

Ecosystem Restoration Management Plan

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

MU: Opaepala Lower I

Overall MIP Management Goals:

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

Background Information

Location: Northern Koolau Mountains

Land Owner: Kamehameha Schools, U.S. Army Garrison – Hawaii (Army) lease

Land Managers: Army Natural Resource Program - Oahu (OANRP)

Acreage: 16-acres

Elevation Range: 1,920 ft. – 2,260 ft.

Description: Opaepala Lower is a 16-acre management unit (MU) located in the northern Koolau Mountain Range, on the island of Oahu. This MU is in the back of a side gulch off of Opaepala stream. Opaepala Lower is a part of the Kawailoa Training Area (KLOA) and is currently leased by the Army from Kamehameha Schools. The annual precipitation averages 3,816 millimeters (mm) (Giambelluca 2013) and elevation ranges between 1,920-2,260 feet. Because of the unique topography and the amount of precipitation in Opaepala Lower, there is one pond with year-round standing water and another pond that is seasonal. The plant community is classified as a montane wet forest. The vegetation is thick/dense and comprised of a mixture of native and introduced species, however it is predominately native. Many slopes are uluhe (*Dicranopteris linearis*) dominated. For a mid-elevation area in the Koolau Mountain Range, this MU has extremely unique native forest patches that have tall koa (*Acacia koa*) and ohia (*Metrosideros* spp.) trees. The Opaepala Lower MU can be accessed via the Peahinaia trail, however due to the length of the trail, OANRP uses helicopters to access the MU for management. Due to lack of military training in KLOA, OANRP is no longer required to manage Tier 2 or 3 taxa. However, these taxa and other rare taxa in Opaepala Lower benefit from ecosystem management for Tier 1 taxa across the MU.

Native Vegetation Types

Koolau Vegetation Types	
<u>Wet forest</u>	<p><u>Canopy includes:</u> <i>Acacia koa</i>, <i>Metrosideros</i> spp., <i>Syzygium sandwicense</i>, <i>Cheiodendron</i> spp., <i>Cibotium</i> spp., <i>Ilex anomala</i>, <i>Psychotria</i> spp., <i>Myrsine</i> sp., and <i>Melicope</i> spp.</p> <p><u>Understory includes:</u> <i>Dicranopteris linearis</i>, <i>Freycinetia arborea</i>, <i>Alyxia stellata</i>, <i>Dianella sandwicensis</i>, <i>Melicope</i> spp., <i>Psychotria</i> spp., <i>Cibotium chamissoi</i>, <i>Machaerina angustifolia</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 Opauala Lower



Top row- Typical vegetation at Opauala Lower.
Bottom left- the larger of the two ponds in Opauala Lower.
Bottom right- *Gardenia mannii* on Puu Melicope.

MIP/OIP Rare Resources Opauala Lower

Organism Type	Species	Pop. Ref. Code	Population Units	Management Designation	Wild/ Reintroduction
Plant	<i>Cyrtandra dentata</i>	OPA-F	Opauala	MFS /T1	Wild
Plant	<i>Gardenia mannii</i>	OPA-A, B, OPA-T, PAA-K	Lower Peahinaia	MFS/T1 GSC/T1	Wild and Reintroduction
Plant	<i>Melicope lydgatei</i>	OPA-D*, E*, F, M, PAA-L	Kawaiiki and Opauala	MFS/T2	Wild
Plant	<i>Myrsine juddii</i>	PAA-H	Kaukonahua to Kamananui-Koloa	T2	Wild
Plant	<i>Phyllostegia hirsuta</i>	OPA-G*	Helemano and Opauala	GSC/T1	Wild
Insect	<i>Drosophila substenoptera</i>	OPA-A	Lower Opauala	MFS/T1	Wild

MFS= Manage for Stability

GSC= Genetic Storage Collection

*= Population Dead

T1 = Tier 1

T2=Tier 2

Other Rare Taxa at Opauala Lower

Organism Type	Species	Status
Plant	<i>Cyanea lanceolata</i>	Endangered
Plant	<i>Exocarpos gaudichaudii</i>	Endangered
Plant	<i>Joinvillea ascendens</i> subsp. <i>ascendens</i>	Endangered
Plant	<i>Stenogyne kaalae</i> subsp. <i>sherffii</i>	Endangered, outplanted in 2013 with Oahu Plant Extinction Prevention Program (OPEPP).
Mollusc	<i>Achatinella curta</i>	Extirpated; last observed by Dr. Hadfield in 1998.
Mollusc	<i>Achatinella sowerbyana</i>	Extirpated; last observed 1996
Insect	<i>Drosophila craddockae</i>	Rare

