

## **Ecosystem Restoration Management Plan**

**MIP Year 15-19, Oct. 2018 – Sept. 2023**

**MU: Manuwai, Manuwai No MU, Alaiheihe No MU**

### **Overall MIP Management Goals:**

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control fire and weed threats to support stable populations of IP taxa.

### **Background Information**

Location: Northern Waianae Mountains

Land Owner: State of Hawaii

Land Managers: Department of Land and Natural Resources (DLNR) – Natural Area Reserve System (NARS), DLNR – Land Division, DLNR – Forest Reserve, Army Natural Resource Program – Oahu (OANRP)

Acreage: 300 Acres

Elevation Range: 1000ft-3000ft

Description: Manuwai Gulch is located in the northern Waianae Mountains. Manuwai Gulch and a series of adjacent, parallel gulches are drainages off the side of Kamaohanui Ridge, which extends eastward from Kaala. The Manuwai Management Unit (MU) consists of the fenced upper half of Manuwai Gulch, and a side gulch that drains into Alaiheihe Gulch, formed off the dividing ridge between Manuwai and Alaiheihe Gulch. The gulch drains to the northeast. Most of the upper portion of the MU is within the Lower Kaala Natural Area Reserve (NAR); the rest is in the State Forest Reserve. There are four landowners, (Bob Cherry, Mike Pietsch, Bitsy Kelley, and the Kaukonahua Ranch), who allow us to access the MU via two roads, which leads to the west and east sides of the MU, through ‘Flying R Ranch’ that connects to a 4x4 contour dirt road managed by The State of Hawaii. There is no formal easement for use of the roads through ‘Flying R Ranch’, however the program will work towards establishing a Right of Entry in order for OANRP staff to continue using the private roads for access. Helicopter access to the MU is available. Helicopter operations usually begin flying from WLU LZ 155 (Bob Cherry’s ranch) to the LZs located in the MU. However, if crews need to fly along the southern fenceline to access SBW LZ 55 (Kamaohanui) and/or SBW LZ 57 (Nalu’s), AirMobile must be requested for the restricted air space 3000 ft. and above from the Army Range Control.

Much of Manuwai Gulch is steep, and some of these steep areas are not accessible on foot without safety ropes. The elevation gradient of the MU is dramatic, and the vegetation types within the MU span from Wet Forest to Lowland Dry Shrubland/Grassland. There are more than several *in situ* rare and endangered plant populations scattered throughout the MU, including *Melanthera tenuifolia* found on cliffs and steep areas, which require ropes to rappel to plants. Overall, the MU is dominated by canopy weeds; however, there are some pockets of forest with high levels of native canopy.

### Native Vegetation Types

	Waianae Vegetation Types
Lowland Dry Shrubland/ Grassland	<p><u>Canopy includes:</u> <i>Erythrina sandwicensis</i>, <i>Myoporum sandwicense</i>, <i>Dodonaea viscosa</i>, <i>Santalum ellipticum</i>, and <i>Hibiscus brackenridgei</i> subsp. <i>mokuleianus</i>.</p> <p><u>Understory includes:</u> <i>Heteropogon contortus</i>, <i>Sida fallax</i>, <i>Eragrostis variabilis</i>, <i>Abutilon incanum</i>, <i>Leptecophylla tameiameia</i>, and <i>Bidens</i> spp.</p>
Dry forest	<p><u>Canopy includes:</u> <i>Diospyros</i> sp., <i>Myoporum sandwicense</i>, <i>Erythrina sandwicensis</i>, <i>Polyscias sandwicensis</i>, <i>Rauvolfia sandwicensis</i>, <i>Santalum ellipticum</i>, <i>Psydrax odorata</i>, <i>Nestegis sandwicensis</i> and <i>Myrsine lanaiensis</i>.</p> <p><u>Understory includes:</u> <i>Dodonaea viscosa</i>, <i>Sida fallax</i>, and <i>Bidens</i> spp.</p>
Mesic mixed forest	<p><u>Canopy includes:</u> <i>Acacia koa</i>, <i>Metrosideros polymorpha</i>, <i>Nestegis sandwicensis</i>, <i>Diospyros</i> spp., <i>Planchonella sandwicensis</i>, <i>Charpentiera</i> spp., <i>Pisonia</i> spp., <i>Psychotria</i> spp., <i>Antidesma platyphyllum</i>, <i>Bobea</i> spp. and <i>Santalum freycinetianum</i>.</p> <p><u>Understory includes:</u> <i>Alyxia stellata</i>, <i>Bidens torta</i>, <i>Coprosma</i> spp., and <i>Microlepis strigosa</i></p>
Mesic-Wet forest	<p><u>Canopy includes:</u> <i>Metrosideros polymorpha</i> var. <i>polymorpha</i>. Typical to see <i>Cheirodendron trigynum</i>, <i>Cibotium</i> spp., <i>Melicope</i> spp., <i>Antidesma platyphyllum</i>, and <i>Ilex anomala</i>.</p> <p><u>Understory includes:</u> <i>Cibotium chamissoi</i>, <i>Broussaisia arguta</i>, <i>Dianella sandwicensis</i>, and <i>Dubautia</i> spp. Less common subcanopy components of this zone include <i>Clermontia</i> spp. and <i>Cyanea</i> spp.</p>
Wet forest	<p><u>Canopy includes:</u> <i>Metrosideros</i> spp., <i>Cheirodendron</i> spp., <i>Cibotium</i> spp., <i>Ilex anomala</i>, <i>Myrsine sandwicensis</i>, and <i>Perrottetia sandwicensis</i>.</p> <p><u>Understory includes:</u> Typically covered by a variety of ferns and moss; may include <i>Melicope</i> spp., <i>Cibotium chamissoi</i>, <i>Machaerina angustifolia</i>, <i>Myrsine sandwicensis</i>, <i>Nertera granadensis</i>, <i>Kadua centranthoides</i>, <i>Dryopteris rubiginosa</i>, <i>Perrottetia sandwicensis</i>, and <i>Broussaisia arguta</i>.</p>
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 Manuwai



Manuwai Gulch  
(looking south)



Manuwai Gulch  
(back of gulch)



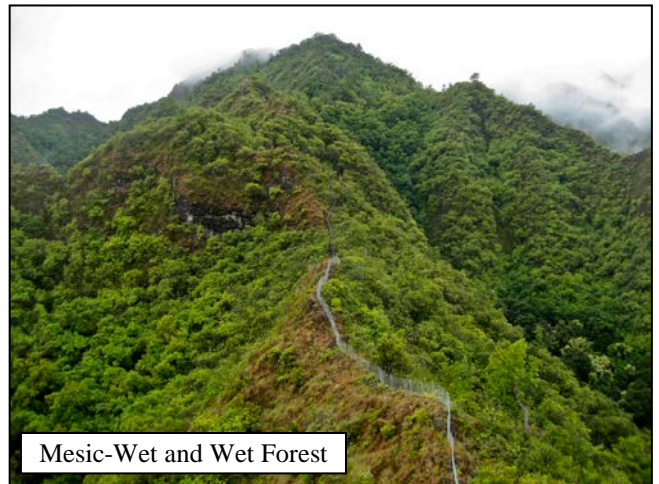
Lowland Dry Shrubland/Grassland



Dry Forest



Mesic Mixed



Mesic-Wet and Wet Forest

## MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/Reintroduction
Plant	<i>Abutilon sandwicense</i>	ANU-A, B, C, D, E, F, G, H, J	Kaawa to Puulu	MFS/GS	Wild
Plant	<i>Alectryon macrococcus</i> var. <i>macrococcus</i>	ANU-A, B*, C* & IHE-A, B, C	Alaiheihe and Manuwai	MFS/GS	Wild
Plant	<i>Cyanea superba</i> subsp. <i>superba</i>	ANU-A	Manuwai	MFS	Reintroduction
Plant	<i>Delissea waianaeensis</i>	ANU-A	Manuwai	MFS	Reintroduction
Plant	<i>Flueggea neowawraea</i>	ANU-A*, B, C	Manuwai	Manage Reintroduction for Stability	Both
Plant	<i>Kadua degeneri</i> subsp. <i>degeneri</i>	ANU-A, B & IHE-A, B, C, D	Alaiheihe and Manuwai	MFS	Both
Plant	<i>Hibiscus brackenridgei</i> subsp. <i>mokuleianus</i>	ANU-A	Kaimuhole and Palikea Gulch	MFS	Reintroduction
Plant	<i>Melanthera tenuifolia</i>	ANU-A, B	Manuwai	GS	Wild
Plant	<i>Neraudia angulata</i> var. <i>dentata</i>	ANU-A, ANU-B, ANU-C†	Manuwai	MFS	Both
Plant	<i>Nototrichium humile</i>	ANU-A	Manuwai	MFS	Reintroduction
Plant	<i>Phyllostegia kaalaensis</i>	ANU-B*	Manuwai	MFS	Reintroduction (failed)
Snail	<i>Achatinella mustelina</i>	ANU-A*	ESU-C	MFS	Extirpated

MFS= Manage for Stability  
 GSC= Genetic Storage Collection

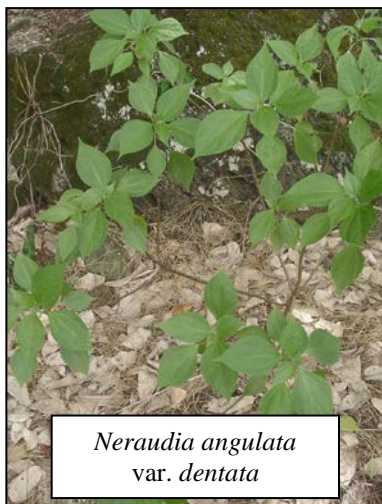
\*= Population Dead  
 †=Reintroduction not yet done

