

Ecosystem Restoration Management Plan
MIP Year 12-16, Oct. 2016-Sept. 2021
OIP Year 9-13, Oct. 2016-Sept. 2021
MU: Kamaili

Overall OIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, weed, predatory snail, rodent, and slug threats in the next five years to allow for stabilization of IP taxa. Implement control methods by 2021.

Background Information

Location: Leeward side of Northern Waianae Mountains, southwestern base of Makaha Valley

Land Owner: City and County of Honolulu Board of Water Supply (BWS)

Land Manager: U.S. Army Garrison Hawaii

Acreage: 2.83 acres (Kamaili Makai, western fence), 6.73 acres (Kamaili Mauka, eastern fence)

Elevation range: 1,800 to 2,200 ft.

Description: Kamaili is a sub gulch located in the lower reaches of Makaha Valley, with moderate to steep slopes and small cliffs. It is divided by several small ridges and gullies. Due to the challenging terrain the MU is divided into two small fence units. One is located on the western side of the gulch, the other on the eastern side of the gulch. Kamaili Mauka fence contains two small gulches with a dividing ridge and is twice the area of Kamaili Makai. The Kamaili Makai fence has one small gulch running through the middle of the fence and incorporates a strategic fence section on the northwestern corner. A campsite and landing zone are located between the two fences to facilitate management work.

Native Vegetation Types:

Waianae Vegetation Types
<u>Mesic mixed forest</u>
<u>Canopy includes:</u> <i>Antidesma pulvinatum</i> , <i>Diospyros</i> spp., <i>Hibiscus arnottianus</i> subsp. <i>arnottianus</i> , <i>Myrsine lanaiensis</i> , <i>Nestegis sandwicensis</i> , <i>Sapindus oahuensis</i> , <i>Rauvolfia sandwicensis</i>
<u>Understory includes:</u> <i>Alyxia stellata</i> , <i>Bidens torta</i> , <i>Coprosma</i> spp., and <i>Microlepidia strigosa</i>
NOTE: For MU monitoring purposes vegetation type is assigned based on theoretical pre-disturbance vegetation. Alien species are not noted.
NOTE: For MU monitoring purposes, vegetation types were subdivided using topography (gulch, mid-slope, ridge). Topography influences vegetation composition to a degree. Combining vegetation type and topography is useful for guiding management in certain instances.



Looking into Kamaili gulch from Makaha subunit I. Arrows indicating fence locations.

MIP/OIP Rare Resources:

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/Reintroduction
Plant	<i>Abutilon sandwicensis</i>	MAK-B, MAK-C	Makaha Makai	(OIP) MFS	Wild
Plant	<i>Flueggea neowawraea</i>	MAK-C	Makaha	(MIP) MFS	Wild
Plant	<i>Neraudia angulata</i>	MAK-C, MAK-D	Makaha Makai	(MIP) MFS	Both
Plant	<i>Nototrichium humile</i>	MAK-C	Makaha	(MIP) GSC	Wild

MFS= Manage for Stability

*= Population Dead

GSC= Genetic Storage Collection

†=Reintroduction not yet done

Other Rare Taxa in and near Kamaili MU:

Organism Type	Species	Federal Status
Plant	<i>Chrysodracon forbesii</i>	Endangered
Plant	<i>Korthasella degeneri</i>	Endangered
Plant	<i>Lipochaeta lobata</i> subsp. <i>leptophylla</i>	Endangered
Plant	<i>Melanthera tenuifolia</i>	Endangered
Plant	<i>Schiedea hookerii</i>	Endangered
Bird	<i>Chasiempis ibidis</i>	Endangered

Rare Resources at Kamaili:



Thumbs up for *Neraudia angulata* MAK-D reintroduction

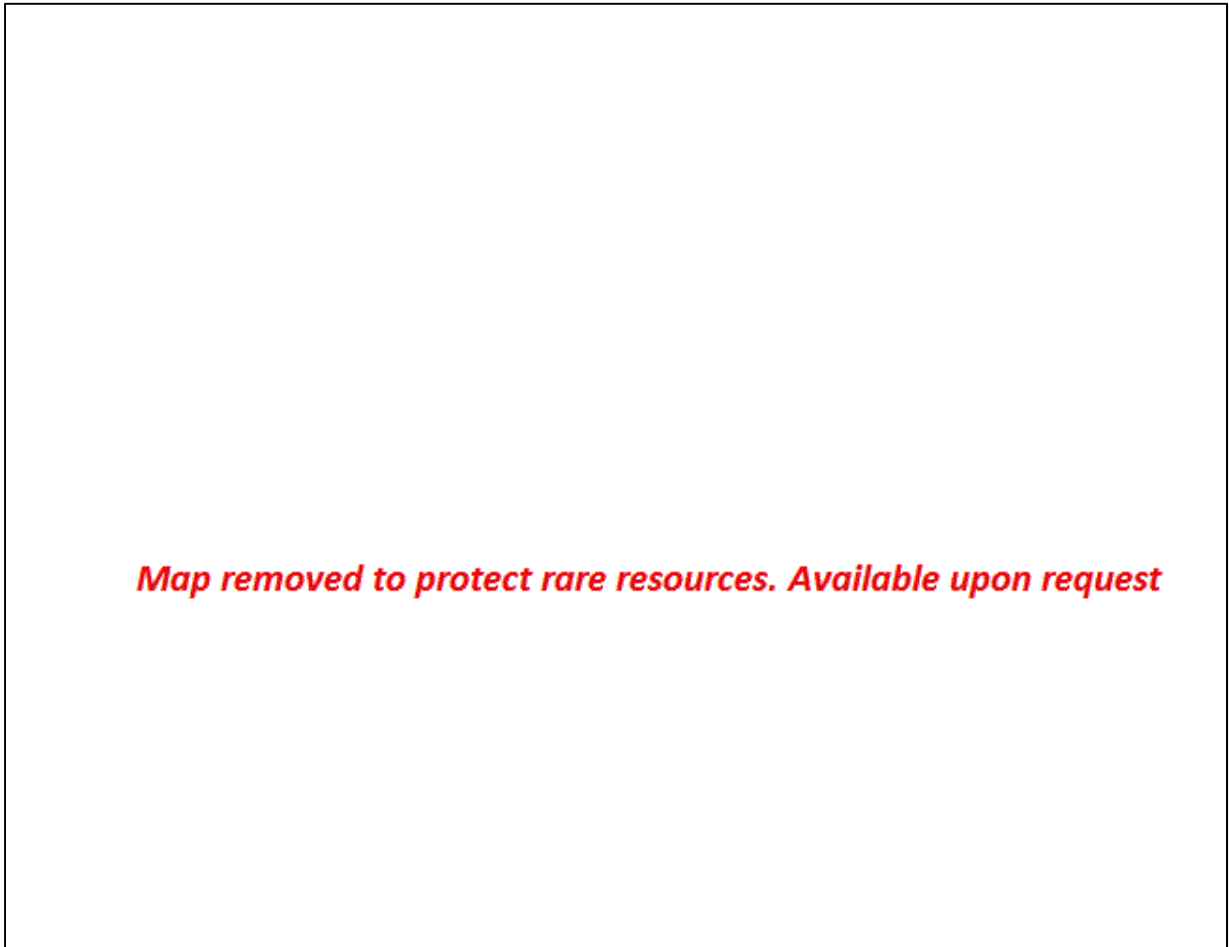


Abutilon sandwicensis MAK-C in mauka fence



Nototrichium humile in flower

Rare Resources Locations at Kamaili:



MU Threats to MIP/OIP MFS Taxa:

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Notes
Pigs	All	No	Yes	MU fenced
Goats	All	No	Yes	MU fenced. Goat control efforts in the region will be planned with the State
Rats	All	Yes	Unknown	No impacts documented in area at this time, so no control currently needed.
Slugs	Slugs are a possible threat to <i>Abutilon</i> seedlings, and are a known threat to <i>Neraudia</i>	Yes	No	Sluggo may be used if no rare native snails are present in the area

<i>Xylosandrus compactus</i> (BTB)	<i>F. neowawraea</i>	No	No	No proven methods currently available
Weeds	All	Yes	Yes	Multiple control techniques are available. Herbicide may be used per a waiver from HBWS, and all use must conform to the restrictions of the waiver (only triclopyr and glyphosate approved).
Fire	All	No	Yes	OANRP is part of the interagency wildlands fire group.

Management History

The Kamaili MU was created fairly recently and is located in a small gulch in Makaha Valley. Surveys and collections of plants have been made over the years to secure species managed by OANRP. The implementation team decided to designate the *N. angulata* population in Kamaili as Manage for Stability in place of Waianae Kai due to poor success of outplantings in Waianae Kai and repeated fence failures.

- 1700-1800s: Intensive subsistence agriculture transforms lower reaches of Makaha Valley.
- 1900s: Ranching and coffee farming continue to modify portions of Makaha Valley with further deforestation.
- 1930-1950s: Reforestation effort by Territorial Government across portions of Makaha Valley.
- 1987: Board of Water Supply gains control of water resources and management of Makaha Valley.
- 2006: OANRP conducts surveys and begins collecting *F. neowawraea*, *A. sandwicensis*, and *N. angulata* from Kamaili area.
- 2010: Forest fire burns lower reaches of Makaha Valley, comes near Kamaili area.
- 2013: LZ built and fence construction started in September.
- 2013: Fence construction complete and deemed ungulate free.
- 2015: First planting of *N. angulata* outplanting, in May.
- 2015: Initial baseline vegetation monitoring conducted using point intercept method.
- 2016: *N. angulata* Manage for Stability designation changed from Waianae Kai MU to Kamaili MU.

Ungulate Control

Identified Ungulate Threats: Pigs, Goats

Threat Level: High

Primary Objectives:

- Maintain MU as pig and goat free.

Strategy:

- Maintain the enclosures as ungulate free of pigs and goats in the MU. Eradication of all pigs and goats within the Kamaili fence units (MAK-E) is complete.

Monitoring Objectives:

- Quarterly fence checks 2015-2021.
- Detect any pig or goat sign in the fence while conducting rare plant monitoring or other weed control work in the MU.

Management Responses:

- If any ungulate activity is detected within the fenced units, implement hunting and/or snaring and trapping program.
- Supplement existing fence with Fickle Fence material if outside pressure is forcing ungulates into the units.

Maintenance issues

The major threats to the fence include falling rocks from steep areas above the units, streams carrying rocks down gulches into the fence, fallen trees, and pigs uprooting areas beneath the fence line. Both fences have problem areas where rocks struck and damaged the fence in the past. If these occurrences are detected repeatedly in the same location, baffles above the fence will be deployed.

Quarterly checks (including maintenance) on fence integrity will be conducted, as well as, monitoring for ungulate sign during the course of other field activities. Fences are also checked after extreme weather events. Given the small sizes of the fence, it is especially important that ungulates do not enter and become trapped in the fence as extensive damage can quickly occur.

Makaha is a popular hunting location for local hunters. Vandalism has been an issue in the past with fences in neighboring areas. Building relationships with local hunters and educating them about the need for fences to protect native resources has been successful in building community awareness and reducing incidences of vandalism. Snares are not used to eradicate pigs or goats in the fences due to the chance of a hunter's dog getting into one of the enclosures. Smaller pigs, if pressured, can penetrate the panel fences that enclose these units. If this is noted, the existing fence will be supplemented with fickle wire fence.

Weed Control

Weed Control actions are divided into five subcategories:

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

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

Vegetation monitoring was initiated at both Kamaili Makai and Kamaili Mauka subunits using point intercept methods to document cover composition and change in the understory and canopy. Results are included in Appendices A and B at the end of this document.

Surveys

Army Training: No

Other Potential Sources of Introduction: NRS, pigs/goats, birds, hikers/hunters, wind

Survey Locations: Roads, Landing Zones, Camp Sites, fencelines, High Potential Traffic Areas

Management Objective:

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

Monitoring Objectives:

- Conduct road surveys, including parking areas, every other year.
- Quarterly surveys of LZ (if used) and Camp Site.
- Note unusual, significant or incipient alien taxa during the course of regular field work.