Rare Resources at Opauala Lower



Gardenia mannii



Stenogyne kaalae subsp. *sherffii*

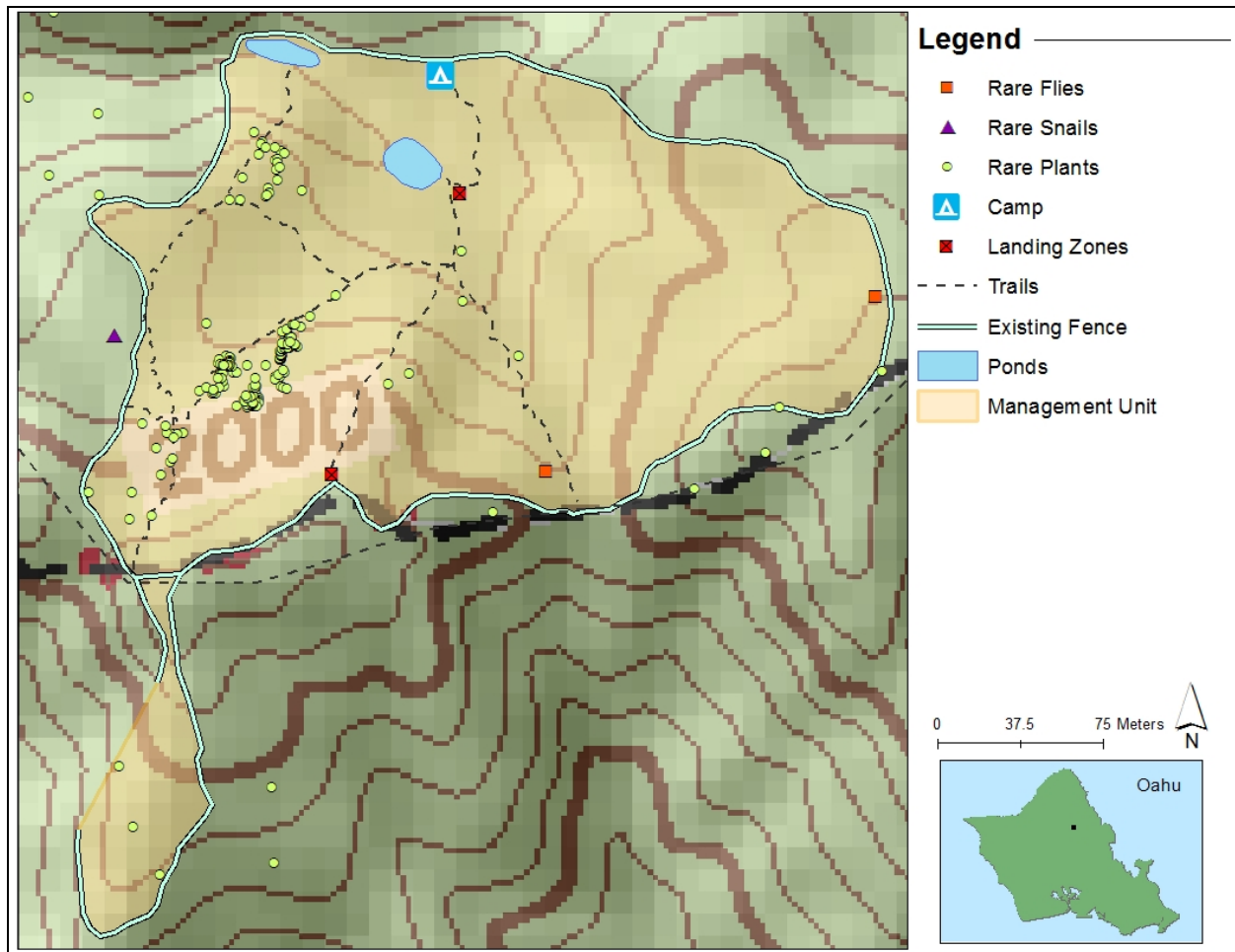


Cyrtandra dentata



Drosophila substenoptera

Locations of Rare Resources at Opaeula Lower



Threats to MIP/OIP MFS Taxa

Threat	Taxa Affected	Management Strategy	Current Status
Rats	All	A24 trapping grid	Rodent damage has been observed in the past on <i>Cyrtandra dentata</i> . Snap traps were established in 2016 around the population. In April 2018, the trapping grid was converted to 50 A24s encompassing the whole MU.
Pigs	All	Fence	Area fenced and ungulate-free.
Weeds	All	Focus on IP rare taxa sites primarily, across MU secondarily.	Regular maintenance required several times per year. Weeds are a threat to both understory and canopy across the whole MU.
Fire	None	N/A	Fire is expected to be highly unlikely given the wet habitat at Opaeula Lower. In the unlikely event of a fire, OANRP will assist by providing information on rare resources and trails to incident command, and may also provide air support.

Threats to MIP/OIP MFS Taxa (Continued)

Threat	Taxa Affected	Management Strategy	Current Status
Black Twig Borer (BTB)	<i>Melicope lydgatei</i>	No effective control methods available.	No control feasible at this time, since the current BTB control methods are not effective. In addition, <i>M. lydgatei</i> is a T2 OIP species and is not being actively managed.
Slugs	<i>Cyrtandra dentata</i> , <i>Gardenia mannii</i> , <i>Phyllostegia hirsuta</i> , <i>Myrsine judii</i>	Yes. Treat IP rare plant sites with molluscicide.	Area has been surveyed by an experienced malacologist to determine whether native snails are present. No native snails have been found. Currently, FerroxxAQ is applied quarterly only around the <i>C. dentata</i> population, which has had observed slug damage in the past. Slug damage has not been seen on other T1 taxa.
Ants	<i>Drosophila substenoptera</i>	Annual surveys	Only <i>Solenopsis papuana</i> is currently known from the area; may impact rare taxa populations. Control may be warranted if more problematic species become established.

Management History

- 1999- May 2001: Initial management began with the use of snares in the area. OANRP ran the snare groups, but removed them due to the area being accessed by hunters.
- 1998-2000: OANRP surveys MU and proposed fenceline for *A. sowerbyana* and *A. curta*, which was reported by Dr. Hadfield. No rare snails were found during those rare snail surveys.
- 2001: Funding for a portion of the MU fence from DLNR was funneled through the Koolau Mountain Watershed Partnership.
- 2002-2003: OANRP begins weed control in flat portions of MU near the pond. However, it was soon discontinued as OANRP staff observed severe pig damage in freshly weeded areas.
- 2011: Staff conduct initial line clearing for fence construction in June. The fence construction was completed in December.
- 2011: During the fence construction, large stands of *Psidium cattleianum* are removed in order to create a camp site for OANRP staff. The area soon turned into grass (*Urochloa maxima* and *Paspalum conjugatum*). This was a major change to the MU's infrastructure and landscape.
- 2012: OANRP resumes snaring to remove any ungulates from the MU. The unit was declared ungulate-free.
- 2012: A tree fall on fence was observed by staff in April during a routine fence check. Staff observed ungulate sign within the fence, so snare groups were promptly set. By June, OANRP caught seven pigs in snares and the unit was deemed pig-free.
- 2012: OANRP resumes ecosystem weed control in the flat areas of the MU.
- 2012: *Rhynchospora caduca*, an incipient weed species not commonly found in Opaepala Lower, was first discovered by staff along the Peahinaia trail that follows the MU fenceline.
- 2013: The Oahu Plant Extinction Prevention Program (OPEPP) reintroduced a population of *Stenogyne kaalae* subsp. *sherffii* in the MU.
- 2013: Due to Army training level changes and a decrease in funding, OANRP no longer receive funding to work with T2/T3 taxa and work on these species halts. MIP/OIP taxa in Lower

Opauala only to include *Cyrtandra dentata* and *Gardenia mannii*. OANRP no longer manages for *Melicope lydgatei* and *Myrsine juddii*.

- 2013-2014: OANRP conducted a *Clidemia hirta* control trial to gain a better understanding of how quickly *C. hirta* grows in Opauala Lower. Results from this trial helped to inform the most effective ways to control *C. hirta*.
- 2013: LZ Frog pond was discontinued due to safety concerns of the unstable muddy grounds, the lack of wind for helicopter lift, and the tall trees surrounding the LZ. OANRP began and currently uses LZ Puu Curta. Although LZ Frog pond was discontinued as an LZ, it still used as a drop zone for camping gear.
- 2015: Staff Surveyed for slugs and native snails in the MU, especially around *C. dentata* population, to gauge need for possible future slug control.
- 2015: OANRP installed fickle fence skirting along the existing fenceline to prevent piglets from entering unit along fence sections below pond/behind camp where pressure is highest.
- 2016: A platform for the future weather port was built by the staff for camping since the area in the MU is constantly muddy and wet.
- 2016: OANRP installs a small localized grid of Victor snap traps around the *C. dentata* population following observations of rat predation of the fruit.
- 2016: OANRP reintroduced *G. mannii* (OPA-A) by the wild *G. mannii* (OPA-B) population. This is the first *G. mannii* reintroduction in this MU.
- 2016: OANRP begins control for slugs around *C. dentata* using Sluggo.
- 2017: OANRP constructed a weather port where the old platform was located.
- 2017: Two new *R. caduca* ICAs were found by staff by the newly constructed weather port and along the Melicope finger fenceline. Because of the new discoveries, OANRP starts to mix a pre-emergent pesticide (sulfomet) to control the seed bank as well as the plants found.
- 2017: Staff noticed fickle skirting beginning to deteriorate/fail due to the extreme soil moisture, but unit remains pig-free. OANRP will investigate using longer lasting materials to replace the deteriorating fickle skirting.
- 2017: OANRP discovers *Setaria palmifolia* along the MU fenceline and around the “little” pond. Although *S. palmifolia* is found elsewhere in the Koolau Mountain Range, it was never previously observed in this MU. Thus, a new ICA was created. Staff check and control ICA quarterly.
- 2017: The use of Sluggo is discontinued since FerroxxAQ, a more effective and longer lasting molluscicide, was approved for forestry-use. OANRP currently uses FerroxxAQ for the *C. dentata* site.
- 2018: OANRP planted more *G. mannii* (OPA-A). To increase native habitat, staff also reintroduces common native shrub *Clermontia kakeana*. This was the restoration action to occur in the MU. OANRP plans to plant more common native species around the *G. mannii* and weather port in the next few years.
- 2018: OANRP converted the Victor snap trapping grid around the *C. dentata* to a GoodNature A24 grid of 50 traps across MU.