ESU= Ecologically Significant Unit

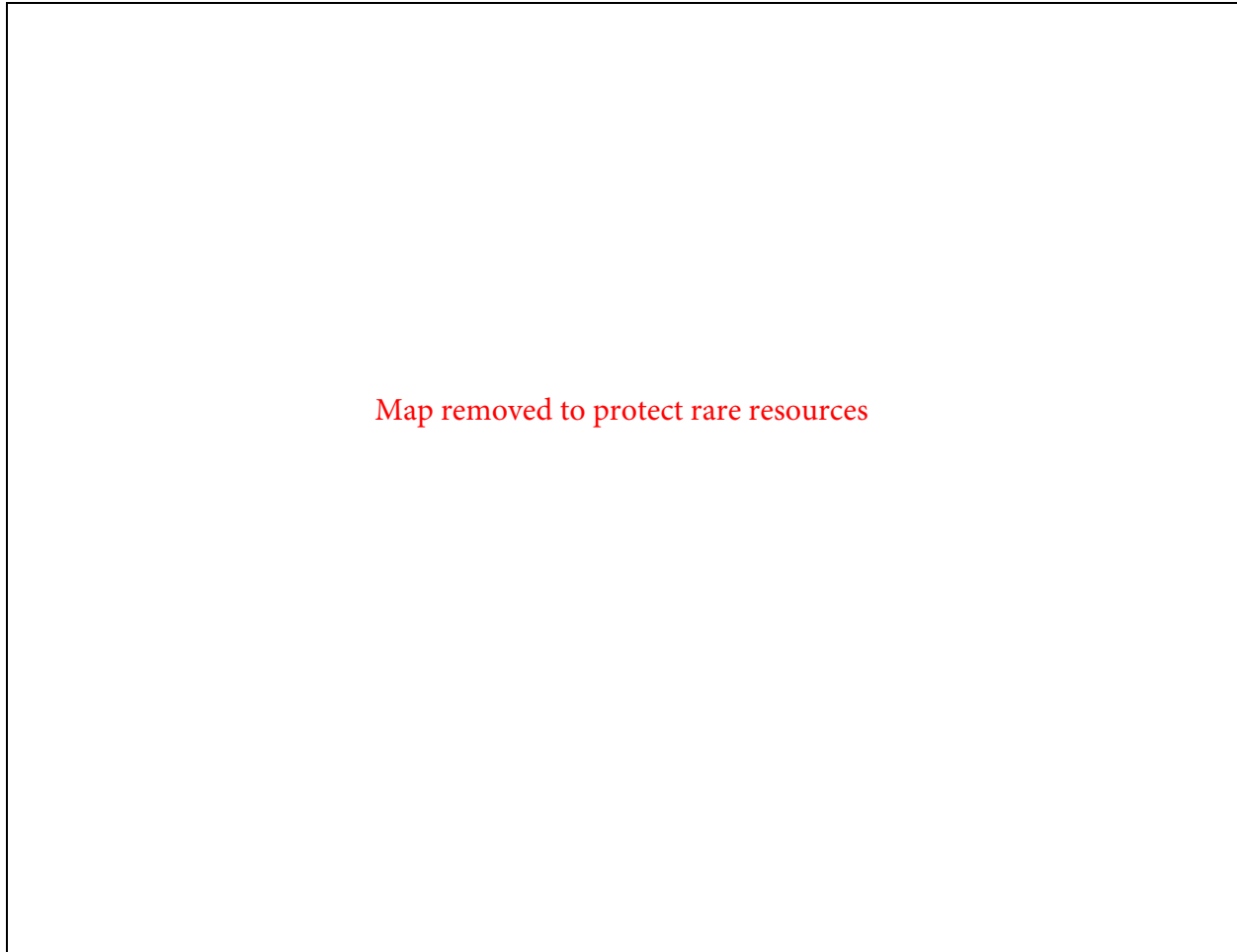
### Other Rare Taxa at Manuwai MU

Organism Type	Species	Status
Plant	<i>Bobea sandwicensis</i>	Endangered
Plant	<i>Chrysodracon forbseii</i>	Endangered
Plant	<i>Chrysodracon halapepe</i>	Vulnerable
Plant	<i>Colubrina oppositifolia</i>	Endangered
Plant	<i>Cyanea calycina</i>	Endangered
Plant	<i>Dubautia sherffiana</i>	Vulnerable
Plant	<i>Exocarpos gaudichaudii</i>	Rare
Plant	<i>Lobelia niuhauensis</i>	Endangered
Plant	<i>Mezoneuron kawaiensis</i>	Endangered
Plant	<i>Pteralyxia macrocarpa</i>	Endangered
Plant	<i>Schiedea hookeri</i>	Endangered
Plant	<i>Strongylodon ruber</i>	Rare
Arthropod	<i>Drosophila flexipes</i>	Rare
Arthropod	<i>Drosophila obatai</i>	Endangered
Arthropod	<i>Drosophila paucicilia</i>	Rare
Arthropod	<i>Drosophila pilimana</i>	Rare
Arthropod	<i>Drosophila reynoldsiae</i>	Rare
Arthropod	<i>Drosophila turbata</i>	Rare
Bird	<i>Chasiempis ibidis</i>	Endangered

**Rare Resources at Manuwai**



### Locations of Rare Resources at Manuwai



### Threats to MIP/OIP MFS Taxa

Threat	Taxa Affected	Management Strategy	Current Status, 2018
Pigs	All	Fence	MU fenced. No animals within fence.
Goats	All	Fence	MU fenced. No animals within fence.
Black Rat	<i>A. mustelina</i> , <i>A. macrococcus</i> var. <i>macrococcus</i> , <i>C. superba</i> subsp. <i>superba</i> <i>Delissea waianaensis</i> , <i>F. neowawraea</i>	Localized trapping grids at chosen rare taxa sites.	One localized A24 trapping grid around <i>D. waianaensis</i> population and another small scale A24 trapping grid at the <i>Drosophila obatai</i> monitoring site.
Slugs	<i>D. waianaensis</i> , <i>N. angulata</i> var. <i>dentata</i> , <i>K. degeneri</i> subsp. <i>degeneri</i>	Localized control treatment with molluscicide at chosen rare taxa sites.	FerroxxAQ is applied around <i>D. waianaensis</i> population quarterly. No evidence of slug damage to <i>N. angulata</i> var. <i>dentata</i> and <i>K. degeneri</i> subsp. <i>degeneri</i> .
Ground Birds	<i>Cyanea superba</i> subsp. <i>superba</i> , <i>D. waianaensis</i>	No control currently. However, control to possibly be studied and developed.	<i>Pternistis erckelii</i> and <i>Lophura leucomelanos</i> are known to damage <i>D. waianaensis</i> stems and eat leaves, fruit, and FerroxxAQ. Control should be investigated.

**Threats to MIP/OIP MFS Taxa (Continued)**

<b>Threat</b>	<b>Taxa Affected</b>	<b>Management Strategy</b>	<b>Current Status, 2018</b>
Black Twig Borer	<i>A. macrococcus</i> var. <i>macrococcus</i> , <i>F. neowawraea</i> , <i>N. angulata</i> var. <i>dentata</i> *, <i>Abutilon sandwicense</i>	Monitor and research new control methods.	There is no current effective control method.
Ants	<i>Drosophila obatai</i>	Survey high traffic and rare taxa sites annually.	<i>Anoplolepis gracilipes</i> are invading from below due to the increase in invasive scale insects. Localized control may be possible if they reach higher elevation sites.
Weeds	All	Focus on rare taxa sites primarily, across MU secondarily	Regular maintenance required several times per year.
Fire	All	Reduce grass cover on the southern edge of MU and participate in Wildland Fire groups.	Fuel pre-suppression via grass control, and rapid response and control of potentially threatening fires
Downy Mildew	<i>Phyllostegia kaalensis</i>	Monitor	No tools to control in field. Before the population completely failed, there were some plants observed with this mildew. Support ongoing research on this topic.

\*Threat suspected. Field observation necessary.

**Management History**

- 1986: Botanist Steve Perlman conducted surveys in area. Manuwai is noted as having patches of the rare forest type, Oahu Diverse Mesic Forest.
- 1990: Mount Kaala Natural Area Reserve Management Plan was written by the Natural Area Reserves System Program.
- 1999-2010: OANRP visited the historical rare plant populations, collected fruit from MIP species, and surveyed for new populations.
- 2000-2004: The goat removal program was established using snares for ungulate control along SBW border east of Kamaohanui in order to keep goats from breaching the fenced MU.
- 2000-2006: Annual or semi-annual hunts for goats were conducted in the general Lower Kaala NAR region.
- 2007: In August, a fire catastrophic wildfire burnt the ridges below the MU. Many rare taxa were affected. The most significant taxon affected was the *H. brackenridgei* subsp. *mokuleianus*. The fire destroyed about 90% of the total number of *H. brackenridgei* subsp. *mokuleianus* on Oahu.
- 2010: Initial vegetation monitoring across MU was conducted.
- 2011: MU fence completed.
- 2011: First discovery of *Pterolepis glomerata* was found on the east fenceline along the ridge. *P. glomerata* was most likely introduced via fence material, which was stored in the Koolaus and used to fence this MU.
- 2011-2012: Ungulate eradication began via snaring.



- 2013: Ungulate sign decreased significantly, however few pigs and goats were caught during this year.
- 2013: *D. waianaensis* (ANU-A), *C. superba* subsp. *superba* (ANU-A), *P. kaalaensis* (ANU-A), *N. angulata* var. *dentata* (ANU-B), *F. neowawraea* (ANU-B and ANU-C) were reintroduced.
- 2013: *K. degeneri* subsp. *degeneri* are reintroduced in two locations. One on the east fenceline (IHE-D) and the other along the interior fenceline on the West side of the MU (ANU-B).
- 2013: *H. brackenridgei* subsp. *mokuleianus* (ANU-A) plants from the wild populations that were located in the gulches, which burnt in 2007, were reintroduced in the south-west portion of the MU. This was the first *H. brackenridgei* subsp. *mokuleianus* reintroduction into a forested gulch habitat in order to reduce the likelihood that *H. brackenridgei* subsp. *mokuleianus* would be destroyed again by a fire.
- 2014: Fence was deemed ungulate free.
- 2014: *P. glomerata* first discovered on the Kamaohanui LZ.
- IPA/Targeted taxa sweeps for select canopy weeds on landscape scale begun in walkable portions of MU.
- 2014: Another reintroduction of *N. angulata* var. *dentata* occurred.
- 2015: Portion of fence in gulch bottom blew out due to flood. Fence was repaired and no pig sign was detected in the MU.
- 2015: *P. glomerata* first discovered during a fence check from Kamaohanui LZ along the west side of the MU.
- 2016: Fence crossing the gulch bottom was replaced with hypalon material allowing water to flow better, which should prevent fence from being blown out again after heavy rains.
- 2016: The 2<sup>nd</sup> monitoring of the vegetation belt plots was conducted.
- 2017: *Chromolaena odorata* found at the perimeter/interior fenceline crossing.
- 2017: *P. glomerata* first discovered on the east fenceline further away from existing known *P. glomerata* site also located on the east fenceline.
- March 2017: Fresh pig sign was found during a *C. odorata* survey. Snares were set.
- August 2017: One pig was successfully removed using snares. No ungulate sign was observed following the captured ungulate.
- September 2017: Fickle fencing was added to fenceline on the East side close to access road where pig activity on the outside of the fence seems to be high.
- June 2018: *Schizachyrium condensatum* first detected in the MU by OANRP staff conducting an IPA sweep for Target Canopy Species.
- 2018: Although one pig was removed in 2017 and the fence was assumed to be pig-free, recent pig activity was found in the main gulch of the MU. Snaring will continue until the MU is pig-free. Additionally, OANRP staff will need to investigate how pigs are continuing to breach the fence.
- 2018: Fickle fencing will be installed along the fenceline to cover the entire east and west side of the MU.
- 2019: West Access Road survey will be established.

## Ungulate Control

Species: *Sus scrofa* (pigs), *Capra hircus* (goats)

Threat Level:

- *Sus scrofa*: High
- *Capra hircus*: High

Management Objectives:

- Maintain the Subunit I/II enclosures as ungulate free.

Strategy and Control Methods:

- Remove pigs from Subunit II with hunts and traps, and Subunit I with hunts, traps and snares as needed if pig sign is detected in the fence.
- Supplement existing fence with fickle fence.
- Conduct fence checks quarterly around entire MU, including strategic section along entire southern ridge.
- Monitor for ungulate sign while conducting other management actions in the fence.
- Check fences especially gulch crossings and hypalon after heavy rains and/or severe weather.

Discussion: There are several sections of the fence that are ‘strategically’ fenced, where natural barriers and geography (cliffs and pinnacle rocks) are used instead of actual fences to prevent pig ingress. There is a break in fencing around a large rock section on the western fenceline. Also, the majority of the southern edge of the MU is not fenced (strategic), since the topography along this ridge is extremely steep, and pigs and goats are not expected to be able to traverse. Additionally, Lihue (the forested gulches behind Schofield Barracks West Range) is fenced but pigs are still present. There are already very few pigs remaining in Lihue, so the chances of ingress are very low. Currently, control is ongoing in Lihue. However, special attention will be given to the strategic portions of the fence during fence checks to ensure that the barriers are effective in keeping ungulates out of the MU. Occasionally, goats from the ranch below the MU make it up to the fence and get caught between the holes in the fencing panels. The lower sections of the fence that cross the gulches are at high risk of getting washed out after heavy rainfall. This has happened a few times, however flow mitigation has been since put in place using a hypalon and a baffle in these gulch bottoms. In 2017, pig sign was discovered in the Subunit II. Snaring and trapping resumed until the pig was caught. OANRP staff speculate that the hogwire and fence panels used have large enough gaps to allow a small pig to fit through. Since then, the pig has been caught, no new pig sign has been seen, and fickle wire has been added along the fence towards the bottom (east side) where there is high pig traffic. OANRP plans to install fickle along the Alaiheih side and any sections with panel gaps exposed to low ground within the next year.

## **Weed Control**

Weed Control actions are divided into 4 subcategories:

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

These designations facilitate different aspects of MIP/OIP requirements.