Management Responses:

- 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)

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.

The Makaha BWS Road will be surveyed every other year, from the first gate (makai of the heiau) to the end of the road. The parking area at the end of the road is used as an LZ; it will be surveyed whenever it is used, not to exceed once per quarter. There is one LZ between the Kamaili fences, and less than 30m away from it is a drop zone and camp site (see map XX below). Both the LZ and camp site will be surveyed whenever used, not to exceed once per

quarter. No weed transects have been created at Kamaili, but staff are directed to note unusual weeds when conducting regular monitoring of fencelines.

Incipient Taxa Control (ICAs)

Management Objectives:

- As feasible, eradicate species identified as high priority incipient invasive aliens in the MU by 2017.
- Conduct seed dormancy trials for all high priority incipients.

Monitoring Objectives:

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

Management Responses:

- If unsuccessful in preventing immature plants from maturing, increase ICA revisitation interval.

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

The table below summarizes invasive taxa at Kamaili. Appendices A and B also list additional non-native taxa in the two units. Note that this MU was not described in the original MIP, and therefore is not included in Appendix 3.1 of the MIP, which lists significant alien species and ranks their potential invasiveness and distribution. This table supplements Appendix 3.1 by identifying target species for Kamaili. The list below provides a good starting point for discussing which taxa should be targeted for eradication in an MU. Three management designations are possible: Incipient (small populations, eradicable), Control Locally (significant threat posed, may or may not be widespread, control feasible at WCA level), and Widespread (common weed, may or may not pose significant threat, control feasible at WCA level). Currently there are no incipient species controlled in Kamaili. NRS staff will monitor the MU and report any new invasive taxa.

Summary of Target Taxa

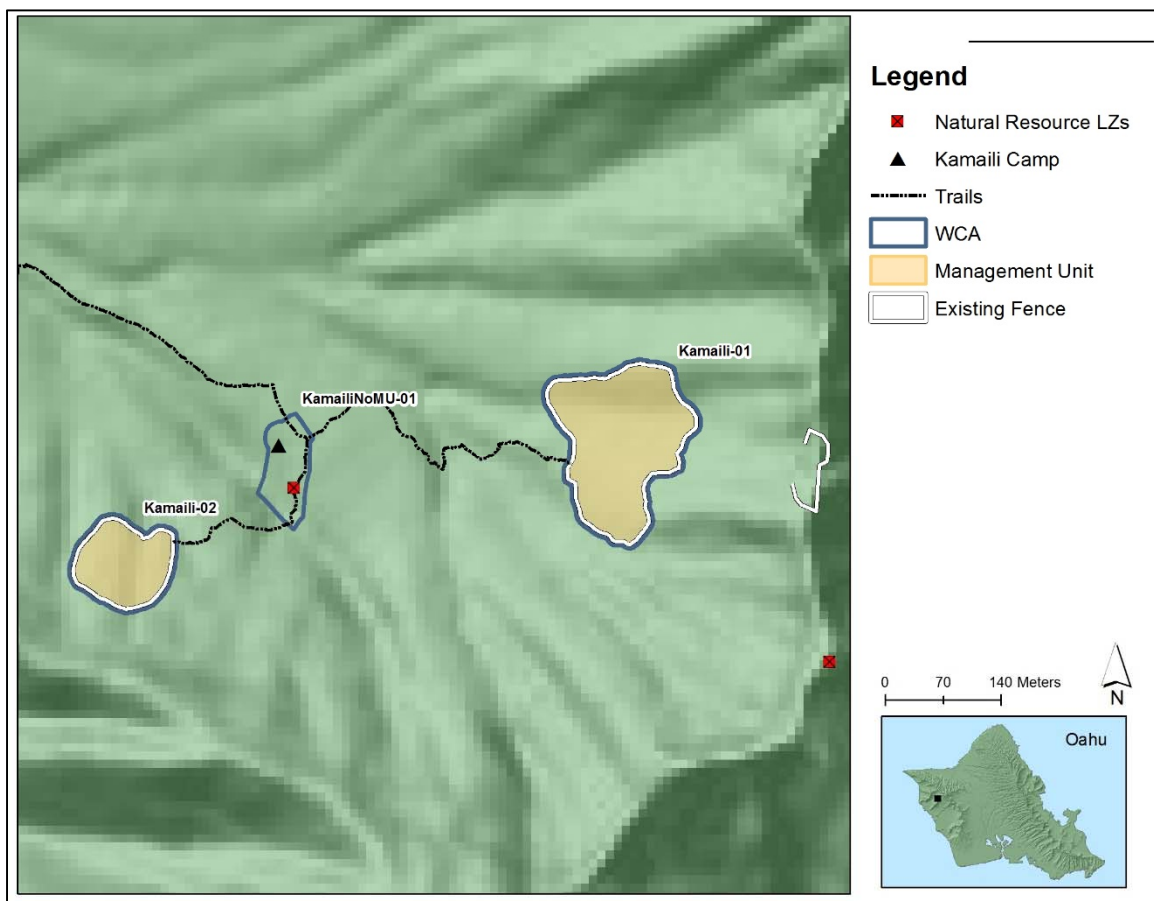
Taxa	Management Designation	Notes	No. of ICAs
<i>Abutilon grandiflora</i>	Control locally	Observed across the MU in sunny locations. Control in WCAs, particularly near <i>Abutilon sandwicensis</i> populations, due to the concern of hybridization.	0
<i>Adiantum hispidulum</i>	Widespread	Observed across the MU. Low priority for control, at least until a control method is identified. This fern thrives in shady areas, and has a WRA score of 18 (very high). Target around rare taxa sites..	0