Ungulate Control

Species: *Sus scrofa* (Pigs)

Threat Level: High

Management Objective:

- Maintain MU as ungulate-free.

Strategy and Control Methods:

- Fence constructed in 2011.
- Maintain the fenced area as ungulate-free by maintaining fence.
- Monitor for sign while checking the fence (inside/outside) and conducting other management actions. Outside activity is reported to gauge pig pressure.
- Conduct quarterly fence checks and monitor stream crossings after storms.
- Document pig sign during vegetation monitoring transects.
- As fickle skirting deteriorates, a suitable replacement may need to be found and installed in the future.

Discussion: The MU fence is 1.397 kilometers long and encompasses 16 acres. The major threats to the perimeter fence are tree falls and erosion. There are many large, old trees in the area. After the fence was completed, snares were set and monitored for a year. No ungulates were caught during this time and there was no activity within the fence. In 2012, tree fall damaged the fence and ungulate sign was observed. Snares were set again and monitored for a few months. Several pigs were successfully caught and removed from the MU. The fence was then deemed ungulate-free. Snares were also set outside the fence to reduce pig pressure. As of 2018, all snares have been removed from inside and outside of the MU. The fence is currently ungulate free. However, if there continues to be heavy pig activity outside of the fence, especially close to the weather port, snares may be set again outside of fence to reduce pressure. The vegetation along the fence will be maintained low (especially grasses and uluhe) to facilitate quarterly monitoring. This weed control is discussed in the Weed Control section. Special emphasis will be placed on checking the fence after extreme weather events since part of the fenceline runs through the “little” pond, which often times is submerged halfway under water. This may deteriorate the fence materials faster, erosion can occur, and/or cause debris to pile up, which can create high spots for pigs to climb over the fence. Monitoring for ungulate sign will occur during the course of other field activities.

Weed Control

Weed Control actions are divided into 4 subcategories:

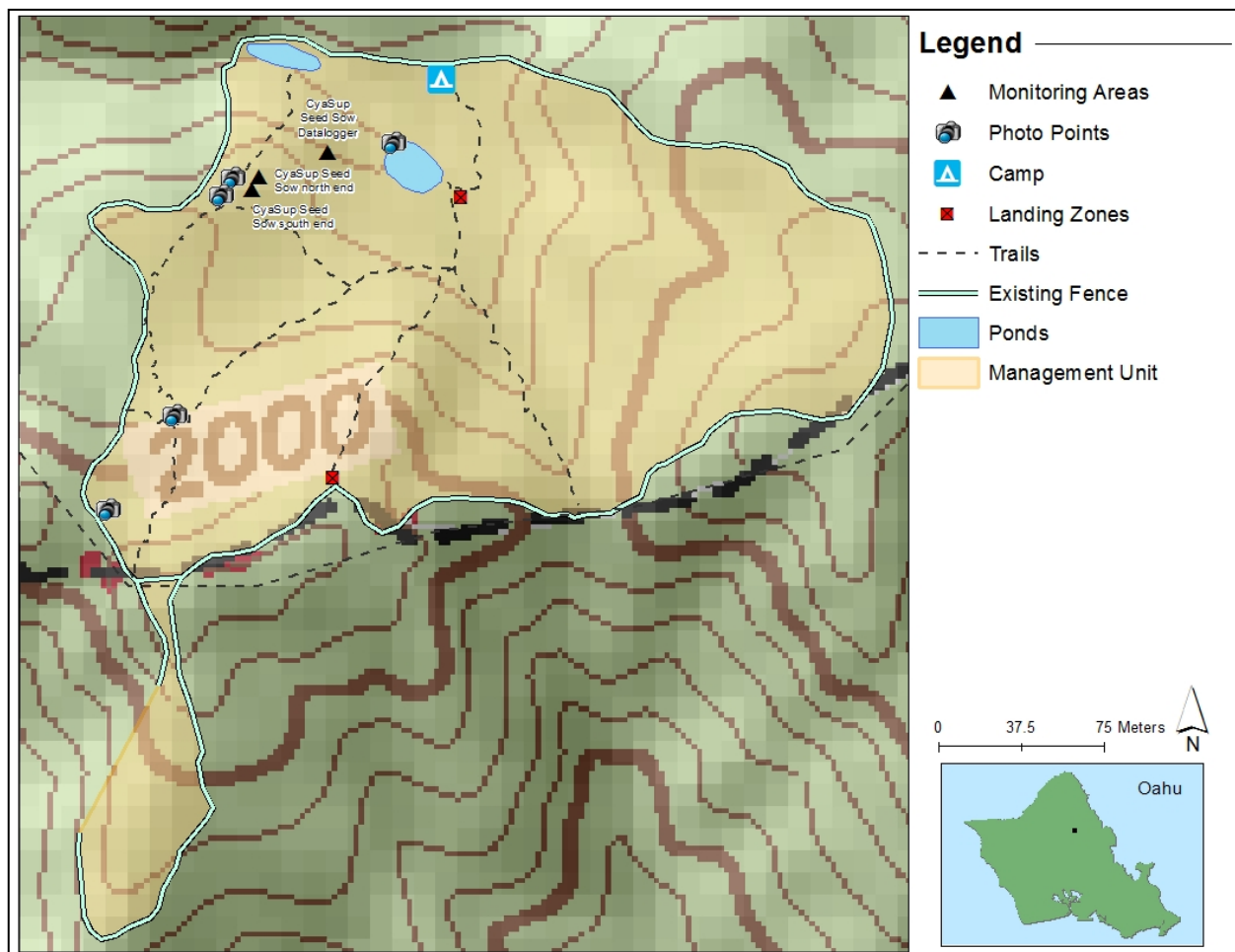
- 1) Vegetation Monitoring
- 2) Surveys
- 3) Incipient Taxa Control (Incipient Control Area - ICAs)
- 4) Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

Due to small size and high density of native vegetation in the MU, belt plot transect protocols implemented at other MUs are not appropriate here. Instead, OANRP has adapted the photo point method of monitoring the changes of the plant community existing in the MU since this was the easiest monitoring method tool to use at the time. Photo points capture change in vegetation qualitatively, however these are not set up to be analyzed. Instead, these photo points were established in order to document the vegetation changes following weeding efforts and around the *Gardenia mannii* population. If the Blue team takes on more aggressive weeding control efforts by removing large stands of *Psidium cattleianum* and outplanting more native common species, OANRP may use point intercept monitoring to document vegetation changes quantitatively. Future use of a drone to capture the vegetation changes in this MU may be used.

Vegetation Monitoring Areas and Photo Points Map



Surveys

Potential Vectors. The Army conducts helicopter training in Kawailoa. The nearby Puu Curta LZ is not currently used by the Army, however OANRP staff use this LZ to access Opaepala Lower MU. Because of the difficulty of accessing the area via hiking, it is unlikely for recreational hikers to access the MU. However, the Peahinaia trail, which was a public trail, is nearby. The trail has since been overgrown and is not used. If recreational hikers are observed near the MU, a weed transect survey may be established to track the weed species seen in Opaepala Lower. OANRP staff, ungulates and birds are all possible vectors of new weed species.

Management Objective:

- Prevent the establishment of any new invasive alien plant or animal species through regular surveys along trails, LZs, campsites and other high traffic areas (as applicable).