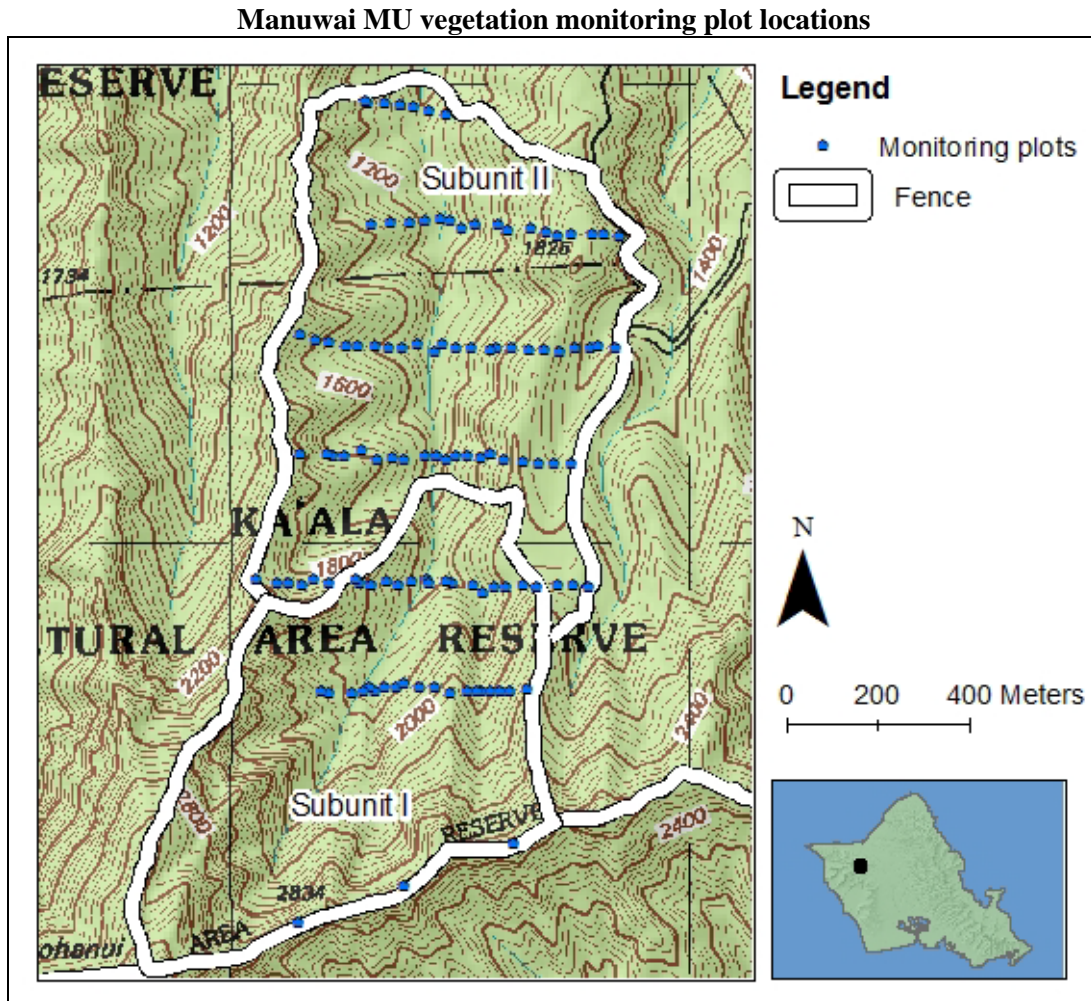
### **Vegetation Monitoring**

#### Background:

Vegetation monitoring occurs on a five-year interval at Manuwai 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 (OANRP 2016).

#### Methods:

Monitoring was conducted in 2011 (OANRP 2011) and 2016 (OANRP 2016) in 114 plots generally located every 40 m along transects. Transects were located in accessible areas (much of the higher elevations in Subunit I are too steep to access), spaced approximately 250 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.



### Summary results:

Management objectives were not met for vegetation percent cover for Manuwai MU in either year, as native cover was low, and non-native cover was high.

### **Median cover (%) of vegetation in plots at Manuwai MU from 2011 to 2016.**

	2011	2016
Native understory	7.50	3.00
Non-native understory	55.00	65.00
Native canopy	15.00	15.00
Non-native canopy	75.00	85.00

There were a number of noteworthy significant differences in the 2016 data as compared with 2011, including:

- Increase in non-native understory and canopy cover
- Increase in non-native understory and canopy richness
- Increase in frequency for non-native species:
  - *Adiantum hispidulum* (understory)

- *Clidemia hirta* (understory)
- *Passiflora suberosa* (understory)
- *Toona ciliata* (canopy)
- Increase in percent cover for non-native species:
  - *A. hispidulum* (understory)
  - *Blechnum appendiculatum* (understory)
  - *C. hirta* (understory)
  - *Oplismenus hirtellus* (understory)
  - *P. cattleianum* (canopy)
- Decrease in percent cover for non-native species:
  - *P. cattleianum* (understory)
  - *Grevillea robusta* (canopy)
- Decrease in percent cover for native species:
  - *Alyxia stellata* (understory)
  - *Psydrax odorata* (understory)
  - *Diospyros sandwicensis* (canopy)
- Percent cover change in weeded plots:
  - Decrease in native understory and *G. robusta* (canopy)
  - Increase in non-native understory
- Percent cover change in unweeded plots:
  - Decrease in native understory
  - Increase non-native canopy and *T. ciliata* (canopy)

Most of the vegetation change that occurred between 2011 and 2016 indicated worsening conditions, with increases in non-native cover, richness and frequency, and declines in some native taxon cover. 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. Manuwai MU is challenging to manage, given access limitations during inclement weather, and difficulties associated with working in very steep terrain.

Impacts of weeding efforts were primarily attributed to IPA control of *G. robusta* and *T. ciliata*. These efforts were effective for reduction of canopy *G. robusta* within weeded areas. The pervasiveness of *T. ciliata* throughout the MU presents a considerable management challenge. The significant increase in canopy *T. ciliata*, as well as non-native canopy cover in general, in plots outside, but not inside, weeded areas suggest IPA efforts may be preventing canopy cover increases for that taxon and for non-native cover in general within treated areas. *T. ciliata* frequency increase in the canopy may be explained in part by vertical growth of individuals that were in the understory in 2011, but reached the canopy by 2016. Because IPA efforts focus on larger individuals in efforts to minimize primary seed sources, the continued presence of smaller individuals within the canopy is to be expected. The increase in non-native understory cover in weeded plots may have been a response to the creation of light gaps in the canopy resulting from IPA treatment. The decline in native understory cover in weeded areas had a similar pattern in unweeded areas, and was not likely influenced by IPA efforts.

Natural resource management staff anecdotally observed increased cover of *Urochloa maxima* in Subunit II within the last year, and expressed concerns that IPA control efforts may exacerbate the problem. Though the frequency of this taxon was too low for statistical analyses, it did appear in more plots in 2016 (in 14% of plots) than in 2011 (in 11% of plots), and cover increased in over half of the plots in which it was observed in 2011, while none had reduced cover.

### Recommendations:

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

- designate prioritized areas for management
- refine management goals to focus on prioritized areas
- more aggressive weed control paired with restoration efforts in prioritized areas
- target uncommon weeds when seen (particularly target taxa)
- continue IPA efforts within areas already treated, as *T. ciliata* and *G. robusta* grow to the targeted size/stage, and expand efforts into new areas, including higher elevations with more native cover
- monitoring of understory change in direct association with IPA treatments (via a separate monitoring regime) may be done to better understand its impact on native and non-native understory cover
- continued discussion and assessment of costs associated with worsening understory conditions resulting from the creation of light gaps associated with large scale IPA canopy removal vs. benefits of controlling IPA target taxa
- aerial spraying of *U. maxima* as possible

### **Surveys**

Potential Vectors: OANRP staff, State Biologists, ungulates, non-native birds, wind.

Survey Locations: Landing zones, fencelines, access roads, and high potential traffic areas.

### Management Objective:

- Prevent the establishment of any new invasive alien plant species through regular surveys along roads, landing zones, camp sites, fencelines, trails, and other high traffic areas (as applicable).

### Strategy and Control Methods:

- Quarterly surveys of LZs (East Ridge camp, MelTen, Spider Camp, Nalu's, Kamaohanui, & Bob Cherry's; if used).
- Surveys of access roads (Lower Kaala NAR and West access road) every other year.
- Quarterly surveys of campsites (East ridge camp & Spider camp; if used).
- Note unusual, significant or incipient alien taxa during the course of regular field work, particularly when walking the fence line.
- Survey high traffic areas (weed Transect on East Side) annually.
- Any significant alien taxa found will be researched and evaluated for distribution and life history. If found to pose a major threat, control will begin and will be tracked via Incipient Control Areas (ICAs).

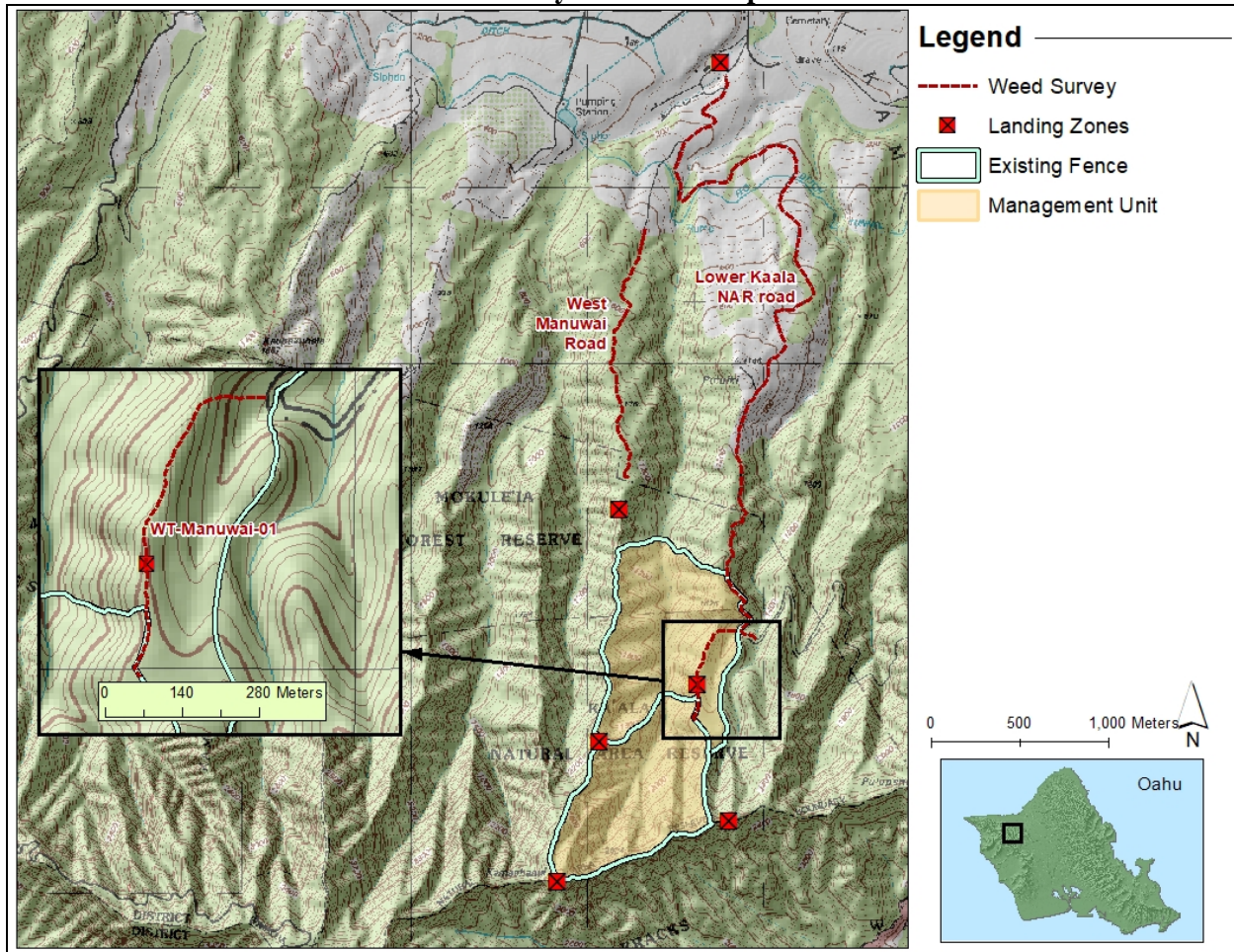
### Discussion:

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Roads, landing zones, fence lines, and other highly trafficked areas are inventoried regularly to facilitate early detection and rapid response; Army roads and LZs are surveyed annually, non-Army roads are surveyed annually or biannually, while all other sites are surveyed quarterly or as they are used.

