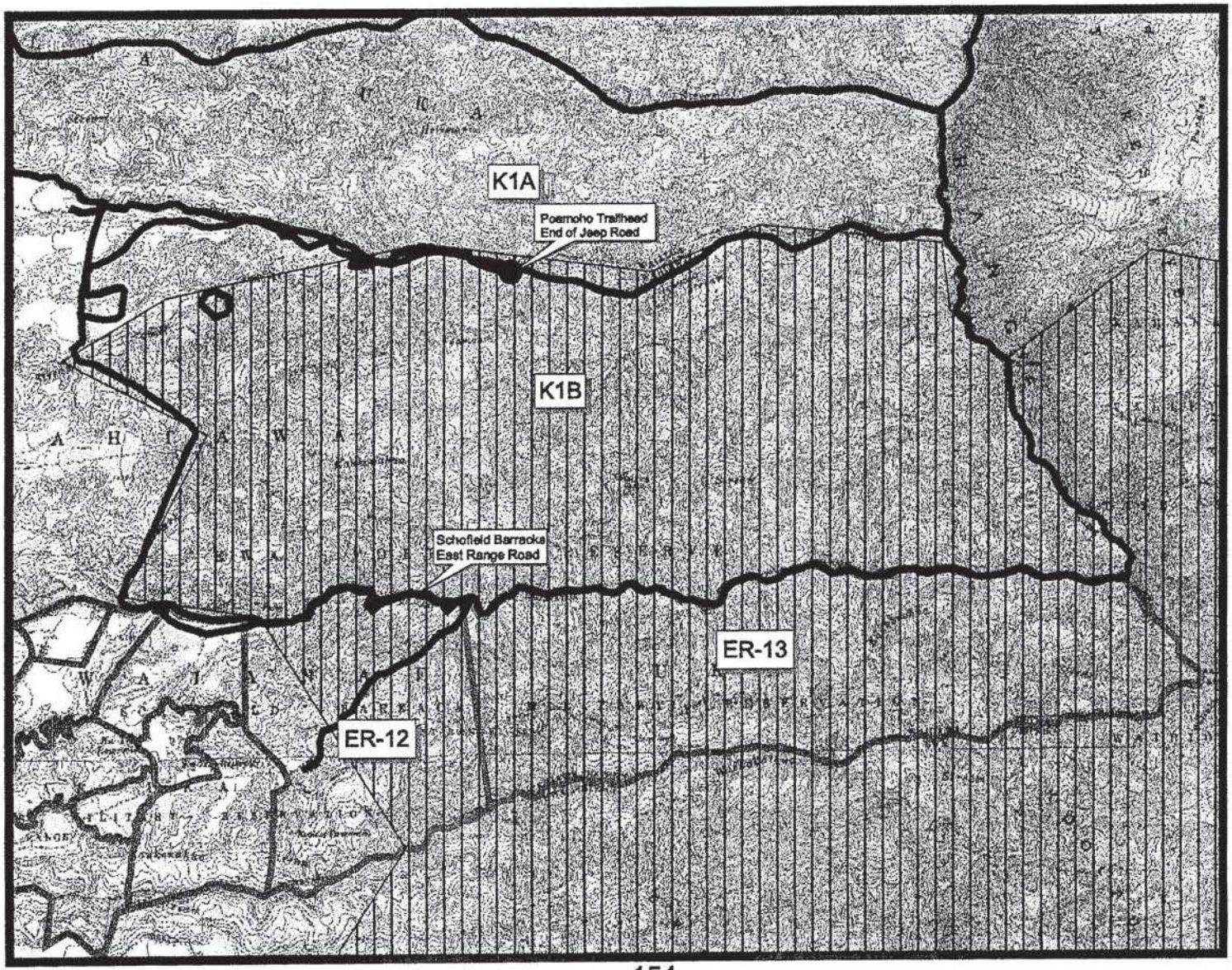
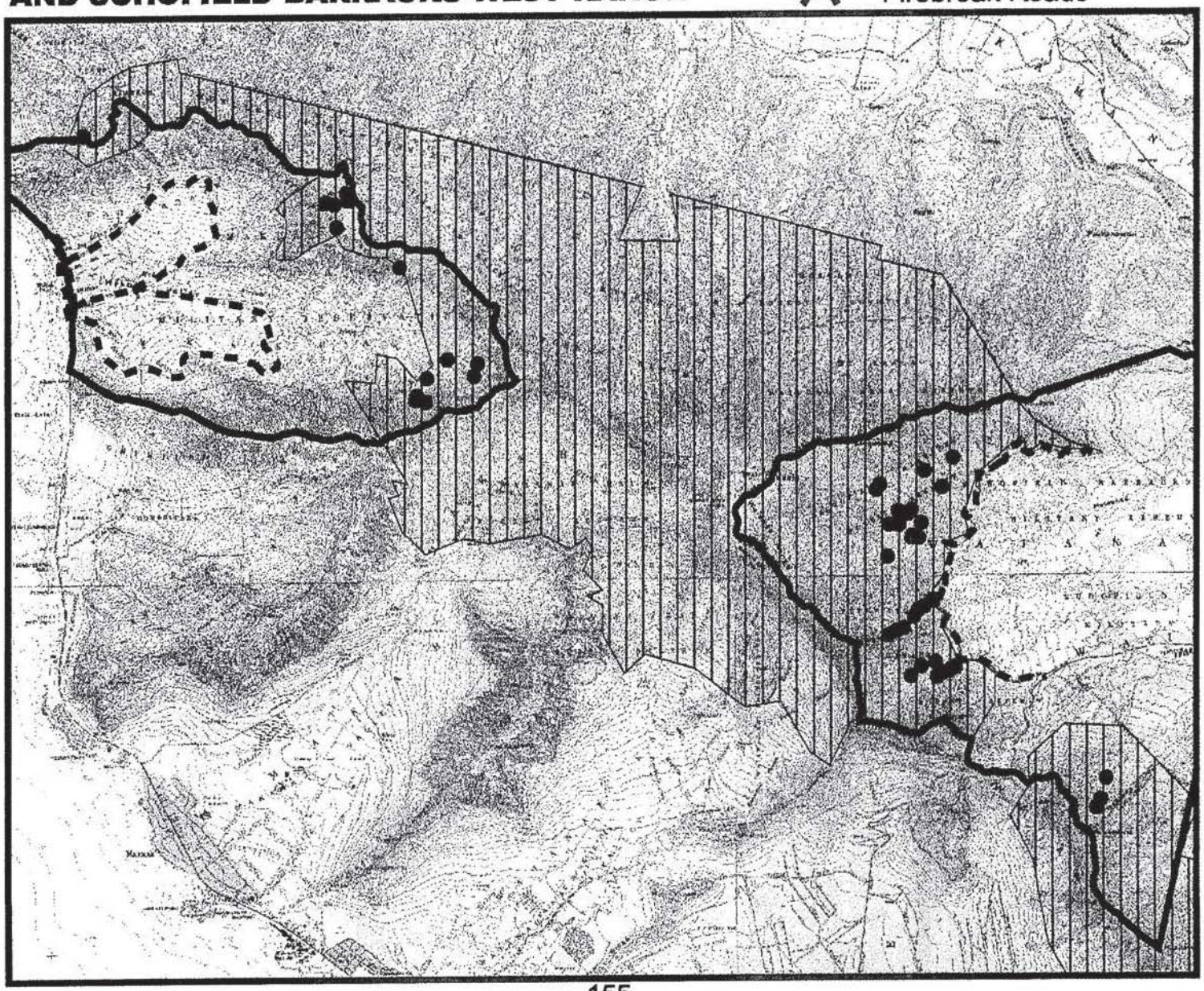


Figure 4-2

PROPOSED `ELEPAIO CRITICAL HABITAT

MAKUA MILITARY RESERVATION AND SCHOFIELD BARRACKS WEST RANGE



year fires started in July 2001 burned areas outside the firebreak road at SBW. These fires did burn some forest designated as proposed `elepaio critical habitat. The first step towards alleviating any potential conflict between training exercises and this newly proposed critical habitat is for the Army to develop a Wildland Fire Management Plan for SBW. In addition, NRS recommends increasing `elepaio banding in territories near the firebreak road. NRS also recommends increasing predator control efforts within elepaio territories in SBW.

4.2 Introduction to Rare Vertebrate Management

Rare native vertebrate faunas on O`ahu training lands include native birds and the Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). The Hawaiian Hoary Bat is not known to establish breeding populations on O`ahu and is only occasionally seen. There are six native 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 (*Paroreomyza maculata*), pueo (*Asio flammeus sandwichensis*), `i`iwi (*Vestiaria coccinea*), and O`ahu `elepaio (*Chasiempis sandwichensis ibidis*). In addition, there is possible habitat for three endangered wetland bird species at DMR. The habitat is such that NRS does not believe that breeding populations could be supported and the presence of any of theses species has never been documented. Wetland birds have been documented from seaside ponds at the mouth of Mākua Valley (Aila personal comm.). `Amakihi and `apapane are still relatively common and ecosystem-wide management actions, such as pig removal should address some of the threats that may affect these birds. No specific management actions are being taken for these species and they will not be discussed in this report. The `alauahio (O`ahu Creeper) is federally listed as an endangered species and has been occasionally reported from Army controlled lands in the past. NRS have never seen `alauahio in the wild and, thus, have not implemented any management actions for this species. The State of Hawaii lists the Pueo as an endangered species on O`ahu. NRS have observed pueo in Mākua Valley, however, no management actions for this species have been undertaken. `Elepaio and `i`iwi have declined precipitously on O`ahu for the past 20 years. The State of Hawaii lists `i`iwi on O`ahu as an endangered species, however, at present they have no federally listed status. On 18 April 2000, the US Fish and Wildlife Service (USFWS) granted the O`ahu `elepaio endangered status under the federal Endangered Species Act (USFWS 2000). These rare O`ahu species have become the focus of NRS vertebrate management efforts. Rare vertebrate management on Army lands follows a three-step approach that includes surveying, monitoring, and threat control.

4.3 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, which 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 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. Species specific surveys are also conducted in habitats where individuals are likely to be found i.e. when surveying for `elepaio it is always best to stay within gulches as that is their preferred habitat. With these efforts, extensive areas have been surveyed and additional rare species found.

4.4 Rare Vertebrate Threats

Hawaiian avifauna have suffered a tremendous rate of extinction. There are four major threats that are suspected of causing these declines. First, habitat destruction has resulted in the loss of the natural environment 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). Of particular concern are avian malaria (*Plasmodium relictum*) and a poxvirus (*Poxvirus avium*), which are transmitted by the introduced southern house mosquito (*Culex quinquefasciatus*). Third, introduced bird species may compete with native birds for resources such as food. Finally, introduced predators including black rats (*Rattus rattus*), polynesian rats (*Rattus exulans*), feral cats (*Felis domesticus*), and Small Indian mongooses (*Herpestes auropunctatus*) may consume native birds and/or their eggs.

NRS control weeds and outplants common and rare species in order to slow habitat loss. 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. At present, predator control has only been implemented within territories of O`ahu `elepaio. Protocol design for predator control methods was obtained with assistance from Dr. Eric VanderWerf, who has been implementing a similar program for other `elepaio populations. His efforts have significantly increased nest success, female survivorship and the number of fledglings per pair within his study areas (E.VanderWerf unpublished reports to DOFAW). Predator control work has also 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 1994, Hooker 1995, O'Donnell 1996).

There is also mounting evidence that low elevation populations of native birds (`amakihi, `apapane, and `elepaio) may be developing immunogenetic resistance to the malaria parasite (van Riper et al. 1986, Jarvi et al. 2000). Predator control methods may also assist in this pathogen-driven selection by allowing birds a chance to breed, thereby possibly passing this resistance on to offspring.

4.5 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. Leonard Freed's (University of Hawaii) 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 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 control methods specifically within their territories.

Banding results for `elepaio are summarized on tables 4-A and 4-B. Individual birds are identified by a four-letter code that corresponds to a unique color 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 when captured. The "Mated" column reports whether or not the bird was observed with a mate the last time it was observed. The "Range" column reports the range in which the bird was banded (SBS for Schofield Barrack SBS and SBW for Schofield Barracks SBW). 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.

4.6 O`ahu `Elepaio Management

4.6.a Makua Military Reservation

At MMR `elepaio are known from Kahanahāiki, Kaluakauila, and Lower Mākua MU. The population of `elepaio in Kaluakauila is comprised of two unpaired males, which are monitored biannually. All suitable habitat in the East Rim Ungulate Control Area, `Ōhikilolo, and C-Ridge MUs has not been completely surveyed. Two more single males were discovered this year. One was observed in Kahanahāiki MU and the other was located in the East Rim Ungulate Control Area. The Nature Conservancy reported `elepaio from the Lower Mākua MU during their 1993 surveys (Hawaii Heritage Program 1994). NRS detected a single male in this area while surveying in 1999. Two more single males and one pair were discovered while surveying in 2000 (Figure 4-3). NRS do not believe that this MU could harbor many additional birds as much of the area has already been surveyed. This past year, NRS were able to gain permission to camp within the MU, which should facilitate surveys of the entire area. This should also facilitate surveys extending into the East Rim Ungulate Control Area, where there is a distinct possibility of discovering some new birds. To date, there are fifteen confirmed `elepaio known in MMR (Figure 4-3).

In 1996, there were initially three males and one female in Kahanahāiki. Since that time BGAW (see Table 4-A) has not been detected and is thought to be dead. GBAR and BABW are a pair, which bred 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 was implemented again this year from 23 January through 23 May 2001. It entailed weekly maintenance of twelve poison bait stations, twelve Victor rattraps, and four Tomahawk live traps. A total of sixteen rodents were caught in snap traps, one cat and two mongooses were caught in live traps, and 599 blocks (56 pounds) of half of molasses/peanut-butter flavored JT Eaton Bait Blocks (.005% diphacinone) and half of Ramik Mini Bars (.005% diphacinone), were taken from bait stations. The average number of rats caught per trap night was 0.12, and the average number of bait blocks taken per station per night was 0.76. This year, NRS decided to keep the predator control grid the same size as last year in order to protect the same area from encroachment by rodents. It is unclear as to the success of the nest this year. NRS observed nest attendance and a single nestling. The nestling had been observed as fledging but NRS have been unable to relocate the bird since that time. NRS are confident that the fledgling has survived and is just being elusive and unresponsive to playbacks.

survey due to their proximity between Pu`u Kapu and Red and Black Landing Zones (LZs). Both US Army and Marine Corp. helicopters heavily utilize these LZs. Playbacks were incorporated into the surveys but no `elepaio were detected. No `elepaio are currently known from KLOA.