Strategy and Control Methods:

- Quarterly surveys of LZ PMH 190 (Poamoho Connex) and LZ KLO 33 (Puu Curta).
- Quarterly survey of the weather port/camp (if used).
- Note unusual, significant or incipient alien taxa during the course of regular field work. Map and complete Target Species form to document sighting.
- Novel alien taxa found will be researched and evaluated for distribution and life history. If taxa found are to pose a major threat, control will begin and will be tracked via ICAs.
- Annual survey of Poamoho road.

Discussion: Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Staff should always be vigilant on finding any new weed species while working in the MU. During a quarterly fence check, *Rhynchospora caduca* was first discovered along the fenceline. This was most likely introduced to the MU by the fence materials that flew from an LZ that had *R. caduca*. *R. caduca* is established along the Poamoho road and the Poamoho Connex LZ. Both Poamoho road and Poamoho Connex LZ are high traffic points that may introduce new weed species to Opaepala Lower MU.

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.

Two incipient species *R. caduca* and *Setaria palmifolia* have been identified by OANRP. *R. caduca* is new to the MU and was likely introduced by management efforts. There are currently three *R. caduca* ICAs and one *S. palmifolia* ICA that are being treated quarterly. OANRP will control *R. caduca* in order to remove all matures within the MU. Return visits will be scheduled in order to prevent immature individuals from reaching maturity. OANRP will continue to monitor and consider control on other possible incipient plant species when appropriate.

Management Objectives:

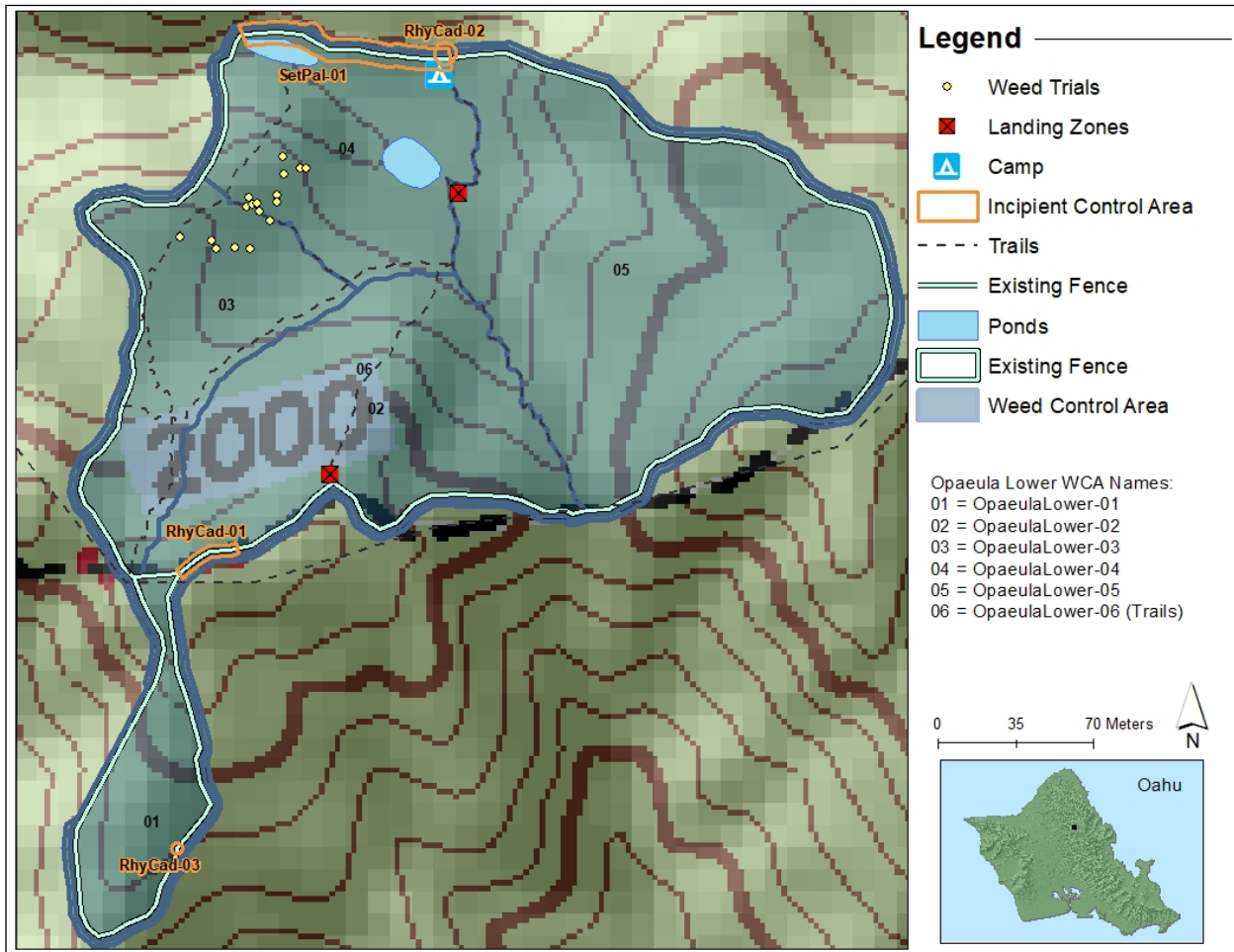
- Eradicate ICAs through regular and thorough monitoring and treatment. In the absence of any information about seed bank longevity for a particular species, eradication is defined as 10 years of consistent monitoring with no target plants found.

- 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, and 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 whenever possible.

Survey locations, Incipient and Weed Control Areas Map



Summary of ICAs

Taxon	ICA Code	Control Discussion
<i>Rhynchospora caduca</i>	LowerOpaeula-RhyCad-01	All three ICAs are monitored and treated quarterly. <i>R. caduca</i> is a high priority for control as it is not found throughout the MU and thrives in wet environments. The Poamoho Connex LZ, used to access this MU, is infested with <i>R. caduca</i> . This ICA is found along the Peahinaia. Five mature plants were discovered in 2012 and controlled by foliar application using a Ranger Pro, water, and pre-emergent mixture. Seed heads are removed and bagged. Although the original spot where <i>R. caduca</i> was found has been effectively controlled, the <i>R. caduca</i> continues persist and is moving along the fenceline. There are some areas in the ICA where it is difficult to search/see <i>R. caduca</i> since the uluhe can be quite thick. Staff will continue to control ICA and will GPS any hotspots.
	LowerOpaeula-RhyCad-02	This ICA is located by the weather port. <i>R. caduca</i> was found in 2017. Three mature and about 30 immature plants were observed outside of the fenceline and were buried under the <i>Setaria palmifolia</i> ICA.
	LowerOpaeula-RhyCad-03	This ICA is located along the Melicope finger trail. Two mature and 5 immature <i>R. caduca</i> were found in 2017 during a fence check.
<i>Setaria palmifolia</i>	LowerOpaeula-SetPal-01	There is one site of this taxon close to the weather port and was first discovered in 2017 just outside the fence. About 10 <i>S. palmifolia</i> plants were found that time. A few months later, the <i>S. palmifolia</i> spread along the fenceline. About 20 mature and 40 immature plants were found and treated. Currently, there are two distinct hotspots that have been monitored and controlled. This is a high priority for control, as <i>S. palmifolia</i> is a highly invasive grass that is not found throughout the MU. <i>S. palmifolia</i> is effectively controlled by frequent visits by foliar application using Ranger Pro, water, and a pre-emergent pesticide. Seed heads are removed and bagged.

Incipient Weed Photos



Pictures of mature *Rhynchospora caduca*

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 except where removal causes harm.
- 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:

- Focus weeding around *Gardenia mannikii* and *Cyrtandra dentata* populations to expand suitable native habitat.
- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Reach 50% or less alien canopy cover 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.
- Modify weeding efforts if population monitoring indicates weed control efforts are not contributing to stable population growth.

