Ecosystem Restoration Management Plan

MIP Year 15-19, October 2018 – September 2023

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, weed, predatory snail, rodent, and slug threats in the next five years to allow for stabilization of IP taxa.

Background Information

Location: Southern Waianae Mountains

Land Owner: State of Hawaii

Land Manager: Army Natural Resource Program – Oahu (OANRP)

Acreage: 200 acres

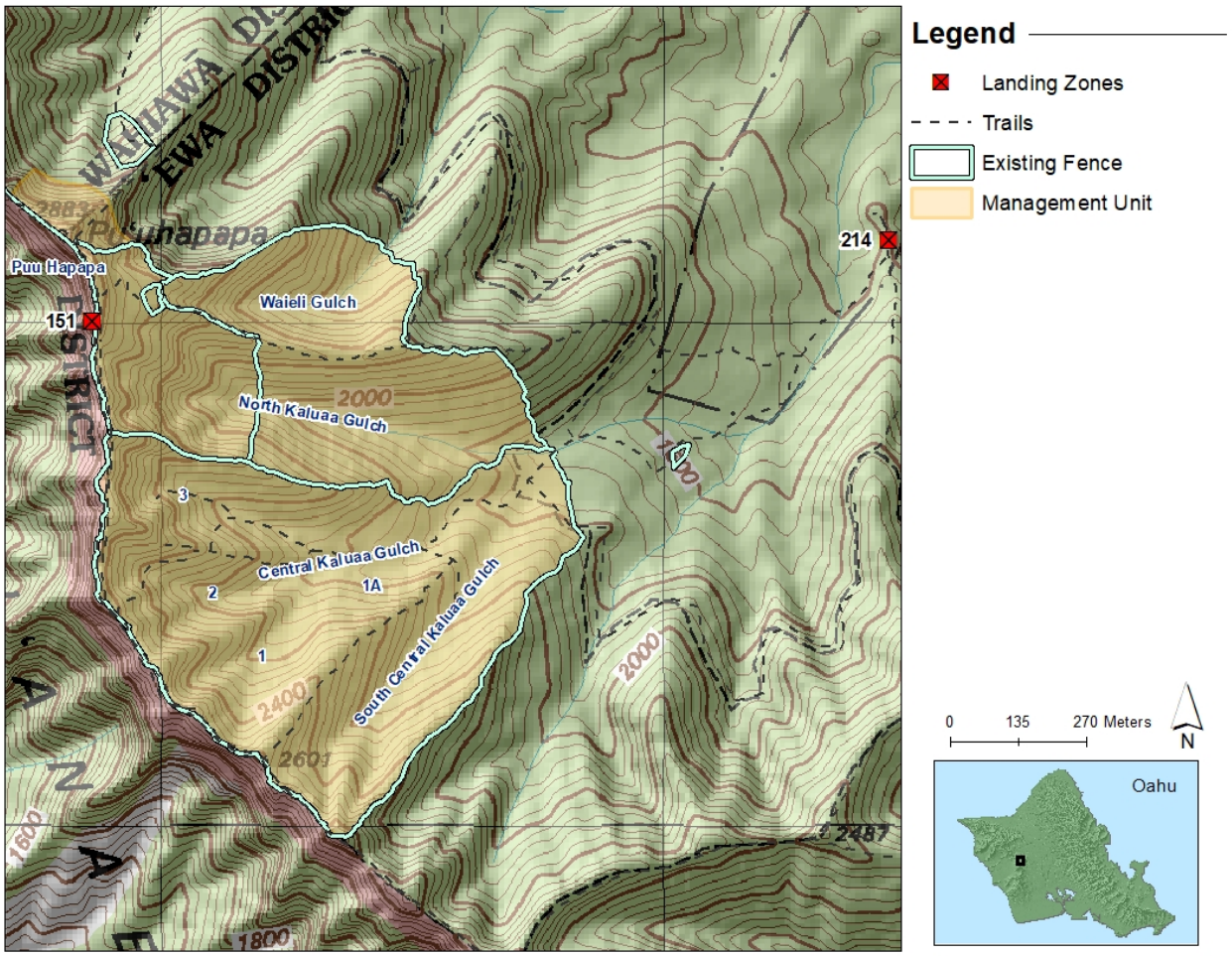
Elevation Range: 1,800-2,883ft

Description: The Kaluaa and Waieli Management Unit (MU) is located on the northern end of Honouliuli Forest Preserve, and is accessed via Schofield Barracks South range. Access is by 4WD road through the SR-1 gate and IED lanes. Two improved landing zones located on state land enable access to Puu Hapapa via helicopter, one at the Kaluaa trailhead, and one on the ridge near Puu Hapapa. Terrain is varied, ranging from gradual slopes to vertical cliffs. The vegetation type across the Kaluaa and Waieli MU is mixed mesic forest, though the dominant native trees vary by aspect and elevation.

The Kaluaa and Waieli MU fence is comprised of three subunits. Subunit I (Central Kaluaa) on the south is the largest section encompassing four sub-gulches and extending from the bottom of this gulch system up to the Waianae summit ridge. From south to north, the sub-gulches within Central Kaluaa are referred to as South Central Gulch, Gulch 1, Gulch 2, and Gulch 3. In the lower elevations of Central Kaluaa, before the Gulch 1-2-3 split, is a site referred to as Gulch 1A, a core outplanting site of The Nature Conservancy (TNC) later adopted and expanded by OANRP. To the north of Central Kaluaa, the Subunit II fence encompasses the upper elevations of North Kaluaa Gulch up to Puu Hapapa. Below Puu Hapapa, on a flatter area referred to as Hapapa bench, is the Hapapa snail enclosure. Subunit III encompasses the lower elevations of North Kaluaa Gulch as well as Waieli Gulch to the north. North Kaluaa Gulch and Waieli Gulch are divided by the Hapapa Access Ridge.

Below and to the east of Kaluaa and Waieli MU runs a contour trail. This trail extends throughout Honouliuli Forest Reserve. It is intersected by the main Kaluaa gulch trail, which runs from the trailhead LZ up into North Kaluaa and Central Kaluaa, and the Hapapa access trail, which splits off from the Kaluaa gulch trail and follows Hapapa Access Ridge to the Hapapa snail enclosure and the Hapapa LZ.

Gulch names in Kaluaa and Waieli MU



Native Vegetation Types

Waianae Vegetation Types	
Mesic mixed forest	Canopy includes: *Acacia koa*, *Metrosideros polymorpha*, *Nestegis sandwicensis*, *Diospyros* spp., *Planchonella sandwicensis*, *Charpentiera* spp., *Pisonia* spp., *Psychotria* spp., *Antidesma platyphyllum*, *Bobea* spp. and *Santalum freycinetianum*. Understory includes: *Alyxia stellata*, *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.	

Terrain and Vegetation Types at Kaluaa and Waieli MU

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

Kaluaa from Puu Hapapa looking south

Mesic forest within MU

Typical crest vegetation

Typical mesic gulch vegetation

MIP/OIP Rare Resources at Kaluaa and Waieli MU

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	GSC	Both
Plant	*Cyanea grimesiana* subsp. *obatae*	KAL-B Reintro KAL-C,D, E	Central Kaluaa	MFS	Both
Plant	*Delissea waianaeensis*	ELI-A KAL-B Reintro KAL-C,D	Kaluaa	MFS	Both
Plant	*Euphorbia herbstii*	Reintro KAL-A	Kaluaa	MFS	Reintroduction
Plant	*Flueggea neowawraea*	KAL-A*	Kaluaa		Wild
Plant	*Phyllostegia hirsuta*	KAL-A ELI-A,B*,C* SBS-A*,B*	Hapapa to Kaluaa	MFS	Wild
Plant	*Phyllostegia mollis*	KAL-D* Reintro KAL-B*,C	Kaluaa	MFS	Both
Plant	*Plantago princeps* var. *princeps*	Reintro ELI-A	Waieli	GSC	Reintroduction
Plant	*Schiedea kaalae*	KAL-A* Reintro KAL-B,C	Kaluaa and Waieli	MFS	Both
Plant	*Stenogyne kanehoana*	KAL-A* Reintro KAL-B,C*,D	Central Kaluaa	MFS	Both
Insect	*Drosophila montgomeryi*	n/a	Kaluaa and Waieli	MFS	Wild
Snail	*Achatinella mustelina*	ELI-A, B KAL-A, B†,C†, D†,E,F†, G	ESU-D1	MFS	Wild

MFS= Manage for Stability *= Population Dead
GSC= Genetic Storage Collection †=Population translocated into enclosure

Other Rare Taxa at Kaluaa and Waieli MU

Organism Type	**Species**	**Status**
Plant	*Asplenium dielfalcatum*	Endangered
Plant	*Cenchrus agrimonioides* var. *agrimonioides*	Endangered
Plant	*Chrysodracon forbesii*	Endangered
Plant	*Clermontia persicifolia*	Endangered
Plant	*Cyanea calycina*	Endangered
Plant	*Cyanea membranacea*	No status
Plant	*Cyanea pinnatifida*	Endangered
Plant	*Cyanea superba subsp. superba*	Extinct
Plant	*Embelia pacifica*	No status
Plant	*Exocarpos gaudichaudii*	No status
Plant	*Gardenia brighamii*	Endangered
Plant	*Labordia kaalae*	Endangered
Plant	*Melicope christophersenii*	Endangered
Plant	*Melicope cornuta* var. *decurrens*	Endangered
Plant	*Notocestrum longifolium*	No status
Plant	*Panicum beecheyi*	No status

Other Rare Taxa at Kaluaa and Waieli MU (continued)

Organism Type	Species	Status
Plant	*Pteralyxia macrocarpa*	Endangered
Plant	*Schiedea hookeri*	Endangered
Plant	*Schiedea pentandra*	No status
Plant	*Solanum sandwicense*	Endangered
Plant	*Tetramolopium lepidotum* subsp. *lepidotum*	Endangered
Plant	*Urera kaalae*	Endangered
Bird	*Chasiempis ibidis*	Endangered
Insect	*Drosophila divaricata*	No status
Insect	*Drosophila hemipeza*	Endangered
Snail	*Amastra intermedia*	No status
Snail	*Amastra spirazona*	No status
Snail	*Laminella sanguinea*	No status

Locations of Rare Resources at Kaluaa and Waieli MU

Map removed to protect rare resources

Rare Resources at Kaluaa and Waieli MU

Euphorbia herbstii

Stenogyne kanehoana

Cyanea grimesiana subsp. *obatae*

Achatinella mustelina

Drosophila montgomeryi

Schiedea kaalae

Threats to MIP/OIP MFS Taxa

Threat	Rare Taxa Affected	Management Strategy	Current Status, 2018
Pigs	All	Across MU (fence)	No animals within fence.
Weeds	All	Focus primarily on rare taxa sites, across MU secondarily	Regular maintenance required several times per year.
Rodents	*Achatinella mustelina*, *Cyanea grimesiana* subsp. *obatae*, *Delissea waianaeensis*	Predator-proof snail enclosure, localized A24 grids	No animals within snail enclosure. Trap grids maintained tri-annually.
Jackson's chameleon	*Achatinella mustelina*	Predator-proof snail enclosure, manual capture and removal	No animals within snail enclosure. Manual control conducted quarterly outside.
Rosy Wolf Snail	*Achatinella mustelina*	Predator-proof snail enclosure	No predatory snails within the enclosure. Enclosure inspected/maintained every 6 weeks and swept annually.
Slugs	*Cyanea grimesiana* subsp. *obatae*, *Delissea waianaeensis*	Affected rare taxa sites only	Ferroxx AQ slug toxicant applied every 6 weeks.
Ant	*Drosophila montgomeryi*	No control as toxicants may harm *Drosophila*	Research on possible control method to be completed by 2020. Sites monitored annually.
Vespula	*Drosophila montgomeryi*	*D. montgomeryi* sites only	No vespula present. Sites monitored monthly.
Downy Mildew	*Phyllostegia hirsuta*	No control	Monitor rare plants. No tools to control in the field; research on-going.

Management History

- 1860s-80s: The Kaluaa and Waieli area is 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 is established for watershed protection purposes.
- 1930s-50s: Division of Forestry and Civilian Conservation Corps builds roads, trails and fences; continues removal of feral goats and cattle; and plants 1.5 million trees in the Honouliuli Forest Reserve, mainly below 800' elevation.
- 1940s: The area below the contour trail in Kaluaa is actively farmed and used for ranching by Leilehua Ranch.
- 1940s-50s: The area below the contour trail is first used for US Army training.
- 1970s: *Clidemia hirta* is first introduced to the Waianae Mountains in the South Kaluaa contour trail area.
- 1972: One individual of *Drosophila montgomeryi* is recorded from Kaluaa Gulch.
- 1990-2009: Honouliuli Preserve is managed by TNC after they obtain a conservation easement from the Campbell estate.
- 1996: TNC installs the 0.2 acre Ti Leaf Flats fence; *Delissea waianaeensis* and *Cyanea pinnatifida* are the first endangered plant reintroductions.