4.6.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. Sandee, accompanied by NRS, visited the site where Shallenberger had reported the `elepaio, and was unable to detect any. She and NRS also systematically covered other areas searching for `elepaio, utilizing playback technology, but surveys were unsuccessful. At present, no `elepaio have been identified in KTA.

4.6.e Dillingham Military Reservation

All suitable habitat at DMR has been surveyed for elepaio. No birds have been detected.

4.7 `I`iwi Management

4.7.a Makua and Dillingham Military Reservations

No reports of `i`iwi from either of these training areas have been made. Neither training area has habitat that is expected to support `i`iwi populations.

4.7.b Schofield Barracks Military Reservation

`I`iwi have never been reported from SBS. `I`iwi habitat is limited in SBS and NRS have surveyed this small area without finding any `i`iwi. In 1976, Shallenberger surveyed SBW. 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. 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 vicinity. 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 readily observed in the bog.

4.7.c Kawailoa Training Area

`I`iwi have been observed in KLOA in the recent past. Shallenberger reported one bird from the Poamoho Trail in 1977. More recently, Ken Wood of the NTBG reported a small flock from the Pe`ahināi`a Trail vicinity. On 5 December 1995, NRS discovered a population of `i`iwi in Kawailoa. 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 arnotianus*, which appears to bloom heaviest in winter. Birds were often seen feeding on *Hibiscus* flowers and NRS believe that it is this resource, which draws them into the area. Banding efforts continued in the winter of 1996. Fewer birds were detected (two or three) and no birds were captured. However, the *Hibiscus* was

not flowering as vigorously as in 1995. In the winter of 1997, no birds were detected and banding was not attempted. However, surveying efforts were not extensive and the *Hibiscus* was not observed at the peak of flowering. In the winter of 1998, three birds were detected again but banding efforts were unsuccessful and the *Hibiscus* was not observed at the peak of flowering. Playbacks were utilized this time in an effort to facilitate banding but the `i`iwi did not respond strongly. The `i`iwi appeared to be curious about the playbacks, but not in an aggressive manner. In response to the calls and songs, the `i`iwi would move into the vicinity of the tape player and vocalize several retorts. NRS believe that the birds may react more aggressively in order to defend a food resource, as opposed to a territory. NRS and Dr. VanderWerf revisited the area in 1999. Two birds were observed 30 November and 18 December, but banding efforts were again unsuccessful. As a side note, on 14 June 2000, NRS and U.H. 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 roughly two to three kilometers from the gulch that the `i`iwi are usually observed. NRS were unable to monitor the `i`iwi in 2000 due to logistical and scheduling difficulties.

4.7.d Kahuku Training Area

`I`iwi have never been reported from Kahuku. There is little habitat expected to support `i`iwi in the KTA.

4.8 O`ahu Creeper Management

4.8.a Makua Military Reservation

An unconfirmed `alauahio (O`ahu creeper) sighting was reported in 1976 from MMR. NRS have revisited the location multiple times and detected nothing.

4.8.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 have been unconfirmed reports of `alauahio from the Poamoho vicinity in Kawailoa since 1977. NRS have never detected this species despite frequent visits to areas where `alauahio have been sighted.

4.8.c Kahuku Training Area and Dillingham Military Reservation

`Alauahio has never been reported from these training areas.

4.9 Pueo Management

4.9.a Makua Military Reservation

NRS have 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, and mongooses may pose a threat. While Wildlife Services has removed feral dogs from the area, no specific management actions for this species have been undertaken. Behavior that may be indicative of nesting was observed 31 May 2000. A pair had been observed flying around the landing zone at `Ōhikilolo and down into the back of Mākua Valley several weeks prior. The pair was flying around a localized area near to a known

population of *Fluggea neowawraea* and *Alectryon macrococcus macrococcus*. Upon closer inspection on the 31 May the pair appeared to aggressively defend the area. They were observed diving and soaring just overhead and calling out, perhaps as if defending a nest.

NRS again documented behavior indicative of nesting on 21 and 22 May 2001. NRS noted that the birds seemed to be utilizing the same area to nest, possibly the same nest. NRS observed one adult circling overhead and barking. Other vocalizations, perhaps two nestlings, were also heard further back in gulch area along a grassy step/cliff area.

4.9.b Schofield Barracks Military Reservation, Kawailoa, and Kahuku Training Areas

Though all of these areas have habitat that may support populations of pueo, NRS rarely observe 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.

4.9.c Dillingham Military Reservation

NRS are unaware of any pueo sightings from DMR. There are only small areas of habitat expected to support this species at DMR.

4.10 Wetland Bird Species

4.10.a Dillingham Military Reservation

Wetland bird habitat on O`ahu training lands is limited to DMR and the entrance of Mākua Valley. 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 endangered water bird nesting. If there is enough standing water at any time throughout the year, some birds may utilize the area to feed. As yet, NRS have been unable to document any standing water at DMR. In addition, a fire in 1998 that was caused by military training activities, burned the vegetation in the entire area.

No protection actions have been implemented for wetland bird species.

4.10.b Makua 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 (*Anas wyvilliana*), `Alae`ula (*Gallinula chloropus sandvicensis*), and Ae`o (*Himantopus mexicanus knudseni*) occasionally utilizing the ponds (Aila, W. 2000). In addition, the `Auku`u (*Nycticorax nycticorax hoactli*) 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 these water birds and any possible migratory species. No birds were observed by NRS on any of these dates. It is possible that the birds occasionally come in 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 not be conducive to any nesting activity. NRS will continue to monitor the area in conjunction with other management actions in Mākua and community members have agreed to assist.

4.10.c Schofield barracks Military Reservation, Kawailoa, and Kahuku Training Areas

Endangered water birds have not been documented from any of these training areas. There is little if any habitat that would be expected to support any populations of these bird species.

4.11 Hawaiian Hoary Bat

4.11.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. No management actions have been conducted for this species to date.

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 ( ) 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 shall initiate surveys for bats by incorporating them in with camping trips and using the bat detector.

4.11.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. It is possible that `Ōpe`ape`a could inhabit any of the habitat contained within these training areas and just not been detected. NRS will initiate `Ōpe`ape`a surveys on all Army Training Lands by incorporating this effort into all overnight camping expeditions and utilizing the bat detector.

Table 4-3 Recommended Rare Vertebrate Monitoring and Management Schedule

Range	MU	Action	Q4	Q1	Q2	Q3
DMR		Survey area for potential water bird habitat.	X			
KLOA	Castle	Survey for `Ōpe`ape`a.	X	X	X	X
KLOA	Kahuku Cabin	Survey for `Ōpe`ape`a.	X	X	X	X
KLOA	Lower Pe`ahināi`a	Survey for `Ōpe`ape`a.	X	X	X	X
KLOA	Poamoho	Survey for `Ōpe`ape`a.	X	X	X	X
KLOA	Upper Pe`ahināi`a	Survey for `Ōpe`ape`a.	X	X	X	X
KLOA		Survey for `Elepaio in stream drainage's north of Pu`u Kapu.	X	X		
KLOA		Resurvey Shallenberger's old `Elepaio sites.	X	X		
KTA		Survey stream drainage's for `Elepaio.	X	X		
MMR	East Rim UCA	Survey for `Elepaio.	X	X	X	
MMR	Kahanahāiki	Conduct predator control.		X	X	
MMR	Kahanahāiki	Monitor and attempt to band new `Elepaio.	X	X		
MMR	Kaluakauila	Monitor `Elepaio.	X	X		
MMR	Lower Mākua	Conduct predator control.	X	X		

Table 4-3 Continued

MMR	Lower Mākua	Attempt to band new pair and possibly some males.	X	X		
MMR	Lower Mākua	Conduct predator control for Pueo nest.		X	X	
MMR	Lower Mākua	Survey for `Ōpe`ape`a.	X	X	X	X
MMR	`Ōhikilolo	Survey for `Ōpe`ape`a.	X	X	X	X
MMR		Continue survey efforts for water birds.	X	X	X	X
SBE	Schofield-Waikāne	Survey for `Ōpe`ape`a.	X	X	X	
SBE		Survey stream drainage's and Shallenberger's old site for `Elepaio.	X	X	X	
SBE		Continue banding efforts for `I`iwi.	X			
SBE		Participate in annual Audubon Society Christmas bird count.	X			
SBS		Monitor and maybe band `Elepaio.	X	X	X	
SBW		Monitor and conduct predator control for `Elepaio.	X	X	X	
SBW		Monitor for `I`iwi.		X	X	

CHAPTER 5 INVERTEBRATE MANAGEMENT

5.1 PCSU Contract Requirements

The following is a list of PCSU contract requirements related to rare snail management followed by a brief discussion of NRS accomplishments.

Makua Military Reservation

Requirement (1k)

Monitoring three populations of *Achatinella mustelina* in MMR annually. Monitoring shall include the analysis of impact by *Euglandina rosea* and rats. If impacts are observed, predator control shall be implemented. The data shall include parameters as described on Enclosure 4. Based on the analysis of data and observations, recommendations shall be made for management actions.

Discussion

NRS have continued to monitor the same three populations of *Achatinella mustelina* in MMR annually. One ʻŌhikilolo population still remains rat and *Euglandina* free. The other two sites have rat bait buckets and are monitored at least quarterly. More information is given within the *Achatinella mustelina* section of this chapter.

Various Training Areas

Requirement (1l)

Monitoring existing snail (*Amastra* sp., and *Laminella* sp.) populations in SB SBS every two months. Monitoring shall include the analysis of impact by *Euglandina rosea* and rats. Predator control shall be implemented if impacts are observed. The data shall include parameters as described on Rare Snail Monitoring Form. Based on the analysis of data and observations, recommendations shall be made for management actions.

Discussion

The SB SBS snail populations continue to be monitored at least every two months. Rat bait buckets are set up in two separate locations here and the take is consistently high. More information is presented within the *Amastra micans* and *Laminella sanguinea* sections of this chapter.

Requirement (1m)

Surveying for new *Achatinella* populations around known locations at KWTA and SB (approximately 10 acres) and improving the monitoring method for *Achatinella* species found in the Ko'olau mountains. Based on the analysis of data and observations, recommendations shall be made for management actions.

Discussion

NRS continue to search for new populations of snails and to survey extended boundaries of known snail sites. There are presently four sites in the Ko'olau Mountains where rat bait buckets are set to help protect these rare species. With helicopter support, NRS now revisit these sites on a quarterly basis. More information regarding these sites is given in the text of this chapter.

5.2 Introduction to Rare Snail Management

The island of O`ahu has forty-one 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, 10 species of *Achatinella* have been found on Army training lands on O`ahu, as well as a few equally rare land snails in different genera. Included here are: *Achatinella apexfulva*; *A. byronii*; *A. curta*; *A. leucorraphe*; *A. decipiens; A. lila*; *A. livida*; *A. mustelina*; *A. pulcherima; A. sowerbyana*; *Amastra micans*; and *Laminella sanguinea.*

There are three steps in the NRS snail management approach: surveying to identify new populations of snails; monitoring known populations; and threat control in areas where it is deemed necessary. NRS are presently working in close cooperation with Dr. Michael Hadfield, Professor of Zoology at the University of Hawaii. Since 14 August 1997, NRS have been listed as sub-permittee's on Dr. Hadfield's US Fish and Wildlife permit to work with endangered snails. As sub-permittee's NRS 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.

5.3 Rare Snail Surveys

Snail surveying involves hiking in areas expected to have rare snails and searching trees for tree snails and the appropriate ground substrate for terrestrial snails. Surveys have been conducted by Hadfield, 1984, and Christensen, 1985, for members of the genus *Achatinella* on O`ahu training lands. NRS have concentrated survey efforts in areas of known snail habitation as reported in the 1984 and 1985 surveys and from documented sightings. With the help of The Nature Conservancy of Hawaii and USFWS, NRS have obtained maps from the HINHP with plotted 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 Hawaii, Dr. Daniel Chung of Kapiolani Community College and USFWS Field Staff.

5.4 Rare Snail Threats

Various factors are thought to be responsible for the swift decline of land snails in Hawaii: loss of habitat; predation by rats and *Euglandina rosea*; 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 further 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. Tree snails survived nearly 200 years of European rat predation and more than 1,000 years of predation by the Polynesian rat. This long-term predation does not appear to have significantly reduced snail numbers. The Hawaii 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 has acquired an Experimental Use Permit for a bait developed to control *E. rosea*. The bait consists 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. NRS are working with the Toxicant Working Group to facilitate the use of such a toxicant for snail management in the future.

5.5 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 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. NRS plan to spearhead a cooperative effort to develop and standardize rare snail monitoring and management approaches this year and have drafted a preliminary Rare Snail Monitoring Form that will stimulate discussion.

5.6 Rare Snail Management

In the following section each rare snail species reported from O'ahu Army lands since 1970 is discussed. The status of each species and the management conducted for it is described.

5.6.a *Achatinella apexfulva*

The historical range of *A. apexfulva* 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. NRS first participated in a search for *A. apexfulva* along the Poamoho Trail with USFWS staff and representatives from the University of Hawaii on 13 July 1998. On this field trip one snail was found and brought back to the Dr. Hadfield's laboratory for captive rearing. Suitable habitat is at fairly low elevations where the main threat is *E. rosea*. NRS have continued snail searches in the areas where Dr. Hadfield has monitored *A. apexfulva* along the Poamoho Trail. No new individuals were found in 2000.

On 7 March 2001 two more snails were found at this same location and they were both brought back to the lab at UH. Only eight snails of this species are known and they are kept at the captive rearing facility at UH. It was especially encouraging to find two more in the field after 32 months since the last find. If more individuals are discovered in the future, NRS will discuss bringing them into captivity with Dr. Hadfield. This species has been slow to reproduce in captivity. Dr. Hadfield theorized that perhaps this was 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 has recently been added to the tree snail lab. Early signs are that this higher temperature may be more suitable for these snails.