Discussion: OANRP weed control at Opaeula Lower is focused on reducing alien vegetation encroachment on the populations of *C. dentata* and *G. mannikii*, however T2/T3 OIP taxa also benefit when weeding throughout the MU. The major weed threats in the MU are *P. cattleianum* and *C. hirta*, which have the potential to form dense monotypic stands, and are a dominant presence in other areas of the Koolau Mountains. From 2013-2014, OANRP conducted *C. hirta* control trials to evaluate how fast *C. hirta* was able to re-invade weeded areas. The trial was able to show that *C. hirta* weeded areas were best to re-visit weed control within 6 to 12 months. If re-visitation to weed do not happen within 6 to 12 months, *C. hirta* will return to near prior weeding levels. Additionally, in order to give potential native recruitment a chance to grow, re-visits are not recommended any time before 6 months from weeding the area. This experiment also revealed that if weeding occurs in *C. hirta* dominated areas, non-native grass quickly invaded the area, so grass control should be coupled with *C. hirta* management (OANRP, 2015).

Another priority for weed control in Opaeula Lower will focus on conducting ground sweeps across all portions of the MU where the more intact native forest patches are, targeting *P. cattleianum* and other weeds (listed in the Summary Target Taxa table). The entire MU has been divided into Weed Control Areas (WCAs) to assist in tracking and scheduling control efforts. WCAs will be weeded on a rotational basis given the difficulty of access, terrain, and limited staff resources. The WCAs that are most accessible, have the gentlest terrain, the rarest resources, and the fewest weeds will be prioritized for control. If the Blue team decides to remove stands of *P. cattleianum*, the use of a chipper and aggressively outplanting common native plant species must also happen.

The table below summarizes invasive weeds found at Opaeula Lower, 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
<i>Angiopteris evecta</i>	Scattered	Incidental observations of <i>A. evecta</i> around the MU have been made. Plants seen should be GPSed and removed manually or with herbicide. The adjacent gulches are infested with this taxa, which feed spores into Opaeula Lower. Control is a high priority. Control any plants found during regular weed sweeps using Garlon4 or Polaris (for large mature plants). Also control plants seen outside the MU, if near the fence. Conduct aerial surveys as needed to guide ground treatments.
<i>Citharexylum caudatum</i>	Scattered	Trees are scattered across MU and the presence of numerous seedlings and saplings point to an increase of this taxa within Opaeula Lower. While not as prone to forming monotypic stands as <i>P. cattleianum</i> , this taxa should be controlled due to it having bird dispersed seeds and its aggressive competition with native shrubs and trees.
<i>Clidemia hirta</i>	Widespread	Widespread throughout the MU. <i>C. hirta</i> has the potential to grow into monotypic stands. OANRP targets this taxa around rare taxa. Follow-up on <i>C. hirta</i> removal must be no more than a year, otherwise <i>C. hirta</i> will grow back quickly.
<i>Lantana camara</i>	Widespread	One large patch was at campsite in OpaeulaLower-04 and has since been controlled. <i>L. camara</i> is scattered throughout the MU and should be targeted when weeding through the MU.
<i>Leptospermum scoparium</i>	Unknown	Not known in Opaeula Lower at this time, however, vigilance is important in keeping it out of the MU. <i>L. scoparium</i> is commonly found in the adjacent areas of this MU and the seeds are wind dispersed. There are known and managed ICAs along the Poamoho road. If found in the MU, it would be a priority for control and will be an ICA.
<i>Paspalum conjugatum</i>	Widespread	Concentrated around the campsite and ponds in OpaeulaLower-04, but also scattered throughout the MU. <i>P. conjugatum</i> is controlled around the campsite, trails, and around rare taxa. Ranger Pro for Aquatic use is applied around the weather port and camp DZ to control <i>P. conjugatum</i> . While, Fusilade sprayed around rare taxa to control <i>P. conjugatum</i> .
<i>Pterolepis glomerata</i>	Widespread	This melastome is ubiquitous across the Koolaus. It thrives in disturbed areas, particularly pig wallows. NRS do not currently target it for control but now that pigs have been excluded, hopefully native vegetation will colonize <i>P. glomerata</i> zones, as anecdotally observed in the Opaeula fence.
<i>Psidium cattleianum</i>	Widespread	Patches scattered across Opaeula Lower. Primary target of WCA sweeps for isolated stands in the more native and intact forest patches. In the Koolaus, <i>P. cattleianum</i> take on a multi-trunked clump form and have the proclivity for slash to re-sprout. The largest and thickest stands tend to be in gulches and draws.
<i>Sphaeropteris cooperi</i>	Scattered	Scattered individuals in the middle of the MU, especially in OpaeulaLower-03. Lower Opaeula is perfect habitat for <i>S. cooperii</i> , and many immature plants have already been removed from the MU. Few large, mature individuals have been found. Due to its documented invasiveness, it is a priority for control. The most effective control method is to cut-stump with no herbicide application.
<i>Urochloa maxima</i>	Scattered	One population treated at campsite in OpaeulaLower-04. While the habitat here is a little wet for this grass, its habitat-altering characteristics make it a control priority. Target when seen in MU. Possibility for eradication.

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 restoration projects at Opaeula Lower.

Taxa Considerations for Restoration Actions:

Native Taxon	Outplant?	Seedsow/ Division/ Transplant?	Notes
<i>Acacia koa</i>	Yes	No	Tree. Fast-growing. Easily grown from seed.
<i>Alyxia stellata</i>	Yes	Seed sow	Fast-growing shrub. Easily grown from seed.
<i>Cheirodendron trigynum</i>	Yes	No	Tree. Moderately fast-growing.
<i>Cibotium</i> spp.	No	Transplant	Fern. Translocate <i>Cibotium</i> spp. along and outside the fenceline into weeded areas.
<i>Clermontia kakeana</i>	Yes	No	Easily grown from seed.
<i>Dianella sandwicensis</i>	No	Division	Small shrub. Grows easily from divisions.
<i>Freycinetia arborea</i>	Yes	Seed sow	Can grow from seeds; slow to reach outplant size.
<i>Ilex anomala</i>	Yes	No	Small tree. Slow growing. Can grow from seed.
<i>Metrosideros polymorpha</i>	Yes	No	Slow growing tree. Can grow from seed and cuttings.
<i>Microlepia strigosa</i>	No	Division	Fern. Translocate <i>M. strigosa</i> from along the fenceline.
<i>Polyscias oahuensis</i>	Yes	No	Tree. Easily grown from seed.
<i>Pipturus albidus</i>	No	Seed sow	Fast-growing. Easily grown from seed.
<i>Psychotria</i> spp.	Yes	No	Tree. Can grow from seed.
<i>Scaevola</i> spp.	Yes	No	Fast-growing. Easily grown from seed.

WCAs: OpaualaLower-01 (Melicope Finger Fence)

Veg Type: Wet Montane

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

Targets: All woody species, particularly *Psidium cattleianum*, *Clidemia hirta*, and *Citharexylum caudatum*.

Notes: This is the southernmost WCA and encloses a *Melicope lydgatei* rare plant population. The majority of this WCA is dominated by *Dicranopteris linearis*, with a *Metrosideros polymorpha* and *Acacia koa* overstory. Most of the weeds (*C. hirta* and *C. caudatum*) are concentrated at the southern end of the WCA near the stream bottom and low lying areas. This area is also under consideration for additional *Gardenia mannii* reintroduction with the hope of replicating wild sites and other successful reintroductions in West Range in *D. linearis* dominated habitat. Weed sweeps will concentrate on *C. hirta* removal around rare taxa locations and native forest patches every 3-5 years. If the site becomes a *G. mannii* reintroduction site, weeding efforts in the bottom of the WCA will be scheduled.