- 2000-2007: TNC management consists of installing an extensive catchment system, project stewardship plots, and field nursery; trail construction; reintroduction of several thousand common and endangered natives (including *S. kaalae* and *S. kanehoana*); rat control for snail and elepaio protection; and a volunteer hunting program.
- 2001: The 115 acre Subunit I (Central Kaluaa) fence is completed by TNC staff, volunteers and contractor John Hinton.
- 2002: OANRP begins using the Central Kaluaa fence area for endangered reintroductions as part of the MIP plan. *Delissea waianaeensis*, *P. mollis*, and *U. kaalae* are planted.
- 2003: *Cyanea grimesiana* subsp. *obatae* reintroductions are planted in Central Kaluaa Gulch 1.
- 2003: Extensive archeological surveys in the area below the boundary of the TNC preserve document numerous cultural and historical sites.
- 2004: The 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). This area consists mostly of old pineapple fields, but also some portions of the forested area as a buffer safety zone.
- 2006: The 25 acre Subunit II (Hapapa/North Kaluaa) fence is completed by TNC, volunteers, and OANRP staff (NRS).
- 2007: *Plantago princeps* var. *princeps* are reintroduced at Hapapa. This population is subsequently augmented in 2009 and 2013.
- 2007: *Angiopteris evecta* is first discovered in South Central Kaluaa gulch.
- 2007: An incipient control area (ICA) is created for *Casuarina equisetifolia* along the southern fence as a follow-up to eradication work done previously by TNC.
- 2007: OANRP begins control of *Morella faya* in an area previously controlled by the Oahu Invasive Species Committee (OISC). An ICA is created in the flats between the Hapapa access trail, the Kaluaa gulch trail and the contour trail.
- 2008: One mature *Clusia rosea* is found and controlled along the contour trail.
- 2008: Several mature individuals of *Solanum capsicoides* are found along the stream bed below the management unit. This ICA is later extended further up into North Kaluaa Gulch as more plants are discovered.
- 2009: One mature *Arthrostemma ciliatum* is found along the trail by the TNC Ti Leaf Flats fence.
- 2009-2010: The Army Compatible Use Buffer Program purchases Honouliuli Preserve with assistance from State and private partners, and negotiation by Trust for Public Land, primarily for endangered species management. The title transfers to the State of Hawaii for management as a forest reserve with uses such as recreational hiking and hunting. This is done partially as a result of shifting management focuses within TNC, and their decision to discontinue work in Honouliuli Forest Reserve.
- 2010: *Drosophila montgomeryi* is 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: NRS completes construction of the 56 acre Subunit III (Waieli/ North Kaluaa) fence and all pigs are removed.
- 2010: MU vegetation monitoring is conducted for the first time via belt plot transects.

- 2011: A contracted New Zealand company, Xcluder, completes the 0.25 acre snail enclosure at Puu Hapapa. Translocation of snails into the enclosure begins.
- 2011: In December, 6 Jackson's Chameleons (*Triceros jacksonii* subsp. *xantholophus*) are found and removed from the newly built snail enclosure. Manual search and removal, including tree-climbing, is implemented. A total of 32 chameleons are removed, the last one found in May 2015.
- 2011: OANRP begins active habitat management of *D. montgomeryi* sites via specific weed control efforts. Host plants *Urera kaalae* and *Urera glabra* are first planted by OANRP at Hapapa bench the following year (2012) in conjunction with other common native outplantings. *Urera* restoration areas are expanded in 2015 to include *D. montgomeryi* populations in North Kaluaa and Gulch 1.
- 2012: *Achatinella mustelina* are released into the Puu Hapapa snail enclosure from the UH lab. Since its completion, over 1800 *A. mustelina* have been released into the Hapapa enclosure; it is home to 70% of the *A. mustelina* protected in such enclosures, as well as other species of concern relocated by the Snail Extinction Prevention Program (SEPP).
- 2012: A single mature *M. faya* is found along the crest north of Puu Hapapa.
- 2013: A small patch of *Dovyalis hebecarpa* is found in Waieli gulch.
- 2013: One mature *Ehrharta stipoides* is found near the Hapapa shelter.
- 2013: Incision point application (IPA) sweeps are first conducted by the OANRP Ecosystem Restoration crew focusing on mature *Toona ciliata* and *Grevillea robusta* trees throughout the management unit.
- 2014: More *E. stipoides* is found along the Hapapa access trail.
- 2015: Puu Hapapa LZ is reconstructed.
- 2015: MU vegetation monitoring is conducted for a second time.
- 2015: Monthly slug control using Sluggo is implemented at the Kaluaa Gulch 1A site to protect wild *C. grimesiana* subsp. *obatae* and a large reintroduction of *D. waianaeensis.*
- 2015: Outreach finds an immature *A. evecta* in a volunteer weeding area in lower Central Kaluaa gulch.
- 2016: The Army Corps of Engineers improves Kaluaa access road. A new LZ is constructed on state land near the Kaluaa trailhead to facilitate helicopter operations and ease of access to the management unit.
- 2016: Localized rat control is implemented at the Kaluaa Gulch 1A and North Kaluaa *C. grimesiana* subsp. *obatae* sites. In 2017, these are converted to A24 grids.
- 2017: Ferroxx AQ Slug and Snail Bait is approved for use on state land; it is implemented within the MU and slug control is changed to a 6-week interval.
- 2017: The OANRP ungulate team skirts a problem section of the fence in Waieli gulch, where outside pressure is high and pig sign outside the fence is often observed.
- 2017: Paul Krushelnycky confirms the adverse effects of the thief ant (*Solenopsis papuana*) on native *Drosophila*. One study sites is Hapapa bench.
- 2017: The first *E. herbstii* are planted in North Kaluaa. This population is augmented in 2018.

- 2018: Pig sign is detected in the upper North Kaluaa fence by the *C. grimesiana* subsp. *obatae* outplanting. This is the first pig in this section of the fence. It is successfully snared.
- 2018: *Chromolaena odorata* is found along the Hapapa access trail. Buffer sweeps and trail surveys are implemented to determine further actions.
- 2018: The *E. stipoides* ICA (Kaluaa-EhrSti-01) at Hapapa bench is eradicated.

Ungulate Control

Species: *Sus scrofa* (pigs)

Threat Level: High

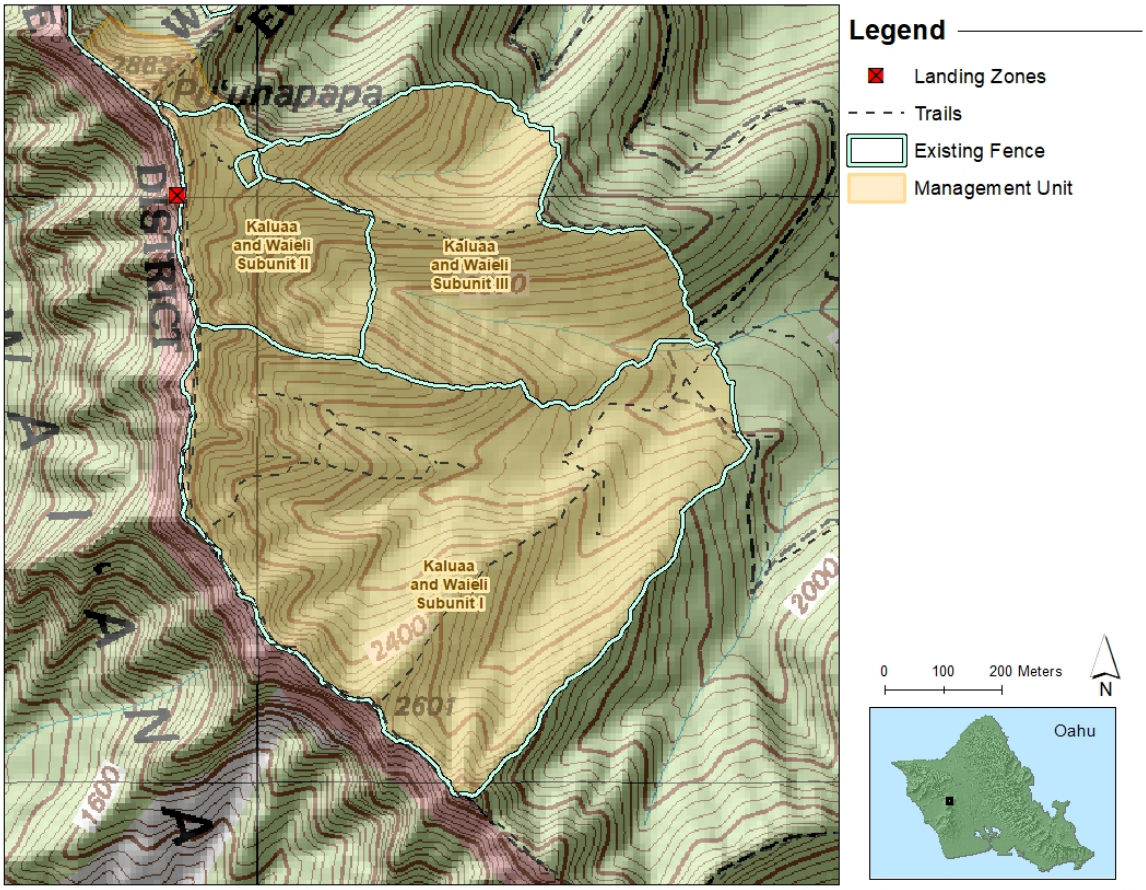
Management Objectives:

- To maintain all areas within fenced units as pig free.

Strategy and Control Methods:

- Conduct perimeter and centerline fence checks quarterly. Maintain fences and monitor for pig ingress.
- Annually monitor interior fence section separating units II and III.
- Monitor for pig sign while conducting other management actions in the fence.
- If any pig activity is detected in the MU, implement snaring program or conduct control hunts with permission from the State of Hawaii.
- Conduct fence checks after storm events with emphasis at gulch crossings.

Ungulate Management at Kaluaa and Waieli MU



Discussion: Quarterly checks, including maintenance, on fence integrity are conducted along the perimeter and centerline (separating Subunit I from Subunits II and III). The fence separating Subunits II and III is checked annually. Though not necessary to prevent ingress, this fence can make surveying and snaring easier if a pig does enter from the outside, as keeps the animal contained to a smaller area. Fences are also checked after extreme weather events, and staff monitors for pig sign during the course of other field activities.

The fence is especially vulnerable at its two stream crossings. Though water rarely flows here, there is typically water present, resulting in higher pig presence and increase pressure from the outside. In addition, extreme weather events can cause water to rush down the gulches, collecting debris and pressuring the fence from the inside. To mitigate these threats, baffles are installed inside Subunits I and III where the Kaluaa gulch trail crosses into North and Central Kaluaa Gulches, and both stream crossings are skirted.

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 and Restoration Actions (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP requirements.

Vegetation Monitoring

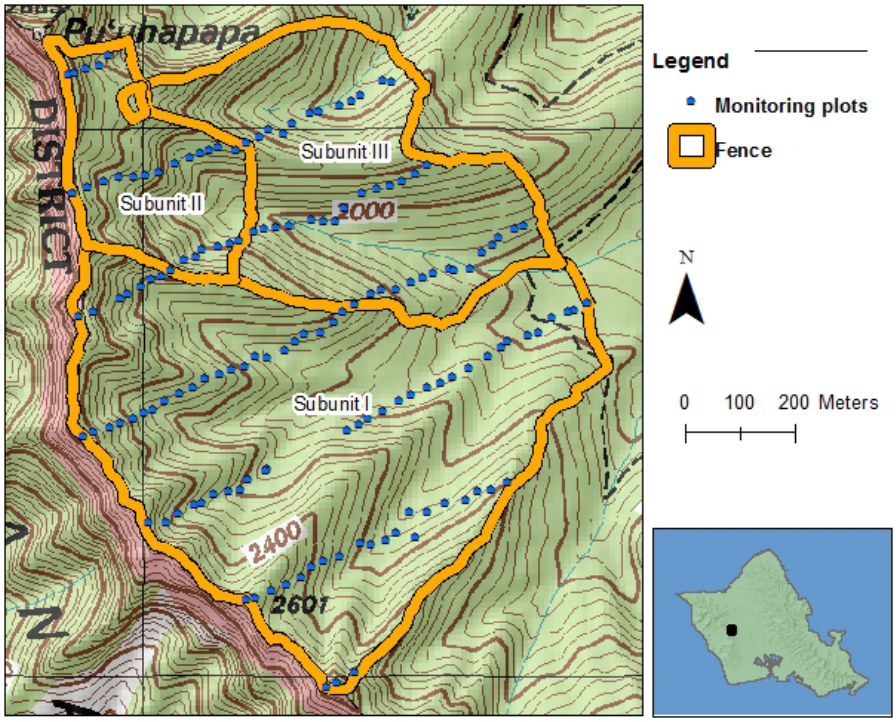
Background:

Vegetation monitoring occurs on a five-year interval at Kaluaa and Waieli MU in association with MIP/OIP requirements for long term monitoring of vegetation composition and change over time (OANRP 2008). The primary objective of MU monitoring is to assess if the percent cover of non-native plant species is less than 50% across the MU, or is decreasing towards that threshold requirement. The secondary objective is to assess if native cover is greater than 50% across the MU, or is increasing towards that threshold recommendation.