5.6.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

group. This snail was historically known from the southern boundary of the KLOA and areas to the south. It is considered to be extant with some recent sightings by Dr. Michael Hadfield (USFWS 1992). A healthy population of approximately 66 *A. byronii* was discovered while on a field trip to the Schofield Waikāne Trail area in May 1997. Eight of these individuals were brought back to the University of Hawaii snail laboratory and have grown to a population of 20+ today. NRS have continued to monitor this group of snails only once a year or one and one half years so as not to negatively impact the habitat. NRS recommend continued monitoring of this site to ensure that rats and *E. rosea* do not decimate it, and to begin threat control if necessary. NRS will also continue to search nearby habitats for more surviving snails. NRS make a point of not eating food while in this area so as not to attract rats.

In December 1998, 77 individuals were counted with Randy Kennedy of the Division of Forestry and Wildlife. In August 1999, three staff members counted a total of 136 individuals at this same location. The more the surrounding areas are searched, the more this site seems to be an anomaly. Nearby areas are nearly devoid of snails. On the most recent annual trip to this area in the North Kaukonahua Stream drainage 9 August 2000, a total of 178 snails were counted. This does not necessarily signify that the population is growing but rather that the population remains robust and that some new areas were included in the survey. There were no trips planned for this past year to monitor the area but NRS do plan to return there during the coming year.

On 26 February 2001 a survey was conducted along the southern boundary of the SBE just west of Pu'u Ka'aumakua . Although the habitat looks perfect for snails and the elevation is favorable, only one *A. byronii* was found here. It was discouraging to find two live *E. rosea* here at 2,400 ft. and perhaps may explain why more native snails were not found here. On 8 May 2001, areas to the west of Pu'u Pauao and the Summit Trail were surveyed. At approximately 2,380 ft. elevation a total of ten *A. byronii* were counted. These areas are promising for future snail survey efforts because the habitat is primarily native, elevation is in the desired 2,000+ ft. range, and there is little record of past surveys in the area.

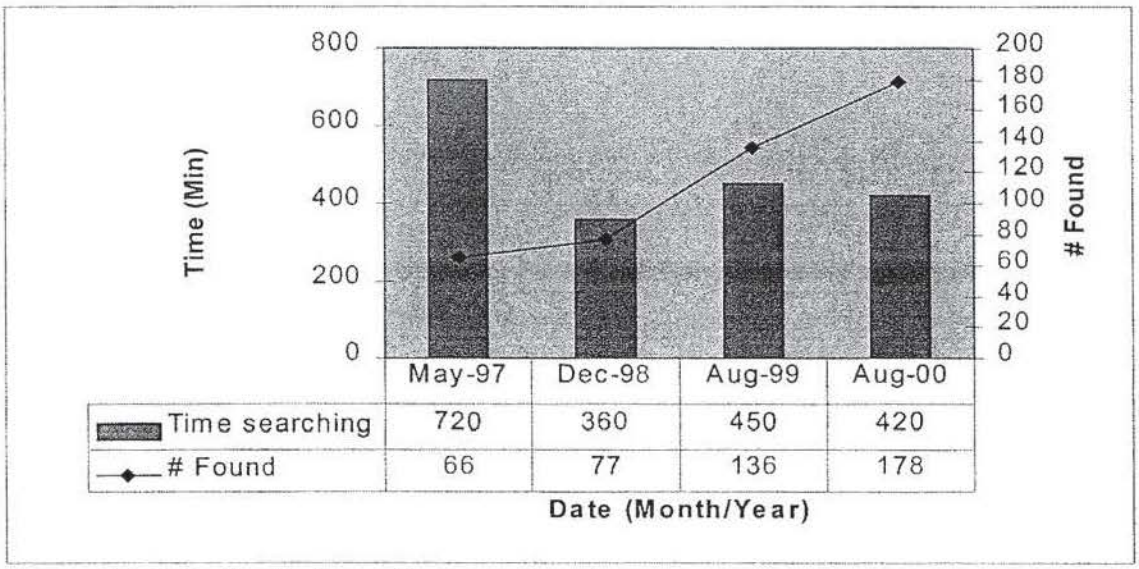


Figure 5-1 *Achatinella byronii* survey trend

Figure 5-1 gives information about the main site just north of the Schofield Waikāne Trail. Numbers of snails seen on four trips over the past three years are given as well as an estimate of

the amount of time spent searching. The rising numbers should not be interpreted as increases in snail populations, but rather are more probably an indication that searchers are becoming more familiar with preferred snail habitat. Thus, more snails are found with less time searching.

5.6.c *Achatinella curta*

A. curta was historically found throughout the KLOA. In the past fifteen years only two snails have been seen; one of these on the Kawailoa Trail and one on the Pe`ahināi`a Trail. None have been seen in the past twelve years. At the start of the Natural Resources Program in 1995, it was thought that given enough searches this snail could be found. The reality of the situation is that it may possibly be extinct. NRS have conducted numerous searches along the Pe`ahināi`a Trail near the area where it was last seen and have never been successful in locating any *A. curta*. In March 1999, NRS camped for two nights in the Lower Pe`ahināi`a area but were again unsuccessful in finding any *A. curta*. Two years ago NRS camped along the Kawailoa Trail and with the use of plotted GPS points searched in the vicinity of the 1986 sighting. Only *Succineas* and one live *E. rosea* in an ohia tree were found. NRS recommend continuing these periodic searches in areas where *A. curta* was known to live. If found, specimens should be collected for captive propagation before the species goes extinct in the wild.

On 25 October 2000 surveys were done in the area of "Pu`u Roberto" on the Pe`ahināi`a Trail. On a previous trip, some snails had been seen and the trees tagged. NRS returned to this site and identified the snails as *A. sowerbyana* and not *A. curta*. There still remains much unexplored territory in this region and more searches will continue to be undertaken.

5.6.d *Achatinella leucorraphe*

A. leucorraphe is considered critically rare and may only be surviving in very restricted habitat. Historically, it was found in SBE and further south. Only one snail has been identified in the past twelve years, along the Schofield Waikāne Trail. NRS have searched the SBE environs and hiked off-trail in appropriate habitat, including the area where Dr. Daniel Chung last reported seeing one *A. leucorraphe*, 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. NRS will continue surveying SBE to find *A. leucorraphe*, and will collected it for captive propagation, if found. Two of the surveys that were conducted during the past year were in *A. leucorraphe* historical habitat but none were found. More searches will be required before this species can be considered extinct.

5.6.e *Achatinella lila*

This species is historically known from the Schofield Waikāne Trail, Poamoho Trail and connecting Summit Trail areas. NRS no longer see it in the southern regions but have seen individuals north of the Poamoho Trail and Summit Trail junctions. It is considered to be uncommon with a very restricted range. In March 1999, NRS hiked off-trail from the known *A. lila* population into very promising habitat, but were unsuccessful in finding any new snails. NRS continue to monitor known locations biannually but under the advice of Dr. Hadfield are not doing any predator control until there is sign of predation. NRS will continue monitoring the known populations and searching new areas for *A. lila*.

While surveying for the `Ōpae`ula Watershed Project fence exclosure, one *A. lila* was found 4 February 2000 north of the Pe`ahināi`a Trail and Summit junction. On 23 August 2000 five more *A. lila* were found near the Pe`ahināi`a Trail and Summit area while clearing the fence line. This

is especially good news because these snails were found in the area where they had not been seen for the past three years. Much of these snails' habitat is now protected within the exclosure.

On 25 September 2000 Dr. Michael Hadfield led a group of six people to survey some of his old sites along the Summit Trail. One site is approximately 5 minutes hiking south of the Poamoho/summit junction on the windward side, where 5 *A. lila* were found. Unfortunately, a live *Euglandina rosea* was also found at this site; this shows the precarious circumstances that threatens native Hawaiian tree snails. On the same day, the group proceeded north to another old study site of Dr. Hadfield's. This site has the healthiest known population of *A. lila*. A total of 22 were counted. This site had been visited a few times over the past few years but no records were kept of the number of snails counted. On 13 June 2001 the area was further surveyed and this time a total of 19 *A. lila* were counted. Each time that NRS return to this area, survey boundaries are expanded and new unexplored terrain is searched.

5.6.f *Achatinella livida*

A. livida is a species, which is known from the 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 more recently but NRS do know of individuals at some of Dr. Hadfield's study sites further south near the old Kahuku Cabin. This area along the Summit Trail supports some of the richest *Achatinella* habitat in the entire Ko`olau range. On 16 March 1998, NRS visited the Crispa Rock site along the Summit Trail with Dr. Hadfield and Richard Helling. Here, NRS marked 20 *A. livida* snails. Unfortunately, these snails were unable to be identified later because the wet conditions of the Ko'olau summit washed the shell markings away. When the snails are re-marked a liquid plastic coating will be used to help preserve the identification markings. The "Crispa Rock" site supports a vibrant population found in an area where there are only scattered individual snails.

Two years ago NRS explored areas farther north along the Summit Trail with Dr. Hadfield and decided to initiate predator control at the northernmost site north of the old Kahuku Cabin. Snap traps for rats were set out at five stations, bait buckets with diphacinone for rats at three stations, and *Euglandina* bait at two stations. The following day one rat was found in a snap trap directly below the one tree harboring five *A. livida*. These traps were in an area that had been visited biannually during helicopter trips in the Ko`olaus. Because these areas are so remote and so rarely visited it is difficult to maintain a strong presence of predator control. NRS recommend that snail monitoring and predator control should continue here and that other nearby areas surveyed for potential undiscovered populations. These populations of snails are now monitored quarterly to restock bait buckets. Also, the number of bait buckets has been increased from two to four at the northernmost site.

In 1999, both of these Ko`olau sites were monitored twice. In both May and August 1999, bait stations were restocked and snail sites were monitored. These *A. livida* populations appear to be holding their own with little fluctuation in total snail counts. On 10 August 1999, staff visited these sites with Dr. Hadfield and his associates: Chela Zabin, Kevin Olival, and Brenden Holland. Brenden is doing genetic research on the different *Achatinella* species and took samples from four sites along the Summit Trail back to the University of Hawaii to analyze. This genetic research will help clarify relationships between and within species.

The northernmost site is significant because there are no known snails' further north and the only snails known to the south are an hour walk along the trail. During the past year, NRS have been to this site to restock the rat bait buckets four times but have not spent enough time to sufficiently

survey the area. Because the predator control work is done with the use of helicopters, only about a half-hour is spent at the site. Only one snail has been seen in the tree recently.

The chart below shows the number of snails found at "Crispa Rock." During the mark/recapture visit in March 1998, a total of 20 snails were found. This site is a very isolated pocket; when the surrounding areas were searched no more snails were found. To improve rat control the number of bait buckets at this site has also been increased from two to four. On 2 January 2001 NRS counted and marked 34 snails at the "Crispa Rock" site. The snails were marked with a pink dot and coated with a protective layer of varnish. The site was revisited on 12 March 2001 and this time 36 snails were counted, 24 of them unmarked and 12 of them marked. Using the Lincoln Index the 2001 information gives us an estimate of a total of 102 snails. This estimate may be a bit high because the two surveys were performed by different people and it is likely that a slightly different area was checked and many of the unmarked snails found on the second survey were in trees that were not included in the first survey.

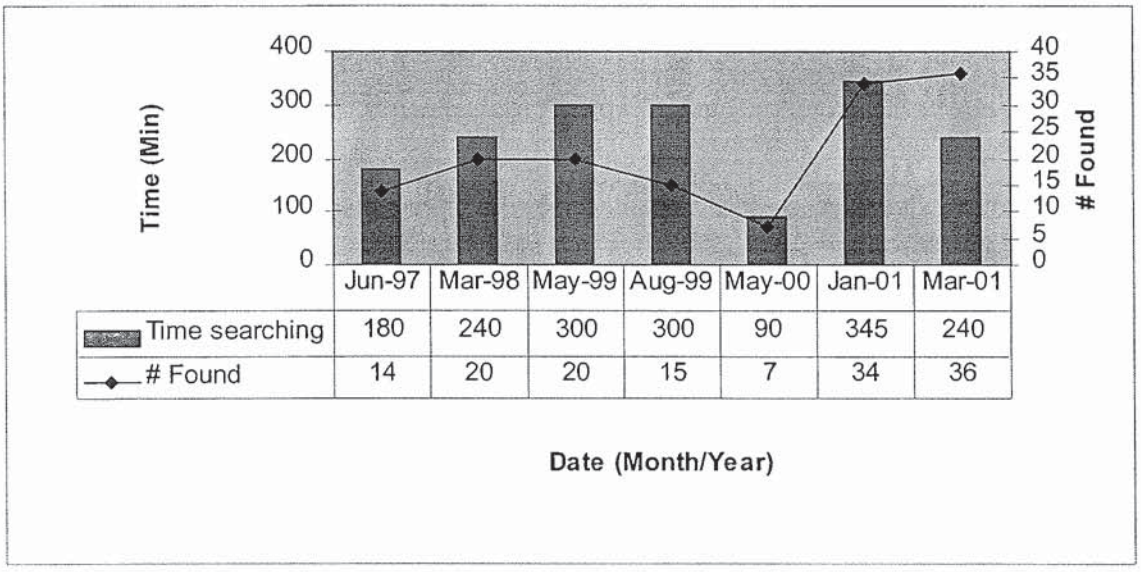


Figure 5.2 Snail surveys of "Crispa Rock" site.

The "Radio LZ" chart shows the number of snails found at "Radio LZ." This is another one of Hadfield's old study sites and it is now monitored four times per year. During the snail sample collection surveys of August 1999, samples were collected from this site. This is also an isolated pocket and when the surrounding areas were searched no new snails were found. The bait buckets at this site have also been increased from two to four for better coverage.