WCA: OpaualaLower-02 (Puu Curta Slopes/Ridge)

Veg Type: Wet Montane

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

Targets: All woody species, particularly *P. cattleianum* and *C. hirta*.

Notes: Rare plants in this WCA include *Cyrtandra dentata*, *Melicope lydgatei* and *Exocarpos gaudichaudii*.

This WCA encompasses northern slopes of Puu Curta and the vegetation is predominantly native, with a heavy *D. linearis* understory. Weed sweeps will focus on *P. cattleianum* and *C. hirta*, which are

concentrated in the lower part of the WCA. This WCA also contains the main landing zone for the MU, as well as a *Rhynchospora caduca* ICA along the southwest fenceline. The main focus in this WCA are to minimize alien cover around the *C. dentata* plants. Other high priority actions are to maintain trails and fencelines as needed in order to facilitate other work in this area. Weed sweeps in native areas that are *D. linearis* and native dominated and steep will utilize spotters with binoculars to direct targeted weed control to minimize damage to *D. linearis*. These sweeps are scheduled once every 3-5 years. Weed sweeps around the *C. dentata* plants are scheduled annually. Additionally, weeding canopy species should be gradual as the light gaps allow grass and *C. hirta* to invade area quicker.

WCA: OpaualaLower-03 (South-West enclosure)

Veg Type: Wet Montane

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

Targets: *Sphaeropteris cooperi* and *Angiopteris evecta*. All woody species, particularly *P. cattleianum*, *C. caudatum*, and *C. hirta*.

Notes: The flatter areas of this WCA contain large stands of nearly monotypic *P. cattleianum* and *C. hirta*, which are targeted for removal around the native-dominated forest patches and managed OIP taxa. Mature and immature *S. cooperi* and immature *A. evecta* have also been observed in the WCA and will be controlled weed sweeps once every 3-5 years. This WCA has an abundance of native species in some areas, including *M. polymorpha*, *Antidesma platyphyllum*, and *C. platyphyllum* in the canopy, and *Wikstroemia oahuensis*, *Psychotria hathewayi*, and *Cibotium* spp. in the understory. Rare plants in this WCA include *C. dentata* (wild) and a *S. kaalae* var. *sherffii* (reintroduction). Since OANRP does not manage *S. kaalae* var. *sherffii*, OANRP will coordinate with the Oahu Plant Extinction Prevention Program on weeding efforts around the *S. kaalae* var. *sherffii*. Photopoints to document changes in vegetation after weeding have been set throughout the WCA. Other high priority actions are to maintain trails and fencelines as needed in order to facilitate other work in this area.

WCA: OpaualaLower-04 (North-West Corner and Ponds)

Veg Type: Wet Montane

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

Targets: All woody species, particularly *P. cattleianum*, *Psidium guajava*, *C. caudatum*, and *C. hirta*. *Paspalum conjugatum*, *Urochloa maxima*, and *Lantana camara* will be targeted at the camp site and around the ponds.

Notes: This WCA is easy to access and weed sweeps can be conducted over the entire area. The “little” pond is located in this WCA, which maintains an open area of a native aquatic fern and weeds. This is the only area that will not be swept and will remain weedy. Weed sweeps to cover the whole WCA is to focus on select weed species, such as *Angiopteris evecta*, *Citharexylum caudatum*, and *Sphaeropteris cooperi* once every 3-5 years. Weed sweeps around the *Gardenia manii* reintroduction site are scheduled annually and the main focus is to control *P. cattleianum* and *C. hirta*. Other weeds including *P. conjugatum*, *U. maxima*, and *L. camara* will be targeted at the camp site and around the ponds. The western half of the WCA contains high amounts of native vegetation, including *W. oahuensis*, *Alyxia stellata*, *Freycinetia arborea*, and *Antidesma platyphyllum*. Photo points to document changes in

vegetation after weeding are established near the main pond. Other high priority actions are to maintain trails and fencelines as needed in order to facilitate other work in this area. This WCA is the first area for restoration work. Minimal restoration efforts in this WCA began in 2017 (OANRP YER Restoration 2018). *Clermontia kakeana* plants have been outplanted around the *G. mannii* reintroduction site. There are plans to further expand restoration efforts to supplement native understory and canopy around the *G. mannii* and reduce alien dominated areas in other areas of the WCA. OANRP plans to continue restoration efforts for the next few years by slowly removing *P. cattleianum* and planting native common plants including *Acacia koa*, *Clermontia kakeana*, *Ilex anomala*, and *Cheirodendron trigynum*, especially in the native forest patches to increase native abundancy and decrease *C. hirta* and *P. cattleianum*.

WCA: OpaualaLower-05 (Puu Melicope Slopes/Fenceline/Blue Puu Curta trail)

Veg Type: Wet Montane

OIP Goal: Less than 50% alien cover elsewhere.

Targets: All woody species, particularly *P. cattleianum*, *P. guajava*, *C. caudatum*, and *C. hirta*.

Notes: This WCA contains a high percentage of native vegetation, including *D. linearis*, *M. polymorpha*, *A. koa*, and *F. arborea*. There is a *M. lydgatei* rare plant population on the southern fenceline. Sweeps will be conducted to remove canopy weed species, every 3-5 years, across the WCA. Spotters with binoculars will be utilized to direct targeted weed control to minimize damage to *D. linearis*. There are two large non-native palms in this WCA that need to be identified and controlled. Understory weed control will be concentrated around the rare taxa and native forest patches. Other high priority actions are to maintain trails and fencelines as needed in order to facilitate other work in this area.

WCA: OpaualaLower-06 (Fence and Trails maintenance)

Veg Type: Wet Montane

OIP Goal: N/A

Targets: *P. cattleianum*, *P. guajava*, *C. caudatum*, *C. hirta*, and alien grasses.

Notes: This WCA was created to maintain the main trails and the fencelines. The main trails are important to keep maintained since they are used as WCA boundaries.

Small Vertebrate Control

Species: *Rattus rattus* (Black rat), *Rattus exulans* (Polynesian rat), *Mus musculus* (House mouse)

Threat level: High for *Rattus* spp. for *Cyrtandra dentata*. Unknown for *Gardenia mannii* and *Drosophila* spp.

Seasonality/Relevant Species Biology: Spikes in rodent population are often observed in other MUs following the fruiting season (about twice a year) of *Psidium cattelleanum*, then followed by a return to normal activity levels. It is assumed rodent activity follows similar patterns.