Methods:

Monitoring was conducted in 2010 (OANRP 2011) and 2015 (OANRP 2016) in 148 plots generally located every 30 m along transects spaced approximately 200 m apart. Vegetation was recorded by percent cover for all non-native and native species present. Summary percent cover by vegetation type (shrub, fern, grass/sedge) in the understory, overall summary percent cover of non-native and native vegetation in the understory and canopy, and bare ground (non-vegetated < 25 cm AGL), were also documented.

Kaluaa and Waieli MU vegetation monitoring plot locations



Summary results:

In both monitoring years, management objectives were met only for percent cover of non-native canopy. Native cover was low, and non-native canopy was high.

Median cover (%) of vegetation in plots at Kaluaa and Waieli MU from 2010 to 2015.

	2010	2015
Native understory	15.0	7.5
Non-native understory	35.0	35.0
Native canopy	25.0	25.0
Non-native canopy	75.0	85.0

There were a number of noteworthy significant differences in the 2015 data as compared with 2010, including:

- Increase in non-native canopy cover
- Decrease in non-native understory richness
- Increase in non-native canopy richness
- Decrease in frequency for non-native understory species:
  - *Toona ciliata*
- Increase in frequency for non-native canopy species:
  - *Passiflora suberosa*
  - *T. ciliata*
- An increase in percent cover for non-native species:
  - *Blechnum appendiculatum* (understory)
  - *P. suberosa* (canopy)
  - *Psidium cattleianum* (canopy)
  - *T. ciliata* (canopy)
- An increase in percent cover for native species:
  - *Acacia koa* (canopy)
  - *Metrosideros polymorpha* (canopy)
- A decrease in percent cover for non-native understory species:
  - *Schinus terebinthifolius* (understory)
  - *T. ciliata* (understory)
- Increase in non-native canopy cover in plots without IPA control
- Increase in *T. ciliata* (canopy) in plots without IPA control

The beneficial changes that occurred were generally small, while the worsening changes were larger, particularly in the canopy, irrespective of weeding efforts. Given the high level of non-native canopy cover in the MU, management goals of < 50% cover may be unrealistic across the MU. Refinement of management goals to apply specifically to prioritized areas (those with greater potential for restoration) within the MU may result in goals that are more likely to be successfully accomplished.

Toona ciliata frequency and cover decline in the understory paired with an increase in the canopy may be explained in part by vertical growth of individuals that were in the understory in 2010, but reached the canopy by 2015. Plots where *T. ciliata* was absent in the understory in 2015 but present in 2010 were anecdotally observed to have *T. ciliata* individuals in the lowermost portions of the canopy in 2015.

The significant increase in non-native cover (including *T. ciliata*), in plots outside, but not inside IPA controlled areas suggest IPA efforts may be preventing increases in non-native canopy cover within the areas treated. However, IPA treatment occurred in the lower elevations of the MU, where non-native cover was already uniformly high, as opposed to the higher elevation areas where non-native cover was

lower. IPA control targeted only the largest mature individuals of two species in attempts to minimize primary seed sources, such that other non-native species and smaller individuals of the targeted taxa remained in the lower reaches of the canopy, potentially masking impacts of canopy reduction via IPA. As IPA efforts expand into higher elevations, perhaps resulting canopy reduction will be more apparent.

Recommendations:

Based on the results of vegetation monitoring, a number of recommendations were made with the goal of making progress towards meeting management objectives:

- more aggressive weed control paired with restoration efforts in prioritized areas
- target uncommon weeds when seen (particularly target taxa)
- expand IPA efforts into new areas, including higher elevations with more native cover, and continue IPA efforts within areas already treated, as *T. ciliata* and *Grevillea robusta* grow to the targeted size/stage, as necessary
- monitoring of understory change in direct association with IPA treatments (via a separate monitoring regime) should be done to better understand it's impact on native and non-native understory cover

Surveys

Potential Vectors: Army Training, OANRP activity, hikers/hunters, pig, rodents, alien birds, wind

Management Objective:

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

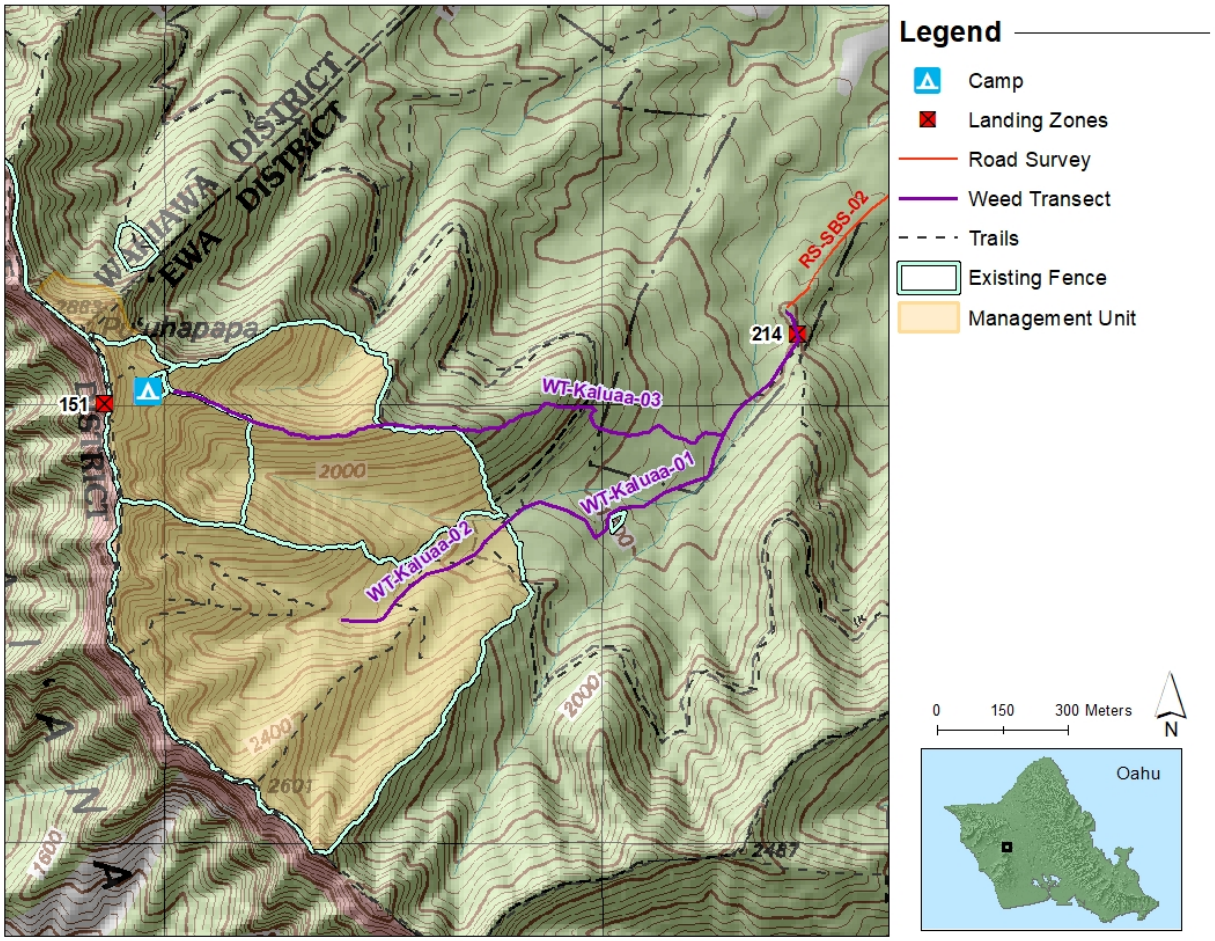
Strategy and Control Methods:

- Quarterly surveys of LZs when used, to include: Waieli-TNC Hapapa LZ (151) and Kaluaa Trailhead LZ (214)
- Quarterly survey of Hapapa shelter/campsite when used.
- Annually survey 3 weed transects along main Kaluaa gulch trail and Hapapa access trail for incipient weeds (see map).
- Annually survey Kaluaa access road as part of the Schofield Barracks South range (SBS) road surveys.
- Note unusual, significant or incipient alien taxa during the course of regular field work, and particularly when doing fence checks. Map and complete Target Species form to document sighting.

Discussion:

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. At Kaluaa and Waieli, LZs, camp sites, trails, and the access road are inventoried regularly to facilitate early detection and rapid response. The only LZs approved for use within this MU are Waieli-TNC Hapapa LZ (151) and Kaluaa Trailhead LZ (214). In addition to LZ surveys, staff also conduct surveys at the Puu Hapapa shelter (the primary campsite in the MU), and along 3 heavily trafficked trails. The Kaluaa access road is also surveyed annually as part of the SBS road surveys.

Survey Locations at Kaluaa and Waieli



Incipient Taxa Control

All weed control geared towards eradication of a particular invasive weed is tracked via Incipient Control Areas, or ICAs. Each ICA is species-specific and geographically defined. Some ICA species are incipient island-wide, and are a priority for ICA management whenever found. Others are locally incipient to the MU, but widespread elsewhere. In either case, the goal is eradication of the ICA. The goals, strategies, and techniques used vary between ICAs depending on terrain, surrounding vegetation, target taxon, size of infestation, and a variety of other factors.

Management Objective:

- Eradicate ICAs through regular and thorough monitoring and treatment. In the absence of any information about seed bank longevity for a particular species, eradication is defined as 10 years of consistent monitoring with no target plants found.
- Study seed bank longevity of ICA taxa, and revise eradication standards per taxon.
- Evaluate any invasive plant species newly discovered in MU, and determine whether ICA-level control is warranted. Factors to consider include distribution, invasiveness, location, infestation size, availability of control methods, resources, and funding.

Strategy and Control Methods:

- Monitor the progress of management efforts, and adjust visitation rates to allow staff to treat plants before they mature. Remember that one never finds 100% of all plants present.
- Use aggressive control techniques where possible. These include applying pre-emergent herbicides, clearcutting, aerial spraying, and frequent visits.

Species and ICAs are listed in the table below. History and strategy is discussed for each species.

Summary of ICAs

Taxon	ICA Code	Control Discussion
Angiopteris evecta	Kaluaa-AngEve-01	This ICA follows the bottom of South Central Kaluaa Gulch. It is monitored every 6 months. *Angiopteris evecta* are mostly found on rocks within 5 meters from the bottom of the gulch. Smaller, immature plants, such as those typically found in this area, have been successfully controlled manually. However, *A. evecta* here have been observed to re-sprout vegetatively from cut parts of the root ball in sufficient moisture; thus controlled plants should be hung off the ground, thoroughly pulverized to facilitate desiccation, or treated with herbicide. Foliar spray of 20% triclopyr, 80% biodiesel is also known to be effective. This ICA has been expanded considerably since it was established in 2007 with additional plants being found up and down-gulch. Since 2007, no additional matures were found, but immatures are consistently found. There is no known data on the longevity of spores, or time to maturity. Further buffer surveys may be necessary to ensure we are not missing other mature plants up-gulch (a possible source for the plants we control in the bottom), and to more accurately determine the extent of the infestation.
Angiopteris evecta	Kaluaa-AngEve-03	One immature plant was found by Outreach in lower Central Kaluaa Gulch. It seems to be an outlier as it was right along the trail in a frequently weeded area. Monitoring will continue every 6 months. If no additional plants are found, this ICA will be considered eradicated in 2020.
Arthrostemma ciliatum	Kaluaa-ArtCil-01	A member of the Melastomataceae family, *A ciliatum* is highly invasive, seeds prolifically and has a presumably long-lasting seedbank. It is known mostly from the Koolau mountains. Given these characteristics, this area should be closely monitored for recruitment in order to prevent infestation. However, only one plant is known in this location: a small mature along the trail below the TNC Ti Leaf Flats fence. Though primarily bird-dispersed, this individual was likely introduced by hikers, hunters or NRS. If no other plants are found, this ICA will be considered eradicated in 2019. Individual plants may be hand-pulled, seeds bagged and removed, or vegetative plants can be controlled with a foliar spray of 2% glyphosate.
Casuarina equisetifolia	Kaluaa-CasEqu-01	This ICA is along the southern side of the fence. It was established as a follow up to eradication work done here previously by TNC. It is currently monitored annually. Plants are controlled via cut stump with of 20% triclopyr, 80% biodiesel.