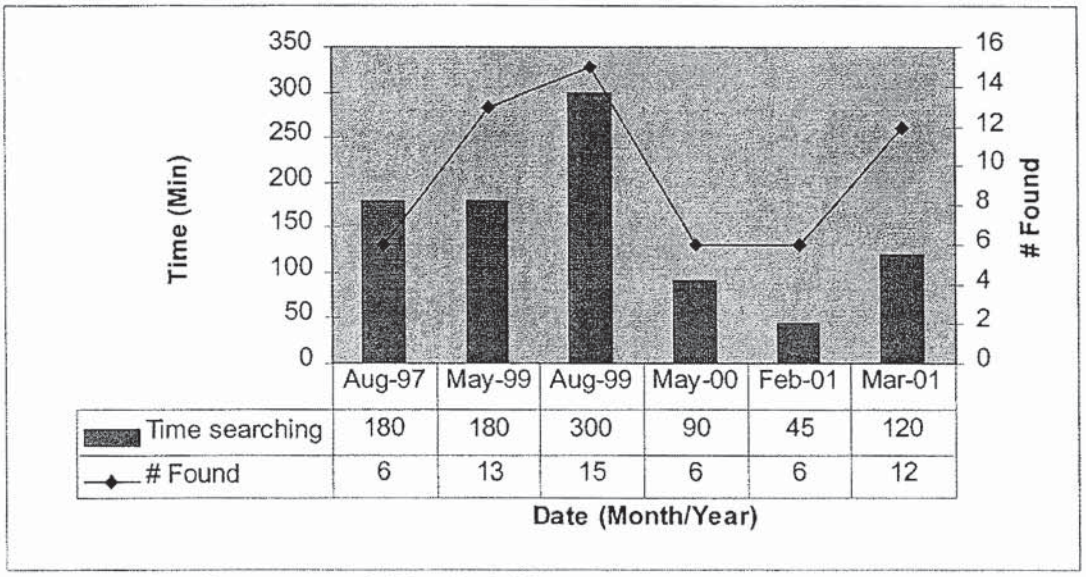


Figure 5.3 Snail surveys of "Radio LZ"

5.6.g *Achatinella mustelina*

This is the only Wai`anae Mountain Range *Achatinella* species and it is considered to be the most abundant *Achatinella* species on O`ahu. It is found in MMR, SBW, and SBS. A great deal is known about this species because Dr. Hadfield has been researching it since 1974. He has demonstrated the impacts of predators on *Achatinella* spp. by studying *Achatinella mustelina* populations in the Wai`anae s. Between September 1974, and December 1975, 222 snails were individually marked and measured at a site near Pu'u Kānehoa in the Wai`anae Mountains, O`ahu (Hadfield and Mountain, 1980). By August 1979, shells of *E. rosea* were abundant in and around the study area and no living specimens of *A. mustelina* or any other arboreal snail species could be found. Hadfield concluded that *E. rosea* was responsible for the destruction of the study population and will eventually cause the extinction of similar land snails if preventative action is not taken.

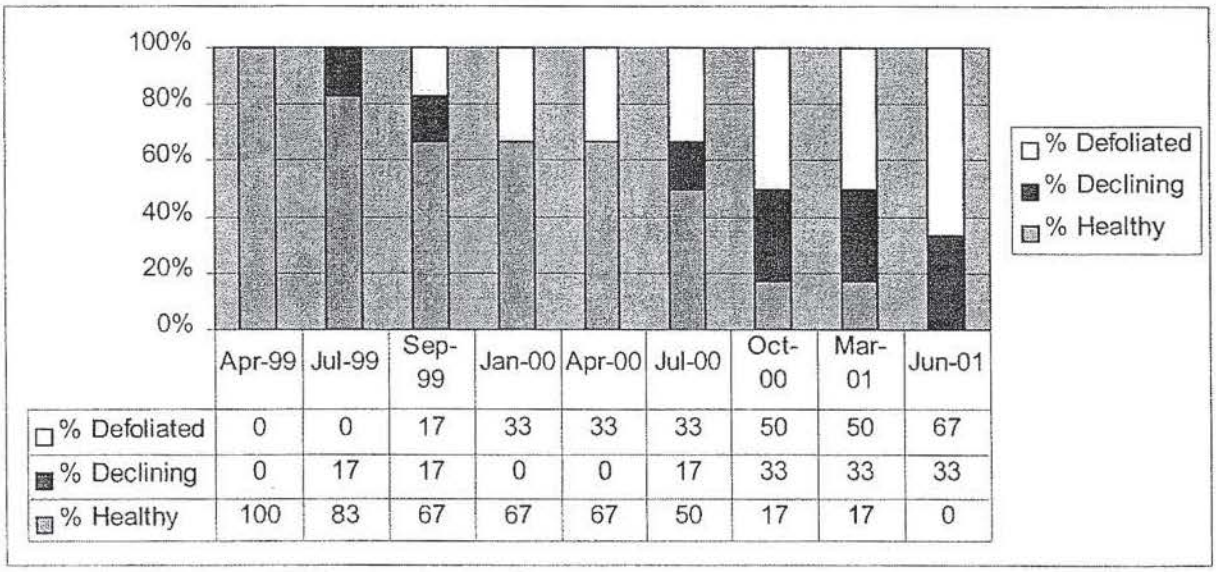
Dr. Hadfield studied another site in Pahole between November 1983 and November 1987. In a 25 m^2 quadrat up to 300 snails had been found. In mid 1989, only four mature snails were present. The *A. mustelina* were first attacked by rats, which tend to select larger snails as prey and may leave an area before destroying all of the prey snails present. Reproductive output of snails may be temporarily destroyed by such predation but the population can survive. After rats were trapped at this site the snail populations rebounded and then fell into a state of decline again. This time *E. rosea* was discovered to be the culprit. The multi-year study of population dynamics at Pahole has revealed that populations of *A. mustelina* have the capacity to grow when not under predation pressure; the population doubled in about three years when predation was controlled.

As part of the snail monitoring program, NRS are currently maintaining three *A. mustelina* mark/recapture sites in the Wai`anaes. The `Ōhikilolo Ridge site in MMR has what is probably the densest population of *Achatinella* tree snails found anywhere on the island of O`ahu. There are two sites where snails have been marked. One is in "Pteralyxia Gulch," where only six snails have been marked. Rat-eaten snails have been seen at this site. Three years ago, NRS began setting out bait buckets with diphacinone to control rats and thus help to protect the snails.

The second site is now located within a fenced exclosure, free from goat activity. NRS revisit this area quarterly and perform mark/recapture operations. One problem that has been observed in this area is a marked decline in the health of many *Myrsine lessertiana*. This tree is a primary host species for *Achatinella*. During the course of one year, completely foliated trees have become defoliated. In 1998, NRS made a quarterly natural resource management trip to `Ōhikilolo and outside professional help was sought. Desmond Ogata of the University of Hawaii Agricultural Diagnostic Service Center collected some *Myrsine lessertiana* samples and identified a native fungus called *Phomopsis*. He stated that this fungus acted secondarily and that something else was most likely the primary stress factor.

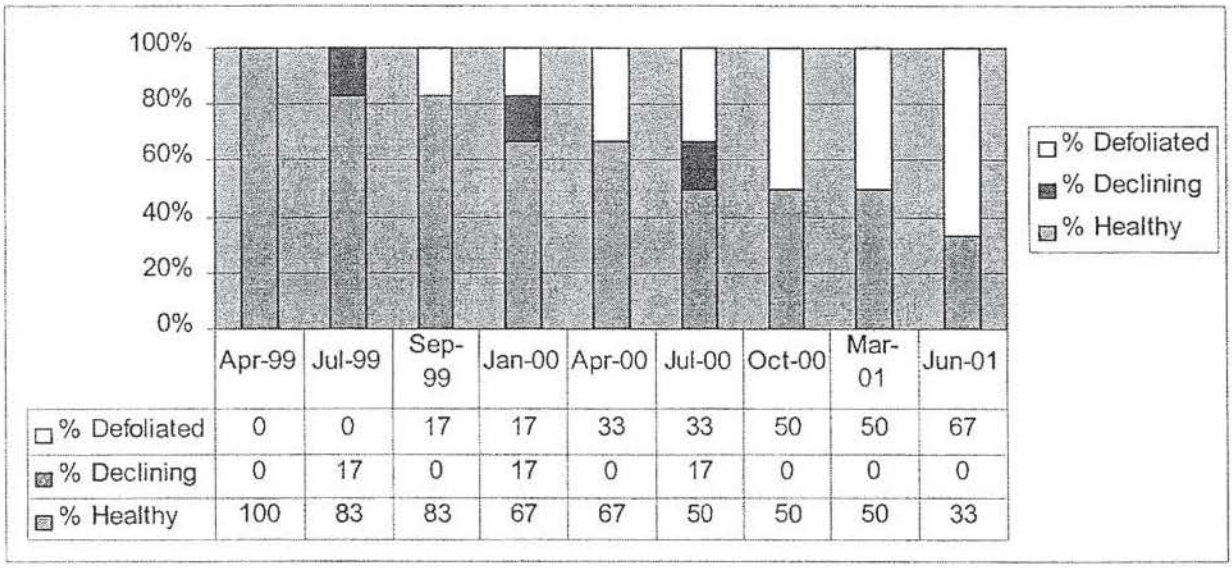
It appeared that it might take more time to discover the major cause of the decline, so it was decided to take action that might at least be beneficial in the meantime. Three categories of living plants were designated and six trees in each category were selected. The three categories are foliated (F), partially foliated (P), and leafless (L). Three plants of each category were given Miracle Grow and the other three Nutricote fertilizer. Miracle Grow is a fast-acting liquid fertilizer whereas Nutricote is a slower-acting capsule that releases fertilizer slowly over time into the soil. These fertilizer treatments were continued during the next three visits, but were then discontinued because they did not seem to be effective. In fact, some of the treated trees had begun to lose their leaves.

Over the past two years of this study four of the originally "foliated" trees are now leafless and the other two are in decline. Also, four of the originally "partially foliated" trees are now leafless and the other two remain partially foliated. The originally leafless trees are still leafless and disintegrating. No tree was ever observed to lose its leaves and then regrow them. The trees that were selected for the partial category were healthy trees to begin with and were not selected because they had already started to lose their leaves. They were just not as full of leaves as the "foliated" trees. Considering these data, a full 75% of the original healthy trees have already lost their leaves and two more are in decline.



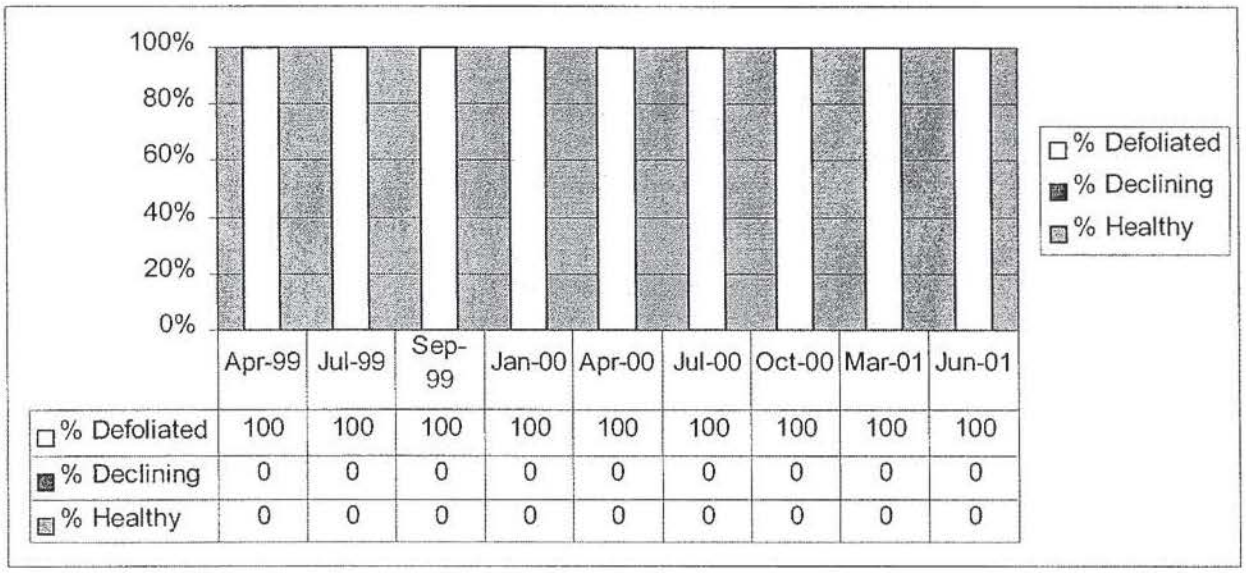
	Apr-99	Jul-99	Sep-99	Jan-00	Apr-00	Jul-00	Oct-00	Mar-01	Jun-01
% Defoliated	0	0	17	33	33	33	50	50	67
% Declining	0	17	17	0	0	17	33	33	33
% Healthy	100	83	67	67	67	50	17	17	0

Figure 5.4 "Foliated" *Myrsine lessertiana*



	Apr-99	Jul-99	Sep-99	Jan-00	Apr-00	Jul-00	Oct-00	Mar-01	Jun-01
% Defoliated	0	0	17	17	33	33	50	50	67
% Declining	0	17	0	17	0	17	0	0	0
% Healthy	100	83	83	67	67	50	50	50	33

Figure 5.5 "Partially foliated" *Myrsine lessertiana*



	Apr-99	Jul-99	Sep-99	Jan-00	Apr-00	Jul-00	Oct-00	Mar-01	Jun-01
% Defoliated	100	100	100	100	100	100	100	100	100
% Declining	0	0	0	0	0	0	0	0	0
% Healthy	0	0	0	0	0	0	0	0	0

Figure 5.6 "Leafless " *Myrsine lessertiana*

On the `Ōhikilolo trip in July 2000, Jen Saufler, a UH graduate student, collected soil and plant samples to help with the *Myrsine lessertiana* analysis. In her preliminary study she found that extreme cavitation in plant xylem can be caused by root flooding followed by drought. This phenomenon can lead to dieback in affected plant species. Another significant find was that the soil moisture in the dieback areas averaged 60%, whereas in the healthy areas it averaged only 33%. This may appear contrary to what might be expected; if drought is causing the *Myrsine* dieback, then the area of dying *Myrsine* should be drier and not wetter. According to Talbert Takahama of the state of Hawaii NAR, the healthy area may be drier because it has more "pumps," meaning there are more healthy trees present absorbing moisture. In the wetter area there may be fewer healthy trees using the available water and therefore the soil moisture level is higher. NRS also plan to outplant more greenhouse-grown *Myrsine* that have been propagated from seeds collected from `Ōhikilolo.