Management Objectives:

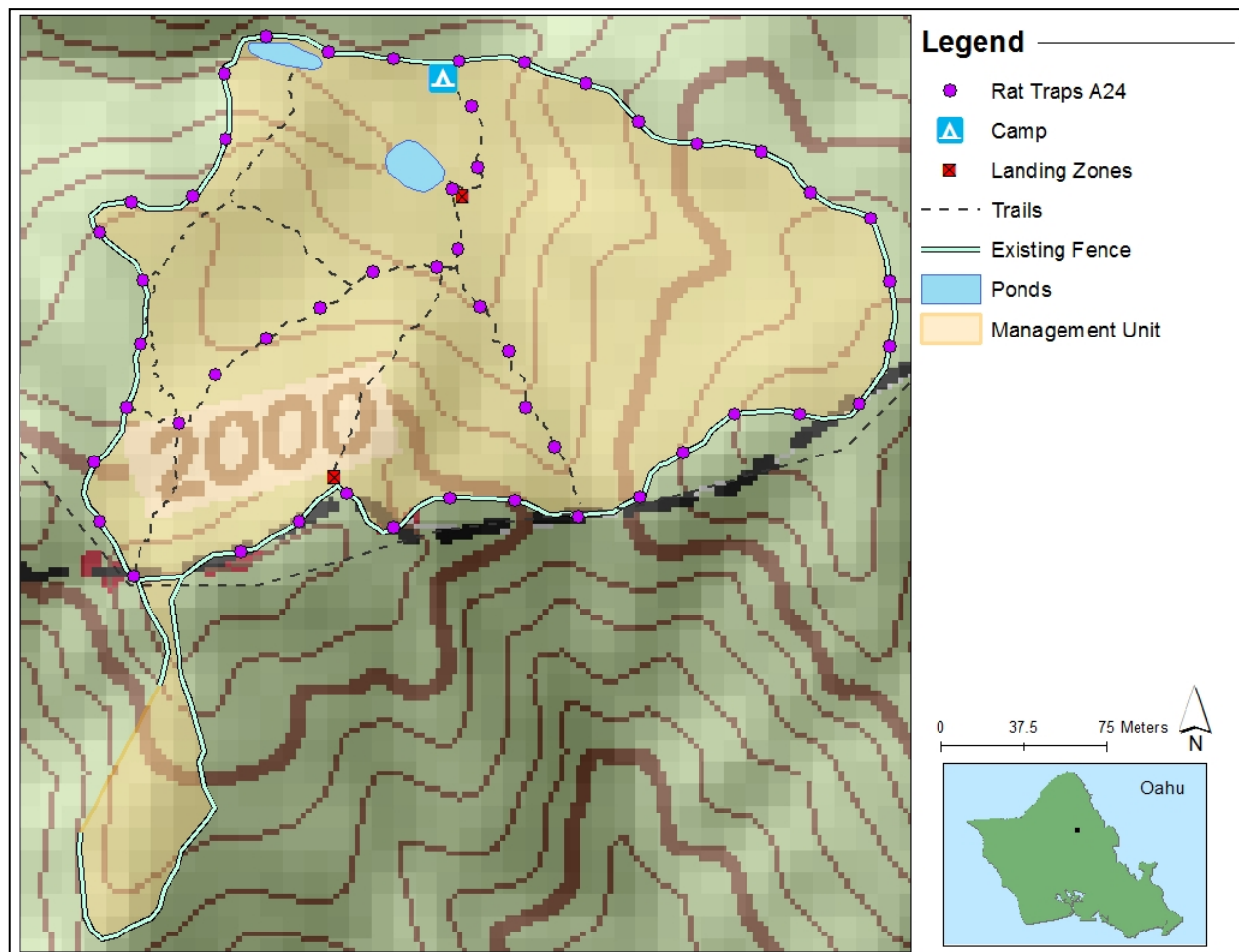
- Mitigate threat of rodent activity on managed plants.

Strategy and Control Methods:

- Active GoodNature A24 (50) grid across the MU. Traps are deployed every 20 m along trails and the perimeter fenceline.
- Monitor MIP/OIP rare plant (*C. dentata* and *Gardenia mannii*) populations, as well as other native species.

Discussion: Formerly rodent control was only conducted around the *C. dentata* reintroduction site using Victor snap traps. All Victor snap traps were replaced with GoodNature A24s to protect *C. dentata* year-round. Since this MU is relatively small in area, OANRP created a GoodNature A24 trapping grid encompassing the whole MU excluding the *Melicope* finger, since there are no IP species located there. OANRP staff check A24s every 4 months.

Small Vertebrate Management Map



Ant Control

Species: *Solenopsis papuana* (Detected in August 2018)

Threat Level: High for endangered *Drosophila*.

Seasonality/Relevant Species Biology: Varies by species.

Management Objectives:

- 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 if needed for *Drosophila* conservation.
- Detect incursions of new ant species prior to establishment.

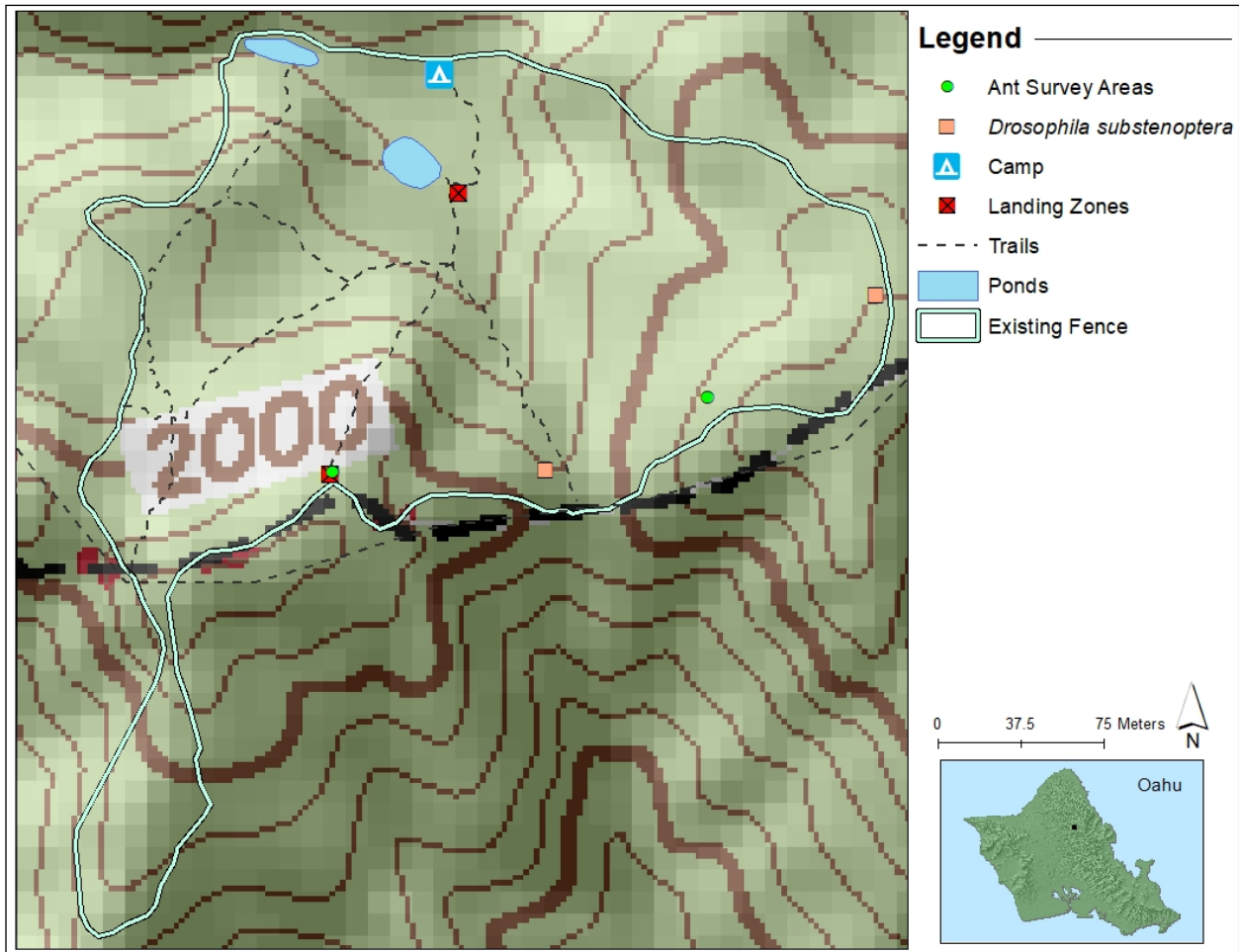
Strategy and Control Methods:

- 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 (<0.5 acre infestation), begin control.
- Sample ants at campsite, LZ and *Drosophila* sites.