Summary of ICAs (continued)

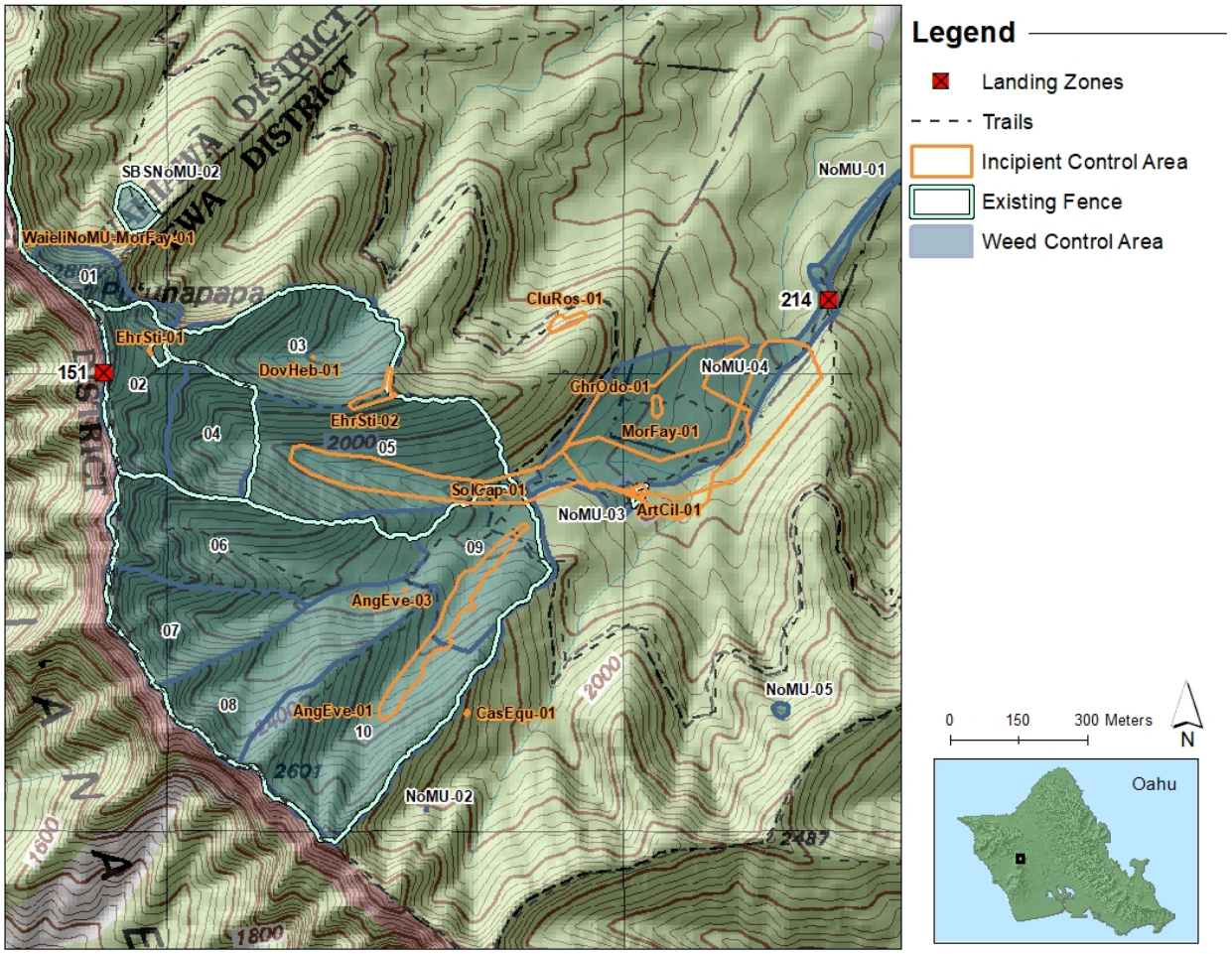
Taxon	ICA Code	Control Discussion
Chromolaena odorata	KaluaaNoMU-ChrOdo-01	This highly invasive shrub is a major target. It was discovered in May 2018 along the Hapapa access trail. Staff conducted 200m buffer surveys around the site, and a thorough trail survey from the parking area to Hapapa snail enclosure. Only one mature *C. odorata* was found, and all other plants were concentrated around it to about 40 meters at the most. Given their proximity to a frequently travelled trail, these plants were likely introduced by NRS. Seeds are primarily wind-dispersed, but can also spread via contaminated boots and gear. Seeds of *C. odorata* last at least 3 years in soil, and further seed bank longevity testing is underway. This ICA is a high priority. It is currently monitored quarterly. Plants are hand-pulled, seeds bagged and removed, or controlled via cut stump with 20% triclopyr, 80% biodiesel. Larger patches, or plants that have already dropped seeds should be controlled aggressively with a thorough spray of 2% glyphosate and a pre-emergent to prevent recruitment.
Clusia rosea	Kaluaa-CluRos-01	This ICA is located along the contour trail, north-east of the management unit. It is currently monitored annually. A hardy tree with often hard-to-reach prop roots, *C. rosea* may require several follow-up treatments, or use of a chainsaw for effective control. Control has previously been done via cut stump or a deep girdle with 20% triclopyr, 80% biodiesel. The most effective control known to date for large trees is a drilling method with 100% triclopyr.
Dovyalis hebecarpa	Kaluaa-DovHeb-01	This ICA is in the bottom of Waieli Gulch below a *D. waianaeensis* outplanting. It is currently monitored annually. Although large populations are known to exist lower in the gulch, only plants within the fence (and management unit) are controlled. Control via cut stump with 20% triclopyr, 80% biodiesel.
Ehrharta stipoides	Kaluaa-EhrSti-02	Although common in other MUs, this is only the second *E. stipoides* site found within Kaluaa and Waieli MU. This ICA is found along the trail to the Hapapa snail enclosure; the first was at the enclosure. As it is common in other areas where snail management occurs (namely Palikea MU), and the seeds are readily spread when stuck to boots, clothing, or gear, it was likely spread by NRS or others involved in snail conservation work. An invasive grass that can dominate understory even in the shade, *E. stipoides* is a high priority target. This ICA is currently monitored every 6 months. Control aggressively with a thorough spray of 2% glyphosate and pre-emergent to prevent recruitment. Mature seeds should be bagged and removed.
Morella faya	Kaluaa-MorFay-01	This ICA encompasses the flats between the Hapapa access trail, the Kaluaa gulch trail and the contour trail. This area was previously controlled by OISC. *Morella faya* is a significant habitat modifier. Although common in other areas along the Waianae mountains, its extent near the Kaluaa and Waieli MU is limited and therefore eradication is feasible. This ICA is currently swept annually. Control via basal-bark method or cut stump with 20% triclopyr, 80% biodiesel.
	WaieliNoMU-MorFay-01	A single mature *M. faya* was found and controlled along the crest north of Puu Hapapa. This ICA is currently monitored annually. If no additional plants are found, this ICA will be considered eradicated in 2022.

Summary of ICAs (continued)

Taxon	ICA Code	Control Discussion
Solanum capsicoides	Kaluaa-SolCap-01	This ICA follows the stream starting near the Kaluaa trailhead and extending into North Kaluaa Gulch. The winged seeds of *S. capsicoides* imply wind-dispersal, but the locations of previously found plants suggest they may have spread along the gulch via water movement. *Solanum capsicoides* has a high fruit yield, and fruit have been observed to mature even after the plant is pulled; thus any fruit (immature or mature) should be bagged and removed to prevent recruitment. In addition, revisiting sites of mature plants should be prioritized to check for and control recruits. This ICA is currently surveyed annually. Its large area can possibly be decreased depending on future survey results and the extent of new plants found.

ICAs Eradicated at Kaluaa and Waieli MU: *Ehrharta stipoides* (Kaluaa-EhrSti-01)

Incipient and Weed Control Areas



Ecosystem Management Weed Control

All weed control geared towards general habitat improvement is tracked in geographic units called Weed Control areas, or WCAs. The goals, strategies, and techniques used vary between WCAs, depending on terrain, quality of native habitat, and presence or absence of rare taxa.

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.
- Increase/expand weeding efforts if MU vegetation monitoring (conducted every 5 years) indicates that goals are not being met.

Discussion:

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 ridge crest is largely native. In addition, there are belts of *Acacia koa* (koa) canopy which run along prominent ridgelines that are in 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.

The majority of management action are focused directly around rare taxa. However, the expansion of the Ecosystem Restoration crew (EcoRest) and the implementation of new weed-control techniques, have made possible more MU-scale management. One of these techniques is incision point application (IPA) sweeps. First implemented in 2013, use of IPA sweeps has resulted in 268 acres surveyed and controlled with minimal time of 465 staff hours. Target species include *T. ciliata* and *G. robusta*. IPA sweeps have been implemented in every WCA within the Kaluaa and Waieli fence, and there are plans to expand these efforts further.

Native *Drosophila*

One unique consideration in Kaluaa and Waieli MU is picture-wing *Drosophila* habitat. Picture wing flies require particular host plants to complete their lifecycles. The endangered *Drosophila montgomeryi* is found within the Kaluaa and Waieli MU and is an OIP stabilization species. *Drosophila montgomeryi* breed in rotting plant material of *Urera glabra* and *Urera kaalae*. While *U. glabra* occurs widely across the Waianae range, it often occurs as scattered clumps of one or a few individuals, unsuited for survival of *D. montgomeryi* and probably not viable for long-term survival of this dioecious, wind-pollinated tree. *Urera kaalae* is critically endangered and only a handful of wild plants remain. Therefore, the remnant patches of these plants should be maintained and expanded.

Since 2002, NRS have planted a total of 137 *U. kaalae* and 211 *U. glabra*, with a survivorship rate averaging around 84%. Active management of *D. montgomeryi* habitat began in 2011 with specified weed actions, as well as augmentations and outplantings of these host trees. One of these reintroductions was in response to a large tree-fall in North Kaluaa that opened a canopy gap in the middle of existing *D. montgomeryi* habitat. *Urera* species should be considered in any future restoration outplantings where they might serve to maintain or restore possible *D. montgomeryi* habitat. *Drosophila montgomeryi* habitat is currently managed in WCA-02 (Hapapa bench), WCA-04 (North Kaluaa), WCA-07 (Gulch 2; weed actions focused around PEPP (Plant Extinction Prevention Program) *U. kaalae* reintroductions), and WCA-08 (Gulch 1).

Stenogyne kanehoana

Stenogyne kanehoana 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. Anecdotal evidence suggests *D. linearis* is sensitive to trampling, and gaps made while weeding or monitoring are often re-vegetated with much less desirable weeds, such as *C. hirta*. OANRP does not have the capacity to actively restore uluhe 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. Reintroductions of *S. kanehoana* are currently managed in WCA-02 (along the ridge crest above Hapapa bench) and WCA-10 (along the southern fence line).

Hapapa bench habitat

Another unique consideration for the Kaluaa and Waieli MU is the Hapapa bench habitat (WCA-02). This zone has a unique set of conditions that support numerous rare native tree and ground snail species, as well as the endangered *D. montgomeryi*. Rare native ground snails in the genera *Amastra* require unique food. They browse fungi growing in leaf litter of plants in the family Urticaceae such as *Pipturus albidis* (mamaki) and *Urera* spp. Native *Achatinella* can also live happily on *Urera*, and, as mentioned earlier, these taxa are essential for the life cycle of *D. montgomeryi*.

While not MIP or OIP taxa, considerations should be made to not affect ground dwelling snails as their habitat can be negatively impacted by digging activities associated with outplanting and fence construction. Particular caution should be taken to survey sites prior to conducting any digging and tree felling activities. These actions should be planned in collaboration with the Snail Extinction Prevention Program (SEPP).

The table below summarizes invasive weeds found at Kaluaa and Waieli MU, excluding ICA species. While the list is by no means exhaustive, it includes the species targeted/prioritized for control. The distribution of each taxon is estimated as: Widespread (moderate to high densities of individuals, common across MU), Scattered (low densities across all or much of the MU), or Restricted (low or high densities, all in one discrete location).

Summary of Target Taxa

Taxa	Distribution	Notes
Ardesia elliptica	Restricted	Not known inside MU. Concentrated in South Kaluaa. Target whenever seen inside MU. Control technique: Cut stump with 20% triclopyr, 80% biodiesel.
Blechnum appendiculatum	Widespread	An invasive fern that can create a thick ground cover and hinder recruitment, control with priority directly around rare taxa. Control technique: Foliar spray with 2% glyphosate is most effective, clip-and-drip with 20% triclopyr, 80% biodiesel is moderately successful.
Buddleja asiatica	Widespread	A fast-growing shrub, *B. asiatica* produces a lot of seed. Control technique: Basal-bark or cut stump with 20% triclopyr, 80% biodiesel.
Clidemia hirta	Widespread	Widespread and often forming dense patches throughout the MU. Known to quickly invade and spread into canopy gaps. Control technique: Basal-bark or cut stump with 20% triclopyr, 80% biodiesel. Immatures can be hand-pulled.
Cyclosorus parasiticus	Widespread	Though easily overlooked, this invasive fern can grow in dense patches and replace natives such as *Microlepia strigose* (palapalai). Control technique: 20% triclopyr, 80% biodiesel applied to tips of rhizomes.
Dicliptera chinensis	Restricted	Not known inside MU. Control along access trail to prevent spread into MU. Control technique: Foliar spray with 2% glyphosate.