NRS have been performing mark/recapture work on `Ōhikilolo snail populations since August 1998. These studies were initiated in accordance with investigations that Dr. Hadfield had done at Kānehoa (Hadfield and Mountain, 1980) Pahole, and Palikea (Hadfield, 1993). NRS have furthered the understanding of demographic characteristics by collecting data for growth rate analysis, size/age frequency distribution, and population estimates. It was hoped that a lot would be learned about the habits of *Achatinella mustelina* on `Ōhikilolo and that this information would contribute to better management of the species.

Tree "N" will give some idea of how the *Myrsine lessertiana* dieback is affecting the native tree snails. In 1998, the original tree "N" had lost its leaves and Dr. Hadfield advised NRS to move the snails in two translocations, half at a time, to a healthy tree. A perfectly healthy-looking *Myrsine lessertiana* was chosen and on 4 March 1998, 13 of the 26 snails present in the tree were moved to the new tree. On 23 June 1998, the remaining snails found in the tree, which now numbered 17, were also moved into the new "N" tree. At this point 30 snails had been added to the tree and there were already some snails living in the tree that had not been marked. On 7 April 1999, a total of 56 *A. mustelina* were counted and marked in this new tree. This was by far the most snails seen by NRS in any one tree but by then the tree had already begun showing signs of leaf loss. By 4 January 2000 the tree was leafless and 43 snails were counted. On 25 July 2000, 34 snails were found, and by March 27, 2001 only 21 snails remained. Some snails chose

to stay in the leafless trees which suggests that the fungus on which they survive can be found growing on the bark of trees as well as the leaves.

According to records 456 total snails have been marked in twenty trees. Of these twenty trees, fifteen have been *Myrsine lessertiana,* and of these fifteen, fourteen have lost their leaves. `Ōhikilolo is of special concern not only because there is a large, healthy population of snails found there, but also because of the *Myrsine* dieback. Following some of the work that Dr. Hadfield had done in his study sites at Kānehoa in 1976 and Pahole in 1984, NRS attempted to distinguish any differences between the population at `Ōhikilolo and these populations. In analyzing these data there appears to be a strong correlation between what was found at `Ōhikilolo and what Dr. Hadfield had seen at his study sites. An analysis of the population's size-frequency distribution showed that there was a fairly even distribution of size classes up to the 18.5 mm size class. Here approximately 40% of the snails measured were found in the largest size categories. This curve was very similar to what Dr. Hadfield had found previously. One dissimilarity was that birth sizes at `Ōhikilolo were somewhat smaller at 3.5 mm (compared with 4.50 mm at Kânehoa). Snails develop a lip or thickened edge of shell around their aperture at the time of sexual maturity and this was generally seen at approximately 18.5 mm to 21.0 mm.

Growth rate curves were plotted using shell length as a measure of increase over time. These data suggest that younger snails grow at faster rates than snails that are approaching their maximum length. This differs from what Dr. Hadfield had found at his study sites. He noted that animals of all sizes appeared to be growing at about the same rate. He also noted that their findings were unusual and that it is more common for gastropods to show rapid early growth and a decreased rate of growth as size increased. These data are inconclusive but this appears to be what was seen on `Ōhikilolo. Snails that joined the study when they were 12.0 mm or 11.0 mm showed growth rates of 3.26 mm/yr or 3.09 mm/yr respectively. Snails that were 17.5 mm or 16.5 mm grew at rates of 1.06 mm/yr or 1.92 mm/yr. Many of the young snails that were marked during the study were marked once and never seen again. Pilsbry and Cooke (1912-1914) had suggested that "young shells wandered more widely than the adults." This was found to be very true in the case of `Ōhikilolo. Many of the snails that were seen and recaptured four or five times were marked initially as adults and therefore could not yield significant data for growth/study analyses because they were already at or near their maximum growth when first seen.

It is not possible to use conventional population estimate methods for `Ōhikilolo, as the population is too large to get a sizable fraction of the entire population. When the mark/recapture data are examined, only about 40% to 60% of the previously marked snails can be found at any one visit. These are not large, leafy trees in which many snails can hide and not be seen. Rather, the data suggest that this is an open population and that there is a lot of migration in and out of trees. This is a violation of many methods of estimating abundance. Random sampling is crucial to all models. To date, NRS have limited sampling efforts to trees that are known to contain high numbers of snails. This sampling method also violates assumptions for models that are designed for open populations. As a side note, the environment has undergone many changes even in the short time that NRS have been visiting the area. These environmental changes also could affect population estimates if snails move in response to such changes. As discussed, 14 of the 15 *Myrsine lessertiana* snail study trees have lost their leaves during the past four-year's time. Most of these trees are still standing but are leafless and still harboring live snails. One tree in particular had 26 snails four years ago which were translocated to a different healthy host tree. After the translocation six more snails moved into the leafless tree and at least that many have been seen there for the past two years (although not necessarily the same six snails). In the meantime, the new host tree has now lost its leaves but at last count had a population of 21 snails.

On the top of `Ōhikilolo Ridge near the main helicopter landing zone is a fenced area comprising approximately 2.5 acres in size. On 28 March 2001 NRS set up 5 transects through this area with the intention of counting snails and estimating the total number of snails present. Transects consisted of 72m, 75m, 78m, 100m, and 108m in length. All were 5 meters wide and ran from one edge of the fence to the other. A total of 207 *A. mustelina* were counted. The transect areas comprise approximately 20% of the total area inside the fence. Using Jolly's Methods for population estimates (Krebs 1989) the total number of snails inside the fence exclosure is 1001 ± 918. Most of the 207 snails that were counted were scattered throughout the transects.

The table below shows what kinds of vegetation they were found on.

Achatinella mustelina

Plant Species	Number of Snails
Antidesma platyphyllum	57
Myrsine lessertiana	27
Freycinetia arborea	23
Melicope oahuensis	23
Metrosideros polymorpha	17
Nestigis sandwicensis	13
Dodonaea viscosa	12
Psychotria sp.	10
Hedyotis acuminata	8
Scaevola gaudichaudiana	7
Alyxia oliviformis	6
Bobea sandwicensis	1
Elaphoglossum aemulum	1
Platydesma cornuta	1
Schinus terebinthifolius	1

Table 5-1 `Ōhikilolo transect snails and vegetation

The size of snails was also considered during the transect counts. The small category was <8mm; the medium category from 8mm to 18mm; and the large category >18mm. The individual snails were not actually measured with calipers but placed into size categories visually. The breakdown was as follows:
Small – 14
Medium – 45
Large - 96
This totals 155 with size classes instead of 207. One leafless *Antidesma platyphyllum* contained 31 snails while one *Myrsine lessertiana* had 21snails. Size classes were not determined in these two trees. The breakdown of snails between the three different size classes is consistent with what has been found previously with NRS monitoring on `Ōhikilolo.

The third site is located within a snail enclosure in the Kahanahāiki Gulch MU, MMR. This project has been a cooperative effort between the Army and the State Division of Forestry and Wildlife and was constructed in 1998. The State provided the materials and construction and NRS have provided the maintenance and monitoring of the enclosure. The snail enclosure is modeled after a design developed in Tahiti on the island of Moorea to protect *Partula* snails. The enclosure combines physical, chemical and electrical barriers to keep out predatory snails and rats. It is designed with a salted trough and electric fence to prevent entry of *E rosea* and an overhanging wall portion to exclude rats. During a Sierra Club Service Project in 1999, a strip of

carpeting was added to the salt trough to help maintain a constant presence of salt. Experiments with live *E. rosea*, showed the salt tough is effective in repelling them. *Acacia koa* trees have been outplanted around the outside of the enclosure to help create some shade where a gap had been made during construction. NRS also plan to outplant *Nestigis sandwicensis* inside the enclosure as other non-native plants are weeded out. In October 1998, NRS marked 55 *A. mustelina* in the enclosure. On 21 June 2000, 54 snails were counted. Of these, 23 were recaptures and 31 were newly marked snails.. When these numbers are applied to the Lincoln Index (Poole 1974) mark/recapture formula, the total number estimated in this enclosure is 129 ± 20. On 3 April 2001 a total of 56 snails were marked with a blue paint pen. On a return trip on 14 June 2001 a total of 62 snails were seen. Of these, 29 had been previously marked and 33 were not marked. Using the Lincoln Index a total of 120±16 snails are estimated for this site. This population is also exceptional, as there are no other known populations as large as this one in this general area.

During the mark/recapture in June 2000, NRS did find some seeds from *Nestigis sandwicensis* that had been eaten by mice or rats. Snap traps were placed inside the enclosure and one rat was caught. This proves that although no rat predation has been seen on the snails, rats can penetrate the enclosure. The enclosure will continue to be monitored to ensure that no predatory animals are eating the snails and NRS plan to bait for rats on the outside of the enclosure. If this type of threat control proves worthwhile it would provide an in-situ environment for raising and protecting snails in the future. One concern with the snail enclosure is that *A. mustelina* on the outside may attempt to get in. From observations using other snails it appears that snails are only repelled by the salt and should not be harmed or killed by it. Recommendations for *A. mustelina* include vigilant and responsible work at all three of the mark/recapture sites. NRS are privileged to be sub-permittee's with Dr. Hadfield and will capitalize on these opportunities to work and study closely with native snails. The snail enclosure will be maintained and monitored. NRS will continue to search for new populations of *A. mustelina* in unexplored areas.

5.6.h *Achatinella pulcherima*

Achatinella pulcherima was reported in 1974 from the Helemano drainage vicinity, KLOA, but has not been found by NRS. Surveys have been and will continue to be conducted to search for individuals of this species.

5.6.i *Achatinella sowerbyana*

This species is the most common in the Ko`olaus. Historically, it was once found throughout KLOA but today is found mostly in the Ko`olau Summit region in the Castle Trail, Poamoho Trail, and SBE areas. Next to *A. mustelina* it is considered to be the most commonly found *Achatinella* species on O`ahu. NRS have flagged trees in the above-mentioned areas where these snails have been identified, have monitored them annually, and plan to monitor them biannually in the future. 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 more microhabitats.

Over the past four years while camping at the Poamoho Trail and Summit Areas, NRS have set out snap traps for rats and often caught two or three in one night. NRS have hiked to some of Dr. Hadfield's old study sites in this area and will continue to monitor the snails here. This past year on 25 September 2000 Dr. Hadfield escorted NRS to his old sites in the vicinity of the Poamoho Cabin. NRS had not surveyed these areas before. At the site 5 minutes walk south of the

Poamoho Trail monument, at 2,450 ft elevation, a total of 17 *A. sowerbyana* were found. At the site just north of the Poamoho Trail junction a total of 64 *A. sowerbyana* were counted. On 8 May 2001 the area to the west of Pu'u Pauao and leeward of the Summit Trail was surveyed for snails. The area surrounding the Poamoho Cabin pond was surprisingly rich for *A. sowerbyana.* A total of 46 snails were counted. The habitat is especially wet here and it seems that perhaps the abundance of moisture acts as a deterrent to predators. Some of the trees actually have water at their base and the opportunities for snails to reach other trees are greatly limited. This pond area was again surveyed on 13 June 2001. No snails were seen along the ridge coming down from the cabin but in the areas in and around the pond a total of 72 *A. sowerbyana* were counted. With this recent survey the pond area seems to be one of the two biggest populations of *A. sowerbyana.*

A. sowerbyana is a good candidate for mark/recapture efforts, if such efforts are shown to be successful at other sites as a population monitoring technique. Threat control will be implemented around known aggregations of *A. sowerbyana* if necessary. The `Ōpae`ula Watershed Project has constructed a fence exclosure in the Pe`ahināi`a/Summit area during the past year. NRS will now have more management work to perform in this area and plan to set out snap traps, collect data, and discuss initiating a predator control program at selected snail sites.

While camping at the Pe`ahināi`a Trail and summit area in August 1999, snap traps were put out on two successive nights. Three mice and three rats were caught. NRS set out three bait buckets for rat control in response to these catches. This past year three more rats were caught and the bait buckets were increased to a total of five. During the August 2000 camping trip, ten snap traps were set out on two successive nights and no rats were caught. 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.

In May 1999, NRS were dropped off by helicopter on a ridge west of the Lehua Maka Noe Bog that is now known as "Bloody Finger Ridge." This ridge was selected because it is almost completely surrounded by water and thus was thought to possibly have fewer predators. Here staff counted 36 *A. sowerbyana* in approximately four hours of searching. This experience shows once again that there are possibilities of finding more snails when new and probably unexplored areas can be searched. In October 1999, NRS spent three days searching an area west of "Radio LZ," which is now known as "Hesperomannia Hill." Although much of this habitat looked suitable for snails, none were found. This is another example that demonstrates how patchy the populations of snails can be. Sometimes miles separate known snail sites.

5.6.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. Amastrids have largely been ignored by most biologists, 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.

Dr. Daniel Chung, a professor at Kapiolani Community College in Honolulu, joined NRS during a field trip to the SBS in 1996. Dr. Chung has been studying snails in Hawaii for more than twenty-five years and is very knowledgeable. He led NRS to a patch of *Freycinetia arborea* (`Ie `ie), *Urera glabra* (Ōpuhe), and *Pipturus albidus* (Māmaki), native Hawaiian plants known to support *Amastra micans* populations. No sightings had been documented since 1966 for these land snails. In this area the group identified three live A. micans and collected numerous empty

shells. *Achatinella mustelina*, *Amastra micans*, and *Laminella sanguinea* are all found together in this same habitat.

After further study NRS discovered signs of rat predation on *Achatinella* shells and also found shells of *Euglandina rosea*. Following Dr. Chung's advice, NRS returned to the site and started a predator control program using diphacinone bait stations to control rats in the area. NRS have continued to maintain this management program for the past three years. Although *A. mustelina* continue to be seen here, *Amastra micans* has been harder to find. None were seen for a period of one and a half years. In July 1999, four live *A. micans* were found. On this same day a live *E. rosea* was also found in the patch. This site is located on a very sloped hillside and monitoring needs to be done carefully to minimize impact. NRS will continue monitoring and maintaining bait stations, and also meeting with the Toxicants Working Group to determine a safe control toxicant for *E. rosea*. Surveys in similar habitat did identify one additional remaining pocket of live amastrids on the slopes below the summit. NRS will conduct surveys at the *A. micans* site during each visit and any *E. rosea* found will be killed.