<i>Ageratina riparia</i>	Widespread	Observed across the MU. Low priority for control. Target around rare taxa sites.	0
<i>Aleurites moluccana</i>	Widespread	This large tree prefers gulches and draws and is found throughout Makaha. It should be targeted for gradual removal within the WCAs.	0
<i>Blechnum appendiculatum</i>	Widespread	Control in WCAs near rare plants and other native dominated areas. This habitat-altering, invasive fern forms dense mats if left unchecked.	0
<i>Coffea arabica</i>	Control locally	Widespread elsewhere in Makaha, little <i>C. arabica</i> is known from the Kamaili fences. It can form dense monocultures and is highly invasive. Zero tolerance for <i>C. arabica</i> within Kamaili fences.	0
<i>Cordia alliodora</i>	Control locally	One of two locations found on Oahu (Waimea Valley is other site). Localized at Kaneaki Heiau, appears to be naturalizing. Control if found near or in MU.	0
<i>Dicliptera chinensis</i>	Widespread	Mostly found in the Makai fence in small patches. Thrives in shady habitat, and can form dense mats. Control near rare taxa.	0
<i>Fraxinus uhdei</i>	Control locally	This large tree was used for forestry plantings in the mid-1900s. It is fast-growing and fruits prolifically. Very few are known from the Kamaili MU. They will be removed from the fences gradually.	0
<i>Grevillea robusta</i>	Widespread	Widespread throughout the valley. Trees shade out <i>Abutilon sandwicensis</i> . Time control with common native plantings, focusing near rare taxa. Selectively control trees as part of WCA efforts. Aminopyralid (Milestone) was effective in controlling <i>Grevillea robusta</i> in Makaha I/II MU. OANRP is no longer permitted to apply this pesticide due to the agreement with Board of Water Supply.	0
<i>Kalanchoe pinnata</i>	Widespread	A common dry forest weed, <i>Kalanchoe</i> reproduces vegetatively from cut leaves and stems. It sometimes forms dense stands. It should not be controlled via clip-and-drip treatments, as cut material may regrow. Plants should be treated with a foliar spray of glyphosate or foliar drizzle of Garlon 4.	0
<i>Montanoa hibiscifolia</i>	Control locally	Escaped from cultivation. Known to create monotypic stands in mesic forests. Found outside the fences, mostly in small numbers. Large patch of plants near LZ. Zero tolerance within fences.	0
<i>Leuceana leucocephala</i>	Widespread	Only a few small patches of plants in fence. This drought and fire tolerant tree thrives in dry conditions. Control during WCA efforts using a 40% dilution of Garlon 4 Ultra in biodiesel. As light levels change there might be an increase in population.	0
<i>Melia azedarach</i>	Control locally	Only a few trees found within fences. Thrives in mesic-dry forest, disperses over great distances, but does not tend to form dense stands. Control during WCA efforts. Can be controlled with basal bark application in an 8 inch band.	0
<i>Melinis minutifolia</i>	Widespread	This grass invades open areas, especially fencelines, and forms fuels which are a fire risk. Control when grass prohibits NRS to thoroughly inspect the fences, and treat all large patches within the fences. Zero tolerance within fence.	0

<i>Oplismenus hirtellus</i>	Widespread	Dominant grass in the understory. It thrives in shade and can form dense mats. Control around rare taxa to encourage recruitment. Treat regularly to maintain at low levels.	0
<i>Paspalum conjugatum</i>	Control locally	Currently, <i>P. conjugatum</i> is not a major component of the understory. However, it readily takes advantage of open gaps, and even thrives in shady areas. It may become a problem as weeded areas are opened. Large patches can be carefully treated with foliar sprays of glyphosate, and small patches can be handpulled. It should be controlled in the course of regular WCA work.	0
<i>Passiflora suberosa</i>	Widespread	Widespread vine in MU. It has a WRA of 12 (very high), roots from multiple nodes, smothers surrounding vegetation, and is labor-intensive to remove. Control around rare taxa as part of WCA efforts.	0
<i>Psidium cattleianum</i>	Widespread	This is one of the most invasive, habitat-altering trees in Hawaii. It is widespread in Makaha, but relatively little is present in the Kamaili fences. It is a target for control in WCA efforts.	0
<i>Psidium guajava</i>	Widespread	This prolifically fruiting tree is found scattered throughout Waianae forests. It should be controlled in the course of WCA efforts, and eliminated from the fences.	0
<i>Rivinia humilis</i>	Widespread	Widespread and dominant in the understory. Low priority until it can be replaced with a native species. This weed quickly recolonizes areas from which it has been weeded, reducing the benefit of control efforts. Investigate seed longevity	0
<i>Schinus terebinthifolius</i>	Widespread	Widespread across the MU, mostly in the mauka fence. Trees shade out <i>Abutilon sandwicensis</i> and rip apart slopes when they fall over. Time control with common native outplantings, focusing removal efforts near rare taxa and more native areas.	0
<i>Sideroxylon persimile</i>	Control locally	Widespread on the northern and eastern slopes of Makaha valley, and scattered across the lower elevations of Kamaili gulch. Not known from inside the management unit. This taxon has a WRA score of 8 (invasive), and thrives in dry-mesic forest. One mature tree was found along the trail from camp to Kamaili Makai. Control when found.	0
<i>Spathodea campanulata</i>	Widespread	This tree is scattered across the valley. It colonizes open areas, and can grow to more than 10m in height. It should be controlled wherever found within the Kamaili fences.	0
<i>Syzygium cumini</i>	Widespread	This tree has a wide distribution. It thrives on slopes and in gulches, and forms dense shade. Large trees are difficult to kill, and often require multiple treatments. <i>Syzygium</i> may host <i>Puccinia</i> rust, which targets native Myrtaceae such as <i>Eugenia</i> and <i>Metrosideros</i> . It should be gradually removed from within both fences.	0
<i>Toona ciliata</i>	Widespread	Widespread across the entire valley and MU, mostly in gulch bottoms. It has not yet fully invaded the Kamaili fences. High priority to remove. Selectively control trees as part of WCA efforts, and have zero tolerance for trees over 2m in height.	0

<i>Triumfetta semitriloba</i>	Widespread	Widespread across MU. The seeds of this shrub are covered in burrs, allowing it to easily hitchhike on staff and feral ungulates. It thrives in disturbed areas. Uncommon in other orange team MUs. Pull during weed control efforts, as well as, along trails, on LZ, and at Campsite.	0
<i>Urochloa maxima</i>	Control locally	This fire-prone grass can form dense stands. It is the dominant vegetation in the makai portions of Makaha. Isolated patches are found at Kamaili and should be controlled during WCA work. Zero tolerance within WCAs or along fencelines.	0

Ecosystem Management Weed Control and Restoration (WCAs)



OIP/MIP Goals:

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

Management Objectives:

- Reduce alien cover in both understory and canopy across the MU, working towards goal of 50% or less alien vegetation cover. .