Summary of Target Taxa (continued)

Taxa	Distribution	Notes
Erigeron karvinskianus	Widespread	Establishes a thick ground cover, spreading by seed and runners. Control in WCAs. Target in cliff and bench areas in habitat for MFS plant taxa (e.g. *Plantago princeps* var. *princeps*). Effective control achieved with 2% glyphosate spray. Trial lower concentrations to avoid negative impacts on native recruits.
Falcataria moluccana	Scattered	Fast growing, habitat-modifying tree. Not known inside MU, but well established below. Treat as part of WCA work. Kill all mature trees within fence. Control technique: Cut stump or girdle with 20% triclopyr, 80% biodiesel. Can also IPA with 100% aminopyralid.
Grevillea robusta	Widespread	Commonly known as silk oak, *G. robusta* is a large tree, widespread across the MU. Control in WCA sweeps (including IPA). Priority to kill matures. Lower priority than *Toona ciliata*. Control technique: Cut stump or girdle with 20% triclopyr, 80% biodiesel; IPA with 100% aminopyralid.
Heliocarpus popayensis	Widespread	Commonly called moho, this tree is 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. Control technique: IPA with 100% imazapyr.
Lantana camara	Widespread	Widespread throughout the MU, this shrub can form dense thickets and climb into the canopy. Its thorns are a hazard to NRS when along trails or survey areas. Larger plants have been observed to re-root in sufficient moisture at Hapapa when cut and left on the ground. Control technique: Cut stump with 20% triclopyr, 80% biodiesel. Stack large stumps off the ground or apply herbicide.
Mallotus philippensis	Scattered	Seedling/saplings are observed in low densities across the MU. Abundant in Lualualei, so re-invasion is likely. Control whenever found. Control technique: Cut stump or girdle with 20% triclopyr, 80% biodiesel.
Melinis minutiflora	Widespread	Commonly known as molasses grass, *M. minutiflora* can form a thick ground cover impeding recruitment and choking out native plants. Control technique: Foliar spray with 1% glyphosate. Manual control has also been used effectively, and grass-specific herbicides (e.g. Fusilade) should be used in sensitive areas.
Oplismenus hirtellus	Widespread	Commonly known as basket grass, control is focused mostly along trails. Control technique: Foliar spray with 1% glyphosate.
Paspalum conjugatum	Widespread	Commonly known as Hilo grass, control is focused mostly along trails. Control technique: Foliar spray with 1% glyphosate.
Passiflora suberosa	Widespread	A vigorous vine, *P. suberosa* can form dense curtains smothering native plants, and causing a tripping hazard for NRS. Control technique: Cut stump with 20% triclopyr, 80% biodiesel. Can be time-consuming to find where all stalks enter the ground.
Psidium cattleianum	Widespread	Widespread and often forming dense patches throughout the MU. Rare tree snails have been observed on this taxa. Take care when controlling in known snail sites. Control technique: Cut stump or girdle with 20% triclopyr, 80% biodiesel.
Rubus rosifolius	Widespread	Widespread and often forming dense patches throughout the MU. Known to quickly invade and spread into canopy gaps. Control technique: Hand-pull. Also basal-bark or clip-and-drip with 20% triclopyr, 80% biodiesel, particularly in areas sensitive to soil disturbance.

Summary of Target Taxa (continued)

Taxa	Distribution	Notes
Schefflera actinophylla	Widespread	Bird dispersed and well established below MU. Target matures as a priority and in canopy weed sweeps across WCAs. Control technique: IPA with 100% aminopyralid, 100% imazapyr, or 100% glyphosate (glyphosate is the cheapest option).
Schinus terebinthifolius	Widespread	Commonly known as Christmas berry, *S. terebinthifolius* is widespread and often forms dense patches throughout the MU. Especially abundant on southern-facing slopes. Control technique: Basal-bark with 20% triclopyr, 80% biodiesel. Even large trees are controlled more effectively without cutting.
Setaria palmifolia	Scattered	Commonly known as palm grass, *S. palmifolia* is a shade tolerant grass that can form dense patches with dense root masses. Within the MU, it is most commonly found in the gulch bottoms (especially North Kaluaa), and in one location at Hapapa bench. It is found in higher densities below the MU. High priority to control around rare taxa and along trails to minimize spread. Control technique: Foliar spray with 2% glyphosate.
Spathodea campanulata	Widespread	Commonly known as African tulip, *S. campanulata* is a vigorous, easily dispersed tree. It is well established below the MU and found throughout. Target matures as a priority and in canopy weed sweeps across WCAs. Control technique: Cut stump immature trees with 20% triclopyr, 80% biodiesel. IPA larger trees with 100% imazapyr. Follow-up monitoring may be necessary to avoid vigorous re-sprouting from root suckers. May not be effective for trees over 160cm diameter (though these are rare within the MU). Further trials are needed.
Toona ciliata	Widespread	Commonly known as Australian red cedar, *T. ciliata* is a fast growing, habitat-modifying tree that can produce a lot of seed and grow in high densities. It is a high priority for control. Target in canopy weed sweeps (including IPA) across higher elevation WCAs. Focus on large matures in lower elevations. Control technique: Cut stump or girdle with 20% triclopyr, 80% biodiesel. Can also basal-bark immatures under 7.5 cm diameter with 20% triclopyr, 80% biodiesel. IPA with 100% imazapyr.
Triumfetta semitriloba	Scattered	Commonly known as Sacramento bur, seeds are easily dispersed hitchhiking on hikers, gear, or pigs. Not known in high densities in the MU, it should be controlled whenever seen, and with priority along trails. Control technique: Clip-and-drip or basal-bark with 20% triclopyr, 80% biodiesel. Immatures can be hand-pulled.
Urochloa maxima	Widespread	Seen in its highest densities along the ridges and fence lines, control of *U. maxima* (Guinea grass) is needed in these areas to facilitate monitoring and maintenance of affected fences, and to prevent spread throughout the MU. Sprays here are logistically difficult because water needs to be hiked or flown in. Use of water catchments should be investigated, and existing catchments rehabilitated as needed. While rarely seen around rare resources, the habitat-altering characteristics of *U. maxima* and its ability to quickly invade light gaps also make it a target for sprays within the gulches. Control technique: Foliar spray with 2% glyphosate. 1% may be used in more sensitive areas.

Restoration activities are discussed in the notes section for each WCA. The table below contains specific notes on what native taxa and what type of stock may be appropriate for projects at Kaluaa and Waieli MU.

Taxa Considerations for Restoration Actions:

Native Taxon	Outplant?	Seedsow/ Division/ Transplant?	Notes
Acacia koa		No	Tree. Grow from seed.
Antidesma platyphyllum		No	Tree. Grow from cutting.
Bidens torta		SeedSow	Herb. Easily grown via seed sows.
Carex wahuensis		Seedsow	Sedge. Grow from seed. Seed sows slow to germinate but effective.
Dianella sandwicensis		No	Shrub. Grow from seed.
Freycinetia arborea		No	Woody vine. Grow from seed.
Kadua cordata subsp. *cordata* (*H. schlechtendahliana*)		Transplant	Shrub. Grow from seed or transplant.
Labordia kaalae		No	Tree, Grow from seed.
Microlepia strigosa		Division	Fern. Survives transplanting in mesic environments.
Myrsine lessertiana			Tree. Grow from seed.
Perrottetia sandwicensis		No	Tree. Grow from cutting.
Pipturus albidus		Seedsow	Small tree. Fast growing. Known to grow from seed sows.
Pisonia umbellifera		Seedsow/Transplant	Tree. Fast growing. Easy to propagate. Know to grow from seed sows.
Planchonella sandwicensis (*Pouteria sandwicensis*)		Seedsow	Tree. Grow from seed
Psychotria hathewayi		No	Tree. Grow from seed.
Urera glabra		No	Tree. Grow from cutting.
Urera kaalae		No	Tree, Grow from seed or cutting.

WCA Kaluaa and Waieli-01: SBS side of Hapapa

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include *S. terebinthifolius, Psidium cattleianum, H. popayensis,* mature *T. ciliata* and *G. robusta*. Understory weeds include *R. rosifolius, C. hirta, E. karvinskianus,* and *M. minutiflora*.

Notes: *Achatinella mustelina* are historically abundant in the area, but most have been translocated into Hapapa snail enclosure. Ground/arboreal dwelling snails were also moved (*Laminella sanguinea* and *Cookeconcha* sp.). Much of this WCA is steep and difficult to move around. Access is also limited as it is partially in the Safety Danger Zone (SDZ) of South Range. Though there are still native taxa in the area (i.e. *Lobelia yuccoides* and *Cyanea calycina*), weed efforts here are thus minimized.

WCA Kaluaa and Waieli-02: Hapapa bench

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include large *S. terebinthifolius, P. cattleianum,* mature *T. ciliata, S. campanulata,* and *G. robusta*. Understory weeds include *S. palmifolia, R. rosifolius, C. hirta, P. suberosa,*

L. camara, C. parasiticus, B. appendiculatum, E. karvinskianus, M. minutiflora, U. maxima, P. conjugatum.

Notes: This large WCA is home to several rare plant wild sites and reintroductions sites, as well as the largest populations of *A. mustelina* in the Waianae Mountains. The Hapapa snail enclosure is included in this WCA. Ground dwelling snails and *Drosophila* are also present. For these reasons, it is the major focus of restoration activities within Kaluaa and Waieli MU. Rare plant taxa (wild and reintroduced) include: *D. waianaeensis, P. princeps* var. *princeps, S. kaalae, S. kanehoana, U. kaalae, C. membranacea, Platydesma cornuta* var. *decurrens, L. yuccoides, Labordia kaalae,* and *Embelia pacifica.*

Trails within the enclosure are needed to establish designated walking paths as more vegetation is planted and with increased natural recruitment. Weeding within the enclosure is needed on a continual basis to ensure adequate food supply for *A. mustelina*. This will likely include gradual removal of mamaki after shade is established and replaced with better host species for *A. mustelina*.

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,* mature *T. ciliata* and *G. robusta,* to foster native recruitment. Remove understory weeds, focusing on shrubs, herbs, and *C. parasiticus.* Snails in the area are using *Psidium* spp., and control of these taxa should be strategic. The entire WCA should be swept for target canopy species, such as *S. campanulata* and *T. ciliata*. At rare plant sites, both understory and canopy control should be conducted.

Setaria palmifolia has been found on the trail from the Hapapa enclosure up to the Hapapa LZ. There is zero tolerance for this target taxa in this WCA.

WCA Kaluaa and Waieli-03: South Waieli

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: Canopy weeds include mature *T. ciliata, G. robusta, S. actinophylla, S. campanulata,* and *H. popayensis*. Understory weeds include *C. hirta, B. asiatica, C. parasiticus* and *R. rosifolius*.

Notes: Weed control is focused around reintroduced *D. waianaeensis.* This area is a priority for control. Understory weeds are targeted in addition to limited canopy control. This WCA encompasses the south branch of Waieli, which is dominated by large *T. ciliata* with nice remnant patches of *Pisonia* and *Diospyros*. The back wall of the gulch, just the Hapapa bench WCA, is very steep and dominated by *S. terebinthifolius*. Control of mature *T. ciliata* is a priority, as this is likely an important dispersal source for this taxa throughout the MU. IPA sweeps were done in this gulch in 2013 and 2014.

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

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include mature *T. ciliata, G. robusta,* and *S. terebinthifolius.* A variety of understory weeds include *P. suberosa, R. rosifolius, L. camara, C. hirta, P. cattleianum, B. asiatica, B. appendiculatum, U. maximum,* and *S. palmifolia.*

Notes: This WCA encompasses reintroductions of *D. waianaeensis* and *C. grimesiana* subsp. *obatae, E. herbstii, S. kaalae, U. kaalae and U. glabra.* Wild trees of *A. macrococcus* var. *macrococcus* are historically found within this WCA. In addition, there are a few large wild *U. glabra* trees which are

appropriate habitat for *D. montgomeryi*. Weed control should be focused on both canopy and understory species around these rare taxa.

The western portion (higher elevations) of this WCA is very steep and dominated by *S. terebinthifolius* canopy; however, successful IPA sweeps were conducted here in 2016 and 2017. This is a priority are for continued IPA sweeps targeting *T. ciliata*.

Setaria palmifolia and *U. maximum* are known within this WCA and should be controlled with priority along trails and around rare taxa.

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* prioritized for control as well as *G. robusta, S. actinophylla, S. campanulata, H. popayensis, U. maximum* and *S. palmifolia* to prevent/minimize spread throughout the MU.

Notes: There are no managed rare taxa within this WCA. Control is focused on preventing spread of target weeds and reducing recruitment pressure on adjacent WCAs. Canopy sweeps are conducted with priority on mature, fruiting *T. ciliata,* as well as *G. robusta, S. actinophylla, S. campanulata,* and *H. popayensis.* IPA sweeps have been conducted here since 2014 and are scheduled to continue.