In a 1998 report, NRS stated an interest to begin a captive propagation program since *Amastra* is not yet listed as endangered but rather is considered a Species of Concern. In February 1999, two live *A. micans* were collected from a new population on the slopes of Pu'u Hâpapa and brought back to the Natural Resources Center. The snails were kept in plastic buckets in an air-conditioned office at between 70 and 75 degrees. Samples of the preferred vegetation mentioned above are kept in a refrigerator and replaced every two weeks. Two *A. micans* were born in captivity but did not survive, possibly because of slightly warmer summer temperatures. One more adult was added and recently both of the original adults died, possibly due to mites, disease, diet, or old age. According to Dr. Chung, *A. micans* live approximately four to five years and these two had been in captivity for one and a half years. NRS continued raising these snails in captivity until 27 September 2000 when the last remaining adult was released back to the original habitat on Pu'u Hāpapa. Trying to raise these snails in the office proved to be a demanding and difficult endeavor. The office environment simply was not suitable over the long-term. The snails could survive but did not seem to prosper. The temperature seemed to be desirable but the air conditioning tended to dry the containers out and moisture needed to be added daily. During the past year no live *Amastra micans* have been recorded.

NRS collaborated with Dr. Chung in writing an article that was published in the Bishop Museum Occasional Papers, 28 May 1998, entitled "Recent Records of the Landsnails *Amastra micans* and *Laminella sanguinea*." The Army Natural Resource Program also contributed 15 dead specimens of *A. micans* and 6 dead specimens of *L. sanguinea* to the Bishop Museum collection.

5.6.k *Laminella sanguinea*

Laminella sanguinea have also been found at the *Amastra micans* site in SBS mentioned above. NRS were happily surprised to locate nine live *L. sanguinea* here in 1996. This was the first documented sighting since 1993. Unfortunately, many empty shells of dead snails were also found. Since *L. sanguinea* and *A. micans* are sometimes found in the same microhabitat, the predator control conducted for *A. micans* applies to both species. *L. sanguinea* is not listed as an endangered species but like *A. micans* is a Species of Concern. NRS have found shells of *L. sanguinea* in other places in the SBW and SBS but had not been able to find live specimens anywhere else. In December 1998, 27 live *L. sanguinea* were found on Pu'u Hāpapa.

Raising *L. sanguinea* in captive propagation was also discussed as a prudent management activity in the PCSU report of 1997-1998. It appears that the same threats affecting all of the other native

Hawaiian snails are also affecting them. Unlike some of the other known areas where NRS find snails, this one is at a much lower elevation and is much more susceptible to the ravages of *E. rosea*. In November 1998, NRS began raising *L. sanguinea* at the Natural Resources Center. Originally one pair was brought back from Pu'u Hâpapa and one other adult added later. It was difficult to raise the snails to maturity and immature snails born in captivity were unable to survive longer than one and one half years. On 27 September 2000 the surviving two adults and two juveniles were released to their original habitat on Pu'u Hāpapa.

Another management proposal for the Pu'u Hâpapa area was to camp there overnight and set out snap traps for rats near the prime snail habitat. This was accomplished when ten traps were set out in one night and three rats were caught. NRS began a predator control project for rats in February 2000 and continue to monitor this area twice a quarter. There are a total of eight bait stations on Pu'u Hâpapa and six more in the SBS. Hopefully, with continued vigilance, the rat problem will be reduced and the snails will be protected.

On 6 June 2000 five live *Laminella sanguinea* were counted in the SBS during the *Achatinella mustelina* surveys. Since then, not as much time has been allotted to surveying while the rat bait buckets are restocked. On more recent trips, only two or three snails have been seen. Up above on Pu'u Hâpapa the rat bait is usually restocked but the area where most of the *Laminella sanguinea* have been seen is avoided. The snails are found in very steep terrain with many loose rocks. It is difficult to work in the area without doing some damage. Therefore, the site is visited infrequently. Five live *Laminella sanguinea* were seen here with Dr. Michael Hadfield on 19 April 2001 and samples were collected for genetic studies.

5.7 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.
- 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 working to develop a predator control technique for wet forest areas that can remain effective over long periods of time.
- Supporting the licensing of a more toxic rodenticide to improve rat control in remote areas.
- Supporting Dr. Hadfield's efforts to develop a bait for controlling *E. rosea* and use it where appropriate.
- Working with other agencies to develop long-range snail management strategies. Increasing visits to Ko'olau snail sites and improve predator control in these areas.

5.8 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 5-2 Recommended Action Time Table

Range	MU	Action	Q4	Q1	Q2	Q3
MMR	Kahanahāiki	Achmus mark/recapture			X	
MMR	Kahanahāiki	Monitor Achmus site/check salt	X	X	X	X
MMR	Kahanahāiki	Achmus rat control	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	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 rat control	X	X	X	X
KLOA	KLOA	Achliv mark/recapture		X		X
KLOA	KLOA	Achliv rat control	X	X	X	X
KLOA	KLOA	Achsow rat control	X	X	X	X
KLOA	KLOA	Monitor known Achbyr sites				X
KLOA	KLOA	Monitor known Achlil sites	X		X	
KLOA	KLOA	Monitor known Achliv sites		X		X
KLOA	KLOA	Monitor known Achsow sites		X		X
MMR	ʻŌhikilolo	Achmus rat control	X	X	X	X
MMR	ʻŌhikilolo	Monitor known Achmus sites	X	X	X	X
MMR	ʻŌhikilolo	Outplant Myrles		X		
SBMR	SBS	Amamic & Lamsan rat control	X	X	X	X
SBMR	SBS	Monitor Amamic & Lamsan sites	X	X	X	X
SBMR	SBW	Survey for Amamic and Lamsan		X		X
		Develop monitoring techniques	X	X	X	X
	General	Rare Snail Task Force Spearhead		X		
		Tripler Damselfly monitoring		X		X

In March 2000, a study was initiated to collect samples of *Achatinella mustelina* from various sites in the Wai'anae Mountains. D'Alte Welch published a book entitled "The Distribution and Variation of Achatinella mustelina mighels in the Wai'anae Mountains, O'ahu" in 1938. This book was the field guide that was used to determine which areas were to be surveyed. Welch separated the snails into sub-species and the genetic work will be used to study the variation between the different populations. These surveys involved not only Army training lands but also land managed by The Nature Conservancy of Hawaii, the State Division of Forestry and Wildlife,

and the Board of Water Supply. The results of the genetic work are complete and are being used by the Mākua Implementation Team to determine future management. Although sequence data revealed clear evidence of highly structured geographic populations of *A. mustelina*, the pattern of genetic variation does not support the morphology-based subspecies proposed by Welch (Holland, 2001).

5.9 Rare Damselfly Management

Damselflies are part of the same order as dragonflies, with similar body structure, but smaller. They hatch from eggs and spend the next 3-4 months of their larval stage in water. When mature, the larvae crawl out of the water onto vegetation or a rock, shed their old cuticle, and emerge as adults with wings. They are federally listed as a Species of Concern.

On 31 March 1999, NRS, along with Arlene Pangelinan of the U. S. Fish and Wildlife Service and Kate Johnson of the University of Hawaii, participated in a translocation of native Orange-black damselflies (*Megalagrion xanthomelas*) from Tripler Army Medical Center (TAMC) to DMR. This damselfly was considered Hawaii's most abundant one in the early 1900s and was even commonly found in Honolulu gardens. Due to loss of habitat and the introduction of alien aquatic species such as guppies and topminnows, the damselfly had been reduced to a single remaining population at TAMC. When this population was threatened by expanding construction projects in 1995, the Army was requested to find another suitable habitat to ensure that this native damselfly would not become extinct on O`ahu. *Megalagrion xanthomelas* is still abundant on Moloka`i, Lāna`i, and Hawaii.

Pinao'ula'ula Stream at DMR was selected because it has no predatory alien fish and is located on a hillside where it will not impact training. The Army was fortunate to combine efforts with Kate Johnson, who used the translocation as a graduate research project and continued to monitor the site weekly for one year. NRS monitored the site bimonthly.

For the translocation the group collected 44 larvae (naiads) by scooping in the sediment of the stream with hand nets. Each naiad was placed in a plastic vial half-filled with stream water to keep the naiads cool. A total of 55 adults (30 females and 25 males) were captured using other hand nets. It was a sunny day, which helped to bring out many adult damselflies, and the collection was complete by 12:30 PM. The wings of the adults were marked so that they could be identified later at the translocation site. Adults were also placed in vials and stored in a cooler with blue ice.

Kate had already designated the relocation sites at the stream so after arriving at DMR the group proceeded to release the naiads in pairs into the water and the adults (one male and one female) into the air. Adults are believed to live for approximately 2-3 months. Kate found adults that had most likely emerged from naiads released in the stream but she never located any adults that had developed from eggs laid at the site. One of the problems that Kate noticed was crayfish. In the thesis that Kate Johnson submitted (Johnson 2001) she reported that she had captured 120 crayfish. While performing surveys for alien fish no one had ever observed crayfish but Kate was able to trap them and she suspected that they negatively impacted the success of the translocation. Although the temperature and pH of the two streams was similar, there were many differences that may have contributed to the failure of the translocation. The plants that were found at the two sites were very different. None of the plants that Neal Evenhuis had found female *M. xanthomelas* using for oviposition at TAMC were present at the translocation site. The water depth differed in that the TAMC stream is deeper (28 cm) compared to the DMR site (10 cm). The streambed bottoms differed in that TAMC was composed of dirt, gravel, and bedrock while the translocation site is muddy. Also, the available food sources differed. It is possible that the translocation failed due to insufficient or unsuccessful reproduction or high mortality in the naiad phase of development.

The long-term survival of *Megalagrion xanthomelas* on O`ahu is important for the conservation of the species on the island and will not be abandoned because this effort to expand their range on

the island failed. The TAMC stream will continue to be monitored and perhaps in the future another more suitable stream will be located for another translocation. The USFWS has received grant funding to continue monitoring of the TAMC site and work in conjunction with the Bishop Museum to locate another site for translocation.

5.10 *Eleutherodactylus coqui* Management

In April 2001, NRS was alerted to the presence of *E. coqui* on SBE. Both the U. S. Fish and Wildlife Service and the State Department of Agriculture (DOA) had become aware of the infestation in the residential area. In exploring the reports, personnel noted that the frogs had crossed the fence onto military property. NRS accompanied FWS and DOA personnel on three trips to hand capture adult male frogs between May and August 2001. Over the coarse of these visits and through conversations with biologists involved with control efforts elsewhere in the State of Hawaii it became apparent that hand capture alone would not be an effective control option for this infestation. The following factors lead NRS, FWS, and DOA to this conclusion. First the infestation is too large. Secondly, there are dozens of male frogs across an area of approximately five acres. Thirdly, only a fraction of these can be removed through hand capture efforts.

Thus far, there has been no marked decline in the number of males detected after hand capture efforts. It is believed that there are probably at least an equal amount of females to males in the area. To date, no females have been removed through hand capture techniques. It is believed that removing males alone will have minimal effects on a population of this size. Another compounding factor is that females can store sperm, possibly for as long as six months.

NRS, FWS, and DOA have decided to take a more aggressive approach to this infestation by clearing vegetation and spraying. DOA and FWS are going to work on the residential side to educate the residence and get permission to spray on their private property. NRS is working with a DPW Entomologist to clear the infested area with bulldozers in preparation for spraying. Once permission has been gained on the private side and the area on the military side has been bulldozed agencies will coordinate spraying operations and post treatment monitoring. All spraying will be performed under DOA special use permit and will utilize either pyronone or caffeine based products. It is expected that spraying should rapidly decimate the population. NRS will continue to lead support to this operation and carefully monitor success.

CHAPTER 6 STREAM MANAGEMENT

6.1 PCSU Contract Requirements

The following is the PCSU contract requirement related to stream management followed by a brief discussion of NRS accomplishments.

Requirement (1n)

Assessing and establishing two stream monitoring plots in the `Ōpae`ula 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, as outlined in the Hawaiian Stream Bioassessment Protocol, Version 1.0. Based on the analysis of data and observations, recommendations shall be made for management actions.

Discussion

Due to time constraints, Dr. Michael Kido from the University of Hawaii Stream Research Center was not able to work with NRS to establish plots this year at `Ōpae`ula . Dr. Kido is still interested in cooperating with NRS to install plots. NRS will wait to perform installation until Dr. Kido is available because his methodology may need to be adjusted to better fit the high elevation environment. NRS and the `Ōpae`ula Watershed Protection Project partners also investigated working with USGS to install a stream gauge to monitor water quality parameters. Unfortunately, the costs were prohibitively expensive. NRS are also pursuing a project with Dr. Fujioka from the Water Resources Research Center at the University of Hawaii. Dr. Fujioka is interested in investigating water quality parameters in a watershed before and after ungulate exclusion.

6.2 Introduction to Stream Monitoring

Hawaii's perennial streams provide valuable surface water for agriculture and recreation. There are an increasing number of groups studying Hawaii's streams. Dr. Kido has been studying the unique biota and ecological functions of the Hawaiian perennial stream. Dr. Kido, Gordon C. Smith (USFWS) and Donald E. Heacock (DLNR) have updated the methodology for determining stream health based on physical habitat properties of the stream and biological criteria. United States Geologic Survey (USGS) has a crew on O`ahu studying both biotic and abiotic stream parameters through the National Water Quality Assessment Program. The University of Hawaii is also involved with water related projects through the Water Resource Research Center. These groups, as well as many more, have been cooperating through the Hawaii Stream Bioassessment Working Group. NRS have attended meetings in the past year and have kept up-to-date with the group's direction. When the group begins to focus on issues to which NRS can contribute, NRS will again attend meetings. NRS have encouraged the group to develop monitoring protocols to help measure and guide natural resource management such as ungulate control, in an adaptive way.

6.3 Stream Monitoring Results

No stream monitoring occurred this year. NRS will continue to pursue opportunities in stream monitoring and management in the coming year.

Table 6.1 Stream Monitoring Recommendations

Range	Action	Q4	Q1	Q2	Q3
KLOA	Establish monitoring plots in the upper reaches of `Ōpae`ula Stream. NRS will work with Dr. Kido to modify protocols to better monitor intact habitats in upper reaches		X		X
KLOA	Work with other watershed partnerships to cost share in addressing the issues of ungulate control			X	X
KLOA	Participate in Hawaii Stream Bioassessment Working Group when NRS can contribute to agenda items	X	X	X	X
KLOA	Encourage research on streams present on Army lands through Hawaii Stream Bioassessment Working Group	X	X	X	X

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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. [illegible]	F. scat	O. [illegible]	O. [illegible]	O.	Meters	F. trail	F. [illegible]	F. scat	O. [illegible]	O. [illegible]	O.	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-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

Goal: To gauge the effectiveness of weed control efforts.