In Manuwai, LZs are surveyed when used, and the Lower Kaala NAR Road and the West Access Road are surveyed every other year. The Weed Transect runs along the main access trail from the parking spot

on the road over the saddle and into the gulch bottom; it is surveyed annually. OANRP will consider installing additional surveys in other high traffic areas, however, incidental observations during regular field management are also important to document new ICAs.

### Survey Locations Map



### 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. One infestation may be divided into several ICAs or one ICA, depending on infestation size, topographical features, and land ownership. 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 Objectives:

- 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 and infestation size, availability of control methods, resources, and funding.

Strategy and Control Methods:

- Species and ICAs are listed in the table below. History and strategy is discussed for each species.
- 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 power spraying, applying pre-emergent herbicides, clearcutting, aerial spraying, and frequent visits.

**Summary of ICAs**

<b>Taxon</b>	<b>ICA Code</b>	<b>Control Discussion</b>
<i>Chromolaena odorata</i>	Manuwai-ChrOdo-01	This highly invasive shrub is a major target at KTA and SBW. When an immature plant was discovered in 2017 along a highly trafficked fenceline, staff conducted 200m buffer surveys around the site, and re-swept areas were the Ecosystem Restoration team went in the MU prior to the first discovery. The spread of <i>C. odorata</i> in this MU was likely introduced by the Ecosystem Restoration team because of their frequent work in <i>C. odorata</i> infested areas (KTA), the timing of their work trips between KTA and Manuwai, the size and estimated age of the plants found, and that Blue team does not work in any other <i>C. odorata</i> areas. OANRP staff are confident that there is only one location of this taxon at Manuwai at this time. <i>C. odorata</i> seeds last at least 3 years in soil, and further seed bank longevity testing is underway. Staff have monitored this site regularly, with no plants found since 2017. This ICA is a high priority. Re-survey buffer areas every 5 years. Since the first <i>C. odorata</i> discovery in the MU, OANRP are now required to use dedicated <i>C. odorata</i> gear when checking <i>C. odorata</i> ICAs elsewhere. However, this <i>C. odorata</i> gear is not required in this MU for conducting the buffer sweeps or checking the existing ICA, to reduce the likelihood of spreading <i>C. odorata</i> further in Manuwai.
<i>Caesalpinia decapetala</i>	Manuwai-CaeDec-01	One population known from bottom of gulch on north end. Staff should be confident about identifying between <i>Caesalpinia bonduc</i> and <i>C. decapetala</i> , since there has been misidentification in the past. Last <i>C. decapetala</i> in this ICA seen 2014. This ICA is now monitored once a year until 2024.
<i>Dietes iridioides</i>	Manuwai-DieIri-01	One population known along the east fenceline. Staff have been controlling and monitoring this site quarterly. Spend more effort surveying infestation area to determine the extent of ICA. OANRP staff have controlled this ICA by foliar application using Ranger Pro and a pre-emergent mixture. However, this technique has not been effective in reducing the numbers of <i>D. iridioides</i> . OANRP will to evaluate more effective weed techniques by testing a 0.75% Polaris foliar spray.
<i>Pterolepis glomerata</i>	Manuwai-PteGlo-01	Located along the East fenceline. This ICA is treated quarterly. However, a significant expansion of the search area of PteGlo-01 occurred when significant numbers were discovered on the south facing slope below the Manuwai Camp LZ found this year 2018. Given the presence of <i>P. glomerata</i> on the LKN road (although not widespread on the road itself) and likelihood of spread by ungulate activity, reevaluation of control intensity and scope may be required.
	Manuwai-PteGlo-02	This population was found on Kamaohanui LZ. The ICA is checked and/or treated quarterly. Last PteGlo found was August 2017.
	Manuwai-PteGlo-03	This ICA is located on the West fenceline near MelTen LZ. The ICA is checked and/or treated quarterly. <i>P. glomerata</i> last found at this ICA back in 2015, when <i>P. glomerata</i> was first discovered.



### Summary of ICAs (Continued)

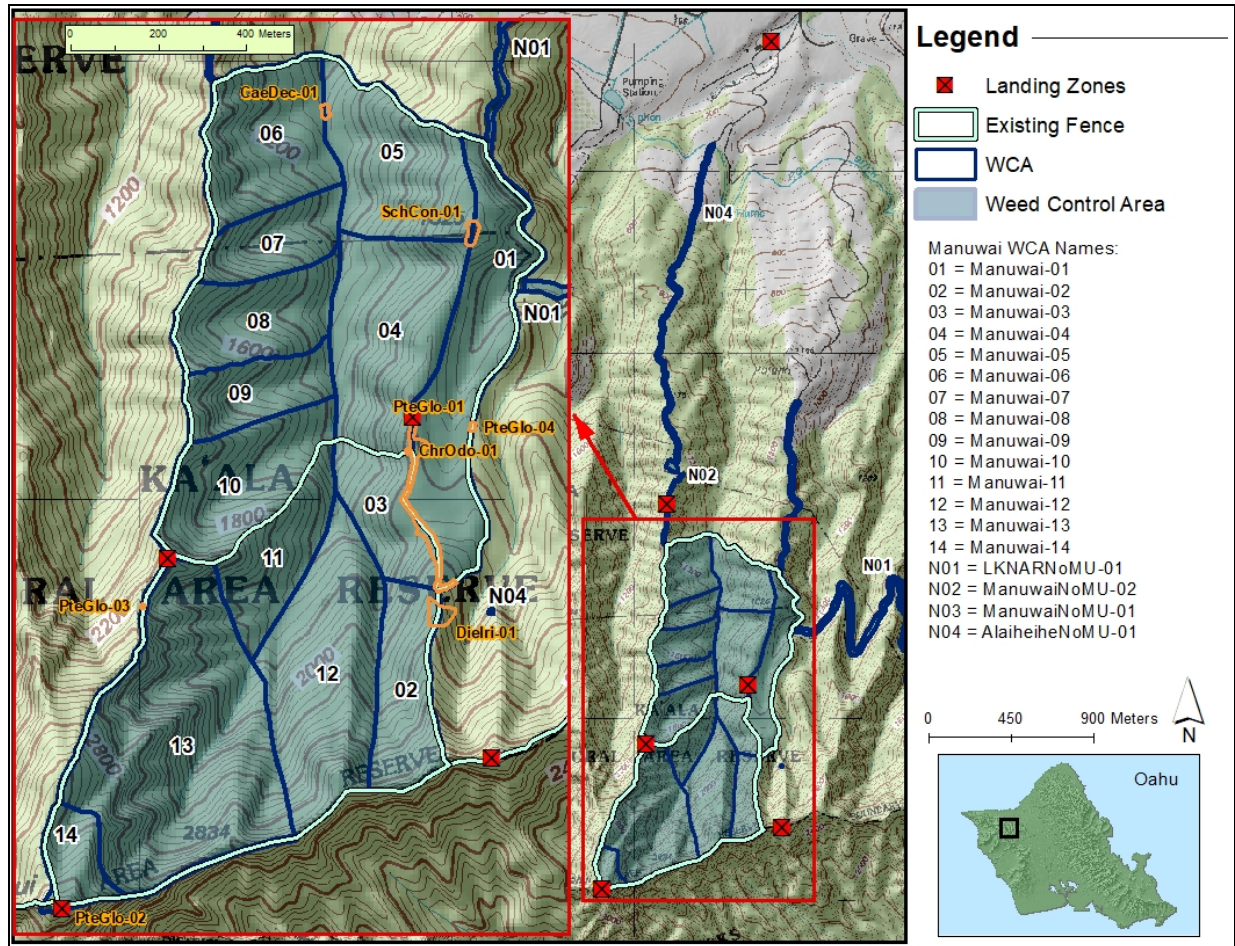
Taxon	ICA Code	Control Discussion
	Manuwai-PteGlo-04	This ICA exists outside the fence along the Alaiheihe side of the fenceline. The ICA is checked and/or treated quarterly. In addition, OANRP plans to dig up and bag soil from this ICA to prevent the seed bank from spreading by soil erosion and pigs.
<i>Schizachyrium condensatum</i>	Manuwai-SchCon-01	First detected by OANRP staff in 2018 during an IPA sweep in the bottom of the MU. Few mature plants and immature plants were found. OANRP needs surveys to determine the ICA's extent and begin control. <i>S. condensatum</i> was likely introduced from contaminated gear from SBE via Ecorestoration team, but still looking at vector pathways. This is only the third location found on Oahu, so this ICA is a high priority for control.

### Incipient Weed Photos



The two immature *C. odorata* found March 2, 2017 at Manuwai.

### Incipient and Weed Control Areas at Manuwai



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

#### Management Objectives:

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

**Discussion:** The entire Manuwai MU was broken up into WCAs to ease data tracking. Due to the high level of non-native cover in much of the MU and patchiness of native canopy pockets, large scale weed sweeps targeting large mature *Toona ciliata* occurs in WCAs not close to managed rare taxa. By targeting

large mature *T. ciliata*, OANRP's goal is to reduce the reproducing tree numbers in the MU. Sweeps in the northern most WCAs of the MU are reduced due to the concern of creating too much of a light gap for grass to grow. These sweeps will be repeated in 5-10 years. OANRP also plans to remove select species across the entire MU (see 'MU targets in summary of Target Taxa table' below). This list was selected based on distribution levels of taxa seen during vegetation monitoring, and also based on known characteristics of the taxa. For example, *Schefflera actinophylla* was chosen as a MU wide target because it had a relatively low distribution throughout the MU making it feasible to control. Furthermore, most of the individuals seen were immature, and if the taxon can be treated across the MU before it becomes reproductive, there is a far greater chance to control it.

In addition to MU-wide weed targets, OANRP will also conduct smaller scale, localized, intensive control around areas with high levels of native canopy, and most especially around wild sites of rare taxa. Weed efforts in Manuwai-06 and Manuwai-10 are focused around rare taxa. Canopy weed control should be cleared in advance of plant reintroductions so as not to disrupt rare plants after they are already in the ground. Understory weeds will be controlled continually as needed. Rare plant reintroductions should avoid large patches of *Blechnum appendiculatum*. It is however, feasible to effectively remove smaller patches of this weed and it should be targeted in all rare plant zones. Additionally, *B. appendiculatum* herbicide trials demonstrated that using 10% Garlon4 spray mix is an effective herbicide to control larger patches of this weedy fern (OANRP 2015).

The WCAs along Kamaohanui Ridge as well as some others are very steep. Ground-based weed control will be difficult or impossible in these areas and in most cases control may only be achieved via methods such as aerial ball sprays or Herbicide Ballistic Technology (still in development). Aerial surveys of these areas is still needed to document distribution of priority weeds.

The table below summarizes invasive weeds found at Manuwai, 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). WCA control refers to only targeting taxa during scheduled WCA weeding around rare taxa.

#### Summary of Target Taxa:

Taxa	Distribution	Notes
<i>Acacia confusa</i>	Widespread	Widespread on ridges. Target during weed control sweeps in priority WCAs. Cut and apply Garlon4 20%.
<i>Begonia vitifolia</i>	Scattered	Treat during WCA control around rare taxa.
<i>Blechnum appendiculatum</i>	Widespread	Widespread and often forming dense patches around rare plant taxa. Known to inhibit rare plant recruitment. Effective control by 10 % Garlon4 foliar application.
<i>Clidemia hirta</i>	Widespread	Widespread and often forming dense patches throughout the MU. <i>Clidemia</i> is best treated by using the clip-and-drip method (cutting stump and applying Garlon4 herbicide).
<i>Clusia rosea</i>	Scattered	Noted from Lower Kaala NAR. Not detected during MU monitoring or initial surveys. If found, will treat as a WCA target. Effective control by IPA coupled with 100% Ranger Pro.
<i>Coffea arabica</i>	Widespread	Treat during WCA control. Forms dense stands. Effective control using IPA method coupled with 100% Polaris or cut-stump/basal coupled with 20% Garlon4.
<i>Cupressus lusitanica</i>	Scattered	Treat as MU target. Not documented as being highly invasive in Hawaii, but staff have noted related species spreading in other areas.
<i>Ficus microphylla</i>	Scattered	Treat during WCA weed control sweeps. IPA control method coupled with 100% Ranger Pro.