- Increase native cover in both understory and canopy across the MU, working towards a goal of 50% or more native vegetation cover.
- All portions of the MU are within 50m of rare taxa.

Management Responses:

- Revise weeding strategy if MU vegetation monitoring (conducted every 5 years) indicates that goals are not being met.

Vegetation monitoring (Appendices A and B) indicates that the Kamaili MU does not currently meet any of the MU vegetation cover goals, with the exception of native canopy cover in the Kamaili-02 WCA (61% cover) and non-native cover in the understory in Kamaili-01 (28%). The forest at Kamaili is dominated by alien vegetation, and while pockets of native forest persist, meeting MU goals will be challenging. There are two WCAs in the MU, one around each fence and one WCA outside of the MU. The MU is small, and rare taxa are found throughout both fences. The entire MU is within 50 m of a rare taxa, meaning the general IP goal is actually for 25% or less alien vegetation cover in both understory and canopy; this is an even more challenging goal. We propose that the 50% alien cover goal be used, instead of the 25% cover goal.

BWS currently allows us to apply herbicide in Makaha Valley under a special permit, and are strongly encouraging us to reduce herbicide usage and expand our restoration toolbox. To this end, we hope to use a combination of weed control and restoration actions (outplanting, seed sowing, transplanting), in harmony, at Kamaili.

Restoration activities are discussed in the notes section for each WCA. See the table titled ‘Taxa considerations for restoration actions,’ below, for specific notes on what taxa may be used at Kamaili.

WCA: Kamaili-01 (Mauka Fence; 6.73 acres)

Vegetation Type: Dry-Mesic forest

OIP/MIP Goal: 25% or less alien cover (rare taxa in WCA). Management goals are nearly met for both non-native vegetation in the understory (28%), and for native vegetation in the canopy (43%).

Notes: This WCA contains two patches of *A. sandwicensis*, one *F. neowawraea*, and a few individuals of *N. humile*. The north end of the WCA is oriented along a small ridge. The WCA then spans a little gully to the south, then another small ridge, and ends on the lower slopes of the second ridge. In general the ridges have more native forest, while the gullies are weed dominated. The WCA consists of four management zones: Lama Zone, Talus Gulch Zone, Rare Plant Zone, and Fence Corridor. Removing fuel-forming alien grasses, particularly *U. maxima* and *M. minutiflora* will be a priority across the WCA.

Since the rare plant zones are primarily in weed dominated habitat, canopy control and understory weed control ideally should be undertaken in conjunction with common native reintroduction efforts. Maintaining a managed buffer around the rare taxa is a high priority to promote regeneration of *A. sandwicensis* and *N. humile*. Removal of canopy trees needs to be balanced against light level changes, and staff availability to conduct follow-up maintenance. The area

likely had a fairly open understory in the past, as with other more intact dry-mesic forest areas, and currently maintains a fairly open understory, with 67% non-vegetated cover.

The Lama Zone is predominantly native and will be a high priority for weed control. Although there are few rare taxa directly in the Lama Zone, it abuts the Rare Plant Zones and contributes towards vegetation cover goals. Removing targets, such as, *G. robusta*, *S. terebinthifolius*, and *T. ciliata*, will be key in maintaining canopy goals for this MU. However, selective efforts are needed given the potential for aggressive colonization by other non-natives and very slow growth of *D. sandwicensis*. *Toona ciliata* removal is a higher priority than other canopy weeds in this zone, as this taxa has great potential to completely overrun the WCA. Other, less common tree weeds, such as *S. cumini* and *M. azedarach* will also be targeted for gradual removal.

Intense restoration is needed in the Talus Gulch Zone of the WCA, but is a low priority except for weed control around rare taxa. Native taxa in the Talus Gulch Zone have been repeatedly struck with rocks. The weed species have outcompeted the natives due to their resilience to the constant rock fall. This zone is a good candidate for a restoration site. A portion of the gully could be opened up to create a light gap, which would be restored with a combination of common native outplantings, seed sows and transplants. Incorporating baffles could be installed to protect the common outplantings, as well as the bottom of the fence. Staff have noted natural recruitment of native plants in the area as well. Some taxa being considered for restoration actions included *Raovulfia sandwicensis*, *Pisonia* spp., and *Sapindus oahuensis*.

The rare plant zones (north gulch and south gulch) requires phased control of weeds and selective control of canopy weeds. Areas near the main *A. sandwicensis* clusters need to be defined and starting points selected. Initial areas should be no larger than can be adequately maintained. Ground cover species like weedy ferns, vines, and grasses should be treated first, then larger understory species, then selective removal of canopy trees. Treated trees will likely need to be cut down, bucked, and debris piled into slash piles. Initial control trips are needed about one to two times per quarter (see action table at the end of this document) with supplemental planting with fast growing species like *Dodnea viscosa*, *Pisonia sandwicensis*, and *Pipturus albidus*. Aggressive follow up is needed for understory weeds like *B. appendiculatum* and grasses once light levels increase.

The Fence Corridor will be maintained (inside and outside) anytime grass or weeds prohibit us from checking the fences thoroughly. A catchment is now on site to facilitate weed control. Caution is needed when spraying along portions of the fenceline given recruitment of *A. sandwicensis* along the line. Removal of *S. terebinthifolius* is needed in some areas to prevent damage to the fence by uprooting or downfall.

WCA: Kamaili-02 (Makai fence; 2.83 acres)

Vegetation Type: Dry-Mesic forest

OIP/MIP Goal: 25% or less alien cover (rare taxa in WCA). Management goals are currently not met for non-native vegetation in the understory (71%), but the goal is met for native vegetation in the canopy (61%)..