U. maximum and *S. palmifolia* are abundant within this WCA and should be controlled with priority along trails and fences to prevent spread throughout the MU.

WCA Kaluaa and Waieli-06: Gulch 3

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include mature *T. ciliata, G. robusta,* and *S. terebinthifolius.* A variety of understory weeds include *P. suberosa, R. rosifolius, L. camara, C. hirta, B. asiatica, T. semitriloba, P. cattleianum, C. parasiticus, U. maximum,* and *M. minutiflora.*

Notes: Weeding in this WCA is focused around reintroductions of *P. mollis, C. grimesiana* subsp. *obatae,* and *S. kaalae*. The back of Gulch 3, where most of these rare taxa are concentrated, is dominated by native *Pisonia* patches. Habitat on the native slopes contains rock talus substrate which can be challenging for weed control. Care should be taken to avoid harm to ground snails, which are known from this area. Canopy is thick and predominately native within the *Pisonia* patches, minimizing the need for aggressive weed control. Weeding efforts are focused on maintaining understory around rare taxa.

An augmentation of *C. grimesiana* subsp. *obatae* further down gulch has patchier native canopy. While there is a decent native seed bank here, increased control is needed targeting both canopy and understory to encourage native recruitment and expand native habitat. Non-native vines such as *P. suberosa* are especially a problem. This is a possible site for restoration work.

Further upslope, there is also a wild population of *D. waianaeensis*. The slope here is especially steep, and the canopy open. NRS should consider erosion and rock fall hazards while conducting weed control. Control is focused on understory weeds such as *M. minutiflora*. Canopy species should be targeted selectively to avoid sudden light changes or canopy gaps that would boost invasion of understory weeds. This is a possible site for restoration focusing on understory species to prevent erosion.

Urochloa maximum is also present in this WCA along the fence bordering WCA-05. It should be maintained to facilitate monitoring and maintenance of the fence line, and to prevent spread throughout the MU. Sprays here are logistically difficult because water needs to be hiked or flown in. Use of water catchments should be investigated, and existing catchments rehabilitated as needed.

IPA sweeps have been conducted in WCA-06 since 2014 and are scheduled to continue.

WCA Kaluaa and Waieli-07: Gulch 2

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% native cover.

Targets: Canopy weeds include mature *T. ciliata, G. robusta,* and *S. terebinthifolius,* and understory weeds include *L. camara, P. conjugatum,* and *R. rosifolius.*

Notes: There are no managed taxa in this WCA. There is a substantial patch of *U. glabra* trees, which have been augmented by a PEPP outplanting of *U. kaalae*. Although no *D. montgomeryi* are known from this area, it is viable habitat and other rare *Drosophila* are present. Weeding is conducted annually to support this potential habitat. IPA sweeps were conducted in WCA-07 in 2016, and will resume in 2019 focusing first around native forest patches, and secondarily around degraded habitat.

WCA Kaluaa and Waieli-08: Gulch 1

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include mature *T. ciliata, G. robusta, P. cattleianum,* and *S. terebinthifolius.* Understory weeds include *P. suberosa, C. hirta,* and *R. rosifolius.*

Notes: This WCA was a core TNC outplanting site which was adopted and expanded by OANRP. A large concentration of rare taxa are found in the lower gulch at the 1A site. These are a combination of reintroductions by TNC, OANRP and PEPP. They include a large outplanting of *D. waianaeensis, S. kaalae, S. sandwicensis, Cyanea pinnatifida* and *U. kaalae*. Also present nearby is the only wild location of *C. grimesiana* subsp. *obatae* in Kaluaa and Waieli MU. There is an intact canopy of native trees, which include *Acacia koa* (koa), *Pisonia umbellifera, Psychotria mariniana, Metrosideros polymorpha, Planchonella sandwicensis,* and *Antidesma platyphyllum.*

Weed control is a high priority in the 1A site. It is a large area, requiring substantial maintenance. Understory weeds, particularly *C. hirta,* grow aggressively in areas where *P. cattleianum* canopy was removed. Encouraging koa recruitment into these sites or common native plantings of koa would likely reduce understory weed prevalence. However, canopy species must be carefully managed to ensure they do not shade out *D. waianaeensis* outplants, which prefer more open canopy.

Weed control in this WCA also takes place around *Urera* outplantings in the back of the gulch as part of *Drosophila* habitat stabilization.

The final area of focus for weed control in WCA-08 extends below the 1A site to the stair trail. Weed control in this area is managed by Outreach. The area includes a population of *Cyanea superba* subsp. *superba* planted by TNC, and there are former project stewardship sites located here. In addition, there is a unique grove of *Pittosporum glabrum, Gynochthodes trimera* and *P. mariniana*. The terrain is generally conducive to volunteer project weed control, though areas of appropriate terrain should be carefully chosen as the slope gets progressively steeper away from the gulch bottom.

Canopy sweeps throughout the WCA were formerly conducted by the Orange team, but will be taken over by EcoRest in the form of IPA sweeps. IPA sweeps were conducted in 2015, and will continue in 2020 focusing primarily in native forest patches, but also in degraded areas.

WCA Kaluaa and Waieli-09: Lower Gulch Gate

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% native cover

Targets: Canopy weeds include *T. ciliata, G. robusta, P. cattleianum,* and *S. terebinthifolius*. Understory weeds include *P. suberosa, C. hirta, R. rosifolius, B. appendiculatum* and *O. hirtellus*.

Notes: This WCA encompasses the lowest elevations of Central Kaluaa gulch. There are no managed taxa within the WCA, but there is a population of *Cyanea superba* subsp. *superba* planted by TNC. This WCA is a focal site for outreach activities. Current weed control, conducted by volunteers, is focused primarily around native forest patches as an extension of WCA-08, and secondly in adjacent weedy zones. Non-native understory, including ferns, is targeted with gradual control of canopy weeds. Common native reintroductions will be used where necessary to support restoration activities.

Along the ridge crest leading up the southern fence line, 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 alien vegetation beginning at the koa dominated ridge crest first, and moving down slope as koa saplings come up could also be employed in restoring this WCA, and the adjacent WCA-10.

The outreach program formerly targeted *T. ciliata* in the upper portions of the WCA to minimize spread into higher WCAs. IPA sweeps were conducted by EcoRest in 2015 and 2017, and more are scheduled in the future. IPA targets include mature *T. ciliata, G. robusta, S. campanulata, H. popayensis*, and *S. actinophylla.*

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

Veg Type: Mesic Mixed Ridge

MIP Goal: Less than 25% non-native cover

Targets: Mature *T. ciliata, P. cattleianum, G. robusta, S. terebinthifolius, C. hirta, L. camara, R. rosifolius,* and *P. suberosa*

Notes: Weed control in this WCA is concentrated around rare taxa: a reintroduction of *S. kanehoana,* and wild population of *Phyllostegia hirsuta.* Both are located along the southern-most ridge in Kaluaa and Waieli MU. As explained earlier, *S. kanehoana* are planted in sensitive uluhe habitat, and care should be taken to avoid trampling which would encourage incursion of weedy species. In addition, *S. kanehoana* have a sprawling habit and delicate canes that weave throughout the uluhe making it difficult to move among them without breaking them. Weed efforts here are better spent buffering the reintroduction zone to expand native habitat and decrease chances of non-native recruitment into the uluhe. Weed control around the *P. hirsuta* focuses on understory taxa with selective canopy control. There is also potential for volunteer weed control efforts lower on this ridge.

The gulch habitat in this WCA is largely degraded. Weed control here is currently limited to IPA sweeps scheduled for 2020, with priority to native forest patches. There is potential for a Drosophila restoration site in this gulch, but other WCAs (02, 04, 07, and 08) are more promising.

WCA KaluaaNoMU-01: Kaluaa Access Road

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *U. maximum*

Notes: This WCA follows the Kaluaa access road from the water tank to the trailhead. Road improvements in 2016 have minimized the need for extensive maintenance. *Urochloa maximum* is power sprayed, and downed-trees cleared as needed.

WCA KaluaaNoMU-02: CryMan

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *B. asiatica, R. rosifolius, T. ciliata*

Notes: No current MIP or OIP goals for this site. Visits were historically conducted to collect from *A. macrococcus* var. *macrococcus* in the area, which has since died, and weed control was conducted in conjunction with PEPP management for *Cryptocarya manii*.

WCA KaluaaNoMU-03: Ti Leaf Flats

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *T. ciliata, S. terebinthifolius, S. actinophylla, C. hirta, R. rosifolius, L. camara, C. parasiticus, D. chinensis, O. hirtellus,* and *P. conjugatum*

Notes: This WCA includes the TNC Ti Leaf Flats fence located along the access trail before the contour trail junction. The goal of weed control within this WCA is to ensure continued survival of *Abutilon sandwicense* reintroductions (planted by TNC). The habitat is alien dominated and most of the native plants within the enclosure were planted. This is a low priority action as there are no current MIP goals for this *A. sandwicense* population.

WCA KaluaaNoMU-04: Kaluaa Access Trail

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *T. Semitriloba, D. chinensis, O. hirtellus, U. maximum,* and *S. palmifolia*

Notes: The trail corridor is managed annually or as needed to facilitate access by NRS, and minimize the movement of weeds into the MU. *Triumfetta semitriloba, D. chinensis, U. maximum,* and *S. palmifolia* are of particular concern as they are easily spread and not yet well-established in the fence. In addition, the Kaluaa trailhead LZ is included in this WCA; it is a priority to maintain vegetation on and around it as needed.

WCA KaluaaNoMU-05: GarMan

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Mature *T. ciliata, P. cattleianum, G. robusta,* and *C. hirta*

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

WCA SBSNoMU-02: (Ie ie Patch)

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *P. cattleianum, S. terebinthifolius,* and *C. parasiticus*

Notes: A small fence once protected a patch of *Frecinetium arborescens,* outplanted *U. glabra,* and a small patch of native forest. *Achatinella mustelina, A. micans,* and *L. sanguinea* are known historically from this location, but are no longer 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.

Rodent Control

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

Threat level: High for *A. mustelina*, *C. grimesiana* subsp. *obatae*, and *D. waianaeensis*

Seasonality: Year-round

Management Objectives:

- Maintain low levels of rat activity around localized control grids.
- Zero-tolerance for rats within the Puu Hapapa snail enclosure.

Strategy and Control Methods:

- Keep sensitive snail populations safe from rat predation via predator proof fence (*Achatinella mustelina* enclosure completed in 2011).
- Maintain predator fence to ensure no breaches occur.
- Monitor ground shell plots for predation of *A. mustelina* by rats.
- Quarterly census monitoring of *A. mustelina* population within the Hapapa snail enclosure to determine population trend and determine if any new threats are present.
- Annual census monitoring of rare plants during fruiting season (*D. waianaeensis*, *C. grimesiana* subsp. *obatae*,) with particular focus on detecting rat damage (gnawed fruit or stalks).
- Maintain 3 localized A24 grids around Hapapa bench, Kaluaa Gulch 1A *D. waianaeensis*, and North Kaluaa *Cyanea grimesiana* subsp. *obatae* sites.
- Keep trails clear and GPS traps to facilitate grid maintenance.

Discussion: Rats are a high threat to both rare plants and invertebrates. They negatively impact rare endangered plants, such as *D. waianaeensis* (pictured below) consuming fruit and seeds and consequentially decreasing seedling recruitment. Rats will also gnaw plants to obtain moisture, especially in drier months, effectively girdling or even chewing through the affected stalk. In addition, rats are known to eat rare snails, as evidenced by predated shells of *A. mustelina* (also pictured below).

Most *A. mustelina* within the management unit are protected from rats by the Hapapa snail enclosure. The enclosure is inspected every 6 weeks and after major rain events. It is inspected for premature rust or weathering of material and erosion that might compromise integrity of the wall. The hood is checked to ensure rats and Jackson's chameleons cannot enter, and surrounding trees are kept well-trimmed to ensure rats cannot jump over the wall. In addition, an Intellesense automatic notification system is maintained in the event of a breach.

Other rodent control in Kaluaa and Waieli MU is currently focused in small-scale grids around affected taxa. There are three grids of automatic self-resetting A24 traps: KAL-A, KAL-D and KAL-E. The KAL-A grid is comprised of 12 traps at Hapapa bench around the snail enclosure; these are intended to protect rare snails in the area that were not translocated into the enclosure, and to reduce outside pressure on the enclosure and possibility of rodent incursion. The KAL-D grid is 6 traps arranged around outplanted *C. grimesiana* subsp. *obatae* in upper North Kaluaa. The KAL-E grid in Kaluaa gulch 1 is the largest, with 30 traps. It was established to protect a large outplanting of *D. waianaeensis* and wild *C. grimesiana* subsp. *obatae*. Other rare taxa protected by this grid are outplanted *S. kaalae*, S*olanum sandwicense*, *U. kaalae*, and *C. pinnatifida*.