**Summary of Target Taxa (Continued)**

<b>Taxa</b>	<b>Distribution</b>	<b>Notes</b>
<i>Fraxinus uhdei</i>	Unknown	Noted from Lower Kaala NAR. Not detected during MU monitoring or initial surveys. If found, will treat as WCA target. <i>F. uhdei</i> is best treated by using the girdle method and applying 20% Garlon4.
<i>Juniperus bermudiana</i>	Scattered	Treat as MU target. Determine if present; easily confused with <i>C. lusitanica</i>
<i>Lophospermum erubescens</i>	Unknown	Treat as MU target. Distribution in the MU is unknown. GPS any plants found. Evaluate effective treatment methods.
<i>Melaleuca quinquenervia</i>	Unknown	Treat as MU target. None found during vegetation monitoring, but known from MU. Has potential to spread quickly in appropriate habitat, especially at upper elevations. Effective control by IPA coupled with 100% Milestone or Polaris.
<i>Melia azedarach</i>	Scattered	Target during weed control sweeps in priority WCAs. Effective control using cut stump coupled with 20% Garlon4 application.
<i>Montanoa hibiscifolia</i>	Widespread	Target during weed control sweeps in priority WCAs. Seed is wind dispersed. <i>M. hibiscifolia</i> is known to inhabit shady areas and has the potential to become a dominant specie in both the understory and canopy. Thus, making it a priority for control.
<i>Psidium cattleianum</i>	Widespread	Widespread and often forming dense patches throughout the MU. Control in rare plant zones and native forest patches.
<i>Urochloa maxima</i>	Widespread	Important to strategically treat patches of <i>U. maxima</i> for fire suppression (see fire section). Target in WCAs as needed by foliar spray. Priority to control along the fencelines and in the rare plant zones.
<i>Roystonea regia</i>	Restricted	Only a few individuals known. Treat as MU target.
<i>Rubus argutus</i>	Restricted	Target in new locations. Frequent retreatment is often required for control of this species. Use effective control measures such as digging out tubers and coupled with 40% Garlon4. Only known from the first 100 m of the fenceline from Kamaohanui LZ.
<i>Schefflera actinophylla</i>	Widespread	Immature plants are somewhat widespread through MU, and there are not many mature individuals. Treat as MU wide target (treat all known immature individuals throughout the MU at one time), and then control as needed in WCAs. Know to be ecosystem altering, fast growing, fruits prolifically, and disperses widely via birds. Effective IPA treatment known.
<i>Schinus terebinthifolius</i>	Widespread	Target during weed control sweeps in priority WCAs. Best treatment is either cut-stump or basal method coupled with 20% Garlon4.
<i>Spathodea campanulata</i>	Scattered	Several individuals throughout MU. High concentrations in Subunit II. Treat as MU target, then control as needed in WCAs. Effective IPA treatment known.
<i>Syzygium cumini</i>	Widespread	Target in WCAs during weed control around rare taxa using IPA method and 100% Milestone application.
<i>Toona ciliata</i>	Widespread	Target in WCAs. There are high levels of this weed in the MU; it occurred in the overstory in 44% of vegetation survey plots, and 48% in the understory in survey plots. The tree is fast growing, and mature trees readily produce lots of offspring nearby. Where possible, target small stands entirely where possible around rare IP taxa. Target large trees during WCA sweeps to decrease reproducing trees in MU. Small trees can be controlled using cut-stump and 20% Garlon4 application. Larger trees are effectively controlled using IPA method.
<i>Trema orientalis</i>	Scattered	Treat as MU target. Many large mature trees seen during vegetation surveys and visual surveys from ridges. Canopy is broad. Several trees are on slopes inaccessible on foot and will require remote or aerial control technologies.
<i>Triumfetta semitrilobata</i>	Scattered	Target during weed sweeps in high priority WCAs, and target along trails, LZs, and campsites. <i>Triumfetta</i> is best treated by using the clip-and-drip method (cutting stump and applying Garlon4 herbicide).

**WCA: Manuwai-01 (Alaiheihe fork)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 50% alien cover (no rare taxa in WCA).

Targets: *Schinus terebinthifolius*, *Syzygium cumini*, *Toona ciliata*, *Psidium cattleianum*, and *Coffea arabica*.

Notes: The terrain in this WCA is not as steep as most of the other WCAs in the MU and has slopes with large stands of native dominated forest including areas with *Acacia koa* canopy, stands of *Diospyros sandwicensis* and a nice short stature shrub forest of *Leptecophylla tameiameia*, *Metrosideros tremuloides*, and *Dodonea viscosa*. It encompasses a side gulch that drains into Alaiheihe Gulch. There are no known rare resources in this WCA, however the native dominated mixed-mesic forest in this gulch would be worthwhile to weed by the Ecosystem restoration team. The Ecosystem restoration team sweeps for Target Canopy Species, such as large fruiting *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. This WCA was swept multiple times in 2017 and a couple times in 2018.

**WCA: Manuwai-02 (Upper East slope/East Fenceline)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *T. ciliata*, *Clidemia hirta*, and *Blechnum appendiculatum*.

Notes: This WCA contains the *K. degeneri* subsp. *degeneri* IHE-D reintroduction and a section of the East fenceline. These two areas are prioritized for Blue team weeding efforts. The WCA shares some of the native dominated forest aforementioned in WCA 1 but is considerably steeper, so much of the WCA is difficult to access. Weed removal along the interior fenceline is also a high priority to avoid vegetation overgrowth and reducing fuel loads along the fenceline. Ecosystem restoration team sweeps in accessible areas for Target Canopy Species, such as large fruiting *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. In extremely steep terrain, this WCA could be another site to use aerial tools to treat weeds.

**WCA: Manuwai-03 (Mideast slope)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 50% alien cover (no rare taxa in WCA).

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, and *C. arabica*.

Notes: There was a population of *Alectryon macrococcus* var. *macrococcus* known from this WCA, however it is now extant. Unless rare plants or suitable habitat for rare plant reintroductions are found, no regular weed control will take place in this WCA. The Ecosystem restoration team sweeps in accessible areas for Target Canopy Species, such as large fruiting *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. Part of this WCA has been swept from 2015 to 2017.

**WCA: Manuwai-04 (Kauila slope/Interior fenceline)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *Aleurites moluccanus*, *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, and *C. arabica*.

Notes: This WCA has several current and historic rare plant populations. Two populations of *Abutilon sandwicense* are present. Only *A. sandwicense* are managed by OANRP. This WCA also contains endangered *Mezoneuron kawaiense* and *Colubrina oppositifolia*, OANRP will coordinate with the Oahu Plant Extinction Prevention Program and the Division of Forestry and Wildlife (DOFAW) for weeding efforts and *Chrysodracon* spp. Reintroductions (for *Drosophila obatai*) in this area. The majority of these rare plants occur across a mostly native, *Diospyros sandwicensis* dominated slope. Blue team control efforts will be focused across this slope and around MIP rare plant species as needed to maintain low levels of alien cover directly around those populations. Blue team is also responsible for weed removal along the interior fenceline is also a high priority. While, the Ecosystem restoration team sweeps this WCA for early removal of Target Canopy Species, such as large *T. ciliata* and/or any other uncommon alien plant species every 3-5 years. This WCA was swept for Target Canopy Species multiple times already (four times in 2014 and once in 2018).

### **WCA: Manuwai-05 (Lower East Manuwai gulch/Fenceline)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, *U. maxima*, and *C. arabica* in the understory.

Notes: This WCA has several steep, grassy ridges and is largely degraded. There are a few rare plant populations in some of the shallow gulches. Blue team weed control efforts will be focused around IP rare plant species as needed to maintain low levels of alien cover directly around those populations and controlling grass around IP taxa and along the fenceline. The Ecosystem restoration team sweeps for Target Canopy Species, such as large *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years in the walkable areas. These IPA sweeps have begun (2015-2016) in a portion of the WCA. The high fuel load, relative dryness, and possible access by recreational hikers/hunters makes it a likely entry point for fire should one occur. Fuel load control is a high priority along the fenceline. There are high levels of *U. maxima* throughout the WCA that will be cleared directly around rare plants in any reintroduction established in this WCA. Aerial or on the ground *U. maxima* control along the northern edge of this WCA (fenceline) will also be evaluated to facilitate fence checks, and may serve as a potential fire break. Possibility of aerial spray for fuel load reduction should be evaluated for grass patches inside and outside of the fence. Ground surveys must be conducted to determine rare plant locations to minimize aerial spray impacts.

### **WCA: Manuwai-06 (Lower West Manuwai gulch/Fenceline)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, *U. maxima*, and *C. arabica*.

Notes: This WCA contains several rare plant reintroductions along with several *in situ* rare plant populations. There are high levels of *U. maxima* in the northern half of this WCA. The 2007 Waialua fire burned the northern edge of this WCA and *U. maxima* has filled in all the burned area. The southern-most gulch of this WCA had a population of *Neraudia angulata*. There is also a sizeable stand of *C. oppositifolia* on the ridge that divides along the fenceline. Currently, this WCA still contains a few wild *N. angulata* and *Abutilon sandwicense* plants. However, from recent reintroductions, this WCA has outplanted *N. angulata* var. *dentata*, *Hibiscus brackenridgei* subsp. *mokuleianus*, *Flueggea neowawraea*, and *Nototrichium humile* sites in two separate small gullies. Weeding efforts around the reintroduction

areas are one of the highest priorities in this WCA for the Blue team. Another priority for the Blue team is to maintain *U. maxima* along the North fenceline to facilitate fence checks and create a fuel break. Again, aerial spray of large grassy slopes adjacent to the unit should be evaluated to reduce risk of fire ingress given the large amounts of rare and endangered taxa in the WCA. The Ecosystem restoration team sweeps for Target Canopy Species, such as large fruiting *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. This WCA has been swept once by the Ecosystem restoration team in 2017.

**WCA: Manuwai-07 (Abutilon gulch)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, and *C. arabica*.

Notes: The boundaries of this WCA run from the fence line down two ridges, and surround one large gulch. There is a small population of *A. sandwicense* in this WCA. Blue team weed control will focus around the *A. sandwicense* at least once a year when it is also scheduled to monitor this population. Ecorestoration sweeps for Target Canopy Species, such as large *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. WCA has been swept once by the Ecosystem restoration team in 2016.

**WCA: Manuwai-08 (West slope- North)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 50% alien cover (no rare taxa in WCA).

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *Grevillea robusta*, *P. cattleianum*, and *C. arabica*.

Notes: The boundaries of this WCA run from the fence line down two ridges, and surround one large gulch. These ridges are mostly native mid-slope, but are thick with coffee closer to the gulch. Ecosystem restoration team sweeps for Target Canopy Species, such as large *T. ciliata*, and/or any other uncommon alien plant species every 3-5 years. This WCA was swept in 2016.

**WCA: Manuwai-09 (West slope- South)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 50% alien cover (no rare taxa in WCA).

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *G. robusta*, *P. cattleianum*, and *C. arabica*.

Notes: The boundaries of this WCA run from the fence line down two ridges, and surround one large gulch. At mid-slope these ridges are mostly native, but are thick with coffee closer to the gulch. The Ecosystem restoration team sweeps for Target Canopy Species such as large *T. ciliata*, and/or any other uncommon alien plant species every 3-5 years. The first of IPA sweep in this WCA was conducted in 2016.

**WCA: Manuwai-10 (MelTen gulch/KadDegDeg reintro)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *G. robusta*, *C. hirta*, *U. maxima*, *Melinis minutiflora*, *P. cattleianum*, and *C. arabica*.