Ant Survey Site Table

Site description	Reason for survey
Puu Curta LZ	High risk of accidental ant introduction.
<i>Drosophila substenoptera</i> area	<i>Drosophila</i> are sensitive to high ant abundance.

Ant Management Map



Discussion: Surveying for ants at this MU was conducted twice in 2015 and 2016 around the camp site and no ants were detected. However, during *Drosophila* monitoring by the program's entomologist, *S. papuana* has been observed at the *D. substenoptera* sites along the fenceline. *S. papuana* is a known threat to *Drosophila* populations. If present, this species would be locally controlled using Amdro (registered for forest use). *S. papuana* is an aggressive ant specie that is known to reduce *Drosophila* survival by 58% (Krushelnycky *et al.* 2017). OANRP plans to conduct annual ant surveys at the LZ Puu Curta and the *D. substenoptera* site along the fenceline.

Slug Control

Species: *Deroceras leave*, *Meghimatium biliniatum* and *Limax maximus*

Threat level: High for *Cyrtandra dentata*.

Seasonality/Relevant Species Biology: Slugs are seasonally abundant during the wet season (September-May). However, due to the already wet environment in Lower Opauala, slug population numbers can be sustained throughout the dry season.

Management Objectives:

- Control slugs locally to ensure germination and survivorship of *C. dentata*.
- Conduct annual census monitoring of T1 OIP rare plant taxa to look for seedling recruitment and slug herbivory.

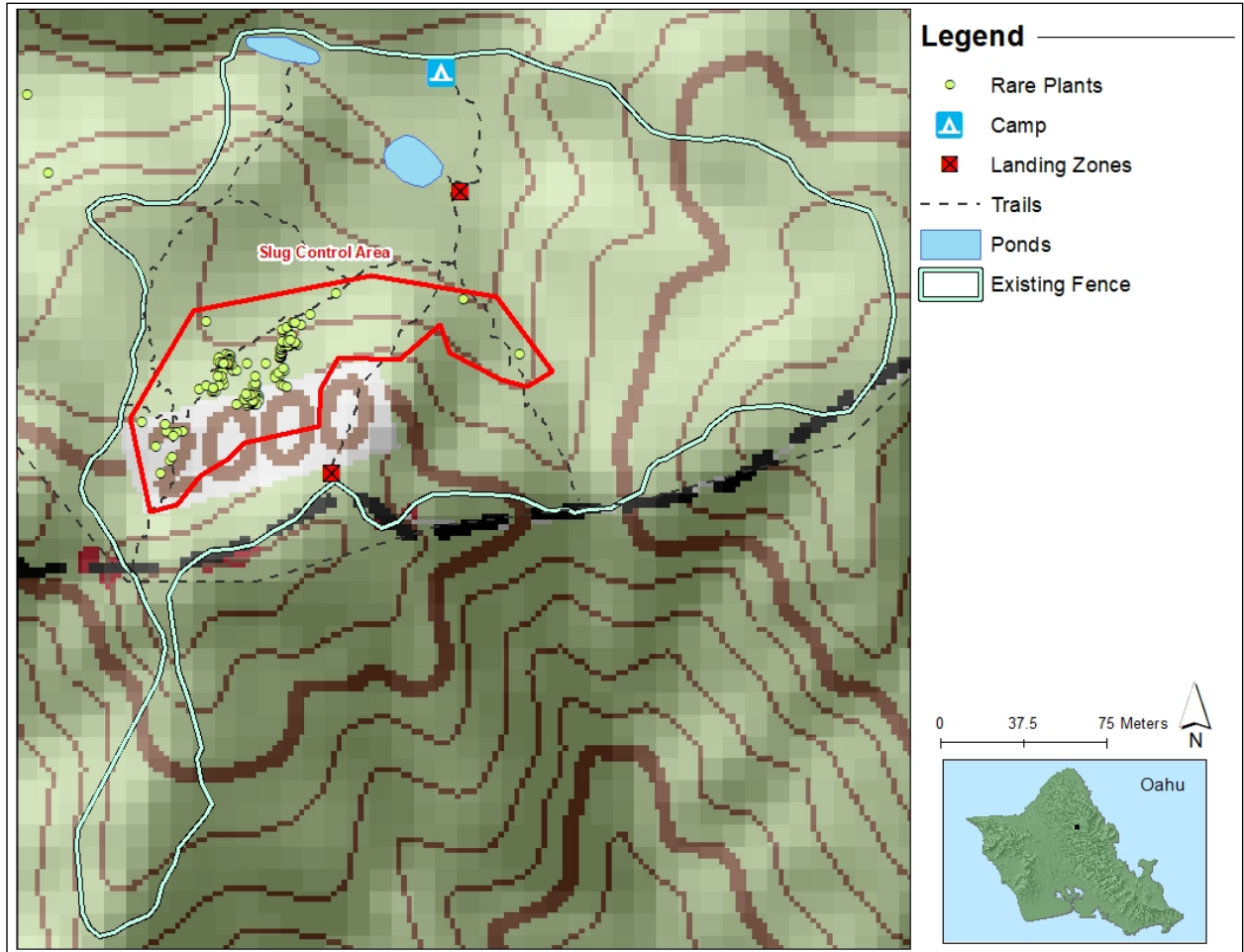
Strategy and Control Methods:

- Slug Control Areas (SLCAs) around rare taxa locations have been surveyed (2015) and cleared of native snails.
- FerroxxAQ is applied to these SLCAs once a quarter. FerroxxAQ is not applied within 20 m of known populations of native snails, however that are no native snails located in the MU.
- 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
OPA-A	<i>C. dentata</i> (OPA-F)	2016

Slug Management Map



Discussion: Based on sampling at the *Cyanea superba* subsp. *superba* seed sow trial sites, slugs are present, but not abundant, at this site (Appendix 4-4 OANRP 2017). However, due to the low *C. dentata* recruitment, OANRP controls any slugs around the *C. dentata* population using molluscicide FerroxxAQ. Our current management actions (sampling slugs once per year and treating rare plants with molluscicide every quarter) are sufficient to mitigate this threat.

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, 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
7843	Ant Monitoring	None	OPA-F	Sample ants using peanut butter and syrup at LZ and at Drosophila site, 10 baits at each site, leave for 1 hour (can leave longer but a minimum of 1 hour). Note weather. Avoid sampling on rainy cold days. If baits are left in the sunshine, place them in the shade under vegetation.				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
				any potentially viable fruit.																				
4432	Weed: LZ Survey	None	LZ-KLOA-033	Survey Puu Curta 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		
6231	Photopoint Monitor	None		Take photopoints installed across MU 1x year.	X				X				X				X				X			
6245	Weed Control	None	OpaepalaLower-01	Sweep entire subunit for canopy weeds and sparse understory weeds, working slowly towards removing all Clihir, once every 2-3 years. Prioritize rare taxa locations and native forest patches.								X						X						
6249	Weed Control	None	OpaepalaLower-02	Conduct control in weedy gulch to west of Blue Curta Saddle trail. Target understory control, and gradual removal of canopy.	X		X		X		X		X		X		X		X		X			
7555	Weed Control	None	OpaepalaLower-02	Control weeds around CyrDen, annually.				X				X				X				X		X		