Targets: All weeds, particularly *D. chinensis*, *G. robusta*, *P. suberosa*, *S. terebinthifolius*, *T. ciliata*, *C. arabica*, *S. cumini*, *S. campanulata*, and *U. maxima* to promote regeneration of rare and other native taxa.

Notes: Like Kamalia Mauka, this area consists of four zones: Lama Zone, Talus Gulch Zone, Rare Plant Zone, and Fence Corridor and has similar management prescriptions for each zone. This WCA stretches from a ridge on the eastern end, across a gully, to a central ridge, and ends on the far side of the ridge by a cliff. The central ridge hosts a *N. angulata* reintroduction on its eastern slope, and a wild *A. sandwicensis* site on its western flank. Much of the central ridge is blanketed by *R. humilis*.

Canopy control and weeding in rare plant zones is ideally undertaken in conjunction with common native reintroduction efforts. Removal of canopy trees needs to be balanced against light level changes. The unit has a fairly dense understory as only 26% of the unit is non-vegetated.

Grevillea robusta and *S. terebinthifolius* will be selectively killed throughout the Lama Zones (primarily on the ridges) and around *A. sandwicensis* to slowly increase light levels. This is mostly on the *N. angulata* reintroduction ridge. Sweeps across the whole area should gradually thin the alien canopy, and all understory weeds need treatment except *R. humilis*. Native fern outplants could be trialed as a replacement for *R. humilis* in spots.

Intense restoration is needed in the Talus Gulch Zone of the WCA but is a low priority. The Talus Gulch Zone is a good candidate for common native outplantings. Common natives selected for this area, such as *Dodnea viscosa*, needs be hardy enough to withstand rockfall. *N. angulata* was augmented in to the fence in 2015 and will be the main focus of this WCA; mainly controlling *P. suberosa*, *D. chinensis*, and other herbaceous weeds.

The main rare plant zones (*N. angulata* reintroduction and *A. sandwicensis* patch along western edge) require similar thinning of the canopy. *Grevillea robusta* removal efforts along the western edge have already benefitted the *A. sandwicensis* plants in the area. Keeping open some bare soil areas near the rare plants is important for recruitment. Grasses and weedy fern species will need to be kept in check. Outplanting natives (e.g., *P. zeylanica*) to compete with *R. humilis* should be trialed particularly along the western edge.

The Fence Corridor will be maintained (inside and outside) anytime grasses or weeds prohibit us from checking the fences thoroughly. Removal of *S. terebinthifolius* is needed in some areas to prevent damage to the fence by uprooting or downfall.

WCA: KamailiNoMU-01 (LZ)

Vegetation Type: Dry-Mesic forest

OIP/MIP Goal: None. Landing Zone (LZ)

Targets: *M. hibiscifolia*, *Conyza bonariensis*, *Ageratum conyzoides*, *T. ciliata*, and *S. terebinthifolius* when it prohibits safe landing of the helicopter.

Notes: WCA efforts will be focused on maintaining the LZ, drop zone and campsite, as well as, controlling a monotypic patch on *M. hibiscifolia*. The boundary of the WCA needs to be GPSed to include the entire *M. hibiscifolia* patch, as well as the adjacent camp drop zone. The *M. hibiscifolia* patch appears to be somewhat isolated, and is fairly monotypic. It is a priority for control, after work within the MU itself, because it reproduces quickly, disperses via wind, and

forms dense stands that are difficult to walk through. Controlling this patch will reduce the chance of *M hibiscifolius* becoming a problem within either MU fence.

The LZ is almost always overgrown with weeds on every quarterly trip to Kamaili. Suppressing herbaceous growth will improve safety and free up staff from constantly clearing the LZ. Conversations about planting sterile grasses to suppress herbaceous weeds and improve LZ safety have been discussed. Species selection, as well as permission from BWS still needs to be attained. Other options including constructing a small platform, or installing weed matting.

Taxa considerations for restoration actions:

Native Taxon	Outplant?	Seedsow/ Division/ Transplant?	Notes
<i>Antidesma pulvinatum</i>	Yes	No	Tree. Grow from cuttings or seed.
<i>Bidens torta</i>	No	Seed sow	Herb. Easily grown via seed sows.
<i>Canavalia galeata</i>	Yes	No	Vine. May not provide enough weed suppression to be worthwhile
<i>Carex meyenii</i>	Yes	Seedsow/Division	Sedge. Grow from seed. Seed sows slow to germinate but effective.
<i>Dodonea visoca</i>	Yes	No	Small tree. Grow from seed.
<i>Hibiscus arnottianus</i>	Yes	No	Tree. Fast-growing. Grow from cuttings.
<i>Metrosideros polymorpha</i>	Yes	No	Tree. Slow-growing. Grow from cuttings or seed.
<i>Microlepia strigosa</i>	Maybe	Division	Fern. Survives transplanting in mesic environments.
<i>Myrsine lanaiensis</i>	Yes	No	Tree. Grow from cuttings or seed.
<i>Nestegis sandwicensis</i>	Yes	No	Tree. Grow from cuttings or seed.
<i>Pipturus albidus</i>	Yes	Seedsow/Transplant	Small tree. Fast growing. Known to grow from seed sows.
<i>Pisonia sandwicensis</i>	Yes	Seedsow/Transplant	Tree. Fast growing. Easy to propagate. Some located just outside of Kamaili Mauka. Know to grow from seed sows.
<i>Planchonella sandwicensis</i>	Yes	No	Tree. Grow from cuttings or seed. Slow growing.
<i>Plumbago zeylanica</i>	Yes	Transplant?	Herb/ground cover. Grow from cuttings or seed. Unknown if transplanting effective.
<i>Psydrax odorata</i>	Yes	No	Tree. Grow from cuttings or seed.
<i>Rauvolfia sandwicensis</i>	Yes	Transplant?	Tree. Some natural recruitment on site. Grow from cuttings or seed.
<i>Sapindus oahuensis</i>	Yes	No	Tree. Grow from cuttings or seed.
<i>Sida fallax</i>	Yes	No	Shrub. Grow from cuttings or seed.

Rodent Control

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

Threat level: Unkown

Current control method: None

Seasonality: N/A

Number of control grids: None

Primary Objective:

- To implement rodent control if determined necessary for the protection of rare plants.