**Notes:** This WCA has high levels of native cover and is a high priority for weeding since rare taxa are present. There are side gulches with *Pisonia sp.*, and *Cyanea angustifolia* scattered throughout the upper regions. There is also large population of *Melanthra tenuifolia* on and around the cliff that forms at the back of the gulch in the WCA. Along the elevation gradient of the gulch there is suitable habitat for rare plants, and the terrain is not as steep as in other parts of the MU and is more manageable from that perspective, making this WCA a prime site for rare plant reintroductions. Blue team weeding efforts are mainly focused around the IP plant taxa. There are rare plant reintroductions within this gulch including *Delissea waianaeensis*, *Cyanea superba* subsp. *superba*, and *F. neowawraea*. Also present in this WCA, there is a *K. degeneri* subsp. *degeneri* (ANU-B) reintroduction site along the interior fenceline on the ridge. This *K. degeneri* subsp. *degeneri* population is shared between this WCA and Manuwai-11. Weed control in this WCA began as site preparation for reintroductions, and since has been conducted to reduce non-native cover around these rare plant populations. This WCA is also high priority for the Ecosystem restoration team to remove any Target Canopy Species, such as large *T. ciliata*, and/or any other uncommon alien plant species every 3-5 years. These sweeps were already conducted from 2014-2015. Restoration efforts by planting common native plant species is a consideration for this WCA around the *D. waianaeensis*, *C. superba* subsp. *superba*, and *F. neowawraea* populations in order to reduce weeding efforts and improve native habitat around the reintroduction zone. However, restoration efforts overall in the Manuwai MU is a lower priority since the habitat is highly degraded making it difficult to commit to restoration efforts for the next 5 years. OANRP plans to revisit restoration actions after MIP Year 19 for the revised Manuwai MU Plan.

#### **WCA: Manuwai-11 (Midwest Slope/KadDegDeg reintro)**

**Vegetation Type:** Mesic Ridge

**MIP Goal:** Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

**Targets:** *S. terebinthifolius*, *S. cumini*, *P. cattleianum*, *T. ciliata*, *C. Arabica*, *C. hirta*, *U. maxima*, *M. minutiflora*, and *Paspalum conjugatum*.

**Notes:** This WCA shares the native forest in WCA 10 along the ridgeline interior fence and has patches of native forests. Blue team is responsible for controlling weeds especially alien grasses around the reintroduction site. It is worthwhile to not only weed around the *K. degeneri* subsp. *degeneri* (ANU-B) plants, but also nearby native forest patches in order to extend the suitable habitat for more rare plant reintroductions in the future. The Blue team also maintains weeds such as *C. hirta*, *U. maxima*, and *M. minutiflora* along the interior fence. The other parts of this WCA is quite steep and therefore less management will take place in those areas. The Ecosystem restoration team sweeps in accessible areas for Target Canopy Species, such as large *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. There has been a few sweeps for canopy target species between 2014 and 2016.

#### **WCA: Manuwai-12 (Kadua/Central ridge)**

**Vegetation Type:** Mesic Ridge

**MIP Goal:** Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

**Targets:** *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *G. robusta*, *U. maxima*, *Melinis minutiflora*, *P. cattleianum*, *Ageratina riparia*, *C. hirta*, and *C. arabica*.

**Notes:** The boundaries of this WCA run down two drainages, and encompass a ridge with a MFS population of *K. degeneri* subsp. *degeneri* (ANU-A). Weed control will be conducted mostly around these rare plants. There are also other rare plants on the slopes of the ridge including: *A. macrococcus*



var. *macrococcus*, *Bobea sandwichensis*, *F. neowawraea*, *Pteralyxia macrocarpa*, *Dubautia sherffiana*, and *Schiedea hookeri*. This is a large WCA, and the southern edge of this WCA is very steep and largely inaccessible. If remote weed control technologies are developed, this would be a WCA where they could be used. The Ecosystem restoration team sweeps in accessible areas for Target Canopy Species, such as large *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. This WCA was swept once in 2016 and once in 2018.

**WCA: Manuwai-13 (Manuwai cliffs)**

Vegetation Type: Mesic Ridge

MIP Goal: Less than 50% alien cover (no rare taxa in WCA).

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, and *C. arabica*.

Notes: This WCA encompasses the cliffs abutting Kamaohanui ridge. The terrain is very steep, or vertical and is mostly inaccessible. Control in this area will be limited to accessible rare taxa and target weed species sites. This is a large WCA, and the southern edge of this WCA is very steep and largely inaccessible. If remote/aerial weed control technologies are developed, they could be used to control Target Canopy Species.

**WCA: Manuwai-14 (Kamaohanui and fence)**

Vegetation Type: Wet Forest

MIP Goal: Less than 50% alien cover (no rare taxa in WCA).

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *P. cattleianum*, and *C. arabica*.

Notes: This WCA includes the highest elevations in the MU and is mostly a mesic forest. Since this WCA has extremely steep areas, remote weed control technologies will be required for control of MU wide target species. However, the Ecosystem restoration team will sweep in accessible areas for Target Canopy Species, such as large *T. ciliata* and/or any other uncommon alien plant species, every 3-5 years. This is the only WCA with *Rubus argutus* located on the Kamaohanui LZ and down the fenceline ~100m, so the Blue team will continue to monitor this population. If *R. argutus* continues to spread or is found in new locations in the MU, Blue team will take immediate action to control this plant species, since it is known to form dense thickets where it is found elsewhere.

**WCA: ManuwaiNoMU-01 (Spider Camp Road)**

Vegetation Type: N/A

MIP Goal: N/A

Targets: *U. maxima*

Notes: This WCA was created to control grass and other weed species to keep the road clear and accessible for vehicles. Controlling grass also reduces the fuel load below the MU and provides access for fire-fighters responding to a fire.

**WCA: ManuwaiNoMU-02 (Manuwai West LZ)**

Vegetation Type: N/A

MIP Goal: N/A

Targets: *U. maxima*

Notes: This WCA was created to control grass and other weed species to keep the trail and LZ clear for use. Controlling grass also reduces the fuel load in the MU.

**WCA: LKNARNoMU-01 (Lower Kaala NAR Access Road)**

Vegetation Type: N/A

MIP Goal: N/A

Targets: *U. maxima*

Notes: This WCA was created to control grass and other weed species to keep the road clear and accessible for vehicles. Controlling grass also reduces the fuel load below the MU and provides access for fire-fighters responding to a fire.

**WCA: AlaiheiheNoMU-01 (KadDeg IHE-C)**

Vegetation Type: Mesic

MIP Goal: Less than 25% alien cover around rare plants. Less than 50% alien cover elsewhere.

Targets: *S. terebinthifolius*, *S. cumini*, *T. ciliata*, *G. robusta*, *U. maxima*, *M. minutiflora*, *P. cattleianum*, *A. riparia*, *C. hirta*, and *C. arabica*.

Notes: This WCA encompasses the wild *K. degeneri* subsp. *degeneri* site outside of the MU fence in Alaiheihe. There are stands of *Metrosideros polymorpha*, *D. sandwicensis*, *D. viscosa*, *Psychotria hathewayi*. Weeding efforts will only coincide with the scheduled *K. degeneri* subsp. *degeneri* monitoring action, since this population is maintained for genetic storage collection.

## Small Vertebrate Control

Species: *Rattus rattus* (Black rat), *Rattus exulans* (Polynesian rat), *Mus musculus* (House mouse), *Pternistis erckelii* (Erckel's francolin), *Lophura leucomelanos* (Kalij Pheasant).

Threat Level: High for *Rattus* spp. on *Cyanea superba* subsp. *superba*, and *Delissea waianaeensis*, moderate on *Chrysodracon* spp. Unknown for *M. musculus*, *P. erckelii*, and *L. leucomelanos*.

Seasonality/Relevant Species Biology: Spikes in rodent population are often observed in other MUs following the fruiting season (about twice a year) of *Psidium cattleianum*, then followed by a return to normal activity levels. It is assumed rodent activity follows similar patterns. *P. erckelii* and *L. leucomelanos* numbers are unknown in the MU, however these ground birds remain threats to rare plant IP taxa since there has been recent observations in other MUs of damage and fruit predation caused by these birds.

Management Objectives:

- Limit rodent predation on *D. waianaeensis* plants and *C. halapepe* seeds.
- Mitigate threat of rodent activity on managed plants. IP goal is having 10% rat activity or less.
- Monitor rare plant IP taxa populations, that do not have rodent control, for rodent damage; promptly initiate control if damage is noted.
  - Rare plant IP taxa not receiving rodent control- *C. superba* subsp. *superba*, *Kadua degeneri* subsp. *degeneri*, *Hibiscus brackenridgei* subsp. *mokuleianus*, *Neraudia angulata* var. *dentata*, *Abutilon sandwicense*, *Flueggea neowawraea*, and *Nototrichium humile*.

- Monitor rare plant IP taxa for damage from *P. erckelii* and *L. leucomelanos*.

Strategy and Control Methods:

- Control rodents annually around *D. waianaeensis* plants and *C. halapepe* seeds using a small localized A24 trapping grid.

### Small Vertebrate Management Map

Map removed to protect rare resources

Discussion: Due to the difficulty of accessing this MU and steep terrain, the only rodent control currently maintained by OANRP staff are around the *D. waianaeensis* reintroduced plants and *C. halapepe* plants to protect the seeds. These rare taxa are protected annually. However, if other rare plant IP taxa are impacted by rodents, OANRP may extend their rodent control efforts in this MU using newly developed rodent traps. OANRP has adopted new models of GoodNature A24 traps and automatic lure pump baits have shown high success in limiting rodent predation on rare taxa in other MUs. OANRP will plan to expand the existing trapping grid to the *C. superba* subsp. *superba* if plants mature. OANRP staff currently checks A24s every 4 months. If damage to rare IP plant taxa from ground birds are observed, OANRP will have to acquire permits to manage these birds and investigate control methods.

## Slug Control

Species: *Deroceras laeve* and *Limax maximus*

Threat Level: Low, due to low counts of slugs in this MU. If slug activity rises, slugs could threaten *Delissea waianaensis* and *Cyanea superba* subsp. *superba*

Seasonality/Relevant Species Biology: Slugs are seasonally abundant during the wet season. We know that in some areas slugs are abundant even during the dry season (for example, West Makaleha and Palikea). In those areas, dry season application of molluscicide is needed. However, slug were only detected three times over two years of sampling. Therefore we can assume slug numbers in this MU are low.

Management Objectives:

- Control slugs locally to ensure germination and survivorship of *D. waianaensis*.
- During annual rare plant monitoring, look for seedling recruitment and slug herbivory.

Strategy and Control Methods:

- Slug Control Areas (SLCAs) around rare taxa locations have been surveyed and cleared of native snails
- FerroxxAQ once a quarter is applied to the SLCA. FerroxxAQ is not applied within 20 m of known populations of native snails.
- If new sites for rare plant reintroductions are chosen outside of the existing SLCAs, areas will be searched thoroughly by an experienced malacologists for slug densities and native snails during the day and at least one night prior to application of FerroxxAQ.

**Slug Control Area Locations Table**

SLCA Code	Plant population reference codes	Date slug control begun
ANU-A-1	DelWai ANU-A	2012 January

### Slug Management Map

Map removed to protect rare resources

Discussion: During annual rare plant monitoring, OANRP staff will inspect plants for herbivory. If present, this will be noted. Indications of slug damage includes the following: lower leaves closer to the ground are more damaged than upper leaves, slime is present, and leaf margins are consumed before the interior of the leaf (unless the midrib is resting on the ground while the margins are curled).

If slug herbivory is suspected and rare native snails are not present in an area, then molluscicide may be applied. FerroxxAQ should be applied at label rates every 6 weeks. However, since this MU is often difficult to access via 4x4 roads and slug counts are already low, FerroxxAQ application is scheduled for once a quarter instead of the 6 week interval that is required elsewhere. If molluscicide is applied, then some weeds, like *Clidemia hirta*, may flourish, so more weeding should be planned if treatments take place.