Limited research has been done on rat densities or frequencies within Kaluaa and Waieli MU specifically. However, population spikes are known to occur in other areas during the summer coinciding with

increased availability of resources, such as *Psidium cattleianum* fruit. With the implementation and improvement of A24 traps, year-round protection for affected taxa is now more efficient and effective. Automatic lure pumps (ALPs) allow constant protection with decreased staff time and maintain efficacy despite seasonal population spikes. A24s require minimal maintenance. The baits are currently changed on a 4-month interval, and trails are maintained as needed. Effectiveness of rodent control is measured by observed impacts (or lack thereof) on target taxa.

Rat Photos

Rat predation of *D. waianaeensis* caught on a game camera


Predated *D. waianaeensis* fruit


Gnaw marks on *Coffea arabica*


Evidence of rat predation on *A. mustelina* shells

Jackson's Chameleon Control

Species: *Triceros jacksonii* subsp. *xantholophus* (Jackson's Chameleon)

Threat level: High for *A. mustelina* and other native snails present in the MU

Seasonality: Year-Round

Management Objective:

- Keep sensitive snail populations safe from Jackson's Chameleon via predator proof fence (*A. mustelina* enclosure).
- Reduce numbers in proximity to outside snails to reduce predation risk.

Strategy and Control Methods:

- Maintain enclosure to ensure no breaches occur.
- While surveying for native snails or conducting any other field work in the MU, note and remove any chameleons.
- Quarterly census monitoring of *A. mustelina* population within the Hapapa snail enclosure to determine population trend and determine if any new threats are present.
- Record 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.

Discussion:

Triceros jacksonii subsp. *xantholophus* are known to consume native snails, including *A. mustelina*, and inhabit many of the same areas. Chameleons were first detected in Kaluaa and Waieli MU in December 2011 after the completion of the Hapapa snail enclosure. Subsequent surveys, including tree-climbing, resulted in 32 total chameleons removed from the enclosure, the last one found in May 2015. In addition, over 600 individuals have since been found and removed from the surrounding area.

The closest naturalized chameleon population is currently located directly outside the Hapapa snail enclosure. Control is limited to hand removal. Spot-lighting at night is the most effecting survey method. It is unknown whether manual control is effective in decreasing overall populations of chameleons, but due to their high fecundity, it is remains a priority to remove them whenever seen in the field.

Night searches for chameleons occur at least quarterly at the Hapapa bench in conjunction with census monitoring of *A. mustelina*. No scheduled control takes place at other *A. mustelina* sites throughout the MU, however chameleons are removed whenever and wherever found during the course of other field work.

Chameleon photos

Chameleon with dissected stomach contents (including *A. mustelina* and other native snails)

Juvenile chameleon found in North Kaluaa

Male chameleon found in North Kaluaa

Female chameleon (note lack of horns) at Hapapa

Predatory Snail Control

Species: *Euglandina rosea* (rosy wolf snail)

Threat level: High for *A. mustelina* and other native snails present in the MU

Seasonality: Peak numbers recorded March through June

Management Objective:

- Maintain enclosure as *E. rosea*-free and reduce numbers outside to promote *A. mustelina* survival.
- Maintain enclosure to ensure no breaches occur.

Strategy and Control Methods:

- Quarterly census monitoring of *A. mustelina* population within the Hapapa snail enclosure to determine population trend and determine if any new threats are present.
- Quarterly sweeps for predatory snails within Hapapa snail enclosure. The entire enclosure should be swept annually. Include searching for *E. rosea* in trees where feasible. 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.
- Close inspection of *Euglandina* barriers.
- Close inspection of any tools, gear, outplantings or transplanted material to prevent introduction of *E. rosea* into the snail enclosure.

Discussion:

Euglandina rosea is one of the biggest threats to native snails and the most difficult to control. Predator proof fences, such as the Hapapa snail enclosure, are currently the only viable method of satisfactory control. No baits have been developed for the control of predatory snails that would not also adversely affect native snails. Little is known regarding their distribution and prey preference. Control is limited to hand removal. Visual searches are time-consuming and difficult, but effective when used in conjunction with a well-maintained snail enclosure. Thus staff time should be prioritized to maintain an *E. rosea*-free enclosure through thorough quarterly sweeps of the enclosure, and close inspection and maintenance of the enclosure barriers.

***Euglandina rosea* Photos**

E. Rosea

E. Rosea predating *A. mustelina*

Slug Control

Species: *Deroceras laeve, Limax maximus, Meghimatium biliniatum*

Threat level: High for *C. grimesiana* subsp. *obatae* and *D. waianaeensis*

Seasonality: Wet season

Management Objectives:

- Eradicate slugs locally to ensure germination and survivorship of *C. grimesiana* subsp. *obatae* and *D. waianaeensis*
- Avoid potential impacts to rare snails.

Strategy and Control Methods:

- Control slugs at sensitive plant populations via Ferroxx AQ application every 6 weeks. A buffer of at least 5 meters from vulnerable plants is recommended. 10 meters is optimal.
- If rare snails are found in an established Slug Control Area (SLCA), treatment will be halted. Rare snails will be relocated to the Hapapa snail enclosure. The site will then be resurveyed (day and night) to ensure no rare snails are present before treatment is resumed. Annual day and night surveys will be conducted at the SLCA for two years after the last rare snail sighting and annual day surveys will continue indefinitely.
- Annual census monitoring of rare plant seedling recruitment following fruiting events (*U. kaalae, D. waianaeensis, C. grimesiana* subsp. *obatae*, *Plantago princeps* var. *princeps*, *Phyllostegia mollis*, *P. hirsuta* and *Schiedea kaalae*) with particular focus on detecting evidence of slug feeding (slime trails, leaf margins and lower leaves consumed, upper surface of thicker-leaved species scraped off.)

- If new outplantings of plants vulnerable to slug attack take place, or if existing sites are enlarged, the Rare Snail Specialist must complete a day and nighttime survey to ensure there are no rare snails are in the area. If no native snails are found, apply Ferroxx AQ every 6 weeks.

Discussion:

Slugs have an adverse effect on native plants as a result of their feeding behavior. They have been observed to consume leaves and strip plant stalks, reducing their survivorship. Certain species are especially vulnerable to slugs in the seedling stage, and slug presence can reduce recruitment significantly. Localized slug control is currently implemented at one site in Central Kaluaa Gulch 1A (SLCA KAL-A-1) to protect wild *C. grimesiana* subsp. *obatae* and outplanted *D. waianaeensis*.

Special consideration must be taken when performing slug control in the Kaluaa and Waieli MU due to the high presence of native snails. Staff should be aware of the possibility of native snails within the SLCA, and attentive when working in this area. Thorough snail surveys are especially important as well when considering any future SLCAs.

Slug Control Area Locations Table

SLCA Code	Plant population reference codes	Date slug control began
KAL-A.1	DelWai.KAL-C, CyaGriOba.KAL-B	2015-05-25

Slug Management Map

Slug photos

D. laeve and typical damage from feeding behavior

Possible slug damage on *C. grimesiana*

L. maximus and eggs

M. biliniatum

Ant Control

Species: *Pheidole fervens, Pheidole megacephala, Plagiolepis alluaudi, Solenopsis papuana, Technomyrmex albipes*

Threat level: High for *S. papuana* on rare *Drosophila*, unknown for other species

Seasonality/Relevant Species Biology: Varies by species, but nest expansion is typically observed in late summer to early fall

Management Objective:

- Prevent spread of ant species into areas where not already established. Conduct annual surveys during the summer to determine what ant taxa are present in the MU.
- Implement control if incipient, high-risk species are found or as needed for *Drosophila* conservation.

- Detect incursions of new ant species prior to establishment.

Strategy and Control Method:

- Continue to sample ants at human entry points using the standard survey protocol (Appendix 6-1 2010 Year End Report) and *D. montgomeryi* sites a minimum of once a year. Use samples to track changes in existing ant densities and to alert NRS to any new introductions.
- Investigate various toxicants and delivery systems for the purpose of ant control while preventing adverse impacts to *D. montgomeryi*.

Discussion: Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. It is therefore important to know their distribution and density in areas with conservation value. This is accomplished using a survey methodology outlined in Appendix 6-1 2010 Year End Report.

In 2017, Paul Krushelnycky (2017 Status Report for the Makua and Oahu Implementation Plans, Appendix ES-10) conducted research at Puu Hapapa and found conclusive evidence that *S. papuana* negatively affects native *Drosophila* survival. The study showed survival was reduced by 58% in the presence of *S. papuana*, whereas, survival was increased 2.4 fold when localized ant control was implemented. *Drosophila* are susceptible to these negative impacts in the larval and pupal stages of development.

Krushelnycky has received grant money and research is underway to assess the effects of AMDRO ant killer on native *Drosophila* and other non-target insects. Results from this study are expected in 2020, and will be used to determine the most effective ant control while preventing adverse impacts to *D. montgomeryi*. If proven safe for use around *D. montgomeryi*, AMDRO can be applied monthly to control ants around host plants and where larvae and pupae are found.

Ant surveys are currently scheduled annually at the 2 LZs: Waieli-TNC Hapapa LZ (151) and Kaluaa Trailhead LZ (214). Other surveys around *D. montgomeryi* populations may be implemented as deemed necessary by the Entomology Program Specialist and the Alien Invertebrate Control and Research Specialist.

Vespula Control

Species: *Vespula pennsylvanica*

Threat level: High for *Drosophila*

Seasonality: Year-Round

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.

Strategy and Control Methods:

- As needed, deploy traps baited with heptyl butyrate and repeat consecutive years at roughly the same time of year. Leave traps in place for two weeks then collect and record catch.
- Determine whether *D. montgomeryi* populations respond favorably to lower numbers of wasps.
- If populations increase substantially over time causing a decrease in *D. montgomeryi*, locate and destroy nests.

Discussion:

Vespula pennsylvanica is a known insect predator; flies have been recorded in their diets on Hawaii Island and Maui. They are likely a significant predator of *D. montgomeryi* and should be monitored within potential habitats. Wasps can also be a hazard to staff. 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.

NRS currently monitor *V. pennsylvanica* numbers monthly at the Hapapa site using 10 traps baited with heptyl butyrate. No *V. pennsylvanica* have currently been detected at *D. montgomeryi* sites within Kaluaa and Waieli MU. Nests were destroyed along and below the contour trail by State of Hawaii Dept. of Agriculture staff in 2001.

Fire Control

Threat Level: Low

Seasonality/Potential Ignition Sources: 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; however, campfires are a possible threat and fire pits have been observed (e.g. Hapapa LZ, Contour trail, Kaluaa trailhead).

Management Objectives:

- To prevent fire from burning any portion of the MU at any time.

Strategy and Control Methods:

- NRS to remain vigilant of campfires and other possible ignition sources seen when working within the MU.
- Monitor fires in surrounding areas to prevent spread into 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.

Discussion:

Fire threat in Kaluaa and Waieli MU is low due to lack of nearby ignition sources, low fuel loads within the MU, and its wetter habitat. There is no recent history of fires burning near the MU; the closest fires have occurred over 1 km away on Schofield Barracks South Range. These are generally well contained and fire response is quick. This MU is easy to monitor from both OANRP baseyards and is within close proximity to the Army Wildland Fire baseyard. Since Honouliuli is state land, the Kaluaa and Waieli MU is within DOFAW's primary response area, and they could also respond in the event of a fire inside the MU.

Action Table

The table below is a comprehensive list of threat control actions planned for the MU for the next five years. Actions are grouped by type; for example, Ungulate Control or Ant Control. Weed control actions are grouped into the following categories: General Survey, ICA code, or WCA code. Cells with **X** denote the quarters in which an action is scheduled. IP years run from October of one year through September of the next. Therefore, Quarter 4 (October-December) is listed first for each report year, followed by Quarter 1 (January-March), Quarter 2 (April-June), and Q3 (July-September). Species names are written as six-digit abbreviations, such as 'CenSet' instead of *Cenchrus setaceus*, for brevity.