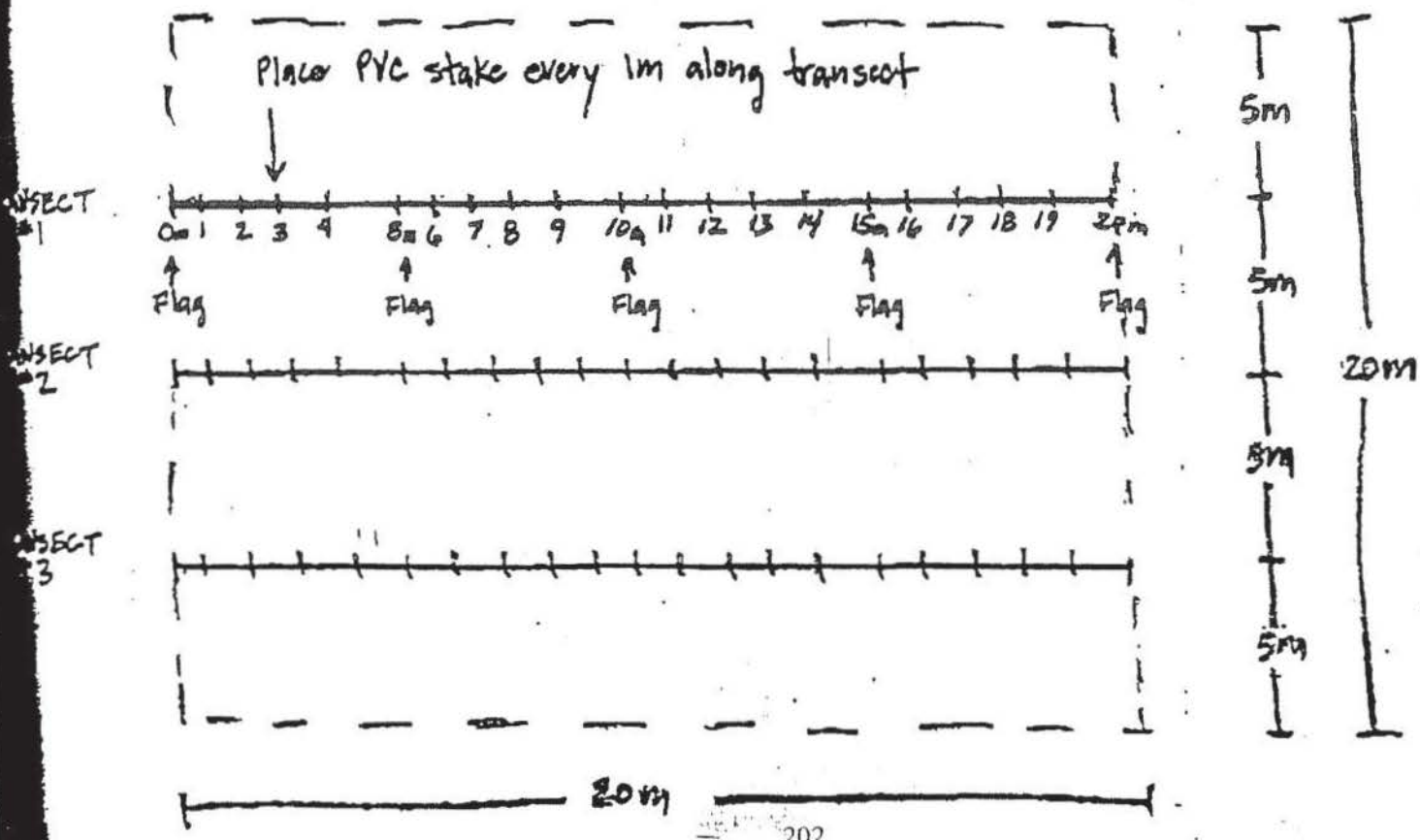
Supplies/Equipment:

- PVC stakes
- Measuring tape
- Flagging (one color)
- 1 m squared quadrat
- Forms
- Sledge/Hatchet to hammer in stakes
- Weed control tools/herbicide

METHODOLOGY

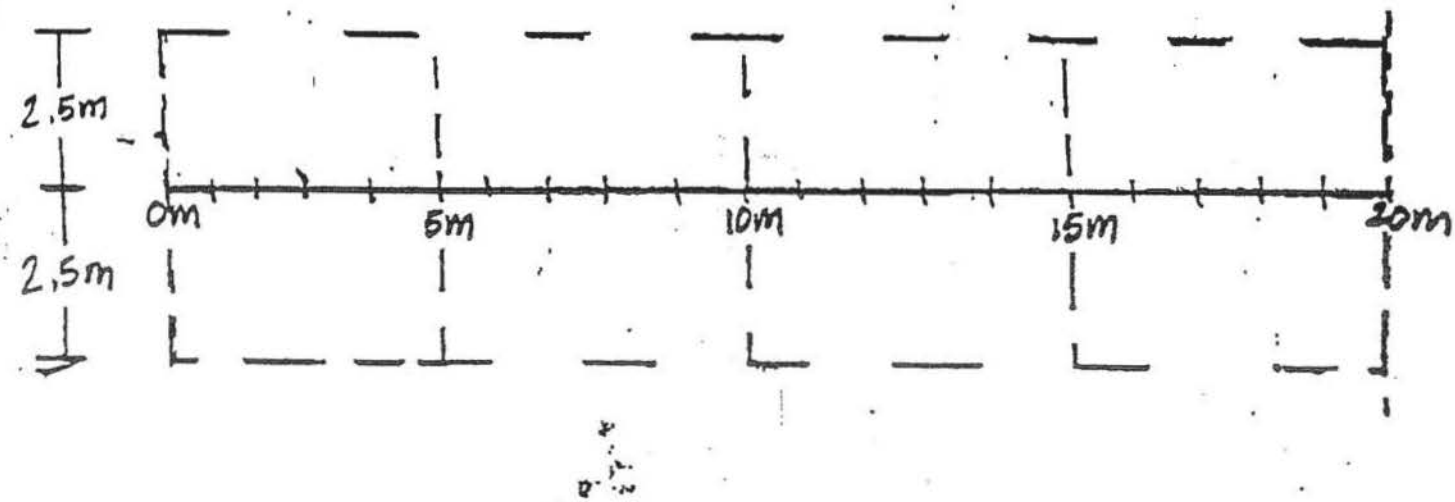
Designate two areas with similar vegetation/aspect/characteristics that are 20 x 20m. One area will be used as a control plot and the second as a treatment. There will be three vegetation monitoring transects in each 20 X 20 meter area. These transects will be used for canopy surveys and understory surveys. 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 through 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 1m X 1m quadrat fits snugly between stakes. Tie a flag at the 0m, 5m, 10m, 15m and 20 m stakes. Schematic of weed plot is as follows:



PART ONE--Canopy Cover Estimates
To determine effect of weed control efforts on canopy composition

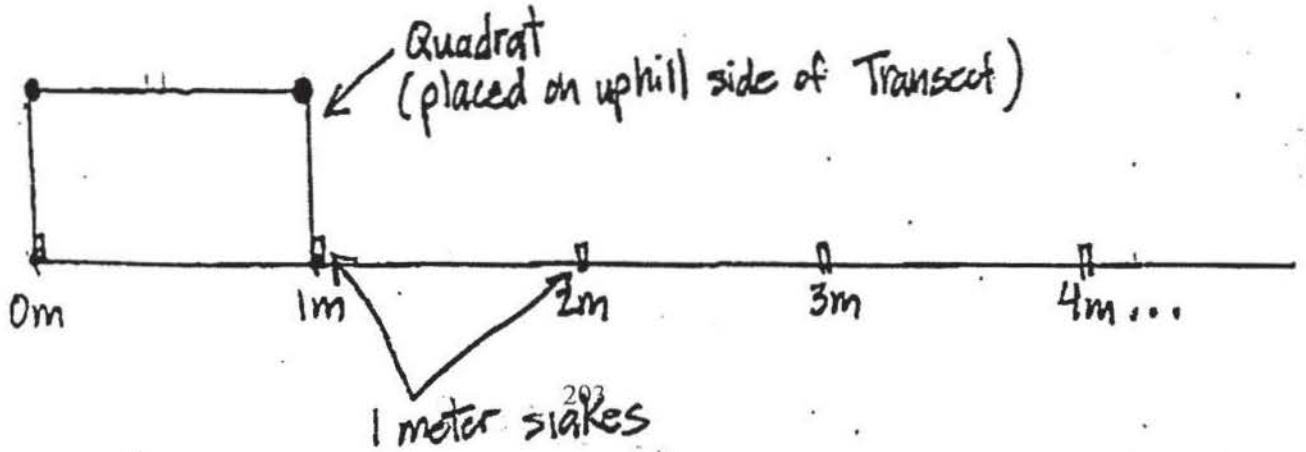
Canopy survey stations are spaced every 5 meters along each of the 20 meter transects and are 5m X 5m in area (5 meters along transect X 2.5 meters along either side of transect). Each transect has 4 canopy survey stations (4 X 5m = 20m) In each station estimate canopy coverage using a 10% incremental scale for <u>each species</u> greater than 1 meter in height. Also obtain estimates for <u>total native</u> canopy cover, total <u>non-native</u> canopy cover and <u>total combined</u> cover. Plot design is as follows:



PART TWO--Understory Survey (cover estimates and seedling count)
To determine effect of weed control efforts on understory herbaceous plants and seedling recruitment.

Understory surveys are done in 1m X 1m plots along each of the 20m transects. All understory estimates are made on the uphill side of the transects. Place 1m X 1m quadrat so that it fits snugly between the 1 meter stakes. To ensure consistent placement of the quadrat make sure the quadrat corners are <u>flush</u> with the top of the 1 meter stakes. Estimate coverage for <u>all species</u> less than 1m in height whether rooted in plot or not. Estimate <u>total native</u>, <u>total non-native</u> and <u>combined total</u> cover for each plot. All estimates are done using 10% incremental scale.

Woody species seedling COUNT
In each 1m X 1m plot obtain a COUNT <u>by size class</u> for <u>all woody species rooted in the plot</u> that are less than 1 meter in height. Size classes for woody species are: 1 = <10cm; 2 = 10-25cm; 3 = 25cm-1m.



Ground Cover Survey

Range: _____ Observer: _____
Plot#: _____ Weather: _____
Transect#: _____ Date: _____

Location: _____

Cover classes

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%

GROUND COVER SURVEY --all species <1m (cover classes given for each species)

species	T. cover	Nat. cover	Non. Nat. cover																									
0-1m																												
1-2m																												
2-3m																												
3-4m																												
4-5m																												
5-6m																												
6-7m																												
7-8m																												
8-9m																												
9-10m																												

Range
Plot
Location

Canopy Survey

Observer
Weather
Date

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

DPW Environmental Weed Control Plot Data Sheet

Range: ______________________ Observer: ______________________

Plot#: ______________________ Weather: ______________________

Area: ______________________ Date: ______________________

#: number of seedlings

%: percent cover

Cover Classes

0:0-1.	4:30-40%	8:70-80%
1:1-10%	5:40-50%	9:80-90%
2:10-20%	6:50-60%	10:90-100%
3:20-30%	7:60-70%	

Location: ____

____

____

____

____

Purpose: ____

Size classes

1:< 10cm

2:10-25cm

3:25-100cm

species	Total Native	Total Non-Nat.	Total Cover																																											
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	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																																														

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																																	
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13-14m																																	
14-15m																																	
15-16m																																	
16-17m																																	
17-18m																																	
18-19m																																	
19-20m																																	

* Size Classes 1: <10cm, 2: 10-25cm, 3: 25-100cm

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: apply. Indicate overstory height, which defines the habitat of the plant. Choose all that

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: from field Circle the appropriate estimated moisture regime. (This may not be possible

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 f or 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

United States Department of the Interior

FISH AND WILDLIFE SERVICE
911 NE 11th Avenue
Portland, Oregon 97232-4181

IN REPLY REFER TO:

LIST OF AUTHORIZED INDIVIDUALS
For TE-043638-3

1. Individuals authorized to conduct activities pursuant to this permit:

   Matthew Burt, Vince Costello, Steven A. Evans, Bill Garnett, Scott Henderson, Jordan Jokiel, Kapua Kawelo, Steven Kim, Joel Lau, Patrice Y. Moriyasu, Jobriath Rohrer, Lena Schnell, Laila N. Tamimi, Chris Tokumaru, and Frederick R. Warshauer.

   Other persons may conduct activities pursuant to this permit only under the direct, on-site supervision of an above-named individual.

6/4/01
Date

Sarah B. Hall
for Chief, Endangered Species

This list is valid only if it is dated on or after the subpermit issuance date.

DEPARTMENT OF THE INTERIOR
U.S. FISH AND WILDLIFE SERVICE

FEDERAL FISH AND WILDLIFE PERMIT

2. AUTHORITY-STATUTES
16 USC 1539(A)

REGULATIONS *(Attached)*
50 CFR 17.62
50 CFR 17.72

1. PERMITTEE

DIRECTORATE OF PUBLIC WORKS
DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY GARRISON, HAWAII
SCHOFIELD BARRACKS, HI 96857-5000

3. NUMBER: TE043638-3 — AMENDMENT

4. RENEWABLE	5. MAY COPY
[X] YES	[X] YES
[ ] NO	[ ] NO

6. EFFECTIVE	7. EXPIRES
06/04/2001	06/03/2005

8. NAME AND TITLE OF PRINCIPAL OFFICER *(If #1 is a business)*
WILLIAM E RYAN III
COLONEL, DIRECTOR OF PUBLIC WORKS

9. TYPE OF PERMIT
THREATENED AND ENDANGERED SPECIES

10. LOCATION WHERE AUTHORIZED ACTIVITY MAY BE CONDUCTED
ON LANDS SPECIFIED WITHIN THE ATTACHED SPECIAL TERMS AND CONDITIONS

11. CONDITIONS AND AUTHORIZATIONS:

A. GENERAL CONDITIONS SET OUT IN SUBPART D OF 50 CFR 13, AND SPECIFIC CONDITIONS CONTAINED IN FEDERAL REGULATIONS CITED IN BLOCK #2 ABOVE, ARE HEREBY MADE A PART OF THIS PERMIT. ALL ACTIVITIES AUTHORIZED HEREIN MUST BE CARRIED OUT IN ACCORD WITH AND FOR THE PURPOSES DESCRIBED IN THE APPLICATION SUBMITTED. CONTINUED VALIDITY, OR RENEWAL, OF THIS PERMIT IS SUBJECT TO COMPLETE AND TIMELY COMPLIANCE WITH ALL APPLICABLE CONDITIONS, INCLUDING THE FILING OF ALL REQUIRED INFORMATION AND REPORTS.