Currently, slugs are managed only around the *D. waianaeensis*. However, SLCA may expand into the nearby *C. superba* subsp. *superba* reintroduction site when plants mature. OANRP staff will continue to monitor this rare plants and conduct slug sampling annually.

## Ant Control

Species: *Anoplolepis gracilipes*

Threat Level: High for endangered *Drosophila*.

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

Management Objectives:

- Prevent spread of ant species into areas where they are 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 if needed for *Drosophila* conservation.
- Detect incursions of new ant species prior to establishment.

Strategy and Control Methods:

- Sample ants at human entry points using the standard survey protocol (Plentovich and Krushelnycky 2009) and *Drosophila* sites a minimum of once a year (see table below). Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- If incipient species are found and deemed to be a high threat and/or easily eradicated locally (<3 acre infestation), begin control.
- Sample ants at campsite, LZ and *Drosophila* sites.
- Partner with the DOFAW to survey and manage any *S. papuana* (if found) around *D. obatai* populations.

**Ant Survey Site Table**

<b>Site description</b>	<b>Reason for survey</b>
East ridge camp site	High risk of accidental ant introduction
Halapepe <i>Drosophila</i> area	<i>Drosophila</i> are sensitive to high ant abundance

### Ant Management Map

Map removed to protect rare resources

Discussion: Ant sampling has never been conducted in this MU previously. However, during *Drosophila* monitoring by the program's entomologist, *A. gracilipes* was detected. There is concern about this ant species invading higher elevations, however there currently is no effective control method for this type of species. *A. gracilipes* is present in the gulch near *Drosophila* monitoring sites and may need to coordinate with DOFAW to control if this species moves to higher elevations. Another ant species *Solenopsis papuana* is a known threat to *Drosophila* populations. If present, this species would be locally controlled using Amdro (registered for forest use). Unlike *A. gracilipes*, *S. papuana* is an aggressive ant species that is known to reduce *Drosophila* survival by 58% (Krushelnycky *et al.* 2017).

Surveying for ants will continue during *Drosophila* monitoring. In addition, annual formal ant surveys at high traffic areas, i.e., east ridge camp and Halapepe *Drosophila* site, where *D. obatai* (IP rare taxon369) occurs, will be conducted to determine what ant species occur if any. If *S. papuana* is found during these surveys, Amdro will be used to control this species. OANRP will partner with DOFAW on managing ants around and *D. obatai* sites.

## Black-Twig Borer (BTB) Control

Species: *Xylosandrus compactus*

Threat Level: High

Seasonality/Relevant Species Biology: Peaks in BTB activity have been observed from October-January

Management Objectives:

- During annual rare plant monitoring, look for signs of twig boring and damage at the rare plant populations commonly impacted by BTB (*Abutilon sandwicense* and *Flueggea neowawraea*).

Strategy and Control Methods:

- If rare plant taxa that are monitored show any sign of boring, report to Rare Plant Manager immediately.
- If there is an urgency to collect any plant material (i.e. seed, cuttings, and saplings) for genetic storage, collect material.

### BTB Photos



Photos of BTB damage (arrows) on *Abutilon sandwicense*.

Discussion: The current control method available for BTB involves the deployment of traps equipped with high-release ethanol bait. However, it is unclear whether this method reduces BTB damage to target plants. Therefore, this control method is not used to control BTB in the field. Since this control method is not effective, OANRP will continue to investigate other control methods. If there is a rare plant population threatened by BTB and there is an urgency to secure its genetic material, OANRP staff will collect any plant material to prevent losing the plant founder altogether.



## Fire Control

Threat Level: High

Seasonality/Potential Ignition Sources: Fire may occur whenever vegetation is dry. Generally this happens in summer, but may occur at other times of the year, depending on variations in weather pattern. *Urochloa maxima* has a high fire index, and is the dominant vegetation across the MU. This site has burned in the past by arsonists along Farrington Hwy.

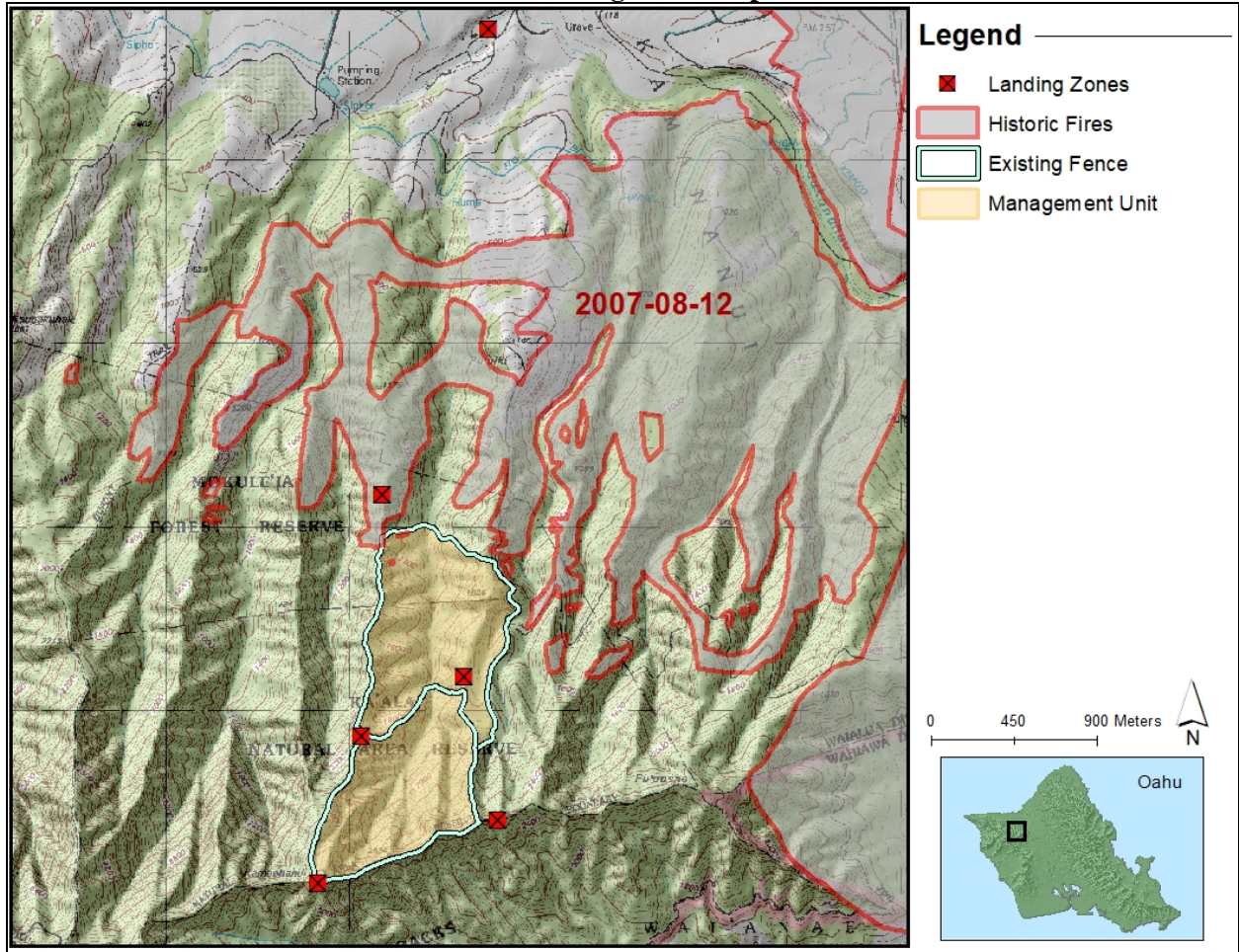
Management Objectives:

- To prevent fire from burning any portion of the MU at any time.
- To prevent fire from damaging any IP rare taxa locations.

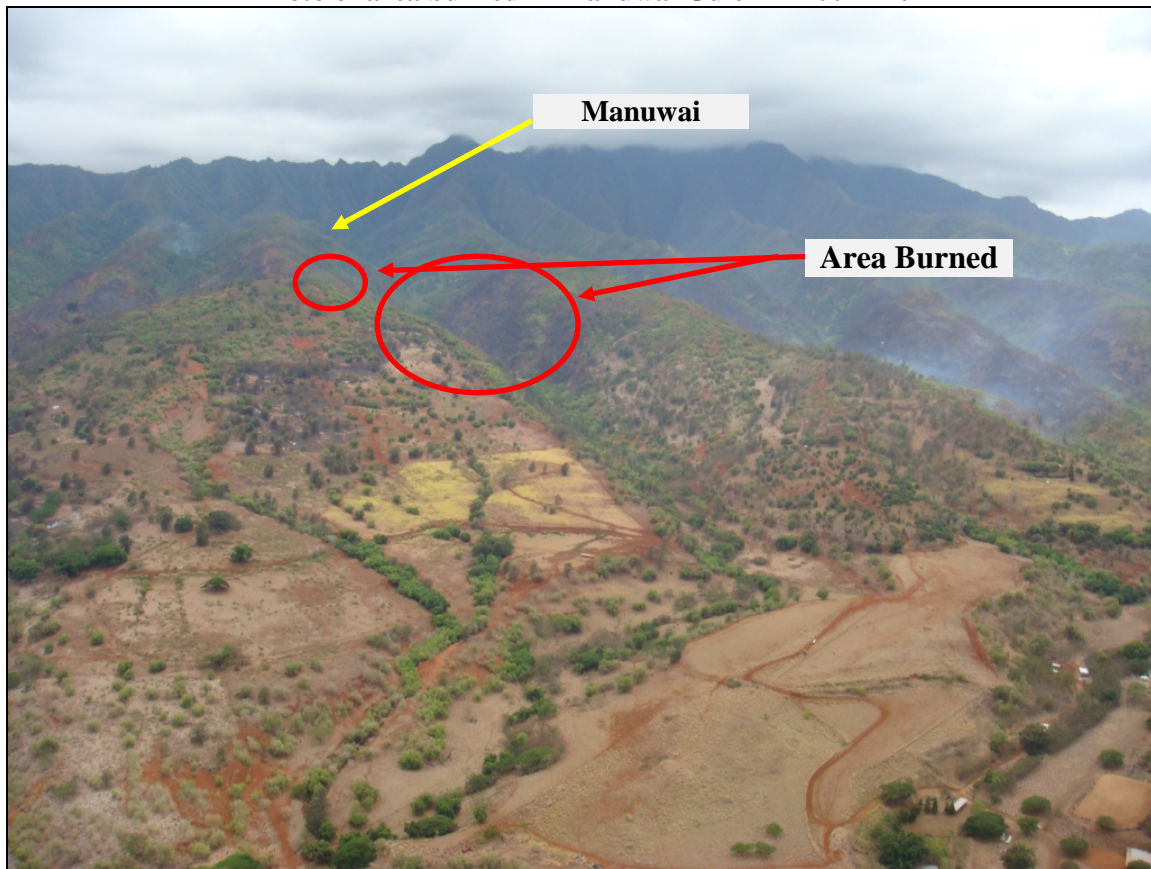
Strategy and Control Methods:

- Reduce fuel loads by grass control along the fenceline and access roads.
- If a fire occurs, conduct a post-fire survey, including mapping the perimeter of the fire and document damage via photos. If possible, rehabilitate burned areas within the fuel break with native species.
- Establish a fuel break corridor along the north fenceline, possibly via aerial spray outside the fence.

### Fire Management Map



**Photo of area burned in Manuwai Gulch in 2007 fire**



**Discussion:** In 2007, a fire started in Waialua, crossed Kaukonahua Road and burned through ranch land, to State Forest Reserve and Natural Area Reserve Land. OANRP staff and other knowledgeable resource managers guided helicopter water drops to priority areas around natural resources for eight days as the fire burned. Prior to 2007, no fires had burned through this area in at least 50 years. The southernmost gulches below the Manuwai MU was burned and many rare plant taxa, including *Hibiscus brackenridgei* subsp. *mokuleianus*, *C. oppositifoli*, *Abutilon sandwicense*, *Bobea sandwicensis*, *Bonamia menziesii*, *Eugenia koolauensis*, *Euphorbia haeleleana*, *Nototrichium humile*, and *Schiedea hookeri*. The most impacted rare plant taxa were the wild *H. brackenridgei* subsp. *mokuleianus* populations, which accounted for about 90% of all *H. brackenridgei* subsp. *mokuleianus* on Oahu. No rare plants were affected in the fenced Manuwai MU, the fire reached as close as 100 meters to known rare plant populations. However, there is evidence that it burned into the *C. oppositifolia* stand at the northwest corner of the fence. The burned area quickly filled back in with *Urochloa maximus*, which serves as a large fuel load at the bottom of the MU.

