

CHAPTER 2: RARE PLANT MONITORING

2.1 PCSU CONTRACT REQUIREMENTS

REQUIREMENT 5.b.6

Monitor approximately eight *Silene hawaiiensis* (threatened plant) sites at Range 8 on an annual basis and provide a report. The report shall compare current observations to observations made in the course of past monitoring events, and shall recommend management actions.

DISCUSSION

The average height and number of the *S. hawaiiensis* found at Range 8 has decreased ($\alpha=0.1$) in the years following the initial monitoring in 1997. There are now 75% fewer individuals than there were in 1999 when the greatest number of plants was recorded. Since 1997, the average plant height has also decreased by 70% ($\alpha=0.1$). Possible causes of the observed decline are: training impacts, environmental conditions, and ungulate browsing. Past and present results indicate that the factors affecting the plants continue to be environmental changes and, most importantly, ungulate impacts.

REQUIREMENT 5.b.7

GPS coordinates shall be obtained for all vegetation and endangered species plots and entered into the GIS database.

DISCUSSION

GPS coordinates have been collected for vegetation plots, rare plant locations and monitoring plots. The previous coordinates proved to be inaccurate; therefore, when locations are identified or newly recorded, accurate coordinates are collected. This has increased the efficiency of monitoring and management efforts.

REQUIREMENT 5.b.8

Monitoring populations of listed plant Priority Species (PS) 1 and 2 (9 species) on a semi-annual basis. Performing cursory inspections of the same populations on a quarterly basis. Monitoring activities shall be used to assess changes in the population structure (numbers of reproductive adults versus seedlings), and vigor (length of longest stem, stem diameter) in response to ungulate grazing pressure. Collecting of fruits shall be done, if available, at the time of monitoring. Results from the monitoring shall be evaluated and recommendations made for management actions. The report shall contain monitoring results from past years to provide an overall assessment of trends of each species and shall include photographs.

DISCUSSION

Past efforts have resulted in the reidentification of recorded locations and the discovery of new, unrecorded locations of PS-1 plants. This year's focus has shifted to reidentifying PS-2 plants and managing known locations of PS-1 and PS-2 plants. Photos were taken and archived for reference.

REQUIREMENT 5.b.9

Monitoring populations of Priority Species (PS) 3, 4 and 5 (5 species) on an annual basis. Monitoring activities shall be used to assess changes in the population structure (numbers of reproductive adults

versus seedlings), and vigor (length of longest stem, stem diameter) in response to ungulate grazing pressure. Collecting of fruits shall be done, if available at the time of monitoring. Results from the monitoring shall be evaluated and recommendations made for management actions. The report shall contain monitoring results from past years to provide an overall assessment of temporal trends of each species and shall include photographs.

DISCUSSION

Following the reconfirmation of plant locations and the implementation of a monitoring schedule for PS-1 plants, PS-2-4 species locations will be reconfirmed and monitored. Photos taken will be archived for reference.

A monitoring program for endangered and threatened species ranked PS-3-5 will be implemented. Once a monitoring program for endangered and threatened species has been implemented, species of concern ranked as PS-3-5 will be monitored biannually rather than annually. Higher management priority and greater monitoring frequency must be given to those species listed as endangered or threatened because of the need to provide accurate information to regulatory agencies.

2.2 INTRODUCTION

With the reidentification of species ranked as PS-1 completed, efforts shifted to managing and reidentifying the more abundant PS-2 species. Because of the large volume of data, this effort required data be well organized. GIS data were completely reorganized to better assess and track plant sites, locations, and individuals. In addition, a database was developed in Microsoft Access to organize monitoring and management data. This database integrates GIS data with plant monitoring and management data. This is the first comprehensive database developed for rare plant monitoring and management at PTA.

2.3 RARE PLANT MONITORING AND MANAGEMENT

INTRODUCTION

Due to PTA's land use history and isolation, access to the area has been limited. As a result PTA harbors unique ecosystems and vegetation. For example, PTA is one of the largest intact sub-alpine dryland forests remaining in the state. Not only is the ecosystem itself rare but so are many of its components. For example, at PTA there are eleven endangered species, one threatened species, and eleven species of concern, including one undescribed species. Six of these plant species are found only at PTA and two species are found at PTA and only one or two other locations in the State.

A Priority Species (PS) list was developed to prioritize monitoring and management actions. *Schiedea hawaiiensis* and *Tetramolopium* sp. 1 are the only PS-1 plants, which are not listed as endangered. These species of concern are included because *S. hawaiiensis* has less than 20 naturally occurring individuals and *T. sp. 1* has less than 100 known individuals. Therefore, they receive the highest priority for management actions. The Priority Species list has been defined and species assigned as follows:

Priority Species of Pohakuloa Training Area

Priority Species 1 (PS-1) – Plants species with fewer than 500 individuals and/or 5 or fewer populations remaining statewide.

Hedyotis coriacea (E)

Schiedea hawaiiensis (SOC)

Neraudia ovata (E)

Tetramolopium arenarium ssp.
arenarium (E)

Solanum incompletum (E)

Tetramolopium sp. 1 (SOC)

Priority Species 2 (PS-2) – Plant species with 500 - 1,000 individuals and/or 6 - 10 populations remaining statewide.

Asplenium fragile var. *insulare* (E)

Zanthoxylum hawaiiense (E)

Silene lanceolata (E)

Priority Species 3 (PS-3) – Plant species with 1,000 – 2,000 individuals and/or 10 - 20 populations remaining statewide.

Festuca hawaiiensis (SOC)

Portulaca sclerocarpa (E)

Priority Species 4 (PS-4) – Plant species with 2,000 – 5,000 individuals and/or 20 - 40 populations remaining statewide.

Eragrostis deflexa (SOC)

Priority Species 5 (PS-5) – Plant species with more than 5,000 individuals and/or more than 40 populations remaining statewide.

Chamaesyce olowaluana (SOC)

Portulaca villosa (SOC)

Cystopteris douglasii (SOC)

Silene hawaiiensis (T)

Dubautia arborea (SOC)

Spermolepis hawaiiensis (E)

Exocarpos gaudichaudii (SOC)

Stenogyne angustifolia (E)

Haplostachys haplostachya (E)

Tetramolopium consanguineum ssp.
leptophyllum (SOC)

Melicope hawaiiensis (SOC)

The term population is one that is often difficult to define in functional terms. Several of the species at PTA are found in isolated clusters of plants, which occupy only a fraction of the species' historic range. Other species appear abundant because they have a large absolute number of individuals at PTA, but their distributions are restricted to PTA and they are found no where else. Due to the differences in the distribution of species, they cannot easily be broken into populations on spatial terms. The most effective means of defining a population is through genetic information that is largely lacking for the species found at PTA. Therefore; the term population is used infrequently in the following text. The term site is used to

roughly identify aggregations of plants as being associated for biotic, abiotic, and management reasons. The term location is used to describe the one to many clusters of plants within a site. The location is the unit that is used for mapping purposes and each has a coordinate associated with it. The term individual describes a single representative of a particular species. There are one to many individuals at a given location.

METHODS

MONITORING

Monitoring units are belt transects with a base stake and end stake identifying the beginning and end of the plot. Extending a measuring tape between the base and end stakes delineates the centerline of the plot. The belt is typically six meters wide, three meters on either side of the centerline. The length of the belt varies depending on the distribution of the plants at the site being monitored. However, it is typically 10 meters long.

Once laid out, the locations of all rare plants within the belt are mapped. This is accomplished using an x- and y-coordinate system. The distance along (y-axis) and out (x-axis) from the meter tape is determined and recorded in meters.

Information collected on each plant consists of height, phenological state, age class, vigor, and presence of animal damage. The height or length of the longest stem of the plant is measured in centimeters or meters and is measured from the base of the plant to the apical meristem of the longest portion of the plant.

The phenological state is classified as: Vegetative, not currently flowering or fruiting; Reproductive, viable flowers are present on the plant; Fruiting, fruit is present on the plant from the most recent flowering event.

A seedling is a plant with apparently functional cotyledons present. A juvenile is classified as a plant that has lost its cotyledons or if present they are apparently non-functional and it has not flowered. An adult is a plant that has flowered in its lifetime, regardless of its current phenological state.

The vigor of the plant is classified as healthy when the plant is producing new leaves, most living leaves are green, and the plant appears generally robust and thriving. The vigor is moderate when the plant is producing fewer new leaves, the living leaves are not quite as green as compared to a healthy plant, and the plant appears viable but not as robust or thriving to the extent that a healthy plant is. The vigor is poor when the plant is producing few, if any, new leaves. Those leaves present may be pale green and/or the edges are brown. In some species the leaves may have little chlorophyll and be red with photo-protective pigments.

Browse is indicated by portions of the plant showing signs of being consumed by ungulates. Browse is further classified as recent browse when the browsed portions of the plant have not healed over. In addition, the browsed portions may be white and there is no new growth above the browsed portions. The browsed portion of the plant having healed over indicates old browse and there is new growth above the browsed portions. No browse is classified as no parts of the plant have been consumed by ungulates.

Seed collection follows the restrictions outlined in the collection permit issued by the USFWS.

MANAGEMENT

Small-scale exclosures are used to provide for the immediate protection of individuals. When possible the exclosure is of sufficient size to include the plant's habitat. These small exclosures address the immediate needs of individuals, but do not provide for the long-term viability of the population and its habitat. Only large-scale fence units can protect enough habitat for conserving populations.

A variety of materials are used for emergency exclosures and include plastic construction fencing, hogwire, or concertina wire. Posts include; T-posts, form stakes and metal conduit, or dead tree branches. Materials selected are based on available resources and are site dependent.

Short-term goals for weed control are meant to address the immediate needs of individuals and provide limited benefit to the surrounding habitat. These are general guidelines and will be adjusted to address the short-term needs of a site. Factors considered are substrate, vegetation cover, topography, and fire threat. The guidelines are not long-term goals for an individual plant, site, or population, but instead address immediate threats.

General guidelines for short-term alien plant control include: control within a distance of 25-50 meters of listed plants depending upon substrate, vegetation cover, topography, and fire threat. Weeds are manually removed within one meter of a listed plant. Beyond one meter weeds may be mechanically controlled using gas-powered weed trimmers. Weeds are completely removed manually or mechanically within three meters of a listed plant and no herbicide is used within three meters of a listed plant. Herbicide may be used beyond three meters of listed plants during calm weather conditions. Broadleaf species such as *Kalanchoe tubiflora* and *Solanum pseudocapsicum* are chemically controlled using the herbicides Garlon 3A and 2,4-D.

Pennisetum setaceum is typically cut with weed whackers to remove dormant and dead vegetation. The young, actively growing portions are sprayed with Round-Up following resprout. Control of *P. setaceum* requires a great deal of time and effort. Control requires the manual or mechanical removal of the dead and/or dormant portions of the plant. When the plants resprout one to two weeks later the young, actively growing shoots are treated with herbicide. A single treatment is typically not effective in killing all plants treated. Complete kill requires repeated treatments to ensure all individuals have been killed. Although this is labor and time intensive, it is currently the most effective method of control. Fortunately, once an area has been successfully treated, *P. setaceum* does not quickly invade.

2.3a *Hedyotis coriacea*

INTRODUCTION

Efforts over two and a half years have resulted in the reidentification of all but three *H. coriacea* locations. Previous records indicated that there were nine sites with 31 locations and 33 to 43 individuals. NRS has identified ten sites with 58 locations and 84 individuals. New individuals continue to be found during surveys and management actions. In addition to surveying efforts, all individuals have been protected with emergency exclosures or are within large-scale fence units. Protecting these plants has allowed them to recover vegetatively from ungulate damage and many have been able to produce seed, some for the first time. With reidentification efforts complete, habitat management will commence.

RESULTS

No additional individuals have been reidentified at Site 01 (Figure 2-1) within the KKFU.

At Site 02, within Training Area 22 (Figure 2-1), three previously unrecorded individuals were discovered. There have been 27 individuals recorded at this site; however, four have died, reducing the total number of living plants to 23. The new individuals have been protected with emergency exclosures. Seed was collected from four individuals.

A tenth individual was found within the emergency exclosure at Site 03 (Figure 2-2). All individuals at this site are within emergency exclosures. Seed was collected from three of the ten individuals.

Currently there are a total of five living plants at Site 04 (Figure 2-2). Emergency exclosures were enlarged during the 2002-2003 reporting period. A single exclosure protects plants 01 and 02. Plant 04 is solitary within an enlarged exclosure. Plants 05 and 06 are found together within a newly enlarged exclosure. No seed was collected from these plants during the reporting period. *P. setaceum* immediately surrounding the plants was manually removed.

The plants at Site 05 (Figure 2-2) continue to do well because of their protection. The emergency exclosure protecting plant 02 was enlarged. Seed was collected from seven of the nine plants at this site.

Plant 01 at Site 06 is a solitary individual (Figure 2-1). It is protected by an emergency exclosure. *P. setaceum* was removed from the immediate vicinity of the plant.

Seed was collected from two of the three individuals at Site 07 (Figure 2-1).

Seed was collected from plant 01 at Site 09 (Figure 2-2); this is the first seed collected from this now solitary individual.

Seven newly recorded individuals were found at Site 10 (Figure 2-2). Four plants found outside the KA-1FU were protected with emergency exclosures. A fifth plant found during the previous reporting period was protected as well. Three of the new plants were found inside of the KA-1FU, emergency exclosures were not placed around these plants because of the relatively low number of ungulates within the fence unit. This population now consists of 31 individuals. All individuals are protected with emergency exclosures or are found within the KA-1FU.

DISCUSSION

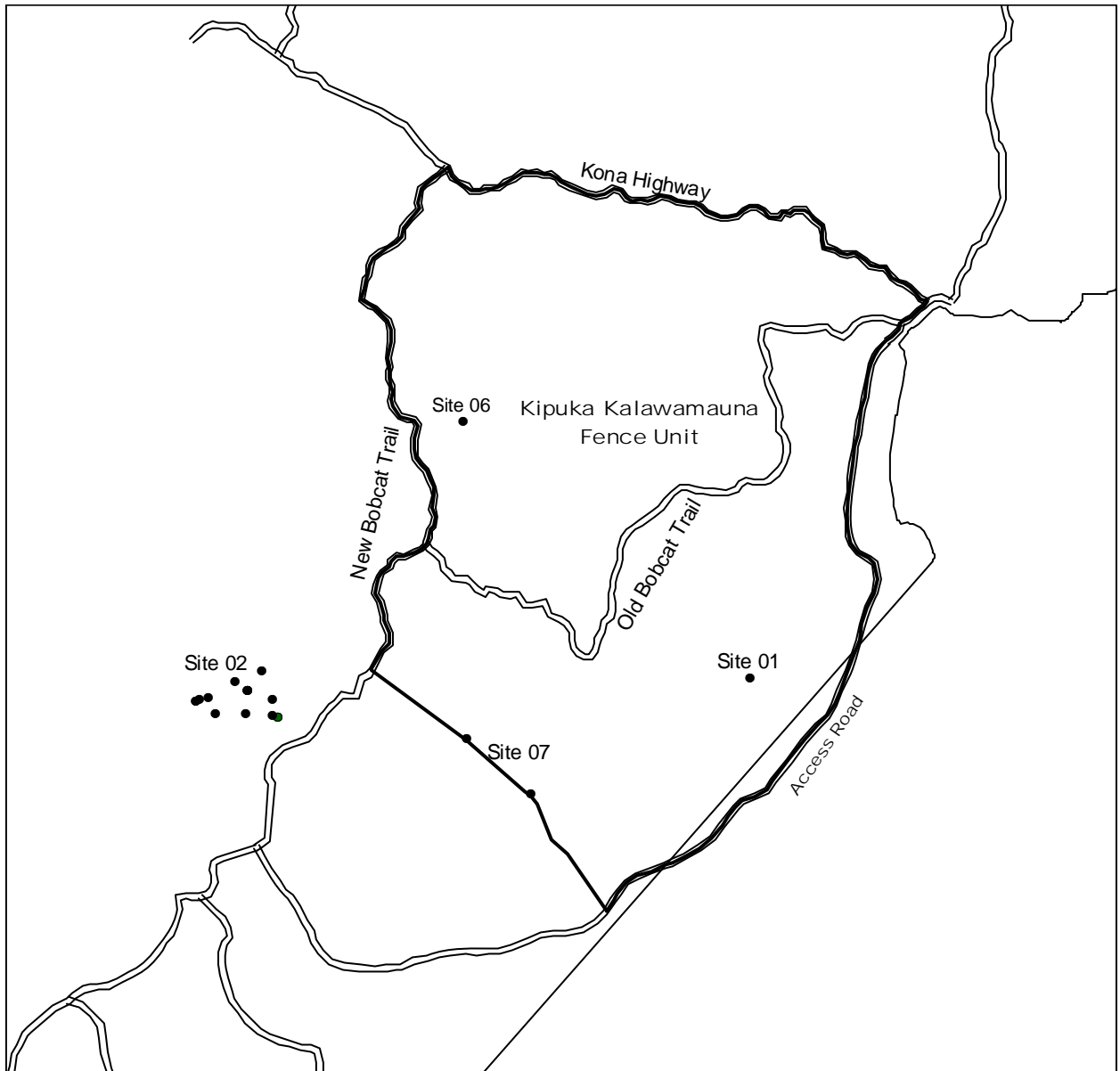
All but three previously recorded plant locations have been reidentified or otherwise accounted for. During the 2002-2003 reporting period 11 individuals were newly recorded. Surveys and management for this species has increased the total number of known, living individuals at PTA to 84. When found outside of large-scale fence units, new individuals were protected with emergency exclosures and all known individuals have been protected by emergency exclosures or large-scale fence units.

Reidentification of previously recorded plant locations is complete. The remaining unconfirmed locations will be surveyed during routine monitoring of the other individuals in the site. Efforts will now shift from reidentification to comprehensive monitoring and inspections as well as habitat management. The majority of individuals are found in habitats that haven't been heavily invaded by *P. setaceum*; therefore it may be possible to control this threat and prevent it from further invading the habitat and jeopardizing individuals. Control of *P. setaceum* around individuals and within their habitat benefits the plants and species by reducing the fuel load, which increases fire risk as well as by reducing competition for space, water, and nutrients.

MANAGEMENT RECOMMENDATIONS

P. setaceum is present in the areas where *H. coriacea* is found at low but increasing densities. *P. setaceum* should be controlled within 25 meters of known plant locations.

Large-scale fence units are necessary for the long-term viability of the species. The widely scattered distribution of *H. coriacea*, its longevity, and its low recruitment suggest that it may require a substantial area to maintain and increase its population size. Other than one plant on Maui, PTA is the only locale with known individuals. This species cannot be recovered or even sustained without large-scale fence units designed to protect the habitat in which the species is naturally found.



Hedyotis coriacea

● Plant Locations

== Roads

— Kipuka Kalawamauna Fence Unit

Figure 2-1

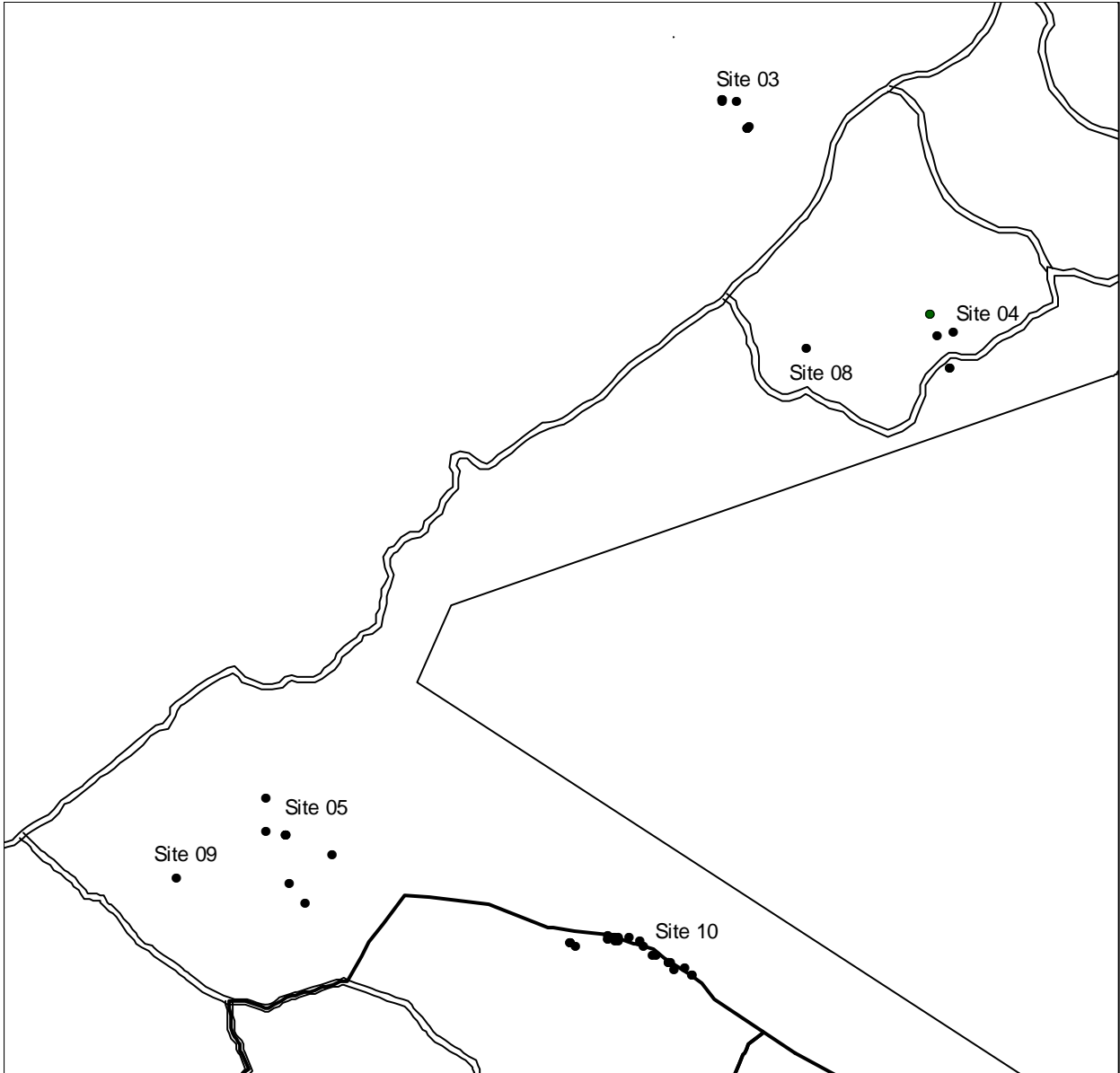
Locations of Sites 01, 02, 06, 07.

Scale 1 : 35,000



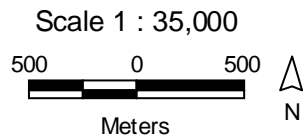
Meters





Hedyotis coriacea
 ● Plant Locations
 == Roads
 — Kipuka Alala Fence Units

Figure 2-2
 Locations of Sites
 03, 04, 05, 08, 09, 10.



2.3b *Neraudia ovata*

INTRODUCTION

Neraudia ovata is a critically endangered member of the Stinging Nettle family (Urticaceae). The loss of its stinging hairs may be due to the lack of native mammalian herbivores in Hawaii. Consequentially, the introduced ungulates in Hawaii have reduced its distribution to four known sites with a total of nine adult individuals. Four adults are found within PTA's borders and three individuals are found on State land immediately adjacent to PTA. A single individual is found within the State of Hawaii's Manuka Natural Area Reserve in south Kona. In addition, a solitary individual is found on private lands in north Kona.

RESULTS

Monitoring and inspections have continued with positive results from emergency exclosures. In the fall of 2002, rain enabled germination from the seed bank under several adult plants at Site 01. From the initial flush of approximately 50, 15 juvenile plants remain. Germination occurred beneath plant 0101, which was recorded as dead in September of 1999. The 15 juveniles are being cared for through supplemental irrigation on an approximately monthly basis.

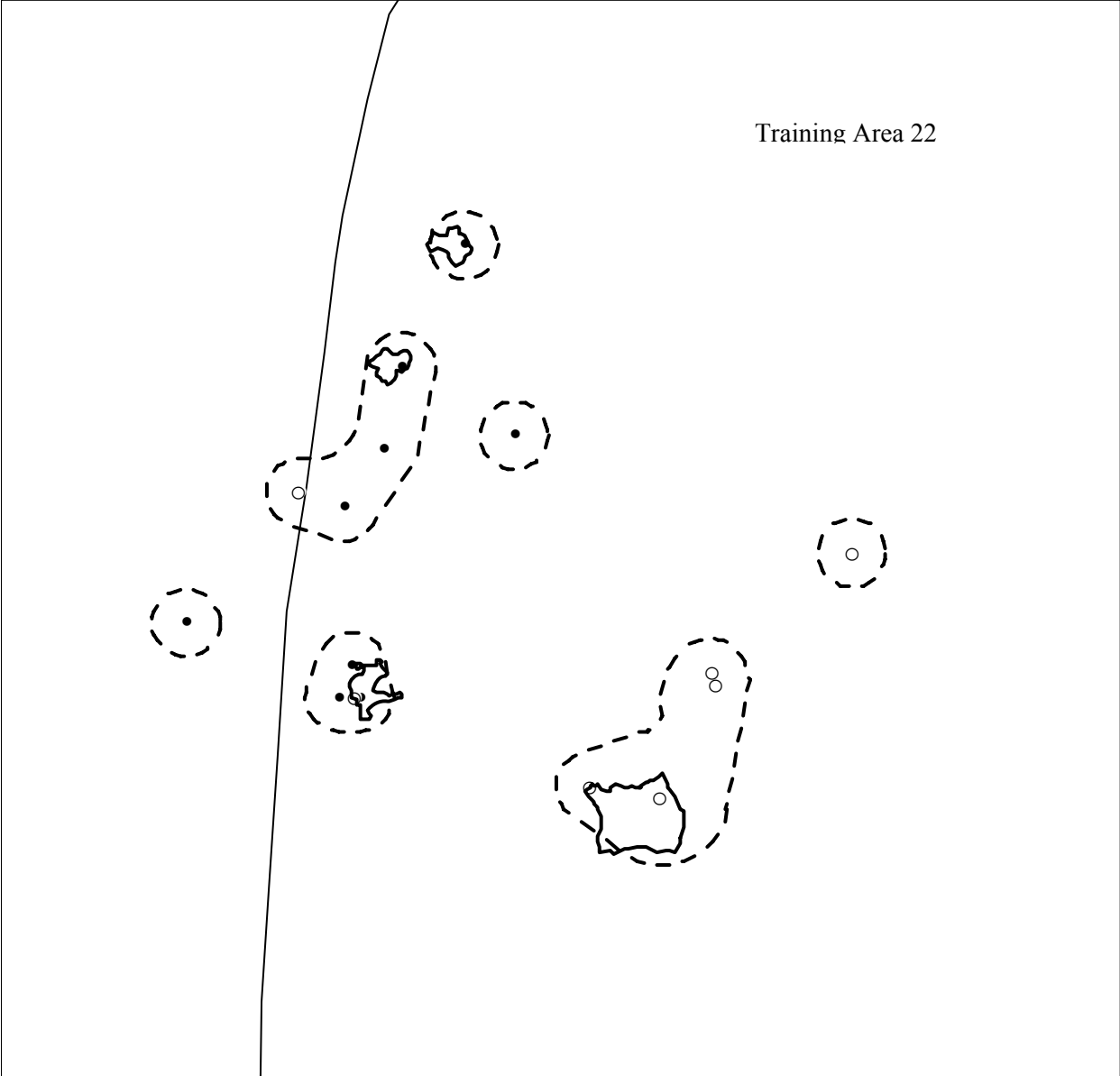
Approximately 22 personnel-hours have been spent manually, mechanically, and chemically controlling *P. setaceum*, *Kalanchoe tubiflora*, and *Solanum pseudocapsicum* in approximately 0.57 hectares (1.4 acres) of habitat for *N. ovata* and *Solanum incompletum* coexisting in the area (Figure 2-3).

At Site 02 the emergency exclosures of concertina wire did not adequately protect the two plants. Ungulates were breaching the exclosure and browsing the plants. The plants were further protected with plastic construction fencing and the concertina wire was moved outside and adjacent to the construction fencing. No further browse has been observed and the plants have vegetatively recovered.

Approximately 17 personnel-hours have been spent manually, mechanically and chemically controlling *P. setaceum* in 0.69 hectares (1.7 acres) at this site (Figure 2-4). *P. setaceum* also is being controlled in areas down slope of the plants to prevent the possibility of fire moving upslope and reaching the plants.

A third, newly recorded, individual was found at this site while conducting management actions in the area in June 2003. The plant was protected in July 2003 using the plastic construction fencing. *P. setaceum* is present in the area surrounding the plant.

Training Area 22



- Plant Locations
- *Neraudia ovata*
 - *Solanum incompletum*
 - - Short-term Control Goals
 - Area Controlled

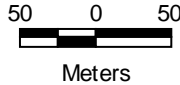
Figure 2-3

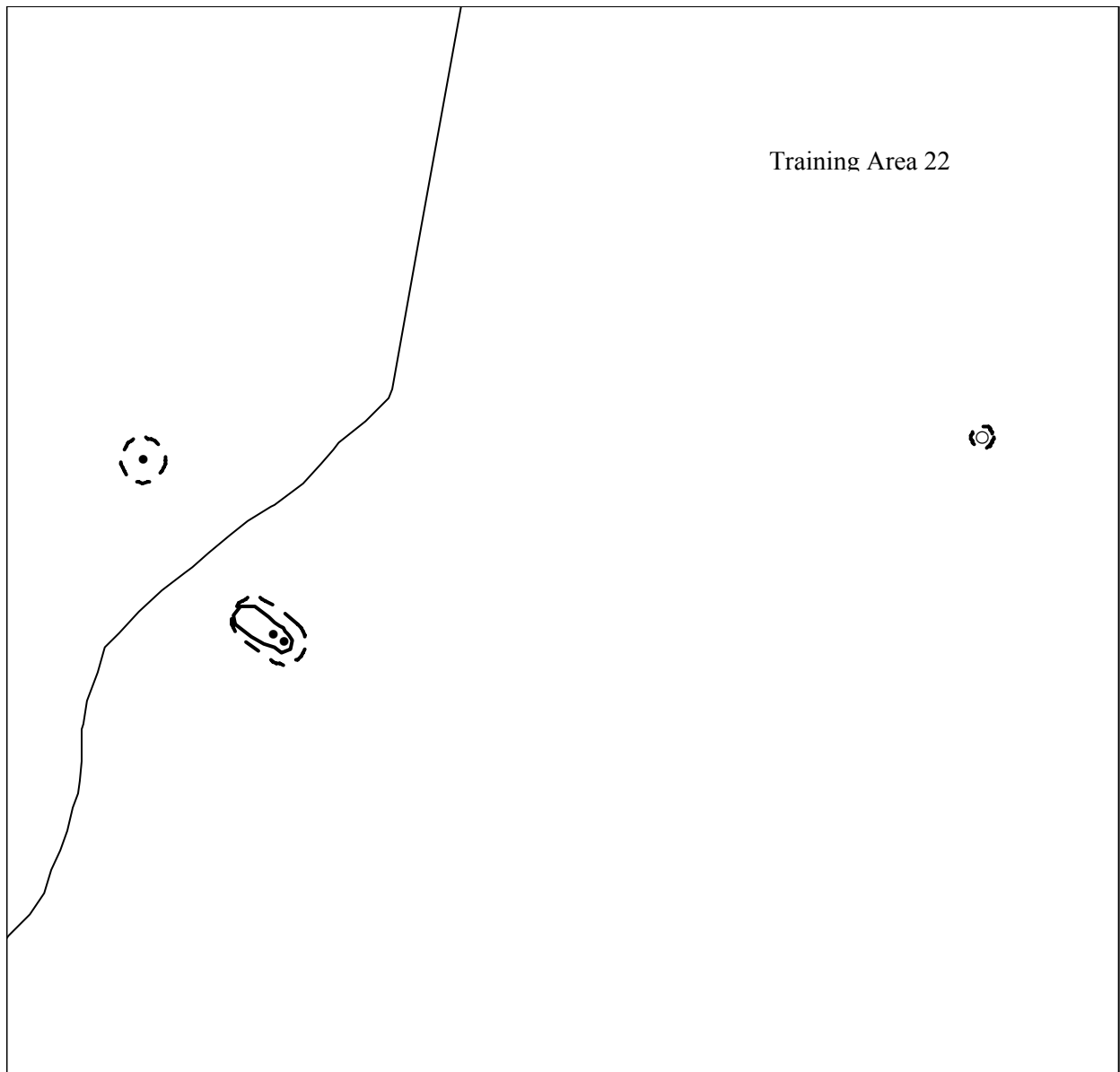
Short-term Control Goals
and Control Efforts.

S. incompletum Stie 01

N. ovata Site 01

Scale 1 : 5,000





Plant Locations

- *Neraudia ovata*
- *Solanum incompletum*
- - Short-term Control Goals
- Area Controlled

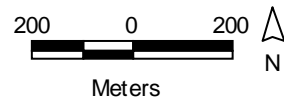
Figure 2-4

Short-term Control Goals
and Control Efforts.

S. incompletum Stie 02

N. ovata Site 02

Scale 1 : 15,000



DISCUSSION

Needed recruitment of this long-lived perennial has occurred at Site 01. The adult plants are in excess of ten years of age and their lifespan is unknown. It is therefore very important to make every effort to ensure that the seedlings survive.

Weed control has been effective in controlling alien species around individual plants. This has reduced fuel loads and competition. Ungulate exclusion together with weed control may have contributed to the germination observed.

Emergency exclosures and weed control have reduced the immediate threats to the individual plants. However, ungulates remain in the area and three weed species are also present. The presence of ungulates and alien plant species continues to degrade the habitat in which *N. ovata* is found. PTA is home to the most intact occupied habitat for this species. The plants at PTA and in adjacent lands are vital to the recovery of this species.

MANAGEMENT RECOMMENDATIONS

Further surveys need to be conducted in areas where plants have been recorded as well as in areas identified as having potentially suitable habitat. Every individual found benefits this species that has a total of nine mature individuals.

All known plants have been protected with emergency exclosures. Emergency exclosures protect individuals, but ungulates and/or alien plant species continually degrade the habitat in which the plants are found. Large-scale fence units must be constructed to effectively protect this species and its habitat from the deleterious impacts caused by feral ungulates. Furthermore, large-scale fence units would provide protected areas in which outplanting can be conducted to augment existing populations and/or establish new ones. Until these can be constructed, expansion of the exclosures to protect an area of approximately 500 square meters around each plant would allow for potential recruitment beyond the immediate canopy of the adult plants and provide additional area where other native species may regenerate.

The short-term goals for the weed species found at these sites are illustrated in Figure 2-3 and Figure 2-4. Control of alien plant species will continue and short-term goals will be achieved. The new *N. ovata* individual is in an extremely fire prone area and *P. setaceum* control is a high priority; therefore control of alien plant species is absolutely necessary to achieve short-term goals.

Cooperative efforts with state and other federal agencies have been made to reintroduce this species to portions of its historic range outside of PTA (Chapter 5). These efforts are vital to ensure that any catastrophic events at PTA do not jeopardize the continued existence of this species. These efforts should continue and be expanded to include other responsible agencies and surrounding landowners.

2.3c *Solanum incompletum*

INTRODUCTION

PTA is the only known locale at which this species is found. This species is managed for rodents, ungulates, and weeds, which have severely impacted the habitat. At Site 0101, the large shade cloth canopy and the 500-600 m² hogwire exclosure constructed during the previous reporting period have been effective in reducing solar radiation and preventing ungulate damage. Recruitment has been observed as

well as improvement in the vigor of the plants. The larger enclosure has allowed the vegetation in the immediate area surrounding *S. incompletum* to recover towards a natural state.

RESULTS

Known sites continue to be monitored and inspected to assess the needs and threats to the plants. Weed control efforts of *P. setaceum*, *K. tubiflora*, and *S. pseudocapsicum* have begun. As discussed in the Results section of *N. ovata*, approximately 22 personnel-hours have been spent manually, mechanically, and chemically controlling weed species in approximately 0.57 hectares (1.4 acres) of habitat for *N. ovata* and *S. incompletum* (Figure 2-3). This figure also graphically illustrates the short-term weed control goals and progress towards them for this area.

During weed control efforts at Site 0101, a new *S. incompletum* individual was found (Figure 2-4). The solitary individual was immediately protected with a small emergency enclosure. There are now seven known locations at this site.

A new site was found during a survey in the northern part of Training Area 22. Four individuals were found in late May 2003 and were protected with an emergency enclosure in early July 2003. Fountain grass was manually removed from within the enclosure. Unfortunately, the plants had been browsed between the time of discovery and their protection six weeks later.

There are currently 46 known naturally occurring *S. incompletum* individuals within eight locations and two sites at PTA. All individuals are protected by emergency enclosures. In addition, outplanting efforts have established new sites at PTA and within the species historic range (Chapter 5).

DISCUSSION

Constructing a larger hogwire enclosure at Site 0101 has improved the protection of the plants within it. The habitat within the enclosure is improving and management is more effective. Weed management is also occurring on a larger scale in the kipuka and on the adjacent lava flow where this species and *N. ovata* are found. *S. pseudocapsicum* is of particular interest for control because this introduced species is in the same genus as the endangered *S. incompletum*. Control of *S. pseudocapsicum* may reduce the possibility of cross-fertilization, insect damage, or disease transmission.

MANAGEMENT RECOMMENDATIONS

All known *S. incompletum* have been protected with emergency enclosures or small enclosures intended for immediate protection of individuals from ungulate damage. The need for habitat protection for critically endangered species was discussed in the Management Recommendations for *N. ovata* and is applicable to *S. incompletum* as well. Recovery of a critically endangered species with reduced population size and distribution cannot be accomplished by protecting individual plants and the small area around them. Currently, less than a quarter acre of this species' habitat is protected. Weed control is being conducted; however, ungulates have free access to the plant's habitat. To prevent increasing habitat degradation by ungulates, large-scale fence units must be erected. Recovery efforts will probably be more successful in habitat that is intact and requires less management than degraded areas.

Weed control has begun and will be vital for the recovery of the habitat for the species. This species is found in and adjacent to a degraded Naio kipuka that has been invaded by *P. setaceum* and short-term control is vital to reduce the immediate threat. Future long-term efforts in this area will control *P. setaceum* on the adjacent lava flow and within the kipuka occupied by both *N. ovata* and *S. incompletum*. Weed control is needed at the newly recorded site as well.

The newly discovered site suggests the need for increased surveys of areas that may contain suitable habitat for the species. Initial surveys should target the area between known sites and expand into suitable habitat in other areas.

2.3d *Schiedea hawaiiensis*

INTRODUCTION

In 1997, *S. hawaiiensis* was discovered at PTA, the species' only known location. At that time there were two extant individuals, one of which subsequently died. Great effort has been made to protect these plants from the browsing damage of feral ungulates as well as rodents. Ungulate and rodent exclosures and lethal control have been used to minimize browse. Eliminating the threats to the individual plants and favorable rains enabled successful recruitment from the seed bank and approximately 30 seedlings emerged during the contract period. Fifteen closely spaced individuals were collected since they were likely to die due to competition with each other.

RESULTS

Fifteen of the original 30 seedlings collected from the field and grown out in the Rare Plant Propagation Facility were subsequently reintroduced at sites within the Kipuka Kalawamauna Fence Unit. Details on this effort can be found in Chapter 5. The other 15 seedlings remained in the field and six have survived.

DISCUSSION

Intensive management against ungulate and rodent impacts has been successful in protecting existing plants as well as enabling limited regeneration from the seed bank. These new individuals will be a source of new genetic material that can be used to augment the natural site and establish new sites.

Expanding the distribution of this species has been accomplished at PTA through the collection of seeds, cuttings, and field-collected plants. The plants resulting from these collection methods are subsequently reintroduction into new areas. In addition, cooperative efforts with the State of Hawaii have increased the distribution of this species outside of PTA (Chapter 5).

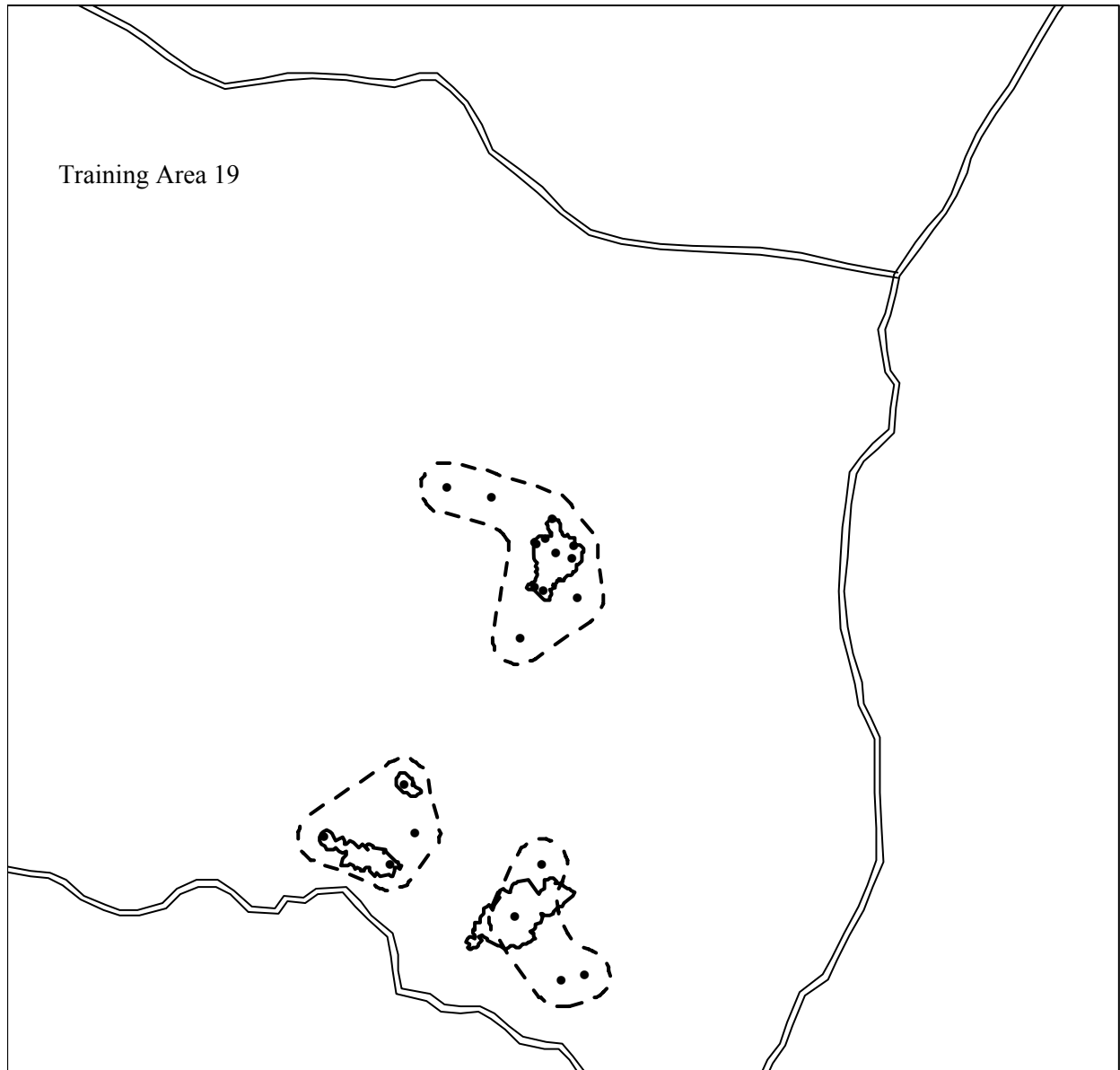
MANAGEMENT RECOMMENDATIONS

The management of rodent and ungulates must continue to ensure the survival of *S. hawaiiensis*. Efforts should continue to establish new sites to enhance the long-term viability of the species. Because ungulates are extremely detrimental to this species and its habitat, it would benefit from a large-scale fence unit to protect its only known location.

2.3e *Tetramolopium arenarium* ssp. *arenarium*

INTRODUCTION

T. arenarium is a species found only at PTA and its distribution is limited to one site (Figure 2-5). All known locations are being managed for *P. setaceum* within 50 meters of plant locations. In addition, control areas will be linked together to form contiguous areas (Figure 2-5). Although *T. arenarium* is found in the fire-prone native habitat of a *Dodonaea viscosa* shrubland, the control of *P. setaceum* may reduce the fuel load as well as reducing the competition for space, nutrients, and water with *T. arenarium*.



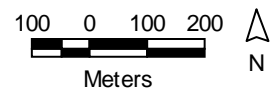
Training Area 19

Tetramolopium arenarium
 • Plant Locations
 - - Short-term Control Goals
 — Area Controlled

Figure 2-5
 Short-term Control Goals
 and Control Efforts.

Site 01

Scale 1 : 13,000



RESULTS

Approximately 90.5 personnel-hours have been spent on manual, mechanical, and chemical control of *P. setaceum* in 3.0 hectares (7.5 acres) in and around *T. arenarium* locations (Figure 2-5).

DISCUSSION

Control of *P. setaceum* is going well and will continue until the short-term goal of clearing 15.5 hectares (38 acres) is met.

MANAGEMENT RECOMMENDATIONS

Control of *P. setaceum* is a high priority and will continue into the future beyond short-term goals. *P. setaceum* remains the greatest threat to the ecosystem in which *T. arenarium* is found. An important step to increase the long-term viability of the species is to coordinate outplanting and management within its historic range both inside and outside of PTA's borders.

2.3f *Tetramolopium* sp. 1

INTRODUCTION

T. sp. 1 is an undescribed species that is found only at PTA in three locations. The greatest threats to this species are degradation of its habitat and increasing fire risk from *P. setaceum*. Management efforts have increased for this undescribed species during this reporting period.

RESULTS

Approximately 10 personnel-hours have been spent manually, mechanically, and chemically controlling *P. setaceum* in 0.61 hectares (1.5 acres) at Site 0301.

MANAGEMENT RECOMMENDATIONS

Control of *P. setaceum* will continue for this species. Although ungulates do not seek out this plant, the two unprotected sites should be protected to prevent accidental trampling by ungulates.

2.3g *Asplenium fragile* var. *insulare*

Monitoring and management have focused on other species during the reporting period.

2.3h *Silene lanceolata*

INTRODUCTION

Efforts to identify new and reidentify previously recorded Priority Species-1 are almost completed. NRS has expanded survey and management efforts to PS-2 plants. *S. lanceolata* populations have been declining at PTA in recent years. *S. lanceolata* is considered a high priority species for surveys and management. Efforts to reidentify locations of *S. lanceolata* have increased during the 2002-2003 reporting period. Surveys have been conducted in Training Areas 17 and 22. In addition, management actions that were begun last reporting period continue and have been expanded to other sites.

Surveys in Training Area 17 were conducted due to its potential use as a military maneuver area. In addition, this was an area where *S. lanceolata* had been previously recorded, and reidentifying individuals in this area was a priority. A survey was also conducted in Training Area 22 to reidentify previously recorded locations of *S. lanceolata* and *Zanthoxylum hawaiiense*.

Surveys were designed in ArcView. Transects were spaced ten meters apart in Training Area 17 and fifteen meters apart in Training Area 22. Waypoints for the beginning and ending of the transects were loaded into GPS units. Personnel walked the survey area north and south between waypoints. The actual route walked was recorded by the GPS (Figure 2- 6).

Field observations indicate that *S. lanceolata* sites are severely impacted by *P. setaceum*, which is the greatest weed threat at PTA and one of the highest priorities for rare species management. The increasing density of *P. setaceum* crowds out *S. lanceolata* and increases fuel loads. High densities of *P. setaceum* around *S. lanceolata* caused the loss of individuals during the 1994 and 1999 Puu Anahulu/Kipuka Kalawamauna fires. During the 2002-2003 reporting period, efforts have been made to reduce the risk through manual, mechanical, and chemical control of *P. setaceum*.

RESULTS

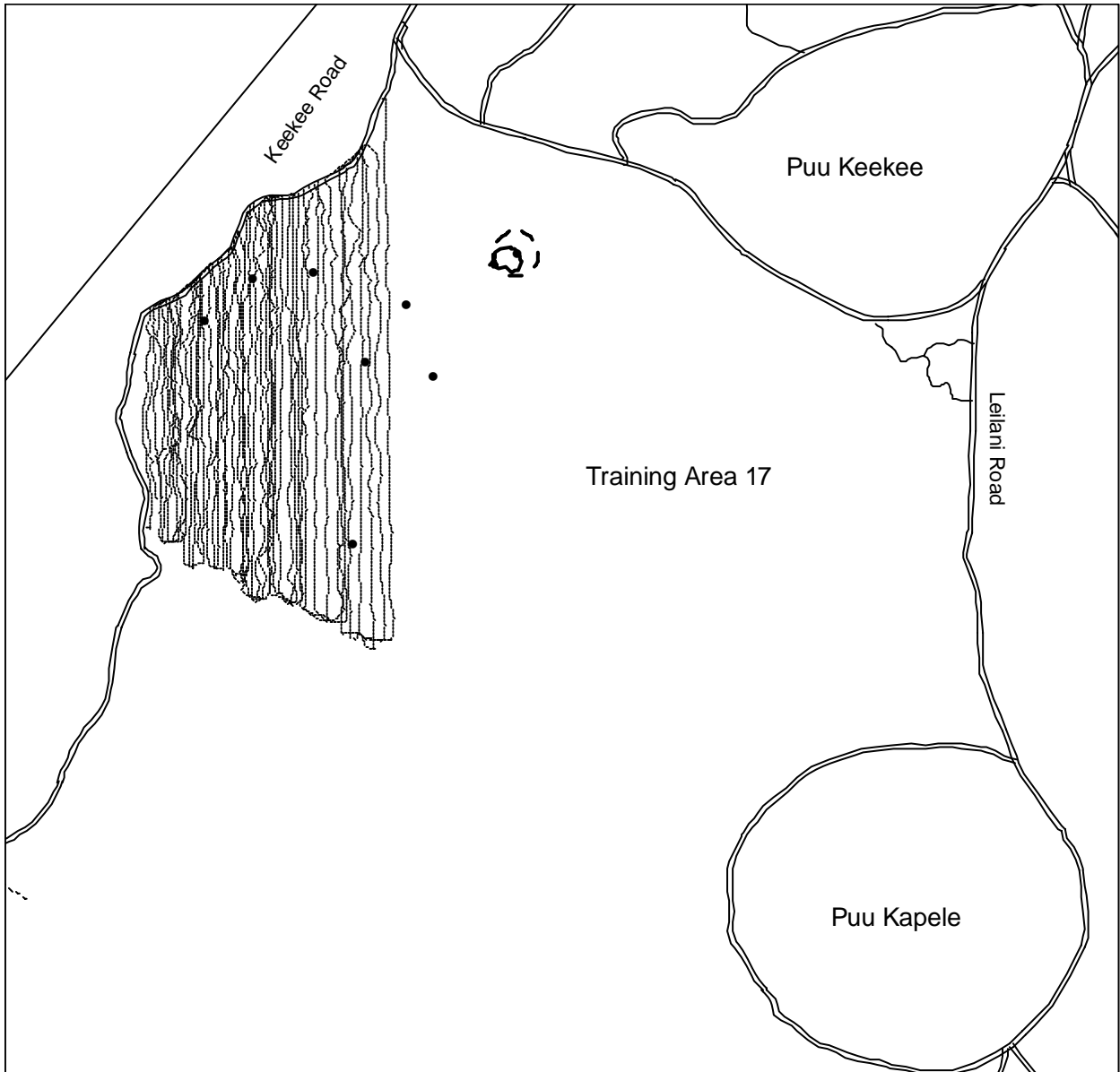
Approximately ten personnel-days were spent surveying 45 hectares (110 acres) of approximately 100 hectares (250 acres) of habitat in which the species had been recorded in Training Area 17 (Figure 2-6). No *S. lanceolata* or other listed species were found.

Three personnel-days were spent on an initial survey for *S. lanceolata* and *Z. hawaiiense* in the southern portion of Training Area 22. Again, no *S. lanceolata* were found within the area surveyed. Results for *Z. hawaiiense* will be discussed in later sections. During a survey in northern Training Area 22, NRS was able to reidentify a previously recorded *S. lanceolata* location (0401) and has subsequently been protected with an emergency exclosure.

A newly recorded location (1005) was found during management actions within the KKFU and is currently being managed for ungulates.

Approximately 227 personnel-hours were expended in manual, mechanical, and chemical control of *P. setaceum* over 1.9 hectares (4.7 acres) at PTA during the contract period. Personnel involved included volunteer groups from three educational and community groups. PTA's Environmental Educator, Kuhea Paracuelles, organized volunteer groups. These groups concentrated their efforts on manually removing *P. setaceum* within 1 meter around *S. lanceolata* individuals and other native plants. After this initial removal near the plants, gas-powered weed trimmers were used in more open areas.

Control of *P. setaceum* has focused around four sites. Approximately 0.25 hectares (0.63 acres) at Site 01 (Figure 2-6) have been controlled. At Site 06 approximately 0.45 hectares (1.1 acres) have been treated (Figure 2-7). The majority of *P. setaceum* control has been conducted at Site 07 (Figure 2-8) and Site 10 (Figure 2-9). Approximately 0.65 hectares (1.6 acres) have been controlled at Site 07. Approximately 0.6 hectares (1.5 acres) have been treated at Site 10.



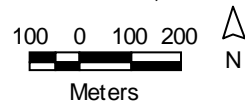
Silene lanceolata

- Plant Locations
- Surveyed Area
- - - Short-term Control Goals
- Area Controlled

Figure 2-6

Survey Area,
Short-term Control Goals,
and Control Efforts.

Scale 1 : 15,000



DISCUSSION

Training Area 17 has been severely impacted by *P. setaceum* invasion and there was evidence of fire in the area. These factors may account for the difficulty in reidentifying previously recorded locations. All potential *S. lanceolata* habitats in the area have yet to be surveyed. Further work in the area may reveal areas that haven't been as severely impacted by *P. setaceum* and fire.

A single day of survey work has been conducted in southern Training Area 22 to reidentify the previously recorded locations in that area. Not enough area has been surveyed to draw any conclusions from the results obtained thus far. The reidentified location in northern Training Area 22, 0401, has been protected. Unfortunately, ungulates had browsed the plants in the intervening time between their discovery and protection six weeks later. This exemplifies the need for large-scale fence units to protect listed species and their habitat. Only complete exclusion of ungulates from endangered and threatened plant habitat will be effective in preventing ungulate damage to these species. Without complete exclusion, using large-scale fence units, ungulates would have unrestrained access to endangered and threatened plant species. Field observations show that a small number of ungulates can do a great deal of damage to unprotected plants in a very short period of time. This type of situation will continue to jeopardize the long-term existence of these species.

MANAGEMENT RECOMMENDATIONS

Surveys to reidentify previously recorded locations and to identify new locations will continue. Once found, locations will be protected from ungulates and weed species will be controlled. Plants and their habitat must be protected and improved to sustain viable populations. The most effective method for preserving the viability of populations is their protection from ungulates using large-scale fence units. In addition, weed species must be controlled on a scale sufficient to preserve the ability of populations to naturally expand into suitable habitat.

Training Area 22



Silene lanceolata

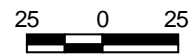
- Plant Locations
- - Short-term Control Goals
- Area Controlled

Figure 2-7

Short-term Control Goals,
and Control Efforts.

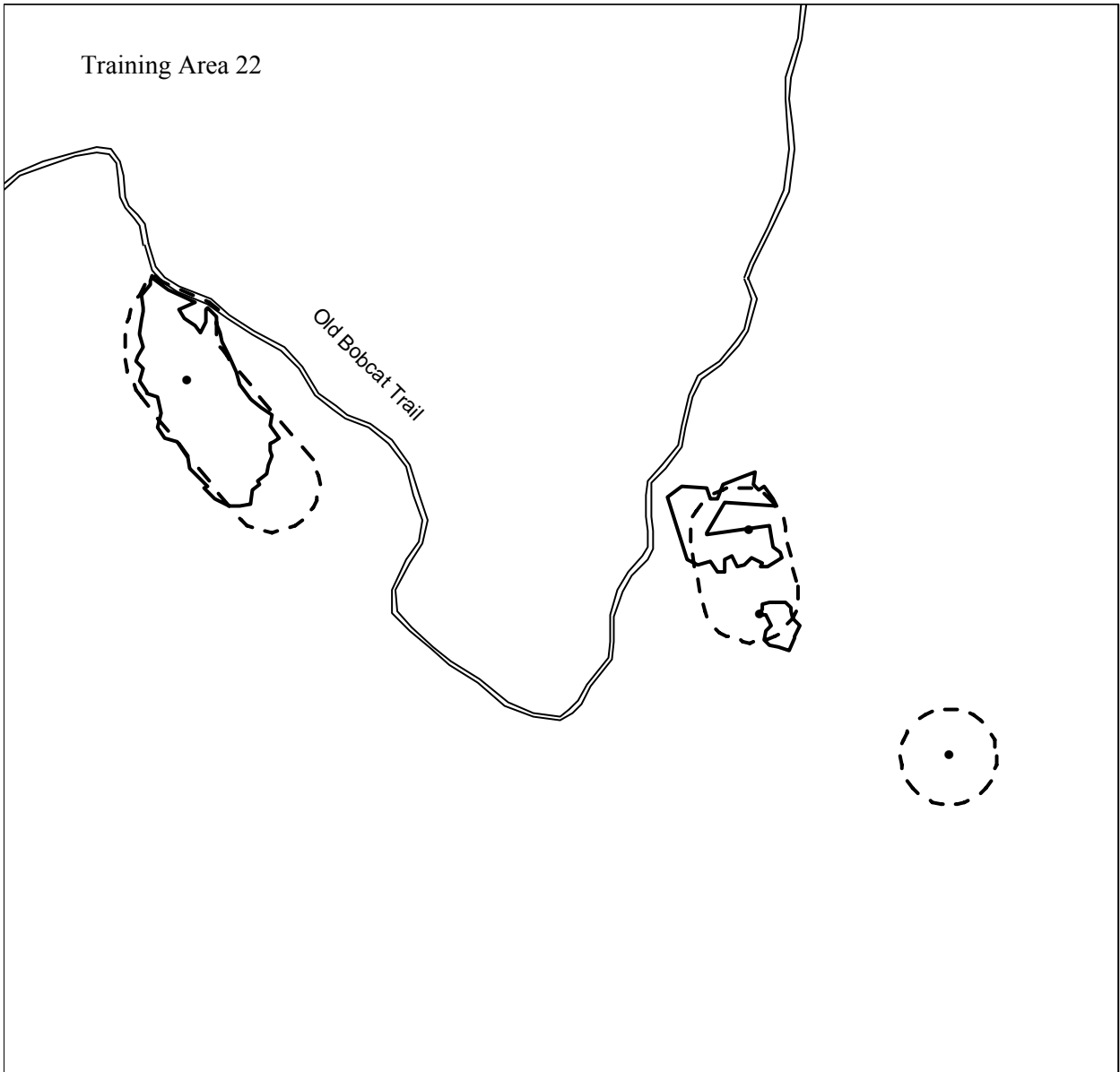
Site 01

Scale 1 : 2,500



Meters





Silene lanceolata

- Plant Locations
- - Short-term Control Goals
- Area Controlled

Figure 2-8

Short-term Control Goals,
and Control Efforts.

Site 06

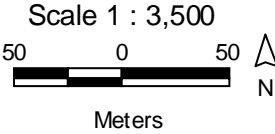


Figure 2-9

Training Area 22



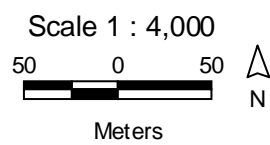
Silene lanceolata

- Plant Locations
- - Short-term Control Goals
- Area Controlled

Figure 2-9

Short-term Control Goals,
and Control Efforts.

Site 10



2.3i *Zanthoxylum hawaiiense*

INTRODUCTION

Z. hawaiiense, a Priority Species-2, was a priority species for surveys and management during the 2002-2003 reporting period. This species is at risk from introduced weed species, rodents, and ungulates. Seed recruitment may be severely impacted by rodents and ungulates. Rodents are believed to consume seeds once they have fallen to the ground. Ungulates will consume any plants or parts that are less than two meters in height. Introduced weed species impact *Z. hawaiiense* by increasing fuel loads and the potential for more frequent fires. Surveys to identify new and reidentify previously recorded locations have been conducted during the 2002-2003 reporting period.

RESULTS

Approximately 46 previously or newly recorded individuals have been found during the 2002-2003 reporting period. These individuals were found in the northern, central, and southern portions of Training Area 22 as well as one reidentified location within the Kipuka Kalawamauna Fence Unit.

Twenty individuals were found during four personnel-days of surveys of Site 09 in the small *Metrosideros polymorpha* mixed-tree kipuka of Site 09 in central Training Area 22 (Figure 2-10). Four of the 20 are believed to be reidentified individuals. All individuals are adults and are of sufficient height to be out of browse range of ungulates. However, they are at risk from bark stripping and such damage was recorded on four individuals.

Three individuals, within Site 13, were found during surveys of Sites 13 and 20 in the southern portion of Training Area 22 (Figure 2-11). Two individuals were from previous records and one was a newly recorded individual. All individuals were adults of sufficient height to be out of browse range.

Twenty-three individuals were found during surveys within Site 17 (Figure 2-12) as well during management actions in the area (Figure 2-13). Only two of the 23 individuals were the reidentified from previously recorded individuals. The other 21 were newly recorded individuals.

Weed control was conducted at Site 18 in Training Area 18. Approximately 0.40 ha (one acre) of *P. setaceum* was mechanically controlled (Figure 2- 14). The area controlled will be expanded to account for topography and fire threats to this site.

DISCUSSION

Previous surveys documented 155 locations of *Z. hawaiiense* at PTA. The surveys conducted during the 2002-2003 reporting period have expanded and filled in the distributional range of this species at PTA. There are now 216 recorded locations with 64 of them being re-identified or newly recorded locations. This increases the estimated number of individuals at previously and newly recorded locations to approximately 300.

Surveys during the reporting period show that Site 09 has a high density of *Z. hawaiiense*. In addition, this kipuka is the best example of the *Metrosideros polymorpha* mixed-treeland vegetation type found at PTA. The understory is of high quality with an apparently full complement of native understory species, unlike other examples of this vegetation type. The density of *P. setaceum* is very low and vegetation types and lava flows surrounding the habitat are conducive to controlling weed species within the kipuka.

Training Area 22

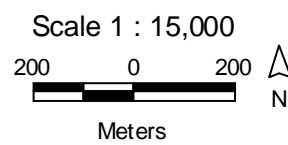


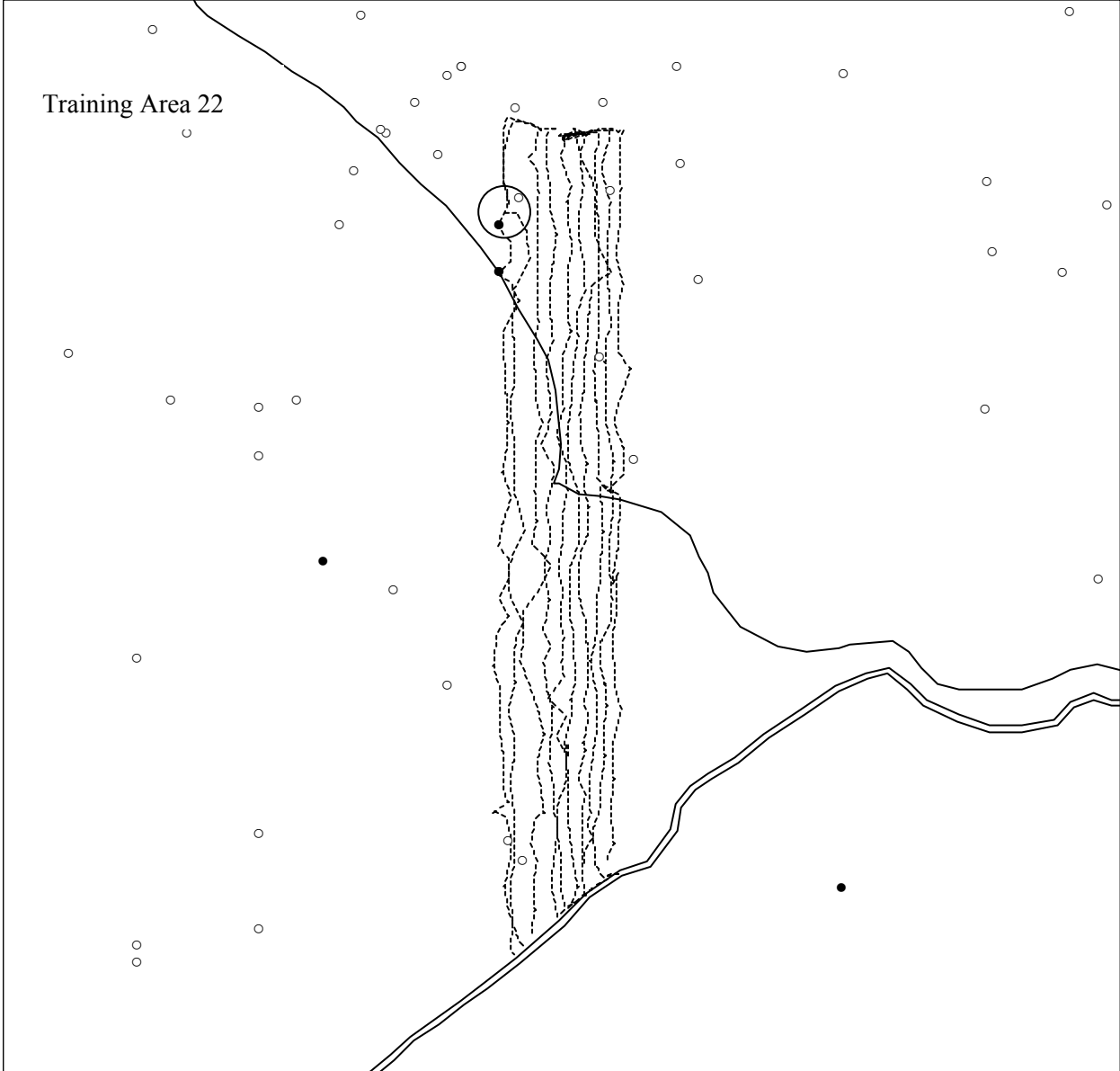
Zanthoxylum hawaiiense

- Plant Locations
- Previously Recorded Plant Locations
- Area Surveyed

Figure 2-10

Site 09 Survey Results.

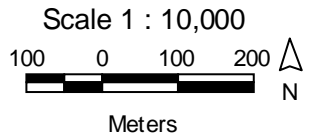


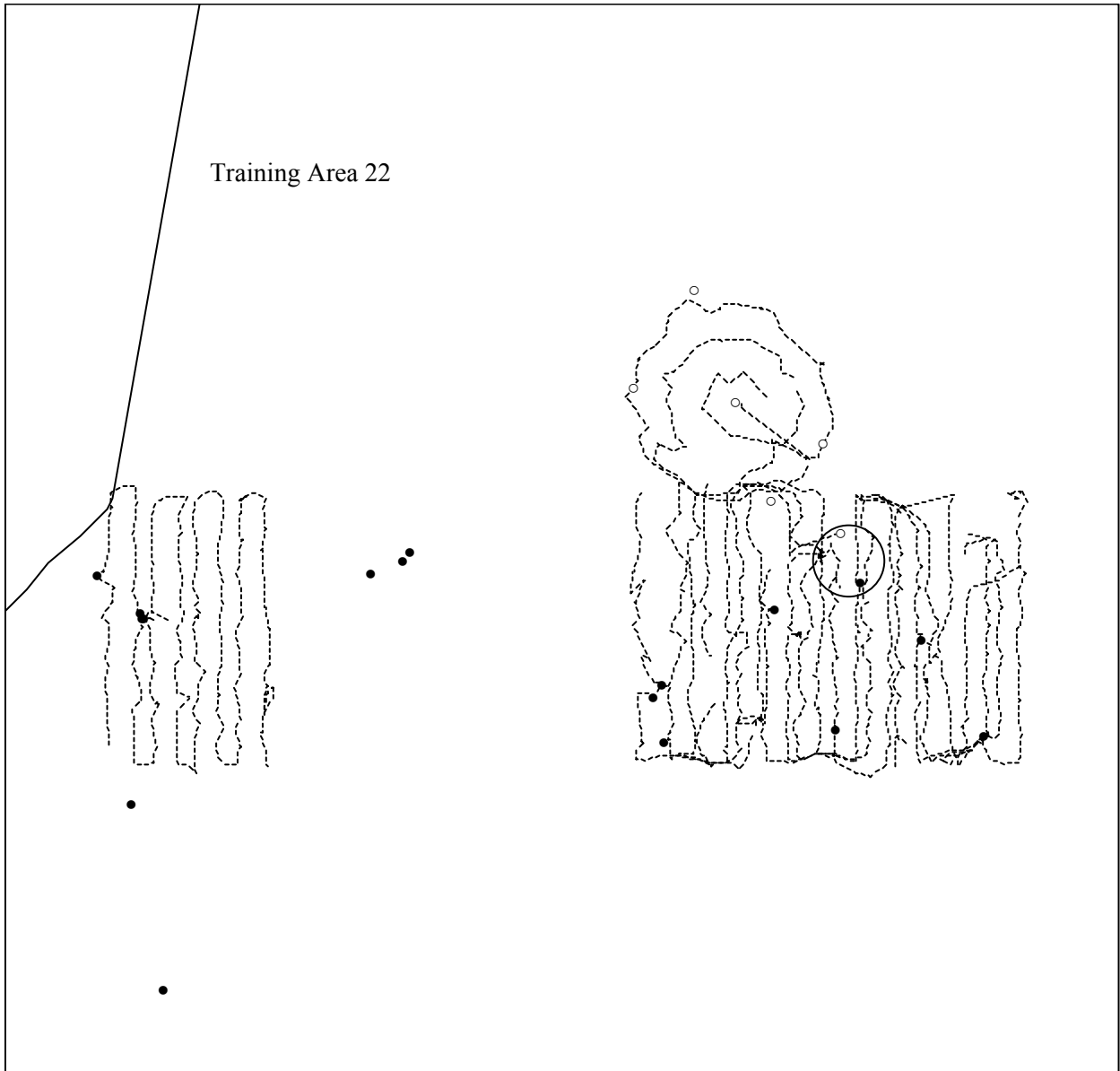


Zanthoxylum hawaiiense

- Plant Locations
- Previously Recorded Plant Locations
- Area Surveyed

Figure 2-11
Site 13/20 Survey Results.





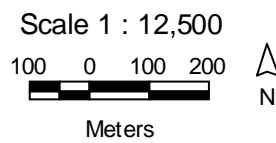
Training Area 22

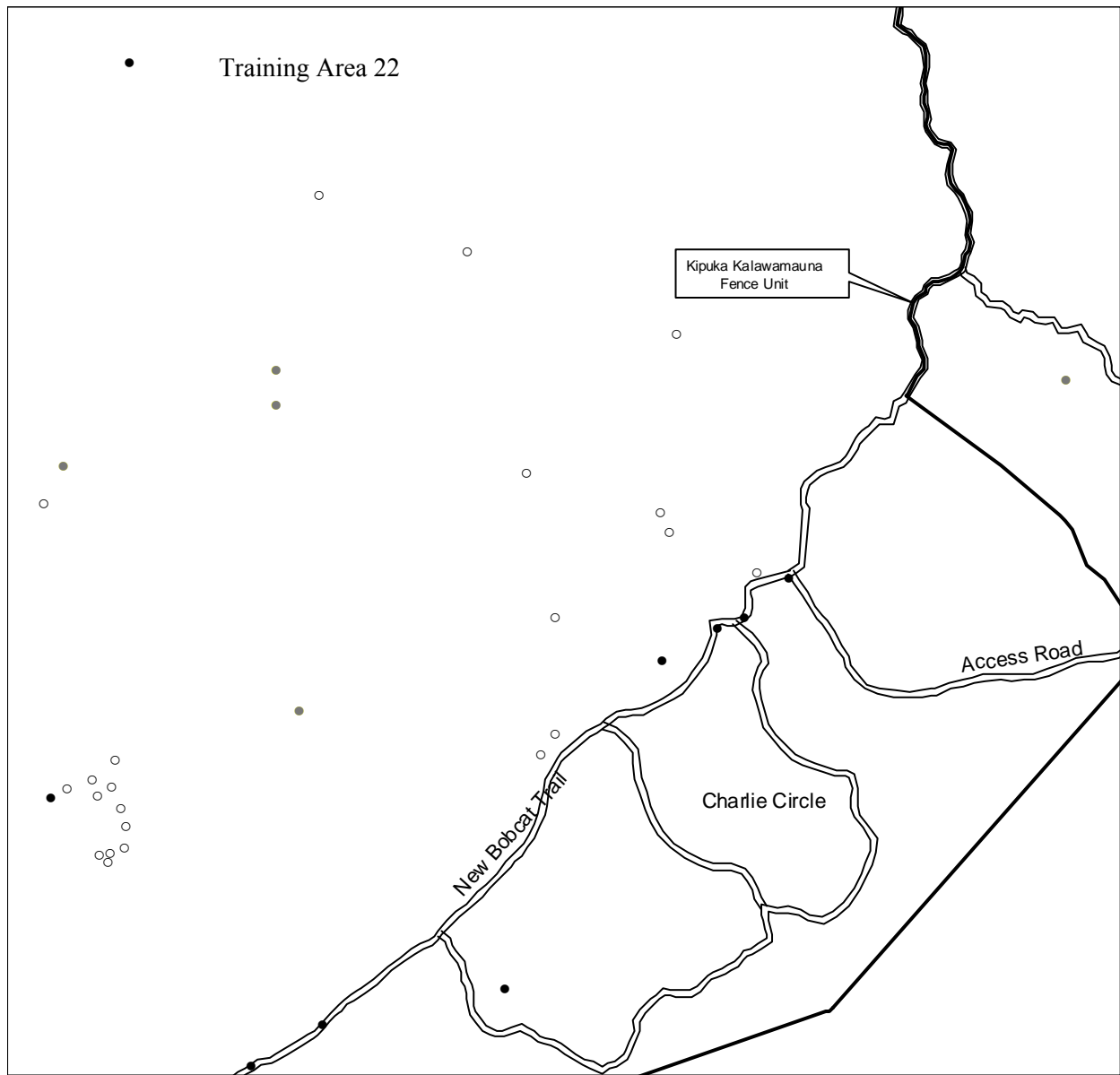
Zanthoxylum hawaiiense

- Plant Locations
- Previously Recorded Plant Locations
- Area Surveyed

Figure 2-12

Site 17 Survey Results.



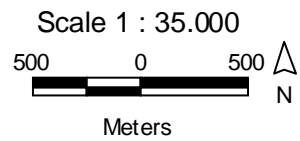


Zanthoxylum hawaiiense

- Plant Locations 2002/2003
- Plant Locations
- Previously Recorded Plant Locations

Figure 2-13

Site 17 Results.



Training Area 17

Site 18

MANAGEMENT RECOMMENDATIONS

Surveys have been successful in reidentifying previously recorded locations as well as recording new locations. Surveys to accurately document the distribution and population size of this species at PTA will continue.

There is little to no regeneration occurring in the field. Rodents are believed to impact the seed bank and ungulates consume newly emerged seedlings and any individuals within their reach. These destructive species must be controlled in *Z. hawaiiense* habitat to enable the populations to regenerate and sustain themselves at PTA. Aerial broadcast application of rodenticide is being investigated by Federal and State agencies for use in large-scale management. Upon approval, aerial bait broadcasting this should be implemented at PTA to control rodents in endangered species habitats. Control of rodents will greatly improve germination. However, ungulates must be excluded from plant habitats to ensure that enough seedlings are able to complete their lifecycle to become reproductive adults. The most effective method for ungulate exclusion is the construction of large-scale fence units around plant habitats. Any other methods leave the PTA populations at risk.

2.3i *Portulaca sclerocarpa*

RESULTS

No reidentification efforts specific to *P. sclerocarpa* have been made during the reporting period; however two new individuals were discovered along the southern fence line within the Kipuka Kalawamauna Fence Unit.

DISCUSSION

Seven sites have been reconfirmed or newly recorded and 26 individuals are known from these sites. There are four additional sites to be reconfirmed. Shaw (1997) estimated the number of individuals found at PTA to be less than 30. The numbers of individuals found at the seven reconfirmed or newly recorded sites and the potential numbers to be found at the four sites that have not been reconfirmed suggests that the number of individuals found at PTA is approximately 30-40.

2.3k *Haplostachys haplostachya*

RESULTS

No surveys or management actions were conducted specifically for this species. Two locations were found during the 2002-2003 reporting period during surveys and management for other species.

MANAGEMENT RECOMMENDATIONS

This species has a PS-5 ranking, therefore, reidentification, monitoring, and management will be prioritized according to the PS rankings or as circumstances necessitate.

2.3l *Silene hawaiiensis*

INTRODUCTION – Range 8

In 1996, the Army approached the USFWS to request a formal consultation on the effects of adding two machine-gun firing lanes at Range 8. This federal action had the potential to negatively impact the

threatened species *S. hawaiiensis*. As part of the consultation process, the Army was required to identify and protect *S. hawaiiensis* locations at Range 8 against damage resulting from the maintenance and use of the range. In addition, an annual monitoring of the known locations was agreed to and the NRS initiated monitoring of all known *S. hawaiiensis* locations at Range 8 in 1997.

RESULTS

Table 2-1 shows changes in the average height and number of the plants at Range 8. The results reported represent the annual monitoring of those adult individuals that were initially recorded in 1997. The number of individuals remaining from the initial monitoring has consistently declined. Thus, the results that were reported in previous reports were typically smaller due to the change in the decreased number of plants used to calculate the average height. The average height and number of the plants has decreased since the first monitoring in 1997.

Table 2-1. Average height of *Silene hawaiiensis* at Range 8.

	1997	1999	2000	2001	2002	2003
Average Height* (cm)	15.8	13.5	12.5	7.5	10.2	4.8
Number of Individuals**	101	105	96	61	58	26
Percent Damaged***	75.3	87.0	71.9	75.0	12.1	32.3

* The average height of adult plants present at Range 8 since 1997.

** The total number of individuals present during that year's monitoring.

*** The percentage of adult plants with signs of ungulate damaged.

DISCUSSION

The average height and number of the *S. hawaiiensis* found at Range 8 has decreased in the years following the initial monitoring in 1997 (Table 2-1). Evans et al. (2002a, 2002b) discussed the possible causes for the observed changes in the plants at Range 8. The discussion considered the potential and real impacts from military training, ungulate browse, and environmental factors. It was concluded that military training was not responsible for the observed changes. In fact, the portion of the range where two-thirds of the plants are found hasn't been used since 1992-1993. However, there have been significant impacts to the plants over this time period. The two additional machine-gun firing lanes at the time of this writing have yet to be utilized and are not operational. Therefore, the factors affecting the plants at the Range continue to be observed environmental changes and most importantly ungulate impacts.

INTRODUCTION – *Silene hawaiiensis* Fence Unit

In April of 1999, a 13.5-hectare (33.4 acres) fence unit was completed in Training Area 3 to protect *S. hawaiiensis*. In May of 1999, monitoring plots were established to assess the effects of ungulate exclusion on this species. The initial monitoring in 1999 serves as a baseline to which subsequent years of monitoring can be compared. Ten plots were established outside and inside of the fence unit. Plots were established in the two locations to test the effects of ungulate exclusion. Monitoring has been conducted annually since 1999.

Four years after fence completion, monitoring and analysis demonstrated that in 2002 the average plant height was greater inside of the fence unit than it was outside. In addition, average plant heights inside the

fence unit in 2001 and 2002 increased from the baseline average in 1999. During the same time period, the average height for plants outside the fence unit remained similar. These differences were attributed to higher browse frequencies on plants outside the fence unit. The lack of protection for plants outside the fence unit leaves them vulnerable to ungulates. The study has shown that the reduction of ungulate pressures on this species can have significant positive effects in a relatively short period of time.

RESULTS

Browse by location for each year is summarized in Table 2-2. A Chi-Square Analysis with Yates Correction for Continuity was used to test differences in browse between locations for each year. The analysis indicates that browse frequency was statistically similar for both locations in 1999, when the fence was completed. Browse frequency in 2000, 2001, 2002, and 2003 was greater outside the fence than it was inside.

Table 2-2. Summary of Browse by Location for Each Year. Results of the Chi-Square Analysis with Yates Correction for Continuity. Results are reported at the 90% confidence level.

Year	Location	Total Plants	Browsed	No Browse	Test Statistic	Critical Value
1999	Outside	50	36	14	1.6070	2.706
1999	Inside	97	80	17		
2000	Outside	42	22	20	23.3281	2.706
2000	Inside	80	9	71		
2001	Outside	33	19	14	32.9369	2.706
2001	Inside	84	6	78		
2002	Outside	36	9	27	5.6536	2.706
2002	Inside	92	7	85		
2003	Outside	27	15	12	28.8645	2.706
2003	Inside	72	4	68		

The average heights from four years of monitoring, 1999 to 2002, of plants inside and outside the fence unit are summarized in Figure 2-15.

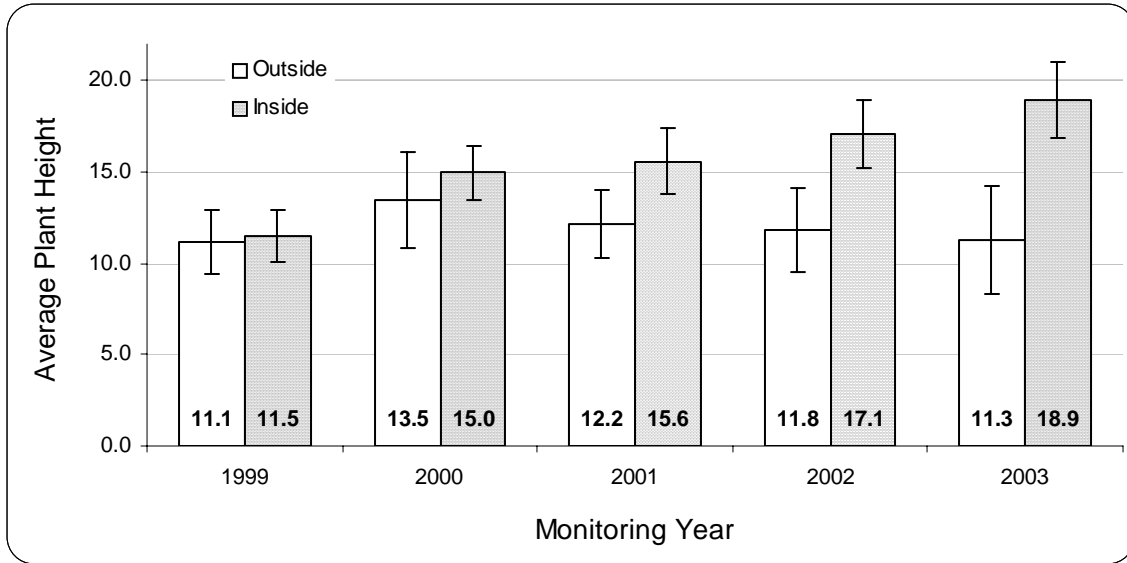


Figure 2-15. Average Plant Height by Location of the *Silene hawaiiensis* Fence Unit in Each Year. Results are reported at the 90% confidence level.

Results of the individual analyses of variance (ANOVA) for each year (Table 2-3) indicate the average plant height between locations is statistically similar from 1999 to 2001. Average plant height between locations was statistically different in 2002 and 2003, with greater average height being found for the plants inside the fence unit (Figure 2-7).

Table 2-3. ANOVA Results Comparing Plant Heights between Locations for Each Year. P-values less than 0.1 indicate statistical significance at $\alpha=0.1$.

	Degrees of Freedom	F-value	P-value
1999	1	0.08	0.780
2000	1	0.61	0.435
2001	1	3.30	0.072
2002	1	7.31	0.008
2003	1	8.43	0.005

An ANOVA indicated there were no statistically significant differences in the average height of plants outside the fence unit between years. However, there were statistically significant differences in the average height for plants inside the fence unit between years (Table 2-4).

Table 2-4. ANOVA Results Comparing Plant Heights between Years for Each Location. P-values less than 0.1 indicate statistical significance at $\alpha=0.1$.

	Degrees of Freedom	F-value	P-value
Outside	3	0.47	0.755
Inside	3	7.22	<0.001

The Tukey Test compared, in a pair-wise fashion, the results of the 1999 monitoring to those of the other years (Table 2-5). The results indicate that the average plant height is similar between 1999 and 2000. There was a statistically significant difference between the 1999 results and the results from 2001, 2002, and 2003. The plants in these three years had statistically significant greater average heights than were found in 1999.

Table 2-5. Tukey Pair-wise Comparisons Identifying the Differences in Height between Years for Plants Inside the Fence Unit. P-values less than 0.1 indicate statistical significance.

	T-value	P-value
2000	2.256	0.0959
2001	2.837	0.0193
2002	3.982	0.0003
2003	4.977	0.0000

The Tukey Test also detected differences when the 2000 monitoring was compared to subsequent years. The average plant height in 2003 was greater than in 2000 (Table 2-6).

Table 2-6. Tukey Pair-wise Comparisons Identifying the Differences in Height between Years for Plants Inside the Fence Unit. P-values less than 0.1 indicate statistical significance.

	T-value	P-value
2001	0.5253	0.9848
2002	1.5619	0.5220
2003	2.6678	0.0588

DISCUSSION

Monitoring and analysis have demonstrated that in 2003 the average plant height was greater inside the fence unit than it was outside. In addition, average plant heights inside the fence unit in 2001, 2002, and

2003 have increased from the baseline average in 1999, while the average height for plants outside the fence unit have remained similar.

The lack of protection for plants outside the fence unit has continued to leave them vulnerable to ungulates. This is most likely why plant height has not changed significantly since the initiation of this study. The average height for plants inside the fence unit has increased by an average of 64.3% over the same time period.

The greater heights for plants inside the fence can be explained by the results of the browse frequency analysis. In 1999, the browse frequencies were statistically similar by location. This was expected because the monitoring was conducted within one month of the fence unit's completion. However, browse frequency was statistically different in subsequent years, with higher browse frequencies on plants outside the fence unit.

Such results demonstrate that after two years of reduced ungulate browsing, the plants inside the fence unit have increased their average height from the baseline obtained in 1999. Furthermore, after three years the plants inside the fence unit have greater average height than those plants outside. This study shows that reducing ungulate pressures on this species can have significant positive effects in a relatively short period of time.

MANAGEMENT RECOMMENDATIONS

Fencing of the plants at Range 8 is needed to attempt to recover this population. It is likely that this population will be extinguished in the next few years, if browsing damage is allowed to continue.

In SHFU, four of the five years of this study have been completed. Results have already demonstrated the positive effects of ungulate exclusion for *S. hawaiiensis*. It is recommended that this study be concluded and that monitoring focus on a population viability analysis (PVA). A PVA would demonstrate the number of individuals necessary to protect a population for long-term sustainability.

2.3m *Spermolepis hawaiiensis*

RESULTS

Two attempts were made to reidentify CEMML recorded locations of this species during other monitoring or management actions during the 2002-2003 reporting period. No plants were located.

MANAGEMENT RECOMMENDATIONS

S. hawaiiensis is a PS-5 ranked species; a systematic monitoring will be implemented for this species according to the PS rankings.

2.3n *Stenogyne angustifolia*

RESULTS

No reidentification efforts or management actions specific to this species have been made during the 2002-2003 reporting period. Unrecorded locations were identified occasionally throughout the year during surveys for other species. These findings have been incorporated into the Rare Plant Database and GIS.

MANAGEMENT RECOMMENDATIONS

S. angustifolia is one of the more abundant endangered or threatened species found at PTA and is categorized as PS-5. No monitoring has been initiated for this species because of its low PS ranking. Once monitoring has been implemented for the higher ranked species, monitoring will be implemented for this species.