Monitoring Objective:

- Monitor rare plant (*N. angulata* and *A. sandwicensis*) populations, as well as other native species to determine impacts by rodents.

MU Rodent Control:

- Currently no rodent control is conducted by OANRP at Kamaili, since rodents are not deemed a threat at this time. If rare plants are determined to be impacted adversely by rodents, OANRP will evaluate the use of localized rodent control for the protection of these species. Given the small size and dry habitat, a grid of A-24 traps might effectively reduce rat numbers to allow for even greater regeneration of fruiting canopy species like *R. sandwicensis* which already recruits more readily than other native canopy species and this would be good for habitat restoration.

Ant Control

Species: Unknown

Threat level: Unknown

Control level: Unknown

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

Number of sites: Four; Two populations of *N. angulata* and two populations of *A. sandwicensis*

Acceptable Level of Ant Activity: Unknown, systematic ant sampling not yet undertaken

Primary Objective: Collect data on species present and control if ant densities are high enough to threaten rare resources, or if incipient, high-risk species are found.

Management Objective:

- If incipient species are found and deemed to be a high threat and/or easily eradicated locally (<0.5 acre infestation), begin control.

Monitoring Objective:

- Sample ants at campsite, LZ, rare taxa sites, DZ, and fencelines to track changes in existing ant densities and to alert OANRP to any new introductions.
- Look for evidence of ant tending of aphids or scales on rare plants.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. It is therefore important to know their

distribution and density in areas with conservation value. Since 2006, we sample ants in high risk areas using the following method:

Vials are baited with SPAM, peanut butter and honey. We remove the caps and space vials along the edges of, or throughout, the area to be sampled. Vials are spaced at least 5 meters from each other. A minimum of 10 baited vials are deployed at each site, in a shaded area for at least 1 hour. Ant baiting takes place no earlier than 8:00 am in the morning no sampling occurs on rainy, blustery or cold days as both rain and low temperatures reduce ant activity. Ants collected in this manner are returned for later identification.

Standardized surveys have not yet taken place.

Slug Control

Species: Unknown, likely *Deroceras laeve* and *Limax maximus* present

Threat level: Unknown

Control level: Unknown

Seasonality: Less abundant in the dry season (May-August)

Number of sites: Potentially four sites, two populations of *Neraudia angulata* and two populations of *A. sandwicensis*

Primary Objective:

- Eradicate slugs locally to ensure germination and survivorship of rare plant taxa.

Monitoring Objectives:

- During annual rare plant monitoring, we will inspect plants for herbivory. If present, this will be noted. Indication that slugs are responsible includes the following: lower leaves closer to the ground are more damaged, slime is present, 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, check for rare native snails within 20 meters of the rare plants before proceeding with a slug control program.
- Sample slugs in the vicinity using baited beer traps. If the number of slugs captured per trap over two weeks exceeds one slug per trap, and, if no rare native snails are present, apply Sluggo monthly until slug numbers are reduced.

Management Objective:

- Enhance seedling germination via reduction of seedling predators. Count numbers of new recruits during annual rare plant monitoring events.

Fire Control

Threat Level: Medium

Available Tools: Fuel breaks, Visual Markers, Helicopter Water Drops, Honolulu Fire Department.

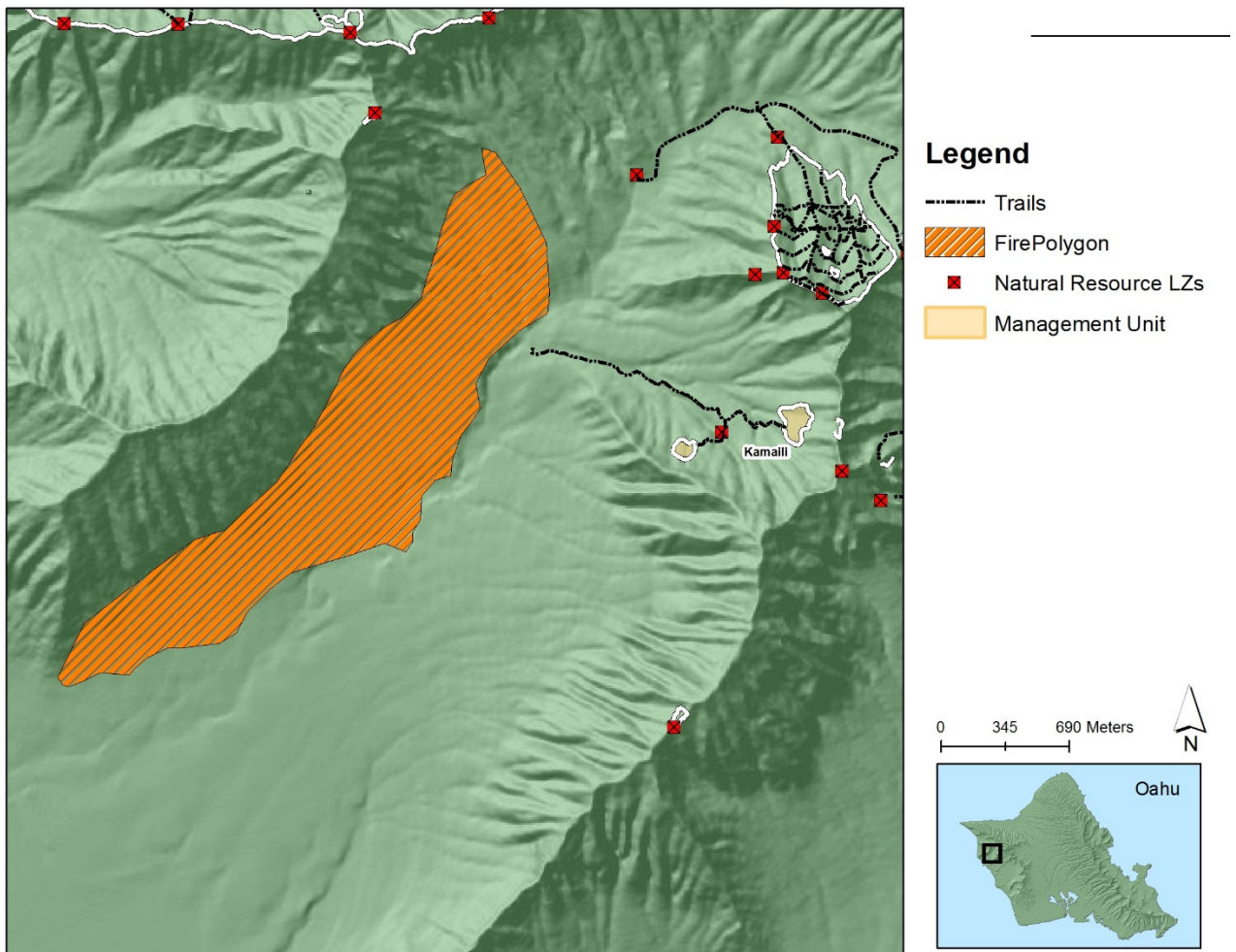
Management Objective:

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

Preventative Actions

Since most ignitions are started by people, fires in Makaha normally start in the lower section of the valley closer to civilization. The majority of the fuel load in Makaha is located on the south facing slopes and in lower elevations where fire had previously burned. BWS has been constructing a fire break on the southern slopes to mitigate this threat. The fire break utilizes tree species to shade out grasses and reduce fire loads at strategic points. Keeping fence corridors clear, as well as, reducing fuel load around high value portions of the MU can provide somewhat of a fuel break. Depending on the location of the fire and what resources are threatened Honolulu Fire Department, State, or Military may assist in fire suppression. In recent years OANRP has provided helicopter support for wildland fire suppression when fire threatens rare resources OANRP manage. OANRP will focus on maintaining good communication with the Wildland Fire Working Group to facilitate aggressive on-the-ground fire responses.

Burned Areas in Makaha near Kamaili in 2010.



Action Table

Species names are written as six-digit abbreviations, such as 'TooCil' instead of *Toona ciliata*, for the sake of brevity.

Action Type	Actions	OIP Year 9 Oct 2016- Sept 2017				OIP Year 10 Oct 2017- Sept 2018				OIP Year 11 Oct 2018- Sept 2019				OIP Year 12 Oct 2019- Sept 2020				OIP Year 13 Oct 2020- Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ungulate Control	Quarterly fence checks Identify and scope high probability ungulate usage areas																				
	Create Baffles																				
Vegetation Monitoring	Conduct baseline vegetation monitoring across MU																				
	Conduct MU vegetation monitoring every 5 years (2021 Q3)																				
General Survey	LZ-Kamaili-199: Survey Kamaili LZ whenever use, not to exceed once per quarter. If not used, no need to survey.																				
	LZ-MAK-096: Survey Makaha Parking Area LZ whenever use, not to exceed once per quarter. If not used, no need to survey.																				
Common Native	Common native collection: collect/monitor fruit from common native plants across Kamaili for propagation or storage. Use Collection Needs list: V: Programmatic /Common Natives /Collection Needs. Action includes monitoring plant phenology.																				
	Kamaili-01: Common native restoration actions in WCA: Scoping, Planting (outplant, sows, divisions/ transplants), Monitoring (plant monitoring, watering).																				

Action Type	Actions	OIP Year 9 Oct 2016- Sept 2017				OIP Year 10 Oct 2017- Sept 2018				OIP Year 11 Oct 2018- Sept 2019				OIP Year 12 Oct 2019- Sept 2020				OIP Year 13 Oct 2020- Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Kamaili-02: Common native restoration actions in WCA: Scoping, Planting (outplant, sows, divisions/ transplants), Monitoring (plant monitoring, watering).																				
General WCA	Water source for both fences (fine tune, install, construct, lay line, etc).																				
	Scoping trips for ecosystem restoration related projects in Kamaili. As needed.																				
Kamaili-01 (Kamaili Mauka)	Sweep through lama-dominated ridges, native canopy zones 1-2x year. Control understory weeds and gradually remove canopy weeds; avoid creating large light gaps; target TooCil, GreRob, SpaCam, and other uncommon canopy weeds.																				
	Control weeds around the two Abusan sites 1-2 times per year.																				
	Control SchTer and other weeds in gulch areas (northern gulch and southern gulch). Control understory, remove SchTer aggressively, conduct consistent follow-up weed control and restoration.																				
	Clear/maintain weeds along fenceline, as needed.																				
Kamaili-02 (Kamaili Makai)	Sweep through lama-dominated ridges, native canopy zones once a year. Control understory weeds, except Rivhum, and gradually remove canopy weeds; avoid creating large light gaps; target TooCil, SpaCam, CofAra and other uncommon canopy weeds.																				

Action Type	Actions	OIP Year 9 Oct 2016- Sept 2017				OIP Year 10 Oct 2017- Sept 2018				OIP Year 11 Oct 2018- Sept 2019				OIP Year 12 Oct 2019- Sept 2020				OIP Year 13 Oct 2020- Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control understory and select canopy weeds around the NerAng MAK-B reintro site, 2 times per year. Qtrs 2 and 4																				
	Control SchTer and other weeds in gulch. Control understory, remove SchTer aggressively, conduct consistent follow-up weed control and restoration.																				
	Control understory and gradually remove select canopy weeds around the western Abusan sites 1-2 times per year.																				
KamailiNoMU-01 (Kamaili LZ and Camp)	Map perimeter of MonHib patch, use to modify WCA boundary. MonHib flowers in winter. Consider heli survey.																				
	Maintain LZ and keep clear for safe helicopter use. This may involve removing trees, and clearing shrubs. Conduct as needed. Consider erosion matting or a platform.																				
	Control MonHib next to LZ and in gulch to west and south. This is an isolated patch, and goal is to prevent it from spreading to the exclosures.																				
Rodent Control	Implement localized rodent control if determined to be necessary for the protection of rare plants.																				
Ant Control	Sample ants at LZ, Campsite, near rare taxa, and on fenceline																				
Predatory Snail Control	Implement control if deemed necessary																				
Slug Control	Determine slug species present and estimate baseline densities to help guide future control if deemed necessary																				