Since the 2007 fire, OANRP began to contract discing of grass growing in fallow fields along Kaukonahua Road until 2014 when a new land owner purchased this area. This creates a wider and continuous fire break at the site where the fire jumped the road in 2007. OANRP plans to meet with the new landowner of the roadside grass fields to re-new the contract and resume discing the grass. Efficient grass spraying techniques such as using helicopters with spray booms and ball sprayers will be investigated. This technique could be useful to create a fuel break at the bottom of the MU or in other strategic locations. Currently, OANRP staff manage fuel loads along the access roads, northern fencelines, and around managed rare plant taxa sites in the MU. It is also important to maintain roads and LZs for fire access and as fire escape routes. The help of OANRP staff and other knowledgeable resource

managers to direct helicopter water drops to priority areas around natural resources is key in dealing with fires across the area. Additionally, it will be important to work with DOFAW to develop a fire management plan for the entire Mokuleia Forest Reserve and Lower Kaala NAR. One of the land owners Kaukonahua Ranch, who acquired land adjacent to the forestry area in 2017, has incorporated fire mitigation in their development plan. This plan includes controlling grass and *Eucalyptus* spp. and planting native dry-forest plants.



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				
3325	Fence	None	ANU-A	All fence monitoring and maintenance actions. Maintenance is defined as any minor repair work or that is LESS THAN 100m. This action also includes clearing fenceline of excess vegetation.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4569	Fence	None	ANU-B	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	X	X	X	X
4497	Fire- Photo point monitor		None	Take Photopoints across LKN/road region. Was 1x/yr, but now 1x/5yrs, or if a big fire occurs.																								
6942	Predator Control-RP	DelWai	ANU-A	Seasonal trapping around fruiting period.	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
7292	Slug Control	DelWai	ANU-A-1	4 lbs. of FerroxxAQ at DelWai ANU-A population as possible. No native snails are present in the area.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6076	Weed Control	None	Manuwai-01	Control weeds across rare plant zone, and high quality lama-band annually. [EcoRest team able to assist with this action].				X				X				X				X				X
6078	Weed Control	None	Manuwai-02	Control weeds around isolated rare plant populations as needed.				X				X				X				X				X
6085	Weed Control	None	Manuwai-03	Conduct weed control around rare plant reintroductions (Cyasup, Delwai), 2-4x per year.	X		X		X		X		X		X		X		X		X		X	
6087	Weed Control	None	Manuwai-03	Conduct weed control around KadDegDeg.ANU-B reintroduction, 1-2x per year.	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
6089	Weed Control	None	Manuwai-04	Weed throughout KadDegDeg.ANU- A population and suitable habitat along ridge, annually.				X				X			X			X				X		
6090	Weed Control	None	Manuwai-04	Evaluate feasibility of controlling target species on the ground (area is very steep). Species include: GreRob, CupLus, JunBer, MelQui, RoyReg, SchAct, SpaCam, TreOri. Where not possible, aerially identify locations of targets. Control with remote control technologies if determined appropriate control for those targets. Complete control by MIP Year 11.										X										
6092	Weed Control	None	Manuwai-04	Maintain LZ and fenceline as needed, 1-2x per year. Control weeds across accessible portion of WCA near LZ	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
6218	Weed Control	None	Manuwai-04	Conduct understory/canopy weed control around Fluneo reintroduction site every 3-6 months. Goal is to manage Fluneo, which requires lots of sun. Control canopy weeds aggressively at site	X		X		X		X		X		X		X		X		X			
6219	Weed Control	None	Manuwai-04	Conduct weed control around NerAng/NotHum/F luNeo reintro zone; prepare and maintain sites.	X		X		X		X		X		X		X		X		X			
6220	Weed Control	None	Manuwai-05	Conduct weed control around HibBramok reintroduction; prepare and maintain sites. Includes grass control.	X		X		X		X		X		X		X		X		X			
6221	Weed Control	None	Manuwai-05	Control weeds, especially grasses, along fenceline, as needed (minimum annually). This WCA is closest to unmanaged grass lands and is at high risk from fire.	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
6990	Weed Control	None	Manuwai-06	Control weeds, especially grasses, along fenceline, as needed.			X				X			X			X			X				
6991	Weed Control	None	Manuwai-06	Control weeds along fenceline and trail, as needed.			X				X			X			X			X				
7490	Weed Control	None	Manuwai-06	Control weeds, especially grasses, along fenceline, as needed (minimum annually). This WCA is closest to unmanaged grass lands and is at high risk from fire.			X	X			X	X					X	X		X	X			
7550	Weed Control	None	Manuwai-07	Conduct weed control around KadDegDeg.ANU-B reintroduction, 1-2x per year.			X	X			X	X					X	X		X	X			
7552	Weed Control	None	Manuwai-10	Conduct sweeps across lama dominated slopes and ridge shared with WCA 10.	X				X				X				X							
7560	Weed Control	None	Manuwai-10	Conduct weed control around KadDegDeg.IHE-D reintroduction, 1-2x per year.		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
7804	Weed Control	None	Manuwai-10	Control weeds around AbuSan ANU-F & J. Target understory weeds, and select canopy weed removal. AbuSan respond well to light gaps. Partner weed control with rare plant monitoring, as feasible.				X				X				X				X				X
7805	Weed Control	None	Manuwai-10	Control weeds around AbuSan ANU-C. Target understory weeds, and select canopy weed removal. AbuSan respond well to light gaps. Partner weed control with rare plant monitoring, as feasible.				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
7096	Weed Control	None	Manuwai-12	Conduct target species weed control across WCA, in native forest patches in walkable areas; once every 10 years. Species include but not limited to: GreRob, CupLus, JunBer, MelQui, RoyReg, SchAct, SpaCam, TreOri. For Toocil, only treat trees >6" diameter.	X																			
7601	Weed Control	None	Manuwai-13	Control weeds in and around native forest patches, particularly high quality lama-band; annually. Target both canopy and understory weeds. Take extra care around rare taxa.			X			X				X				X				X		
7742	Weed Control	None	Manuwai-14	Control weeds in and around native forest patches, particularly high quality lama-band; annually. Target both canopy and understory weeds.			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				
4043	Weed Control	None	LKNARNo MU-01	Control grass/herbaceous weeds along the LKN contour road, 1-2x per year or as needed. Use the power sprayer, weedwhack. Goal: maintain road, safety, reduce weed spread. Coordinate with State.			X				X				X				X				X					
6445	Weed Control	None	LKNARNo MU-01	Control EhrSti on eastern end of road.		X				X				X				X				X				X		
7046	Weed Control	None	ManuwaiNo MU-01	Maintain road to spider camp, as needed.			X				X				X				X				X			X		
7047	Weed Control	None	ManuwaiNo MU-02	Maintain ridge trail and Manuwai West LZ (165), clear weeds as needed.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6068	Weed: Incipient Control	CaeDec	Manuwai-CaeDec-01	Monitor/control Caesalpinia decapetala in the bottom of the gulch in Subunit I every 6 months/annually. Pick and remove from field any potentially mature fruit.			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
7419	Weed: Incipient Control	ChrOdo	Manuwai- ChrOdo-01	Sweep/treat ICA, 2-4x year. Pick and remove from field any potentially viable fruit. Check known hotspots and treat with Oust every 3-6 months.	X	X	X	X	X	X		X			X			X			X			X
7539	Weed: Incipient Control/ Survey	ChrOdo	Manuwai- ChrOdo-01	Survey greater area around known locations for ChrOdo, define boundaries of infestation, identify core areas, areas with scattered plants, & any outliers. Sweep designated appropriate habitat. Re-survey in 3-5 years.														X		X		X		X
7418	Weed: Incipient Control/ Survey	ChrOdo	Manuwai- ChrOdo-01	Survey greater area around known locations possible for ChrOdo, define boundaries of infestation, identify core areas, areas with scattered plants, and any outliers. Sweep designated appropriate habitat. Re-survey in 3-5														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
				years.																				
5921	Weed: Incipient Control	PteGlo	Manuwai- PteGlo-01	Monitor/control Pteglo along east Manuwai ridge between LZ and Alaiheihe fence junction, quarterly. Survey/sweep whole ICA along fenceline. Target Hotspot 1A for intensive treatment, including area off fence. Flag plant locations to guide future efforts. Pick and remove from field any fruit. Use preemergent herbicide to exhaust seedbank. Consider removing soil in select locations.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6536	Weed: Incipient Control	PteGlo	Manuwai- PteGlo-02	Monitor/control Pteglo at Kamaohanui LZ quarterly. Pick and remove from field any potentially mature fruit. Use preemergent herbicide to exhaust seedbank.	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
				Remove soil as feasible.																				
7274	Weed: Incipient Control	PteGlo	Manuwai- PteGlo-03	Monitor/control Pteglo at West Fence site quarterly. Always look for PteGlo when conducting fence checks. Pick and remove from field any fruit. Use preemergent herbicide to exhaust seedbank. Remove soil as feasible.	X		X		X		X		X		X		X		X		X		X	
7542	Weed: Incipient Control	PteGlo	Manuwai- PteGlo-04	Monitor/control Pteglo at Alaiheihe Fence site quarterly. Always look for PteGlo when conducting fence checks. Pick and remove from field any fruit. Use preemergent herbicide to exhaust seedbank. Remove soil as feasible.	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					
7809	Weed: Incipient Control	SchCon	Manuwai- SchCon-01	Monitor/control SchCon at Puu 1825 spot quarterly, or/to every 6 months as numbers decrease. Pick and remove from field any fruit. Use preemergent.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
7808	Weed: Incipient Control/ Survey	SchCon	Manuwai- SchCon-01	Survey extent of SchCon infestation in Manuwai around Puu 1825, and in any appropriate habitat. Refine ICA boundaries as needed. Track areas swept in Weed_Survey_Polygon. Coordinate efforts with Blue Team.	X	X																							
6520	Weed: Survey	LopEru		Map all known locations of Lophospermum erubescens (formerly Maurandya antirrhiniflora), create map of infestation. Use to decide how and if to control.																									

**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
5994	Weed: Survey	None		Collect samples of unknown Pinus and Cupressus (pine and juniper) taxa along road. Need male and female cones and pictures of bark to make positive ID. Submit to Bishop. Evaluate for control.		X																		
5181	Weed: LZ Survey	None	LZ-CHERRY-155	Survey Cherry's Ranch 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		
2864	Weed: LZ Survey	None	LZ-SBW-055	Survey Kamaohanui LZ (55) 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		
4395	Weed: LZ Survey	None	LZ-SBW-057	Survey Nalu's LZ whenever used, not to exceed once per quarter. If not used, do not need to survey. This does not include Fencing team visits (they have separate	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
				action).																				
7171	Weed: LZ Survey	None	LZ- Manuwai- 209	Survey Manuwai MelTen LZ (209) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
6065	Weed: Other Survey	None		Survey Campsite on east ridge 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
6067	Weed: Transect Survey	None	WT- Manuwai-01	Survey Manuwai upper access trail from fence gate at parking spot, up slope to ridge, and up the crest to the subunit 1/2 fence corner that heads down into gulch, and beyond to camp, ending at fence tag B-447. Survey annually.		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		
4294	Weed-Road Survey	None	RS-LKN-01	Survey road from gate at top of Bob Cherry's ranch as far as can survey along LKN road. Also survey Western Access Road to parking spot to complete this survey. Survey every other year.		X									X							X				
7154	Weed: Survey	None		Conduct aerial survey of canopy weeds in Manuwai, to guide IPA efforts. As needed.			X																			
5638	Vegetation Monitoring	None												X												