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
7837	Ant Control	DroMon	None	Survey ants at LZ and at Puu Hapapa annually for the protection of Drosophila				X				X				X				X				X
7845	Common Collections	MyrLes	None	Common native collection of Myrsine lessertiana (Kolea): Collect/monitor fruit for use in restoration projects in Kaluaa and Waieli and Seed Zone: OA-8. Several founders on Hapapa bench and slope above. Action includes monitoring phenology of common native species.	X				X				X				X				X			
1242	Fence Monitor/ Maintenance	None	KAL-A	All fence monitoring and maintenance actions. Maintenance is defined as any minor repair work or that is LESS THAN 100m. Combined sections A and B so it is now just the entire perimeter.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
3390	Fence Monitor/ Maintenance	None	KAL-C	All fence monitoring and maintenance actions. Maintenance is defined as any minor repair work or that is LESS THAN 100m.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5620	Fence Monitor/ Maintenance	None	KAL-D	All fence monitoring and maintenance actions. Maintenance is defined as any minor repair work or that is LESS THAN 100m.				X				X				X				X				X
3136	Predator Control: Rodent	AchMus	KAL-A	A24 Grid at Hapapa. Re-bait every 4 months.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7223	Predator Control: Rodent	CyaGriOba	KAL-D	North Kaluaa CyagriOba Site A24 Grid. Re-bait every 4 months.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7726	Predator Control: Rodent	DelWai	KAL-E	Kaluaa and Waieli 1A Site A24 Grid. Re-bait every 4 months.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5729	Slug Control	DelWai	KAL-A-1	Control slugs at Site 1 (DelWai.KAL-C & SchKaa.KAL-B). Rate is 10 Lbs. of FerroxxAQ for entire site once every 6 weeks. If using Sluggo then apply 20 lbs. of product every month	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
1190	Weed Control	None	Kaluaaand Waieli-01	Control weeds across upper section of SBS/Army Hapapa every 6 months/year. Focus around Achmus sites, potential Drosophila sites, Phyhir, native forest patches. Work to connect these areas. Target Schter, Toocil, Helpop, Erikar, weedy grasses. ACCESS LIMITED, CONDUCT AS FEASIBLE				**X**				**X**				**X**				**X**				**X**
2779	Weed Control	None	Kaluaaand Waieli-02	Conduct understory weed control around Plapri reintro annually. Area is steep and sensitive, exercise caution.	**X**				**X**				**X**				**X**				**X**			
2781	Weed Control	None	Kaluaaand Waieli-02	Control Erikar across crest, steep slopes at west edge of WCA. Focus around native forest patches, potential reintroduction sites. Area is steep and fragile, exercise caution and avoid trampling sensitive areas. Use alternative technologies to treat if possible.			**X**				**X**				**X**				**X**				**X**	

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
2872	Weed Control	None	Kaluaaand Waieli-02	Control weeds across the bench portion of the WCA, including outside snail enclosure, every 6 months. Target understory and gradual removal of canopy weeds. Ensure NO control of snail trees. Focus effort around common reintros, native forest patches, snail zones; seek to connect these sites.	X		X		X		X		X		X		X		X		X		X	
3530	Weed Control	None	Kaluaaand Waieli-02	Control weedy grasses across WCA every 6 months/as needed. Target Melmin, UroMax, PasCon. Primary grass sites are crestline, fenceline, trail, bench flats.	X		X		X		X		X		X		X		X		X		X	
4151	Weed Control	SetPal	Kaluaaand Waieli-02	Monitor/control SetPal on trail from bench to LZ every 6 months/annually. Handpull and remove plant from field.	X				X				X				X				X			

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
6377	Weed Control	AchMus	Kaluaaand Waieli-02	Sweep entire enclosure at least once every 6 months. Focus on vines, woody weed keiki, and grasses. Zero tolerance inside enclosure for Bleapp, Passub, Nepmul, Bidalb. Short-lived herbaceous weeds are not a priority.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6710	Weed Control	AchMus	Kaluaaand Waieli-02	Clear/maintain fence (Ungulate fence, not snail enclosure). Remove downed trees, spray grass, treat thick understory, as needed to keep fence in good repair		X				X				X				X				X		
5659	Weed Control	None	Kaluaaand Waieli-03	Control weeds around reintro zone every 6 months. Focus around Delwai, targeting understory.	X		X		X		X		X		X		X		X		X		X	
6282	Weed Control	None	Kaluaaand Waieli-03	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed to keep fence in good repair		X				X				X				X				X		
2945	Weed Control	None	Kaluaaand Waieli-04	Control weeds around Cyagrioba reintro zone every 6 months. Target understory weeds and gradual control of canopy weeds.		X		X		X		X		X		X		X		X		X		X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
4948	Weed Control	None	Kaluaaand Waieli-04	Control weeds at Drosophila restoration sites and around Uregla patches, every 6 months.	X		X		X		X		X		X		X		X		X		X	
4949	Weed Control	None	Kaluaaand Waieli-04	Control weedy grasses across WCA as needed, at least annually. Target UroMax and SetPal. Focus along trails to prevent further spread.	X				X				X				X				X			
4962	Weed Control	None	Kaluaaand Waieli-05	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed.		X				X				X				X				X		
6397	Weed Control	None	Kaluaaand Waieli-05	Control weedy grasses across WCA as needed, at least annually. Focus on fence, trails to prevent further spread. Target UroMax and SetPal.	X			X				X				X				X				X
2943	Weed Control	None	Kaluaaand Waieli-06	Control weeds through reintro/potential reintro zone every 3-6 months (Cyagrioba, Phymol, Schkaa). Target understory weeds and gradual control of canopy weeds: Schter, Toocil, Budasi, Psicat, Lancam, Bleapp, Chrpar, Passub, etc. Expand boundaries of weeded zone.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
4950	Weed Control	None	Kaluaaand Waieli-06	Control weedy grasses across WCA as needed. Target UroMax, PasCon, SetPal. Focus on fence dogleg (UroMax) and gulch bottom (SetPal).	X		X				X				X				X				X	
5778	Weed Control	None	Kaluaaand Waieli-06	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed.		X				X				X				X				X		
4955	Weed Control	None	Kaluaaand Waieli-07	Control weeds across Alemacmac zone, annually. Target understory around rare taxa and gradual canopy control.				X				X				X				X				X
5784	Weed Control	None	Kaluaaand Waieli-07	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed.		X				X				X				X				X		
6398	Weed Control	None	Kaluaaand Waieli-07	Control weeds in Uregla patches, annually, to support Drosophila habitat. Gradual control of understory and canopy.	X			X				X				X				X				X
2874	Weed Control	None	Kaluaaand Waieli-08	Control weeds around reintro/rare taxa zone every 3-6 months. Target understory weeds (Clihir) and gradual control of canopy weeds (Schter, Psicat, Psigua).	X		X		X		X		X		X		X		X		X		X	

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
5779	Weed Control	None	Kaluaaand Waieli-08	Control weeds at Drosophila restoration sites and around Uregla patches in back of gulch, every 6 months.	X	X		X		X		X		X		X		X		X		X		X
6400	Weed Control	None	Kaluaaand Waieli-08	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed.		X				X				X				X				X		
3929	Weed Control	UroMax	Kaluaaand Waieli-09	Monitor/control UroMax along north Kaluaa fenceline quarterly, or as needed.		X				X				X				X				X		
2785	Weed Control	None	Kaluaaand Waieli-10	Control weeds around Ste kan reintros (2) every 6 months. Target understory weeds (Clihir, Passub, Lancam, Psicat) and gradual control of canopy weeds (Psicat). Work to connect two reintro sites. Exercise caution around delicate SteKan.		X		X		X		X		X		X		X		X		X		X
4953	Weed Control	None	Kaluaaand Waieli-10	Control weeds around Phyhir every 6 months/year. Target understory weeds (Bleapp, Rubros, Budasi, Melmin) and gradual control of canopy weeds.		X		X				X				X				X				X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
4954	Weed Control	None	Kaluaaand Waieli-10	Clear/maintain fenceline. Remove fallen trees, spray grass, treat thick understory, keep trail clear of weeds, as needed. Target Passub, Lancam, Psicat along fence corridor.		X				X				X				X				X		
5169	Weed Control	None	KaluaaNo MU-01	Control grass/herbaceous weeds, clear downed trees along the access road, from the water tank turn off to the trailhead, every 6 months/as needed. Use the power sprayer, chainsaw, weedwhack. Goal: maintain road, public safety, reduce weed spread.			X				X				X				X				X	
2876	Weed Control	None	KaluaaNo MU-02	Control canopy and understory weeds as necessary to allow for collections from Alemac at this site. Visit site with partners from OPEP.			X				X				X				X				X	
5550	Weed Control	None	KaluaaNo MU-03	Conduct weed control within ti-leaf fence as needed to promote survivorship of outplanted Abusan/Delwai to facilitate genetic collections (GSCs). Treat understory aggressively to minimize	X			X				X				X				X				X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
				number of retreatments needed.																				
6281	Weed Control	None	KaluaaNo MU-04	Control weeds along access trail, particularly understory taxa. Focus on DicChi and SetPal, to minimize their spread into MU.			X				X				X				X				X	
5984	Weed Control	None	KaluaaNo MU-05	Conduct weed control around Garman, focusing on understory weeds and limited canopy control. This is a GS population.			X				X				X				X				X	
5985	Weed: Camp Survey	None	OS-Kaluaa-01	Survey Hapapa shelter/campsite (5m buffer around shelter and adjacent areas used for camping) whenever used, not to exceed once per quarter. If not used, do not need to survey.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2834	Weed: Incipient Control	AngEve	Kaluaa-AngEve-01	Monitor/control AngEve in South Central annually. Foliar spray of G4 works well; to reduce non-target drift, cut off large fronds of mature plants and treat when new croziers appear.			X				X				X				X				X	

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
5987	Weed: Incipient Control	ArtCil	Kaluaa-ArtCil-01	Monitor/control ArtCil along access trail. Only 1 plant found; search for seedlings. Monitor annually (and incidentally during other management work).		X				X				X				X				X		
4157	Weed: Incipient Control	CasEqu	Kaluaa-CasEqu-01	Monitor/control CasEqu at spot just outside south fenceline annually.				X				X				X				X				X
4138	Weed: Incipient Control	CluRos	Kaluaa-CluRos-01	Monitor/control CluRos along contour trail. Bring chainsaw for large mature tree. Survey area around tree for keiki, 100m buffer. During course of other field work, keep lookout for other CluRos. Research reliable control method.	X			X				X				X				X				X
6283	Weed: Incipient Control	DovHeb	Kaluaa-DovHeb-01	Monitor/control DovHeb in Waieli gulch. Monitor every 6 months/annually.	X			X			X				X				X			X		
6554	Weed: Incipient Control	EhrSti	Kaluaa-EhrSti-02	Monitor/control Ehrsti at Pig Trap site along Hapapa access trail quarterly. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id. Spray with preemergents.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
4155	Weed: Incipient Control	MorFay	Kaluaa-MorFay-01	Monitor/control MorFay below contour trail. Continue to survey entire Morfay ICA for mature plants. Sweep entire ICA once a year.			X				X				X				X				X	
7762	Weed: Incipient Control	ChrOdo	KaluaaNoMU-ChrOdo-01	Sweep whole ICA, 2-4x year. Pick and remove from field any potentially viable fruit. Check known hotspots and treat with pre-emergent every 3-6 months.	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X		X
3846	Weed: Incipient Control	SolCap	Kaluaa-SolCap-01	Monitor/control SolCap in gulch bottom, above and below contour trail, every 6 months. Use GPS to track coverage of weeded areas (ICA large).	X				X				X				X				X			
6280	Weed: Incipient Control	MorFay	WaieliNoMU-MorFay-01	Monitor/control MorFay north of Hapapa on ridge, every 6 months/year. Only 1 mature plant found.				X				X				X				X				
3553	Weed: LZ Survey	None	LZ-HON-151	Survey Waieli/Hapapa improved LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
7174	Weed: LZ Survey	None	LZ-Kaluaa-214	Survey SBS-Kaluaa LZ (214) whenever used, not to exceed once per quarter. If not used, do not need to survey.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5870	Weed: LZ Survey	None	LZ-SBS-164	Survey Army LZ Cat whenever used, not to exceed once per quarter. Must survey annually at minimum, since Army LZ.		X				X				X				X				X		
1232	Weed: Road Survey	None	RS-SBS-01	Survey all drivable roads inside SR-1 gate, around FP Halo, past Army Town, in front of underground storage areas(northern training area). GPS track and input in GIS. If see any soil/fill stockpiles, survey carefully around them and note location.		X				X				X				X				X		
6260	Weed: Road Survey	None	RS-SBS-02	Survey every drivable road in southern training area (take left after SR-1 gate). TAKE MAP! Includes road to pistol range, roads through 'villages'/IED lanes, 'Medical' LZ/DZ, side roads through old fields, and 4x4 road to Kaluaa trailhead. GPS track and input in GIS. If see any soil/fill stockpiles,		X				X				X				X				X		

Action Table (continued)

Action ID	Action Type	Taxon Code	Action Site Code	Actions	MIP Year 15 Oct 2018-Sept2019				MIP Year 16 Oct 2019-Sept2020				MIP Year 17 Oct 2020-Sept2021				MIP Year 18 Oct 2021-Sept2022				MIP Year 19 Oct 2022-Sept2023			
					4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
				survey carefully around them and note location.																				
5871	Weed: Transect Survey	None	WT-Kaluaa-01	Survey access trail from parking area, along contour trail, to MU gate for weeds, annually.		X				X				X				X				X		
5777	Weed: Transect Survey	None	WT-Kaluaa-02	Survey main Kaluaa gulch trail, from gate up gulch to 2/3 split for weeds, annually		X				X				X				X				X		
5872	Weed: Transect Survey	None	WT-Kaluaa-03	Survey Hapapa access trail, beginning from Carnation trail, crossing contour trail, up fence to Hapapa Snail Enclosure.		X				X				X				X				X		
7761	Weed: Weed Survey	ChrOdo	KaluaaNoMU-ChrOdo-01	Conduct surveys around known ICA, for 200m, to determine if true outlier. Use results of survey to revise ICA shape as needed.	X																			