B. THE VALIDITY OF THIS PERMIT IS ALSO CONDITIONED UPON STRICT OBSERVANCE OF ALL APPLICABLE FOREIGN, STATE, LOCAL OR OTHER FEDERAL LAW.

C. VALID FOR USE BY PERMITTEE NAMED ABOVE.

D. Further conditions of authorization are contained in the attached Special Terms and Conditions.

[X] ADDITIONAL CONDITIONS AND AUTHORIZATIONS ALSO APPLY

12. REPORTING REQUIREMENTS
ANNUAL REPORTS DUE: 1/31
See permit conditions for further reporting requirements.

ISSUED BY	TITLE	DATE
Sarah B. Hall	CHIEF - ENDANGERED SPECIES	06/04/2001

SPECIAL TERMS AND CONDITIONS FOR
Directorate of Public Works

1. You were previously issued this permit on September 28, 1998. The terms and conditions set forth in that permit are hereby superseded by this amendment.

2. Acceptance of this permit serves as evidence that the permittee understands and agrees to abide by the "General Conditions for Native Endangered and Threatened Wildlife Species Permits," 50 CFR Part 13, 50 CFR 17.62 (endangered plants) and/or 50 CFR 17.72 (threatened plants), as applicable (copies attached). In addition, the permittee must have any other applicable State and Federal permits prior to the commencement of activities authorized by this permit.

3. The permittee is authorized to remove and reduce to possession (collect) *Abutilon sandwicense*, *Adenophorus periens*, *Alectryon macrococcus* var. *macrococcus*, *Alsinodendron obovatum*, *Alsinodendron trinerve*, *Asplenium fragile* var. *insulare*, *Bonamia menziesii*, *Caesalpinta kavaiensis*, *Cenchrus agrimonioides* var. *agrimonioides*, *Chamaesyce celastroides* var. *kaenana*, *Chamaesyce rockii*, *Ctenitis squamigera*, *Cyanea acuminata*, *Cyanea crispa*, *Cyanea grimesiana* ssp. *grimesiana*, *Cyanea grimesiana* ssp. *obatae*, *Cyanea koolauensis*, *Cyanea longiflora*, *Cyanea st. johnii*, *Cyanea superba* ssp. *superba*, *Cyrtandra dentata*, *Cyrtandra subumbellata*, *Cyrtandra viridiflora*, *Delissea subcordata*, *Diella falcata*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenza koolauensis*, *Euphorbia haeleeteana*, *Flueggea neowawraea*, *Gardenia manii*, *Haplostachys haplostachya*, *Hedyotis coriacea*, *Hedyotis degeneri* var. *degeneri*, *Hedyotis parvula*, *Hesperomannia arborescens*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Isodendrion laurifolium*, *Labordia cyrtandrae*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophyllum*, *Lipochaeta tenuifolia*, *Lobelia gaudichaudii* ssp. *koolauensis*, *Lobelia niihauensis*, *Lobelia oahuensis*, *Melicope lydgatei*, *Myrsine judii*, *Neraudia angulata* var. *angulata*, *Neraudia angulata* var. *dentata*, *Neraudia ovata*, *Nototrichium humile*, *Phlegmariurus nutans*, *Phyllostegia hirsuta*, *Phyllostegia mollis*, *Phyllostegia parviflora* var. *parviflora*, *Plantago princeps* var. *longbracteata*, *Plantago princeps* var. *princeps*, *Plantanthera holochila*, *Portulaca sclerocarpa*, *Pritchardia kaalae*, *Pteris lydgatei*, *Sanicula mariversa*, *Sanicula purpurea*, *Schiedea hookeri*, *Schiedea kealiae*, *Schiedea nuttallii* var. *nuttallii*, *Silene hawaiiensis*, *Silene lanceolata*, *Solanum incompletum*, *Solanum sandwicense*, *Spermolepis hawaiiensis*, *Stenogyne angustofolia*, *Stenogyne kanehoana*, *Tetramalopium arenarium*, *Tetramolopium filiforme* var. *filiforme*, *Tetramolopzum filiforme* var. *polyphyllum*, *Tetramolopium lepidotum* ssp. *lepidotum*, *Tetraplasandra gymnocarpa*, *Urera kaalae*, *Viola chamissoniana* ssp. *chamissoniana*, *Viola oahuensis*, and *Zanthoxylum hawaiiense* specimens for propagation and the establishment of a genetic storage bank for the purpose of enhancing their survival as specified in the permittee's January 5, 2001 amendment request in accordance with the conditions stated below.

4. Permitted activities are restricted to the following geographic areas in Hawaii:

a. Makua Military Reservation, Island of Oahu
b. Schofield Barracks Military Reservation, Island of Oahu
c. Kahuku Training Area, Island of Oahu
d. Kawailoa Training Area, Island of Oahu
e. Dillingham Military Reservation, Island of Oahu
f. Pohakuloa Training Area, Island of Hawaii

5. Authorized individuals:

Only individuals on the attached List of Authorized Individuals (List) are authorized to conduct activities pursuant to this subpermit. The List, printed on Service letterhead, may identify special conditions or circumstances under which individuals are authorized to conduct permitted activities and must be retained with these Special Terms and Conditions. Each named individual shall be responsible for compliance with the terms and conditions of this permit.

To request changes to the List, the subpermittee shall submit written requests to the Service's Division of Ecological Services (DES), P.O. Box 50088, Honolulu, Hawaii 96813. Two copies of the request shall be submitted at least 30 days prior to the requested effective date. The request shall be signed and dated by the permittee and include:

a. The name of each individual to be appended to the List;

b. The resume/qualifications statement of each person to be appended to the List, detailing their experience with each species and type of activity for which authorization is requested;

c. The names and phone numbers of a minimum of two references; and

d. The names of the individuals to be deleted from the List.

Note: This procedure is for personnel changes only. For requests to renew/amend this permit, a complete application must be submitted to the Chief, Endangered Species, at the Portland Regional Office (PRO), Ecological Services, 911 NE. 11th Avenue, Portland, Oregon 97232-4181.

6. Taking of the *Abutilon sandwicense*, *Adenophorus periens*, *Alectryon macrococcus* var. *macrococcus*, *Alsinodendron obovatum*, *Alsinodendron trinerve*, *Asplenium fragile* var. *insulare*, *Bonamia menziesii*, *Caesalpinta kavaiensis*, *Cenchrus agrimonioides* var. *agrimonioides*, *Chamaesyce celastroides* var. *kaenana*, *Chamaesyce rockii*, *Ctenitis*

Cyanea grimesiana ssp. *obatae*, *Cyanea koolauensis*, *Cyanea longiflora*, *Cyanea st. johnii*, *Cyanea superba* ssp. *superba*, *Cyrtandra dentata*, *Cyrtandra subumbellata*, *Cyrtandra viridiflora*, *Delissea subcordata*, *Diella falcata*, *Diplazium molokaiense*, *Dubautia herbstobatae*, *Eragrostis fosbergii*, *Eugenza koolauensis*, *Euphorbia haeleeteana*, *Flueggea neowawraea*, *Gardenia manii*, *Haplostachys haplostachya*, *Hedyotis coriacea*, *Hedyotis degeneri* var. *degeneri*, *Hedyotis parvula*, *Hesperomannia arborescens*, *Hibiscus brackenridgei* ssp. *mokuleianus*, *Isodendrion laurifolium*, *Labordia cyrtandrae*, *Lepidium arbuscula*, *Lipochaeta lobata* var. *leptophyllum*, *Lipochaeta tenuifolia*, *Lobelia gaudichaudii* ssp. *koolauensis*, *Lobelia niihauensis*, *Lobelia oahuensis*, *Melicope lydgatei*, *Myrsine judii*, *Neraudia angulata* var. *angulata*, *Neraudia angulata* var. *dentata*, *Neraudia ovata*, *Nototrichium humile*, *Phlegmariurus nutans*, *Phyllostegia hirsuta*, *Phyllostegia mollis*, *Phyllostegia parviflora* var. *parviflora*, *Plantago princeps* var. *longbracteata*, *Plantago princeps* var. *princeps*, *Plantanthera holochila*, *Portulaca sclerocarpa*, *Pritchardia kaalae*, *Pteris lydgatei*, *Sanicula mariversa*, *Sanicula purpurea*, *Schiedea hookeri*, *Schiedea kealiae*, *Schiedea nuttallii* var. *nuttallii*, *Silene hawaiiensis*, *Silene lanceolata*, *Solanum incompletum*, *Solanum sandwicense*, *Spermolepis hawaiiensis*, *Stenogyne angustofolia*, *Stenogyne kanehoana*, *Tetramalopium arenarium*, *Tetramolopium filiforme* var. *filiforme*, *Tetramolopzum filiforme* var. *polyphyllum*, *Tetramolopium lepidotum* ssp. *lepidotum*, *Tetraplasandra gymnocarpa*, *Urera kaalae*, *Viola chamissoniana* ssp. *chamissoniana*, *Viola oahuensis*, and *Zanthoxylum hawaiiense*:

The permittee is authorized to remove and reduce to possession seeds, inflorescence, spores, fruits, cuttings, and leaves within the geographic boundaries specified above and the time limitation specified in the permit, provided that:

a. Propagation (including seed storage/tissue culture) will be conducted at the following facilities or a facility that is previously approved in writing by the DES.

   i. Lyon Arboretum
   ii. Waimea Arboretum and Botanical Gardens
   iii. Hawaii Volcano Mid-Elevation Plant Propagation Facility
   iv. National Tropical Botanical Garden
   v. Pahole Mid-Elevation Nursery
   vi. Pohakuloa Rare Plant Shelter
   vii. Schofield Plant Facility
   viii. National Seed Storage Laboratory

b. Except as provided in "c" below, no more than 15 percent of the seeds, fruits, inflorescenses, and spores and no more than six cuttings, which must be less than 8 inches long, per plant may be collected.

c. At species localities with less than 10 individuals and observed to be incapable of natural recruitment, 20-100 percent of seeds produced per plant may be collected. Prior to collecting 20-100 percent of seeds per plant, verbal notification requesting

concurrence shall be made to DES (telephone: 808-541-3441; fax: 808-541-3470) and, within 3 working days, notification in writing shall be made to DES.

d. A photograph showing the population from which the propagules were collected must be properly labeled and deposited with the B.P. Bishop Museum, Honolulu, Hawaii, as a voucher.

e. All propagated plants will be outplanted within protected areas within the historical range of the species, with appropriate permission from landowners, in accordance with recovery plans, and following consultation with the DES.

7. In the event that a plant is accidentally damaged or destroyed, the permittee shall:

a. Within 24 hours, notify the PRO (telephone: 503-231-2063; fax: 503-231-6243) and the DES (telephone: 808-541-2749; fax: 808-541-3470) and, within 3 working days, follow-up such verbal notification in writing to both offices.

With the written notification, the permittee shall include a report of the circumstances that led to the damage or destruction. A description of the changes in activity protocols that will be implemented to reduce the likelihood of such damage or destruction from happening again should be included, if appropriate.

b. Preserve any dead specimens in accordance with standard museum practices. Before expiration of the permit, all preserved specimens will be properly labeled and deposited with the designated depository listed below. The permittee shall supply the depository with a copy of this permit to validate that the specimens were taken pursuant to a permit.

8. Designated depository:

The B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii 96817. If the B.P. Bishop Museum does not wish to accession the specimens, the permittee should contact the Division of Law Enforcement in Honolulu, Hawaii (telephone: 808-541-2681; fax: 808-541-3062) for instructions on disposition. Disposition must be reported in the annual reports.

9. The plant species referenced herein or its progeny shall not be sold, donated, or transferred without written authorization from the DES. This condition applies until authorized disposal of the subject species and its progeny is complete, regardless of the expiration date of this permit.

10. All activities conducted under this permit must be coordinated with the Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife (Honolulu office telephone: 808-587-0166; Hilo office telephone: 808-933-4221).

11. Annual reports of activities shall be submitted to the DES by June 30, following each year this permit is in effect. The report shall be in the following format: (a) an introduction section addressing reasons and objectives for collecting the species; (b) a methodology section addressing data collection and analysis procedures; (c) a results section that provides the data collected, including information on any other federally listed species detected while conducting activities authorized under this permit; and (d) a conclusion section that specifically provides recommendations for recovery of the species. If no activities occurred over the course of a year, indication of such shall be submitted as an annual report. Annual reports must include, but not be limited to the following information:

    a. The amount and type of specimen collected from each plant and the disposition of the collected specimen;

    b. The source of each propagule and maps indicating where the material was collected;

    c. Success or failure of propagation attempts;

    d. Outplanting and transplanting locations; and

    e. Success or failure of outplanting attempts.

6/4/01
Date

Sarah B. Hall
for Chief, Endangered Species

Appendix 5-A Rare Snail Monitoring Form

Species Name:_____ Date:_____
Range:_____ Elevation:_____ft/m Observers:_____
Location:_____
_____
_____
Weather:_____ Effort (people hours):_____

Count/Density Estimate:_____snails _____snails/hour

Damage Observed: Empty Shells: #Rat Damaged_____ #Intact_____
Population Structure:

MATURITY (lip?)	Number counted
Immature	
Mature	

Threats/Management Recommendations/Actions Taken:

_____
_____
Bait Y/N # blocks_____ #stations_____ # Snap traps_____ # Nights_____

Count by Tree:

Tree species	Tag #	Small	Medium	Large	Tree Species	Tag #	Small	Medium	Large

SKETCH MAP OF SITE: