1.2 ECOSYSTEM RESTORATION MANAGEMENT UNIT PLANS

The Ecosystem Management Unit Plans (ERMUPs) included here follow the same format as ERMUPs included in the 2010 Status Report for the MIP and OIP. Each plan includes a summary of rare resources as well as a discussion of all threats to the MU. Each plan includes a table of proposed actions at the end of the document. The ERMUPs are designed to be stand-alone, technical documents which guide OARNP field crews. Some repetitive verbiage is intentional.

1.2.1 Kaluaa and Waieli

Ecosystem Restoration Management Unit Plan

MIP Year 8-12, Oct. 2011 – Sept. 2016

MU: Kaluaa and Waieli

Overall MIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, rodent, arthropod, slug, snail, fire, and weed threats to support stable populations of IP taxa. Implement control methods by 2014.

1.2.1.1 Background Information

Location: Southern Waianae Mountains

Land Owner: State of Hawaii

Land Manager: U.S. Army

Acreage: 154 acres

Elevation Range: 1,800-2,883ft

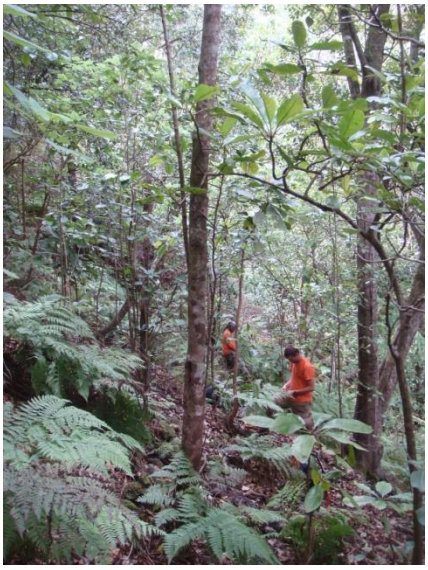
Description: The Kaluaa and Waieli MU is located in the Honouliuli Forest Reserve. The area is accessed via dirt roads through agricultural lands. The unit can be accessed either from the south through Actus Property and the QTR-2 gate or via South Range access roads from Kolekole Pass Road. There is one landing zone which is used to access the portion of the MU near Puu Hapapa. Terrain within the Kaluaa and Waieli MU is varied ranging from gradual slopes to vertical cliffs. Mesic mixed forest is the vegetation type across the Kaluaa and Waieli MU though the dominant native trees vary by aspect and elevation.

Native Vegetation Types:

Waianae Vegetation Types
Mesic mixed forest
Canopy includes: *Acacia koa, Metrosideros polymorpha, Nestegis sandwicensis, Diospyros* spp., *Pouteria sandwicensis, Charpentiera* spp., *Pisonia* spp.,*Psychotria* spp., *Antidesma platyphylum, Bobea* spp. and *Santalum freycinetianum*. Understory includes: *Alyxia oliviformis, Carex* spp., *Bidens torta, Coprosma* spp., and *Microlepia strigosa*
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

Kaluaa and Waieli MU from east, the prominent peak on right is Puu Hapapa.

Kaluaa from Puu Hapapa looking south



Mesic forest within MU

Typical Waianae crest vegetation within MU

Mesic gulch vegetation typical of Kaluaa and Waieli MU

MIP/OIP Rare Resources:

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Alectryon macrococcus* var. *macrococcus*	KAL-A,B,C ELI-A,B Reintro KAL-E	Central Kaluaa to Central Waieli	MFS	Both
Plant	*Cyanea grimesiana* ssp. *obatae*	KAL-B Reintro KAL-C,D, E	Central Kaluaa	MFS	Both
Plant	*Delissea waianaeensis*	KAL-B Reintro KAL-C,D,E	Kaluaa	MFS	Both
Plant	*Plantago princeps* var. *princeps*	Reintro ELI-A	Waieli	Manage Reintroduction for Storage	Reintro
Plant	*Phyllostegia mollis*	KAL-D Reintro KAL-B,C	Kaluaa	MFS	Both
Plant	*Phyllostegia hirsuta*	KAL-A ELI-A,B,C	Hapapa to Kaluaa	MFS	Wild/ Future Reintro
Plant	*Schiedea kaalae*	KAL-A (extirpated) Reintro KAL-B,C	Kaluaa and Waieli	MFS	Reintro
Plant	*Stenogyne kanehoana*	KAL-A Reintro KAL-B,C,D	Central Kaluaa	MFS	Reintro
Insect	*Drosophila montgomeryi*	n/a	Kaluaa and Waieli	MFS	Wild
Snail	*Achatinella mustelina*	KAL-A	ESU-D1	MFS	Wild

MFS= Manage for Stability

Other Rare Taxa at Kaluaa and Waieli MU:

Organism Type	Species	Status
Plant	*Clermontia persicifolia*	SOC
Plant	*Cyanea calycina*	PE
Plant	*Cyanea pinnatifida*	Endangered
Plant	*Cyanea superba*	Endangered
Plant	*Cenchrus agrimonioides* var. *agrimonioides*	Endangered
Plant	*Diellia falcata*	Endangered
Plant	*Exocarpos gaudichaudii*	SOC
Plant	*Gardenia brighamii*	Endangered
Plant	*Melicope christophersenii*	PE
Plant	*Notocestrum longifolium*	PE
Plant	*Panicum beecheyi*	SOC
Plant	*Platydesma cornuta* var. *decurrens*	PE
Plant	*Pteralyxia macrocarpa*	PE
Plant	*Pleomele forbesii*	PE
Plant	*Schiedea hookeri*	Endangered
Plant	*Schiedea pentandra*	SOC
Plant	*Solanum sandwicense*	Endangered
Plant	*Tetramolopium lepidotum* subsp. *lepidotum*	Endangered
Plant	*Urera kaalae*	Endangered
Bird	*Chasiempis ibidis*	Endangered
Insect	*Drosophila ambochila*	Endangered
Insect	*Hylaeus sp.*	SOC
Snail	*Amastra micans*	SOC
Snail	*Amastra spirazona*	SOC
Snail	*Laminella sanguinea*	SOC
Snail	*Cookeconcha sp.*	SOC
Snail	*Endonta sp.*	SOC
Snail	*Auriculella ambusta*	SOC

Other Rare Taxa Directly Adjacent to Kaluaa and Waieli MU:

Plant	*Abutilon sandwicense*	Endangered
Plant	*Cryptocarya mannii*	SOC
Plant	*Gardenia mannii*	Endangered
Plant	*Melicope cinerea*	SOC

SOC=Species of Concern
PE= Proposed Endangered

Rare Resources at Kaluaa and Waieli

Locations of Rare Resources within the Kaluaa and Waieli MU:

MU Threats to MIP/OIP MFS Taxa:

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes, MU fenced.
Rats	*A. mustelina, C. grimesiana, D. waianaensis, A. macrococcus*	Yes	No	Yes, predator-proof fencing and diphacinone bait combined with rat snap traps.
Black twig borer (BTB) *Xylosandrus compactus*	*Alectryon macrococcus* var. *macrococcus*	Yes	No	Repellents under investigation, traps not very effective.
Predatory snails *Euglandina rosea*	*Achatinella mustelina*	Yes	No	Physical barrier (enclosure), to protect *Achatinella* from predators under construction.

Jackson's chameleon	*Achatinella mustelina*, *D. montgomeryi* and birds	Yes	No	Yes, physical barriers and hand capture.
Vespula pennsylvanica	*D. montgomeryi*	Yes	No	Manual destruction of nests. Toxicants may harm *Drosophila*.
Ants	*D. montgomeryi*	Yes	No	No, as toxicants may harm *Drosophila*
Slugs	*C. grimesiana*, *D. waianaeensis*, *P. princeps*, *P. hirsuta* , *P. mollis*, *S. kaalae*, *S. kanehoana*	Yes	No	Yes, Sluggo bait available for use.
Weeds	All	No	Yes	Yes. For steep cliff areas, herbicide ballistic technology being tested.
Fire	All	No	Yes	Yes, fuel pre-suppression.

Management History

- 1860s-80s : Area severely degraded by overgrazing by unmanaged herds of cattle. James Campbell purchases Honouliuli and drives more than 30,000 head of cattle off the slopes and lets the land "rest."
- 1925: Honouliuli Forest Reserve established for watershed protection purposes.
- 1930s-50s: Division of Forestry and Civilian Conservation Corps builds roads, trails and fences and continues removal of feral goats and cattle; plants 1.5 million trees in the Honouliuli Forest Reserve mainly below the 1800' elevation.
- 1940s: Area below the contour trail in Kaluaa actively farmed and used for ranching (Leilehua Ranch).
- 1940s-50s: Area below the contour trail first used by the Army for training.
- 1970's: *Clidemia* first introduced to the Waianae Mountains in the South Kaluaa contour trail area.
- 1972: One individual of *Drosophila montgomeryi* was recorded from Kaluaa Gulch
- 1990-2009: Honouliuli Preserve managed by TNC
- 1996: TNC installed 1/8th acre Ti Leaf Flats fence; *Delissea waianaeensis, Cyanea pinnatifida* were the first TNC endangered plant reintroductions.
- 2000-2007: TNC management consisted of installing an extensive catchment system, trail construction, project stewardship plots, field nursery, reintroduction of several thousand endangered and common natives, rat control for snail and elepaio protection, and volunteer hunting program.
- 2001: 100 acre Central Kaluaa fence completed by TNC staff, volunteers and contractor John Hinton.
- 2002: OANRP first begins using the Central Kaluaa fence area for endangered reintroductions as part of the MIP plan.
- 2003: Extensive archeological surveys in the area below the boundary of the TNC preserve document numerous cultural and historical sites.

- 2004: US Army acquires the South Range Acquisition Area from James Campbell Estate for a second qualifying training range in the South Range area (now known as SRQTR2). Area mostly consists of old pineapple fields but also some portions of the forested area as a buffer safety zone.
- 2006: 25 acre Hapapa/North Kaluaa fence completed by TNC, volunteers, and OANRP staff.
- 2009-2010: Army Compatible Use Buffer Program purchases Honouliuli Preserve with assistance from State and private partners primarily for endangered species management. Title transfers to the State of Hawaii for management as a forest reserve with other uses as well including recreational hiking and hunting.
- 2010: *Drosophila montgomeryi* was documented by Karl Magnacca at one site in Kaluaa gulch and at a second site near the summit of Puu Hapapa (2640 ft. elevation).
- 2010: OANRP completes construction of 42 acre Waieli and North Kaluaa fence and all pigs removed.
- 2011: A contracted company completes the 0.25 acre snail enclosure at Puu Hapapa

1.2.1.2 Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Primary Objective: To maintain all areas within fenced units as pig free.

Strategy:

- Eradication in the MU.
- Consider need to construct strategic ungulate fencing to protect the South Range side of Puu Hapapa.
- Population reduction just outside the MU with State permission. Encourage DLNR to reduce pressure below MU via public hunting.

Monitoring Objectives:

- Conduct perimeter fence checks quarterly and monitor for pig ingress.
- Monitor for pig sign while conducting other management actions in the fence.
- Monitor high priority gulches for ungulate sign biannually.
- Annually monitor interior fencelines.
- Monitor pig sign atop Hapapa in conjunction with regular rat control visits.

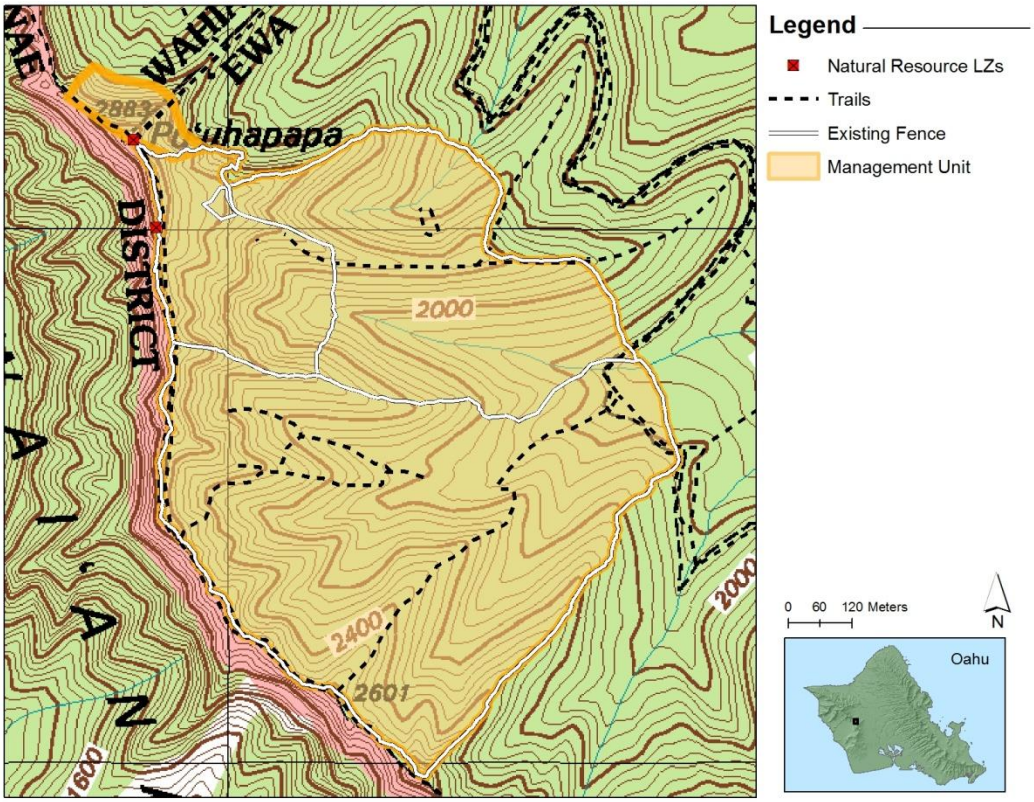
Management Responses:

- If any pig activity is detected in the MU, implement snaring program or conduct control hunts with permission from the State of Hawaii.
- After one year of ungulate monitoring atop Hapapa decide if strategic fencing should be built.

Maintenance Issues

- Maintain fences
- Conduct fence checks after storm events with emphasis on gulch crossings.
- Install signs where MU fence is visible from trails to inform the public about purpose and goal of fence.

Ungulate Management at Kaluaa and Waieli MU



1.2.1.3 Weed Control

Weed Control actions are divided into 4 subcategories:

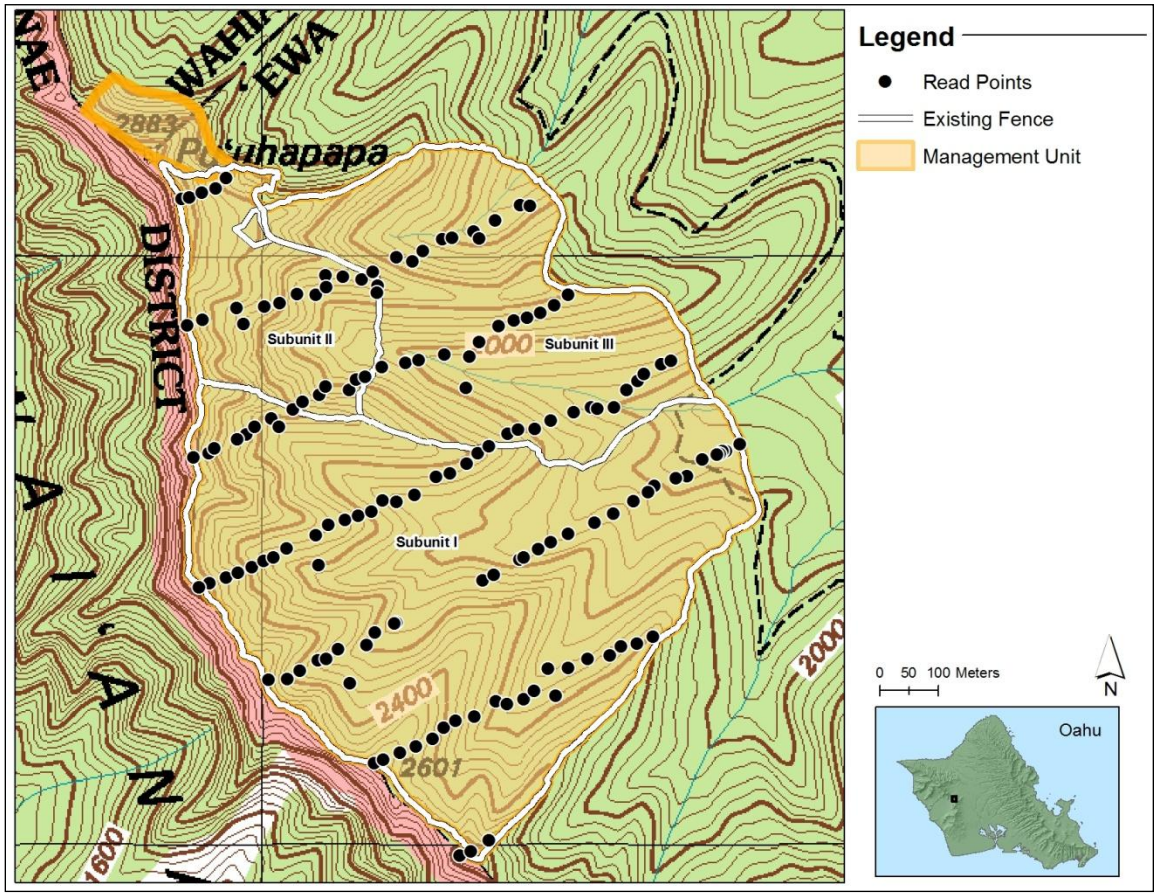
1) Vegetation Monitoring
2) Surveys
3) Incipient Taxa Control (Incipient Control Area - ICAs)
4) Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP/OIP requirements.

<u>Vegetation Monitoring for the Kaluaa MU</u>

From July - September of 2010 vegetation monitoring was conducted for the Kaluaa and Waieli management unit (MU). The total effort including commute time was 280 hours. In the next few months the vegetation monitoring sub-committee will be meeting to set the monitoring interval for this MU. The vegetation monitoring data will provide NRP with trend analysis on the percent cover for alien vegetation in the understory and canopy, invasion and spatial distribution of priority weed species, and species richness. Since the MU vegetation monitoring protocol was designed in order to address two separate MIP management goals, the following analysis is divided into two separate sections. The statistical thresholds used for both sections were copied directly from the Makua Implementation Plan

Vegetation Monitoring



Note: Areas inaccessible due to steep terrain and sections with thick uluhe were excluded from the sampling due to concerns of human impact.

Section 1: Alien Percent Cover Goal

Alien Percent Cover Management Objective: Assess if the percent cover for alien understory and canopy is 50% or less across the entire management unit. For more discussion on this objective refer to Makua Impementation Plan, chapter 10, table 10.1.

Sampling Objectives:

Be 95% sure of detecting a 10% change in percent cover for both alien understory and canopy.

The acceptable level of making a Type 1 error (detecting a change that did not occur) is 10% and a Type 11 error (not detecting a change that did occur) is 20%.

Vegetation Monitoring Protocol: Refer to the monitoring section in the 2008 year-end report.

Analysis: Baseline data collected for the Kaluaa MU in 2010 showed that the mean percent alien vegetation cover was 44% in the understory and 61% in the canopy (refer to MU % vegetation cover table

below). In the understory, the alien percent cover met the management goal of 50% or less vegetation cover. In the canopy, the alien vegetation cover was not met.

Management response: If future vegetation monitoring analysis indicates that the alien percent in either the understory or canopy has not been met and are not getting closer to being reached, the weed control strategy will be re-evaluated by the IT.

Statistical Thresholds and Sample Size Considerations: To determine the minimum sample size required to detect a 10% change in alien vegetation cover a post-hoc power analysis was performed. With 80% power and a standard deviation of 36 (used from alien canopy standard deviation baseline dataset) the minimum sample size needed to meet the sampling objectives was 81 plots. In 2010 a total of 149 plots were monitored. Though only 81 plots were needed to detect a change in alien percent cover, more plots were monitored to ensure that there was a large enough sample size to detect change in the frequency of occurrence goal (discussed in section 2).

Section 2: Frequency of Occurrence Analysis

Frequency data was collected for all species that occurred within the Kaluaa MU in 2010. This data will be used to tracking species richness, spatial distribution, and density of dominate species on an MU scale. This analysis will be used by management to help determine if Kaluaa is getting more or less native over time. For a complete list of species recorded during the 2010 monitoring period and the percent of plots they occurred in refer to appendix 1-6.

Species Richness and Vegetation Monitoring Checklist:

From the 2010 dataset a vegetation checklist of the vascular plant species was compiled. Within the canopy; a total of 77 plant species were recorded; 59 (77%) of these species were native and 18 (23%) were alien. In the understory, a total of 173 species were recorded; 113 (65%) of these species were native and 60 (35%) were alien.

Management Objective for priority alien species control:

- Assess the spatial distribution and frequency for all priority 2 alien species.
- Proved an updated priority weed species list for the Kaluaa MU.
- Track species richness for alien species across the MU.

Sampling Objective: 95% confident of detecting 10% change in occurrence of priority 2 alien weed species.

Vegetation Monitoring Protocol: Refer to the monitoring section in the 2008 year-end report.

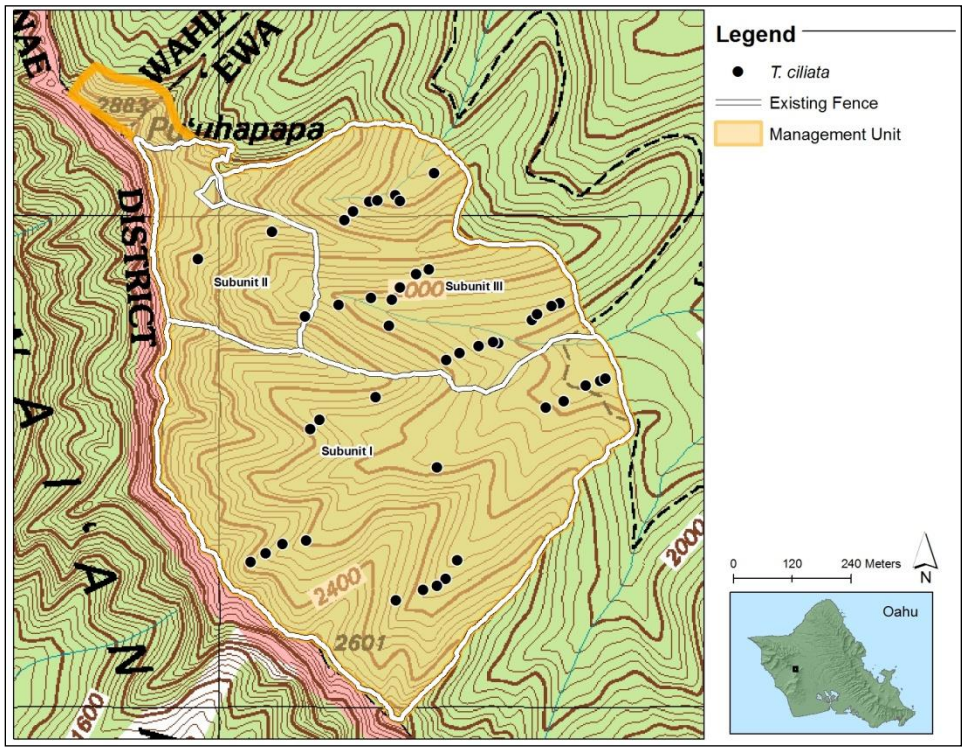
Established Weed Species Discussion: Priority weed species which are of particular interest to NRP due to their ecosystem altering potential are controlled on an MU or WCA scale. For notes on the control strategy for these species refer to the Summary of Target Taxa table in the ICA section of this report.

Two main species from the priority weed list which are targeted for control in all of the WCA's in the next five years are *Psidium cattleianum* and *Schinus terebinthifolius*. Both of these species are established at Kaluaa. The frequency of *Psidium cattleianum* on an MU scale was 38% in the canopy and 45% in the understory. The frequency of *Schinus terebinthifolius* on an MU scale was 68% in the canopy and 63% in the understory. In some areas, these species have created monotypic stands. The management goal for these species is to control them in native forest patches, around rare plant populations, and

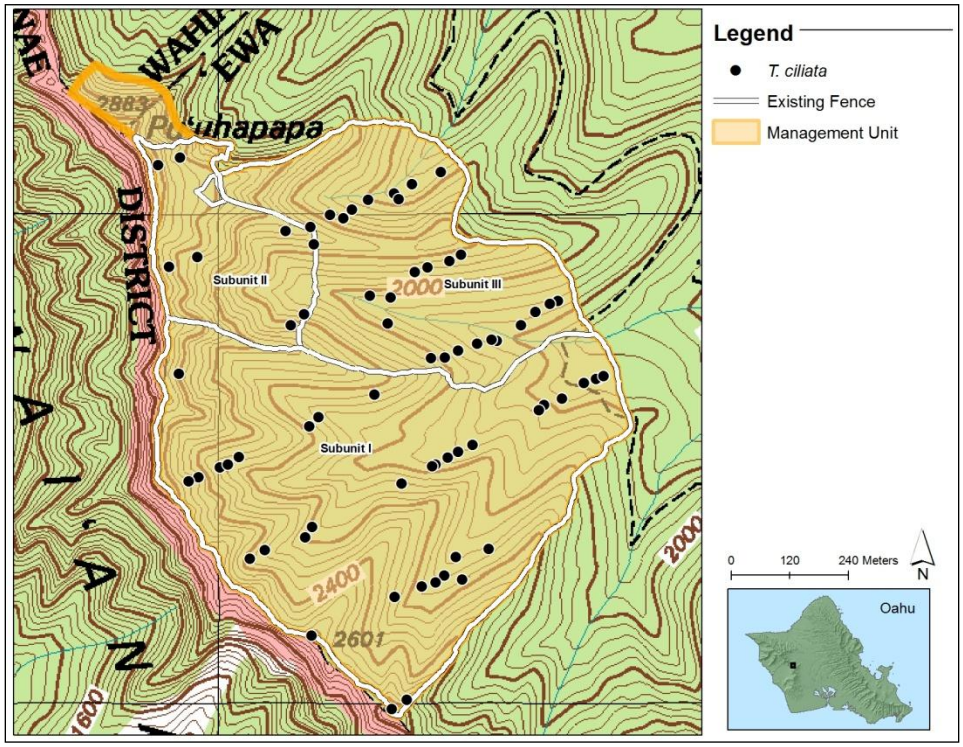
prevent monotypic stands from expanding. Vegetation monitoring will provide NRS with spatial distribution and density trends for these species and will be used to assess priority weed control strategy on an MU scale.

Another invasive tree which is targeted for control on a WCA scale is *Tonna ciliate.* Field biologists from both NRP and TNC have reported this specie spreading rapidly in Kaluaa. It was first established in sub-unit 3 but has since spread into sub-unit 1 and 2. A major challenge of controlling *T. ciliata* is that it grows rapidly in Hawaii, reaching an average height of 10 m after only 8.7 years. In addition, it can mature after six years in open localities and is wind dispersed (Lemmens, 2008). Given this, it will be important to conduct weed sweeps at a minimum of a six year interval, first prioritizing the control of *T. ciliata* within native dominated areas and around PU's. In 2010, the frequency of *T. ciliata* on an MU scale was 31% in the canopy and 49% in the understory. Since the weed control strategy is different between sub-units 1 and 2 and sub-unit 3, it will be informative to track the trend of occurrence within the two areas separately. In the understory the frequency was 34% in sub-unit 1 and 2 combined and 53% in sub-unit 3 which was significant (Chi-Square, P = 0.006). In the canopy, the frequency was 15% in sub-unit 1 and 43% in sub-unit 2 which as significant (Chi-Sqaure, P = 0.00005). As more data is collected, trend analysis will indicate if the current weed control strategy is sufficient at controlling the spread and density for *T. ciliata.* If the trend shows a significant increase in occurrence for this species, weed control strategy will be re-assessed.

Occurrence of *T. ciliata* Canopy*:*



Occurrence of *T. ciliata* Understory*:*



Low Density Priority Two Weed Species Discussion:

An additional benefit of conducting vegetation monitoring was the detection of several low density priority weed species (Refer to list below). NRP treats these species with zero tolerance, so all detected target species found during vegetation monitoring were controlled. Data collected for these species will not be analyzed after re-sampling because actively controlled target species in the sampled area would skew future analysis.

Native Species Frequency Anaylsis:

Target Taxa List	Sample Size	Occurrence of Low Density Taxa
Heliocarpus popayanensis in the Understory	149	2
Heliocarpus popayanensis in the Canopy	149	1
Mallotus phillippenis in the Understory	149	2
Panicum maximum in the Understory	149	2
Spathodea campanulata in the Understory	149	5
Schefflera actinophylla in the Understory	149	3
Setaria palmifolia in the Understory	149	1
Triumfetta semitriloba in the Understory	149	2

Management Objective: Ensure the plant communities within the MUs are stable and native-dominated (MIP.

Sampling objectives: Be 95% certain of detecting a 10% change in occurrence of native species.

Vegetation Monitoring Protocol: Refer to the monitoring section in the 2008 annual status report.

Native Species Frequency Analysis: The most common native tree in both the canopy and understory was *Pouteria sandwicensis*, occurring in 29% of the plots. The next most common native species were *Acacia koa, Metrosideros polymorpha* and *Psychotria mariniana*. For a complete species list refer to Appendix 1-6.

Management response: If there has been significant decline in native species occurrence over time, assess if satisfactory progress is being made to reverse this trend.

Surveys

Army Training?: Yes, training occurs nearby in South Range, QTR 2

Other Potential Sources of Introduction: NRS, public

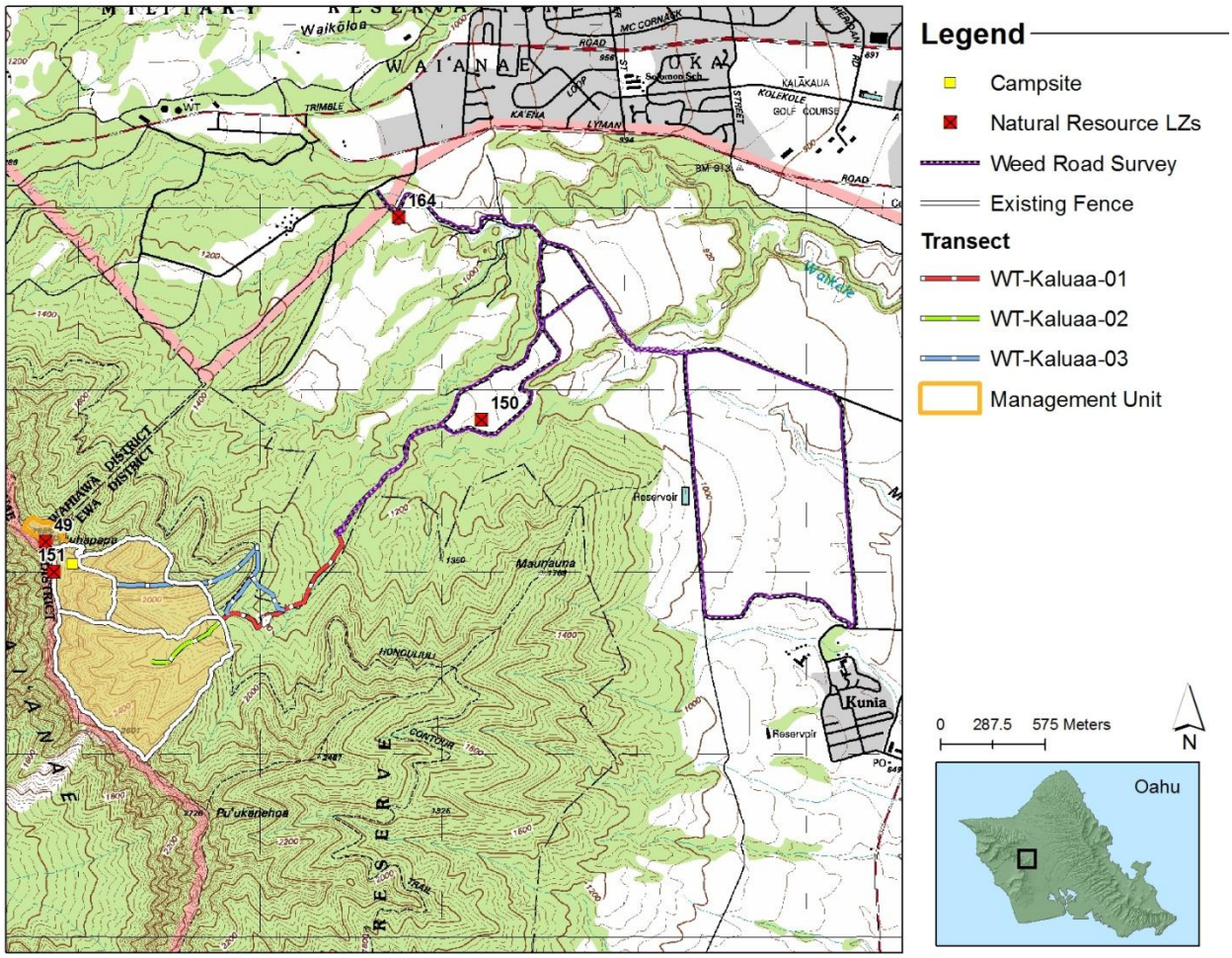
Survey Locations: Roads, Landing Zones, Campsites, Trails, Fencelines, High Potential Traffic Areas.

Management Objective: Prevent the establishment of any new invasive alien plant or animal species through regular surveys along roads, landing zones, camp sites, fencelines, trails, and other high traffic areas.

Monitoring Objectives:

- Quarterly surveys of LZs (if used).
- Note unusual, significant or incipient alien taxa during the course of regular field work particularly when doing fence checks.
- Annually survey contour trail, main Kaluaa gulch trail and the Hapapa access trail for incipient weeds (see map).
- Annually survey Kaluaa access road.

Survey Areas at Kaluaa and Waieli



Surveys are designed to be the first line of defense in locating and identifying potential new weed species. At Kaluaa and Waieli, landing zones are checked when used (not exceeding once per quarter). The only LZs approved for use within this MU are Waieli-TNC Hapapa LZ (151) and SBS Hapapa LZ (49). Relevant LZs for this MU include the Army LZs CAT (164), Dragon X (83) and the OANRP LZs Ekahanui Trailhead LZ (99) and the Kaluaa Trailhead LZ (150). The Kaluaa Trailhead LZ is not currently approved for use, but has been used in the past. These four LZs are not in the MU, however they are used to stage gear and personnel when accessing LZ 151 which is in the MU. Therefore, quarterly surveys for both weeds and invasive insects at these LZs are important. Additionally, the roads leading to the Ekahanui trailhead and CAT LZs are surveyed annually for weeds. The Ekahanui MU plan covers the survey and control of weeds at LZ 99 and for the Ekahanui access road. The Dragon X LZ is used by numerous teams for a variety of flight work and will be surveyed at least once per quarter by whatever team uses it (under jurisdiction of Green Team). The action table in this plan includes quarterly surveys of LZ CAT. In addition to LZ surveys, staff also conducts surveys at the primary shelter/campsite in the MU, along 3 heavily trafficked trails, and along the access roads.

Incipient Control Areas

Management Objectives:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2015.
- Conduct seed dormancy trials for all high priority incipients by 2015.

Monitoring Objective: Visit ICAs at stated re-visitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.

Management Responses: If unsuccessful in preventing immature plants from maturing, increase ICA revisitation interval.

ICAs are drawn around each discrete infestation of an incipient invasive weed. ICAs are designed to facilitate data gathering and control. For each ICA, the management goal is to achieve complete eradication of the invasive taxa. Frequent visitation is often necessary to achieve eradication. Seed bed life/dormancy and life cycle information is important in determining when eradication may be reached; much of this information needs to be researched and parameters for determining eradication defined. NRS will compile this information for each ICA species.

The table below summarizes target taxa at Kaluaa and Waieli, including incipient invasives. Appendix 3.1 of the MIP lists significant alien species and ranks their potential invasiveness and distribution. Each species is given a weed management code: 0 = not reported from MU, 1 = incipient (goal: eradicate), 2 = control locally. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in an MU. NRS supplemented and updated Appendix 3.1 with additional target species identified during field work. In many cases, the weed management code assigned by the MIP has been revised to reflect field observations. ICAs are not designated for every species in the table below; however, occurrences of all species in the table should be noted at Kaluaa and Waieli.

Summary of Target Taxa

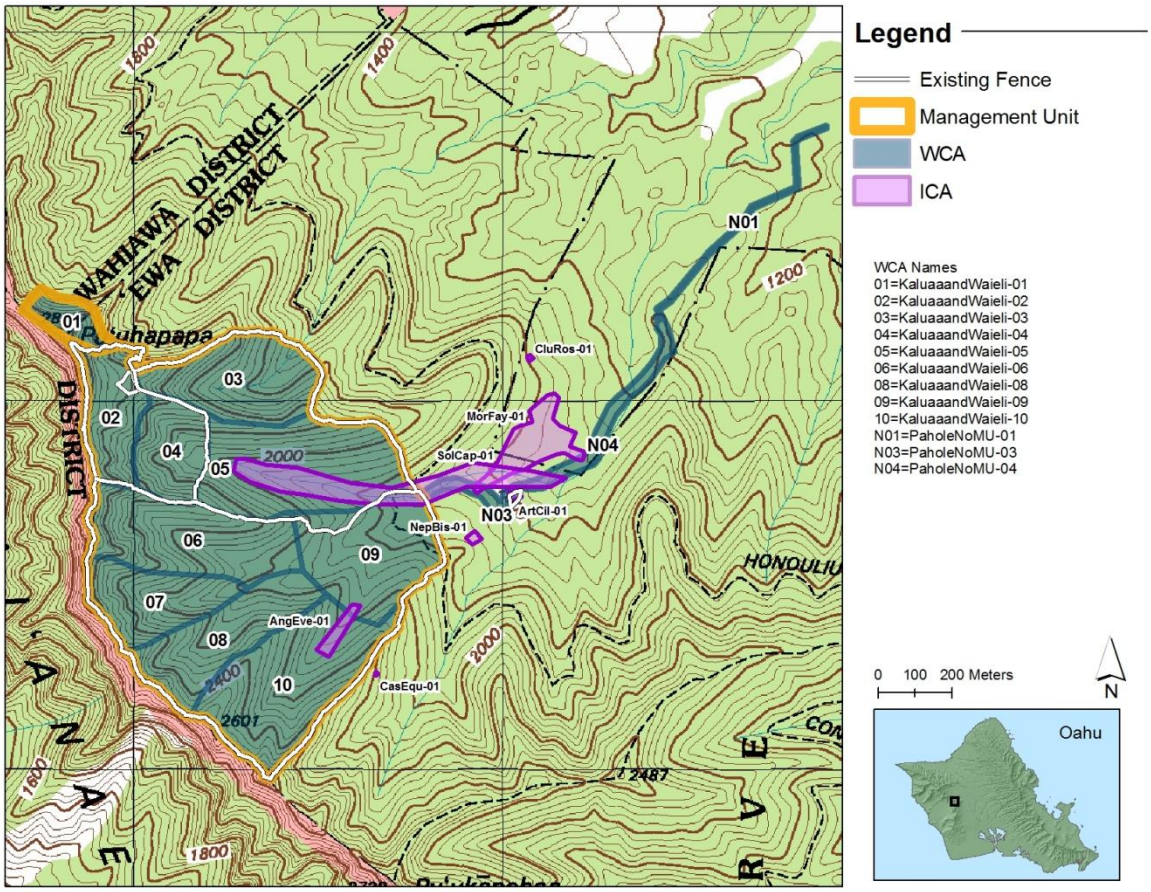
Taxa	MIP weed mgmt code		Notes	No. of ICAs
	Original	Revised		
Ardesia elliptica	0	2	Below MU fence, concentrated in South Kaluaa. Pretty widespread. Keep it out of the fence.	0
Angiopteris evecta	1		In South-Central Kaluaa gulch. Always keep on look out for this in gulches within MU.	1
Arthrostemma ciliata	n/a	1	Concern from sanitation perspective. Only 1 plant known; it was a small mature next to the trail just below the ti leaf fence.	1
Casurina equisitifolia	0	1	Only one location known on South fenceline. Combine control visits with fenceline checks.	1
Clusia rosea	0	1	1 monstrous mature located on contour trail below Kaluaa. Difficult to control. Research control techniques.	1
Dicliptera chinensis	0	2	Concern from sanitation perspective. Not known inside MU. Control along access trail to prevent spread into MU. Naturally roundup resistant.	0
Erigeron karvinskianus	2	2	Control in WCAs. Target in cliff and bench areas in habitat for MFS plant taxa.	0
Falcataria	n/a	1	Treat as part of WCA work. Kill all mature trees within fence. Well	0

Taxa	MIP weed mgmt code		Notes	No. of ICAs
	Original	Revised		
moluccana			established below MU.	
Ficus sp.	0	1	Banyan gulch. Treat as part of WCA work. Kill all mature trees within fence. Established below MU. Research reliable control techniques.	0
Fraxinus uhdei	2	0	Not detected in MU monitoring. No antecdotal observations near or within MU.	0
Grevillea robusta	2	2	Widespread across MU. In vegetation monitoring, taxa occurred in 17.45% of plots in the canopy and in 15.44% of plots in understory. Control in WCA sweeps. Priority to kill matures. Lower priority than *Toona ciliata*.	0
Heliocarpus popayensis	2	2	In vegetation monitoring, taxa occurred in 0.67% of plots in the canopy and in 1.34% of plots in the understory. Concentrated in the northern part of the unit, North Kaluaa and Hapapa bench. Target matures as a priority and in canopy weed sweeps across WCAs. Literature search for reliable control technique.	0
Mallotus phillipinensis	1	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the understory. Abundant in Lualualei, so expect to see re-invasion. Seedling/saplings are observed across the MU. Target all mature trees. Control saplings and seedlings in WCA sweeps.	0
Melia azedarach	0	1	In vegetation monitoring, taxa occurred in 0.67% of plots in the understory, which is one plot of 149 total plots. Treat in WCA work. One plant observed was below Hapapa bench. Melia observed in fields below MU.	0
Montanoa hibiscifolia	0	1	Large population exists to the southeast of the MU. Priority to keep from establishing within the exclosure.	0
Morella faya	0	1	Eradicating from area around carnation trail to prevent spread into MU. No recruitment observed. Maintain control work in ICA.	1
Neonotonia wightii	1	0	Not widespread in or around MU. Note any locations, if found, and evaluate for control.	0
Nephrolepis biserrata	n/a	1	Not detected in MU monitoring. Control as an ICA along the south fenceline ridge so staff don't spread it along trails. Also established on the steep uluhe face on the north side of catchment ridge; this site is difficult to access, and has not yet been designated an ICA. Conduct surveys to delineate extent off of catchment ridge. Become familiar with ID. Research control techniques.	1
Panicum maximum	2	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the understory. Control along trails and in priority restoration habitats. Treat in WCAs. Consider installing catchment in North Kaluaa near old fenceline for control of alien grasses located in that region.	0
Schefflera actinophylla	1	1	In vegetation monitoring, taxa occurred in 2.01% of plots in the understory. Bird dispersed and well established below MU, so could come up anywhere. Target matures as a priority and in canopy weed sweeps across WCAs. Follow up on IPA trials to identify reliable control technique.	0
Solanum capiscoides	n/a	1	Current ICA large, but only small numbers seen in ICA in past. Sweep biannually.	1
Setaria palmifolia	2	2	In vegetation monitoring, taxa occurred in 0.67% of plots in the understory, which is one plot of 149 plots. Occurs in the gulch bottoms. Keep off trails. Along access trail from parking area to contour trail. Treat in WCA work. One known location from Hapapa bench area which should be checked	0

Taxa	MIP weed mgmt code		Notes	No. of ICAs
	Original	Revised		
			during WCA weed control.	
Spathodea campanulata	2	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the canopy and in 3.36% of plots in the understory. Target in canopy weed sweeps across WCAs.	0
Sphaeropteris cooperi	0	1	Survey two known locations in Gulch 1 for this taxa when conducting WCA weed sweeps or while conducting other activites along the gulch corridor.	0
Toona ciliata	2	2	In vegetation monitoring, taxa occurred in 48.99% of plots in the canopy and in 30.87% of plots in the understory. Reaches maturity at approximately 6 years old, use this to plan revisitation. Target in canopy weed sweeps across higher elevation WCAs. In lower elevations, consider targeting with volunteers.	0
Trema orientalis	0	1	Not detected in vegetation monitoring. If seen, target in canopy weed sweeps across WCAs.	0
Triumphetta semitrilobata	0	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the understory. Also occurs on the access trail. Control along trails in high concentration areas to limit spread across MU. Target in weed sweeps whenever seen.	0

*occurrence-percent of total plots containing taxa

Incipient and Weed Control Areas at Kaluaa and Waieli



Ecosystem Management Weed Control (WCAs)

MIP Goals:

- Within 2m of rare taxa: 0% alien vegetation cover
- Within 50m of rare taxa: 25% or less alien vegetation cover
- Throughout the remainder of the MU: 50% or less alien vegetation cover

Management Objectives:

- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Reduce alien canopy cover by 5% across the MU in the next 5 years.
- In WCAs within 50m of rare taxa, work towards achieving 25% or less alien vegetation cover in understory and canopy.

Management Response: Increase/expand weeding efforts if MU vegetation monitoring indicates that goals are not being met.

The following is a discussion of unique considerations for managing the Kaluaa and Waieli MU. The habitat overall in this MU is patchy. The habitat along and just below the Puu Kanehoa to Puu Hapapa crestline is largely native. In addition, there are belts of koa canopy which run along prominent ridgelines that are in a relatively good condition, with many native components. The gulches and slopes within the MU are a mix of native and alien forest. Patches of intact diverse mesic forest remain within the unit. MIP and OIP taxa are found across these zones and thus most of the Kaluaa and Waieli MU is important for stabilization of various taxa.

One unique consideration is picture-wing *Drosophila* habitat. Picture wing flies require particular host plants to complete their lifecycles. The endangered *Drosophila montgomeryii* is found within the Kaluaa and Waieli MU and is an OIP stabilization species. Its' host plant is *Urera*. Maggots use rotting plant material from either *Urera glabra* or *Urera kaalae*. Therefore, the remnant patches of these plants should be maintained and expanded. *Urera glabra* should be used as part of the compliment of native trees selected for common native outplanting.

Another unique consideration for this MU is the taxon *Stenogyne kanehoana* which prefers the Koa forest zone along ridges that contain large amounts of *Dicranopteris linearis* (uluhe) in the understory. This habitat requires delicate management to ensure the uluhe is not disrupted. OANRP does not have the capacity to actively restore uluhe through planting and thus should conduct weed control and outplanting very carefully and with minimal impact to the fern cover. Conversations with horticulturists around the state suggest that uluhe is very difficult to propagate.

The final unique consideration for the Kaluaa and Waieli MU is the Puu Hapapa bench habitat (WCA-2). This zone has a unique set of conditions that support numerous rare native tree and ground snail species. In addition, the endangered *Drosophila montgomeryii* occurs here. Rare native ground snails in the genera *Amastra* require unique food. They browse fungi growing in leaf litter from plants in Urticaceae such as *Pipturus albidis* and *Urera* spp. Fortunately, *Urera* is also essential for *D. montgomeryii*. Native *Achatinella* can also live happily on these taxa. A detailed restoration plan for the Hapapa bench is included as Appendix 1-7 to this document. In addition, ground dwelling snails can be impacted by digging activities associated with outplanting and fence construction, which are both planned for the site in the short term. Particular caution should be taken to survey sites prior to conducting digging and tree felling activities.

There are about 7 elepaio birds within the Kaluaa and Waieli MU. While elepaio here are not managed by OANRP, care should be taken to avoid any tree removal during the nesting season. Pairs are still known from the south central gulch area and along the Central Kaluaa southern fenceline. In addition consideration should be paid to preserve forest structure within elepaio territories.

WCA Kaluaa and Waieli-01: SBS side of Hapapa

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *Schinus terebinthifolius* and *Psidium cattleianum* in canopy and understory weeds including *Rubus rosifolius, Clidemia hirta, Erigeron karvinskianus* and *Melinus minutiflora*.

Notes: *Achatinella mustelina* abundant in area. Ground dwelling snails also present (*Laminella sanguinea).* Some of this WCA is steep and difficult to move around. Be aware of native taxa in the area, such as *Lobelia yuccoides* and *Cyanea calycina* present in the area. Weeding effort will focus on removing canopy elements gradually, to minimize changes in light/moisture to this snail area.

WCA Kaluaa and Waieli-02: Hapapa Bench

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Large *Schinus terebinthifolius* and *Psidium cattleianum* in canopy and understory weeds including *Rubus rosifolius, Clidemia hirta, Passifora suberosa, Lantana camara, Christella parasitica, Erigeron karvinskianus* and *Melinus minutiflora*.

Notes: This large WCA is home to several rare plant wild sites and reintroductions sites, as well as to one of the largest populations of *A. mustelina* in the Waianae Mountains. Ground dwelling snails and *Drosophila* are also present. A predator proof fence is currently being constructed around part of the *A. mustelina* population. A Hapapa Bench restoration plan is appended to this document; please refer to it for a detailed account of ecosystem restoration measures planned for the area.

Due to the presence of such a variety of rare and endangered taxa, care must be taken in replacing weeds with natives, and when conducting any ground disturbance. Conduct gradual removal of canopy weeds, focusing on *S. terebinthifolius* and *G. robusta*, to foster native recruitment. Remove understory weeds, focusing on shrubs, herbs, and *C. parasitica.* Snails in the area are using *Psidium* spp, and control of these taxa should be strategic. The entire WCA should be swept for target species, such as *S. campanulata*. At rare plant sites, both understory and canopy control should be conducted.

WCA Kaluaa and Waieli-03: South Waieli

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: *Toona ciliata* canopy dominates this WCA. *Clidemia hirta, Buddelia asiatica, Christella parasitica* and *Rubus rosifolius*.

Notes: Weed control is focused around wild *Alectryon macrococcus* var. *macrococcus* and reintroduced *Delissea waianaensis.* This area will be a priority for control, both to prepare and maintain the reintroduction site. Understory weeds will be targeted, in additional to limited canopy control. This WCA encompasses the south branch of Waieli which is dominated by large *Toona ciliata* with nice remnant patches of *Pisonia* and *Diospyros*. *Achatinella mustelina* present in low numbers. The back wall of the gulch, just below where it abuts the Hapapa bench WCA is very steep and dominated by *Schinus terebinthifolius*. Control of mature *T. ciliata* is priority, as this is likely an important dispersal source for this taxa throughout the MU.

WCA Kaluaa and Waieli-04: North Kaluaa above old fence

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: *S. terebinthifolius* and a variety of understory weeds including *Passiflora suberosa, Rubus rosifolius, Lantana camara, Clidemia hirta* and *Psidium cattleianum.*

Notes: There are reintroductions of *Delissea waianaensis* and *Cyanea grimesiana* ssp. *obatae*. Wild trees of *Alectryon macrococcus* var *macrococcus* are also found within this WCA. In addition, there are a few large *Urera glabra* trees which are appropriate habitat for *Drosophila montgomeryi* although, as of yet, no flies have been observed. The westerly portion of this WCA is very steep and dominated by *S. terebinthifolius* canopy. This area may be managed for incipient canopy weeds using HBT. One mature *Falcataria mollucana* tree was removed from this WCA. The site should be monitored and all recruits treated. *Setaria palmifolia* and *Panicum maximum* are known from within this WCA but are continuous with the populations of these weeds in WCA-3. They should be controlled as a priority in WCA-04 over WCA-03 because of the rare species habitat within this WCA.

WCA Kaluaa and Waieli-05: North Kaluaa below old fence

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: Mature *T. ciliata* will prioritized for control. *Panicum maximum* and *S. palmifolia* should be controlled to prevent/minimize spread throughout the MU.

Notes: There is a dominant canopy of *Toona ciliata* which will be controlled strategically within this WCA in support of neighboring WCA management. During vegetation monitoring in North Kaluaa, *Mallotus phillipinensis* was observed. This is not well established in the MU thus comprehensive sweeps should be conducted to control it within this WCA. *P. maximum* and *S. palmifolia* are abundant within this WCA and should not be spread throughout the Kaluaa and Waieli MU. Control within this WCA should be concentrated along trails and fencelines. *U. glabra* trees should be maintained and expanded for use by *D. montgomeryii*.

WCA Kaluaa and Waieli-06: Gulch 3

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *S. terebinthifolius* and a variety of understory weeds including *Passiflora suberosa, Rubus rosifolius, Lantana camara, Clidemia hirta*, *Buddelia asiatica*, *Triumphetta semitriloba* and *Psidium cattleianum.*

Notes: High Priority. Weeding in this WCA has been focused around native *Pisonia* patches where there are reintroductions of *Phyllostegia mollis*, *Cyanea grimesiana* spp. *obatae* and *Schiedea kaalae*. Also found in this WCA are wild populations of *D. waianaensis* and *P. mollis*. Habitat on the native slopes contains rock tallus substrate which can be challenging for weed control. Care should be taken to avoid harm to ground snails which have recently been known from Gulch 3. Large *S. terebinthifolius* trees dominate slopes in between remnant native forest patches.

WCA Kaluaa and Waieli-07: Gulch 2

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% native cover.

Targets: Understory: *L. camara, Paspalum conjugatum, R. rosifolius.* Overstory: *S. terebinthifolius*

Notes: This WCA contains a population of *D. montgomeryii* and a substantial patch of *U. glabra* trees. There is also an isolated population of *A. mustelina* found within a *Pisonia* patch and care should be taken not to impact any snails during weed control activities. Maintenance and expansion of *U. glabra* will be a focus within this WCA. The back wall of this MU below the crestline vegetation is nearly 100% *S. terebinthifolius* in places. There are no current plans for MIP or OIP management in this particular zone.

WCA Kaluaa and Waieli-08: Gulch 1

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include *Psidium cattleianum* and *S. terebinthifolius*. Understory weeds include *Passiflora suberosa, C. hirta* and *R. rosifolius.*

Notes: This WCA was a core TNC outplanting site which was adopted and expanded by OANRP. *Delissea waianaensis* was been planted in large numbers at the 1A fence site. In addition, TNC plantings

of *Schiedea kaalae* and *Solanum sandwicensis* occur throughout the site. *S. sandwicensis* recruits across this site.

The only wild location of *C. grimesiana* ssp. *obatae* in Kaluaa occurs near the bottom of this WCA. There is an intact canopy of native trees, which include *Acacia koa, Psychotria mariniana, Syzigium sandwichensis* and *Pisonia umbellifera*. Understory weeds, particularly *C. hirta*, grow aggressively in areas where *P. cattleianum* canopy was removed and require substantial maintenance. Encouraging koa and Pisonia recruitment into these sites or common native plantings would likely reduce understory weed prevalence. There is a great deal of room for expansion of the 1A site upslope into neighboring areas with native canopy.

The upper slope below the crestine of catchment ridge is dominated by steep uluhe with an open canopy of *Metrosideros polymorpha*. This area is very difficult to traverse and would be challenging to manage using ground techniques. This area may be best to monitor from one ridge to the north or from the air. Amidst this uluhe belt are patches of *Nephrolepis biserrata*. These *N. biserrata* patches will be monitored and may be controlled as an ICA if feasible management techniques become available.

WCA Kaluaa and Waieli-09: Lower Gulch Gate

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% native cover

Targets: *T. ciliata* in the canopy and a variety of understory weeds including *Blechnum appendiculatum* and *Oplismenus hirtellus*.

Notes: This WCA will be the focal site for outreach activities. There are former project stewardship sites located within this WCA. The terrain is conducive to volunteer project weed control. In addition, there is a unique grove of *Pittosporum glabrum, Morinda trimera* and *Psychotria mariniana* within this WCA.

The outreach program will target *T. ciliata* in the upper portions of this WCA to minimize spread into WCA-08. Volunteers will also be used to address the expanding cover of *B. appendiculatum*. Common native reintroductions will be used where necessary to support restoration activities.

Along the ridge crest leading up the catchment ridge, a fairly intact canopy and seed bank of koa remains. This taxon will be used in restoration efforts to replace alien vegetation. A strategy of peeling back the alien vegetation beginning at the koa dominated ridge crest first and moving down slope as koa saplings come up could be employed in restoring this WCA.

WCA Kaluaa and Waieli-10: South Central/Catchment Ridge

Veg Type: Mesic Mixed Ridge

MIP Goal: Less than 25% non-native cover

Targets: *Psidium cattleianum, Clidemia hirta, Passiflora suberosa, Grevillea robusta, Schinus terebinthifolius*

Notes: Target all canopy weeds along catchment ridge to maintain native dominated matrix with care to avoid damaging uluhe understory. Maintain weed free area along south fenceline ridge with particular attention to the *Stenogyne kanehoana* reintroduction. *Achatinella mustelina* are present in low numbers at the back of South Central gulch. Elepaio pairs possibly still present as well. There are some pockets of nice pisonia forest and possible *Drosophila* habitat in *Urera glabra*. It would be beneficial to sweep this WCA for target weeds in the upper elevation area. There also is a wild *P. hirsuta* location in this WCA.

WCA KaluaaNoMU-01: Kaluaa Access Road

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Panicum maximum*

Notes: Alien dominated habitat consisting primarily of forestry plantings with very few native remnants. Control grass/herbaceous weeds, clear downed trees along the Kaluaa access road, from the top of the pineapple fields to the trailhead every 6 months/as needed. Use the power sprayer, chainsaw, weedwhack. End goal is to maintain road as drivable.

WCA KaluaaNoMU-02: CryMan

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Buddelia asiatica, Rubus rosifolius, Toona ciliata*

Notes: Weed control at this site has been conducted in conjunction with OPEP management for *Cryptocarya manii*. No regular weed control trips are planned for this WCA, and any weed control will be conducted during rare plant monitoring trips. Visits are primarily conducted to collect from *Alectryon macrococcus* in the area.

WCA KaluaaNoMU-03: Ti Leaf Flats

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Clidemia hirta, Schinus terebinthifolius, Schefflera actinophylla*

Notes: This WCA includes the exclosure located along the access trail before the contour trail junction within which TNC planted numerous endangered plants. The goal of weed control within this WCA is to ensure continued survival of *Abutilon sandwicensis, and Delissea waianaeensis* reintroductions from which genetic collections are secured. The habitat is alien dominated and most of the native plants within the exclosure were outplanted.

WCA KaluaaNoMU-04: Access Trail

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Dicliptera chinensis, Setaria palmifolia*

Notes: The trail corridor is managed to minimize the movement of weeds into the MU. Only species of concern that are not well established within the MU will be targeted. In addition, the trail will be kept clear of grass, *D. chinensis*, and fallen trees.

WCA KaluaaNoMU-05: GarMan

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *Clidemia hirta, Psidium cattleianum*

Notes: Weed control will be conducted around the endangered *G. mannii* at this site, in conjunction with rare plant monitoring trips. This *G. mannii* is designated for Genetic Storage Collection, rather than management, hence limited effort will be spent here. Understory weeds and some canopy weeds will be targeted directly around the rare plant to encourage its continued health.

WCA SBSNoMU-02: (Ie ie Patch)

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *B. asiatica, P. cattleianum, S. terebinthifolius, C. dentata, C. parasitica*

Notes: A small fence protects a patch of *Freycinetium arborescens*, outplanted *Urera glabra*, and *U. kaalae* and a small patch of native forest. *A. mustelina, Amastra micans*, and *L. sanguinea* are known historically from this location, but are not extant. This site is not in an MU, and is not a priority for management. Some weed control may be conducted here in conjunction with other rare taxa monitoring activities. Access to the site is limited, as it lies behind a live fire training range and the area is frequently closed to OANRP.

1.2.1.4 Rodent Control

Species: *Rattus rattus* (black rat, roof rat), *Rattus exulans* (polynesian rat, kiore)

Threat level: High

Control level: Bait station & snap trap grids (localized control)

Seasonality: Year-round

Number of sites: *Achatinella mustelina* site at Puu Hapapa (Hapapa bench and SBS side), 2 bait grids (12 bait stations, 24 snap traps)

Acceptable Level of Activity: Not tolerated within proposed *A. mustelina* snail enclosure, need to determine appropriate rat activity level outside snail exclosure.

Primary Objective: To maintain rat/mouse populations to a level that facilitates stabilized or increasing plant and snail populations across the MU by the most effective means possible.

Management Objective:

- Keep sensitive snail populations safe from rat predation via construction of a predator proof fence (*A. mustelina* enclosure).
- Maintain predator fence to ensure no breaches occur.
- Maintain rat grid every six weeks and reevaluate/reconfigure as necessary following completing of the predator fence.
- Ensure MIP/OIP rare plant resources within the MU are not impacted by rodents.

Monitoring Objectives:

- Monitor ground shell plots for predation of *A. mustelina* by rats.
- Annual or every other year census monitoring of *A. mustelina* populations to determine population trend.
- A snap grid will be set up inside the exclosure. Staff will set up approximately a dozen snap traps within the exclosure along with a dozen tracking tunnels. Consider placing snaps higher in the trees as well as on ground. Chew tabs may also be used to determine presence or absence of rats. The snap traps will be re-baited weekly until no sign is observed on the tunnels and no rats snapped for 3 weeks. Tunnels and chew tabs will be left in place and re-monitored prior to reintroduction of snails.
- After rats have not been found for 21 days, proceed with quarterly sweeps.
- Quarterly searches for evidence of rats within Puu Hapapa enclosure
- Monitor rare plant resources to help guide localized rodent control.
- Presoak tunnels or use old tunnels from elsewhere to remove odors to aid detection. Inside/outside exclosure comparison.

Localized Rodent Control:

- Rats have been known to eat *Plantago* at Ekahanui and Palawai. At other sites, rodent damage has been observed on *C. grimesiana* and *D. waianaensis*. Possibly could impact juvenile *Urera* spp although no predation has been observed. No damage has been observed at Kaluaa sites thus far. Will respond if predation observed in order to facilitate fruit collections. Control rats to maintain *Achatinella* host trees and prevent *Achatinella* predation.
- Bait station and snap trap grids are deployed around *A. mustelina, D. montgomeryi* and *P. princeps* populations and are restocked twice a quarter. Grids are centered around and extend slightly beyond the boundaries of the populations being protected. Monitoring of rat activity via tracking tunnels will be vital in determining whether control is having the desired effect, as will intensive monitoring of the rare snail and plant populations.

Exclosure Maintenance:

- Inspect every 6 weeks and after major wind events.
- Maintain Intellesense automatic notification system of exclosure breaches
- Ideally inspect upon each visit to see if the mesh is compromised along the leading edge, re-bury the edge if need be with dirt and debris.
- Inspect for premature rust/weathering of material such that it would fail.
- Inspect hood, seams, to ensure that rats, Jackson chameleons cannot enter.
- Inspect outlying trees to ensure that rats cannot jump in, trim trees well before that risk presents itself.
- *Euglandina* barriers will require close inspection to ensure continued efficacy.
- Inspect entry system (ladders need to be secure to ensure safety moving in and out of exclosure).
- Devise method to prevent vandalism/snail collection by securing ladders left on the outside.
- Install signs to prevent people from trying to climb walls (Outreach).
- Trails within the exclosure needed to establish designated walking paths as more vegetation is planted and more natural recruitment observed.
- Weeding needed on a continual basis to ensure adequate habitat for *A. mustelina*. This will likely include removing mamaki over time after shade is established to provide a better host species for *A. mustelina.*

1.2.1.5 Predatory Snail Control

Species: Euglandina rosea

Threat level: High

Control level: Localized (Puu Hapapa)

Seasonality: Peak numbers recorded March through June

Number of sites: *Achatinella mustelina* site at Puu Hapapa

Acceptable Level of Activity: Not tolerated within proposed *A. mustelina* snail enclosure

Primary Objective: Eliminate predatory snails within enclosure and reduce numbers outside enclosure to promote A. mustelina survival.

Management Objective:

- Keep sensitive snail populations safe from predatory snails via construction of a predator proof fence (*A. mustelina* enclosure).
- Maintain enclosure to ensure no breeches occur.

- Reduce *E. rosea* outside the enclosure to reduce risk of incursion.

Monitoring Objectives:

- Annual or every other year census monitoring of *A. mustelina* populations to determine population trend (for more information please refer to the *A. mustelina*
- Weekly searches for predatory snails within *A. mustelina* enclosure immediately following construction. Include searching for *E. rosea* in trees where feasible. After snails have not been found for 40 days (length of time for eggs to hatch) proceed with quarterly sweeps. If snails or egg caches are found during a quarterly sweep, frequency should be increased to once a week until area has been clear of snails for at least 40 days.
- Quarterly searches for predatory snails within *A. mustelina* enclosure. If *E. rosea* detected commence with weekly searches as described above.
- Quarterly searches and removal of predatory snails within 50 m radius of the *A. mustelina* enclosure.

Oxychilus alliarus is an introduced omnivorous snail which threatens native treesnails. It has not been found at Puu Hapapa. It is imperative that proper sanitation methods are in effect so that they are not inadvertently introduced via predator proof fencing materials. This requires materials to be cleaned with a high pressure hose so that all debris is removed prior to transport to the site, in much the same way as greenhouse benches and pots are treated to remove snails. Although *O. alliarus* has not been found at either West or East Base (where materials are usually stored prior to transport onsite) a number of other alien snails are established at these locations including *Gonaxis kibweziensis;* a predatory snail. Care needs to be taken not in inadvertently transport any alien snails to the site.

1.2.1.6 Slug Control

Species: Deroceras leave, Limax maximus, Meghimatium striatum

Threat level: High

Control level: Localized

Seasonality: Wet season

Number of sites: Urera kaalae, Delissea waianaensis, Cyanea grimesiana ssp. obatae, Plantago princeps var. princeps, Phyllostegia mollis, P. hirsuta and Schiedea kaalae.

Acceptable Level of Activity: Slugs to be kept suppressed in proximity to rare plants.

Primary Objective: Reduce the threat of slugs to the germination and survivorship of rare plant taxa as well as those used by Drosophila mongomeryii as host plants.

Management Objective:

- Control slugs at sensitive plant populations via bi-weekly Sluggo® application during the wet season.

Monitoring Objectives:

Determine whether sites are appropriate for Sluggo® application. This requires an experienced malacologist to spend at least one day and one night at the site. If no rare species present, proceed with slug control.

- Annual monitoring of rare plant seedling recruitment (*Urera kaalae, Delissea waianaensis, Cyanea grimesiana* ssp. *obatae, Plantago princeps* var. *princeps, Phyllostegia mollis, P. hirsuta*

and *Schiedea kaalae*) with particular focus on detecting evidence of slug feeding (slime trails, leaf edges consumed, lower leaves consumed). If no slug feeding observed, then Sluggo® applications may be reduced or halted.
- Annual monitoring of slug densities during wet season using beer traps. If numbers are low, then Sluggo® application may be reduced or halted.

1.2.1.7 Ant Control

Species: *Anoplolepis gracilipes, Cardiocondyla wroughtoni,Pheidole megacephala, Plagiolepis alluaudi, Solenopsis papuana* and *Technomyrmex albipes*

Threat level: Unknown

Control level: Localized

Seasonality: Varies by species, but nest expansion observed in late summer, early fall

Number of sites: Ants will be surveyed at four sites. These include two *Drosophila montgomeryi* sites (Kaluaa gulch and Puu Hapapa) and four human entry points: parking area at end of 4 wheel-drive road, at the entrance to Honouliuli preserve (gate along the fenceline), at the Puu Hapapa shelter and at the old TNC field nursery.

Acceptable Level of Ant Activity: Unknown

Primary Objective: Identify control methods for ants without adverse impacts to *D. montgomeryi*.

Management Objective: Investigate various toxicants and delivery systems for the purpose of ant control while preventing *D. montgomeryi* exposure.

Monitoring Objective:

- Continue to sample ants at human entry points using the standard survey protocol (Plentovich and Krushelnycky 2009) and *D. montgomeryi* sites a minimum of once a year. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- Track changes in *D. montgomeryi* numbers and see if these respond positively to decreased ant activity.
- Look for evidence of scale tending by ants on rare plants.
- Detect incursions of new ant species prior to establishment.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. In particular, they are believed to prey upon juvenile *Drosophila.* It is therefore important to know their distribution and density in areas with conservation value. This was accomplished in Kaluaa for the last two years using a survey methodology developed by Plentovich and Krushelnycky (2009). Among the species detected which are among the most aggressive are *Pheidole megacephala* and *Anoplolepis gracilipes*. Species present are widely established and control is not recommended at this time unless damage due to ants is confirmed and a safe control method is identified.

1.2.1.8 Black Twig Borer (BTB) Control

Species: *Xylosandrus compactus* (BTB)

Threat level: High

Control level: Localized

Seasonality: Population builds through the spring (March-May) with flight occurring between June and August.

Number of sites: *Alectryon macrococcus* var. *macrococcus* populations KAL-A,B,C, ELI-A,B and Reintro KAL-E

Acceptable Level of Activity: Unknown

Primary Objective: Reduce air layer failure due to BTB damage and promote health of *Alectryon macrococcus* var. *macrococcus* by depressing BTB populations.

Management Objective:

- Deploy BTB traps equipped with High Release Ethanol bait (Alpha Scents, Portland, OR) and Vaportape™ (Hercon Environmental, Aberdeen, PA) insecticidal strips if damage is observed. Service traps every three weeks until *A. micrococcus* air layers are established.
- Test efficacy of experimental repellents.

Monitoring Objective: Check *A. macrococcus* air layers for BTB damage.

OANRP has conducted extensive testing on the efficacy of trap deployment to reduce BTB damage (Joe 2009). Results have been mixed. Trees with traps sustained (on average) 25% less damage than those without, however, this difference was not statistically significant. As traps need maintenance every two to three weeks to be effective, the labor investment is considerable. Despite these drawbacks, trapping is the only option for managing BTB in a forest setting. Traps may be used, if needed, to protect air layers during establishment. There are no plans currently to install traps at wild *Alectryon macrococcus* var. *macrococcus* sites. OANRP is planning to test an experimental beetle repellent Verbenone® (ConTech Inc. Grand Rapids, MI). If proven effective, we will work with the manufacturer to get it registered for use in the State.

1.2.1.9 Vespula Control

Species: *Vespula pennsylvanica*

Threat level: Likely high

Control level: Localized

Seasonality: Year-Round

Number of sites: Two: *Drosophila montgomeryi* sites (Kaluaa gulch and Puu Hapapa)

Acceptable Level of Activity: Unknown

Primary Objective: Determine whether *V. pennsylvanica* populations come into contact with *D. montgomeryi*. If found, eradicate *V. pennsylvanica* from local area.

Management Objective:

- Locate nests by following workers. Destroy nests mechanically (by bagging nests and leaving in the sun, for example) if possible, as pesticides may impact *D. montgomeryi.*
- Cooperate with Big Island researchers in getting fipronil bait registered.

Monitoring Objective:

- Deploy traps baited with heptyl butyrate to monitor *V. pennsylvanica* presence. Reset and check traps quarterly. Leave baited traps in place for two weeks then collect and record catch.
- Determine whether *D. montgomeryi* populations respond favorably to lower numbers of wasps.

Vespula pennsylvanica is an important insect predator and flies have been recorded in its diet on the Big Island and Maui. It is likely a major predator of *D. montgomeryi* and should be monitored. No poison baits are currently approved for use in suppressing wasp numbers, however, USGS researchers at Hawaii Volcanoes National Park hope to get a finpronil bait registered. NRS will cooperate in this effort. Until better control methods are available, staff will monitor wasp numbers quarterly using traps. If populations increase substantially over time coinciding with a plunge in *D. montgomeryi* numbers NRS will locate and destroy nests.

Nests have been destroyed along and below the contour trail by State of Hawaii Dept. of Agriculture staff in 2001 at the request of TNC.

1.2.1.10 Jackson's Chameleon Control

Species: *Chamaeleo jacksonii* ssp. *Xantholophus* (Jackson's chameleon)

Threat level: High

Control level: Localized (Puu Hapapa)

Seasonality: Year-Round

Number of sites: One: *Achatinella mustelina* site at Puu Hapapa

Acceptable Level of Activity: Not tolerated within proposed *A. mustelina* snail enclosure.

Primary Objective: Reduce chameleons in proximity to snails to reduce predation risk. Eradicate within enclosure.

Management Objective:

- Keep sensitive snail populations safe from chameleons via construction of a predator proof fence (*A. mustelina* enclosure).
- Maintain enclosure to ensure no breaches from chameleons.
- Quarterly night-time sweeps of above and below the Puu Hapapa bench to capture and remove Jackson's chameleon as well as within and around the enclosure.

Monitoring Objectives:

- Annual or every other year census monitoring of *A. mustelina* populations to determine population trend.
- GPS locations of captured chameleons to track changes in their distribution and proximity to native snails. Follow numbers of captured animals over time to estimate density.
- Facilitate research by B. Holland (PhD) and Chiaverano (PhD) (UH Center for Conservation Research & Training University of Hawaii) to estimate chameleon population size, optimal foraging strategy, locality and range size on Oahu.

Chameleons are known to consume *Achatinella* where their ranges overlap. A single chameleon was *Achatinella* enclosure. Staff will continue to sweep the area for chameleons to ensure they do not threaten snails.

1.2.1.11 Fire Control

There is no recent history of fires burning near the Kaluaa and Waieli MU. The last significant fire was in 1996 in the Mauna Una area south of the MU near the old microwave reflection screen. The area is somewhat protected by weedy tree species. Forestry plantings of *Eucalyptus robusta* adjacent to the MU fence are susceptibility points. Ignition sources could be from military training although direction of fire

from South range is to the north, away from the Kaluaa and Waieli MU. There is currently limited public access to this unit and therefore the threat of arson is low, although campfires remain a constant threat and fire pits are observed on an irregular basis (e.g. Hapapa LZ, Contour trail, Kaluaa trailhead). This MU is easy to monitor from both OANRP baseyards and it is within close proximity to the Army Wildland Fire Baseyard. Now that Honouliuli is State land, DLNR, DOFAW staff could respond in the event of a fire within the MU.

Emergency landing zones were previously cleared and maintained by TNC on Mauna Una and the Hapapa Access Ridge but have since become overgrown. These could be cleared again as needed should fires break out in the MU.