Ecosystem Restoration Management Plan

Updated July 2016

MIP Year 12-16, Oct. 2016 – Sept. 2021

MU: Ohikilolo Lower

Overall MIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, rodent, fire, and weed threats to support stable populations of IP taxa. Implement control methods by 2021.

Background Information

Location: Northern Waianae Mountains

Land Owner: US Army Garrison Hawaii

Land Manager: Oahu Army Natural Resources Program (OANRP)

Acreage: 70

Elevation Range: 100 – 400ft.

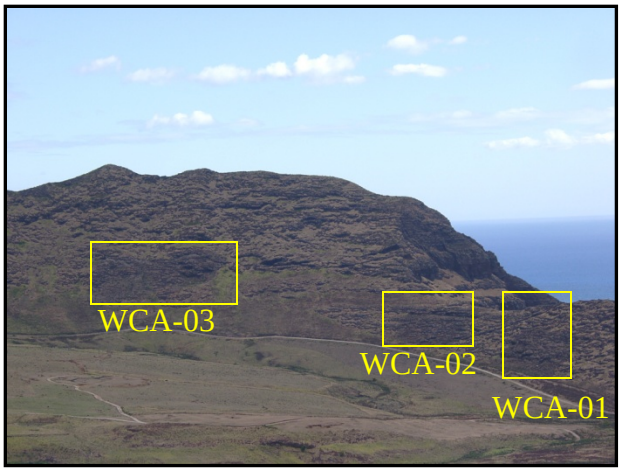
Description: Lower Ohikilolo MU is located in the Makua Military Reservation (MMR). It lies in the southwestern corner of Makua valley, on the bottom section of Ohikilolo ridge where it curves to parallel the ocean. This MU is accessed via the Makua firebreak road and consists of rocky cliffs. Due to a recent unexploded ordinance (UXO) incident, access to this MU was suspended from May 2015 to December 2015. Following a complete UXO clearing of Lower Ohikilolo patches, OANRP has resumed management of the area. While the MU is home to large populations of endangered plants, the overall landscape is highly degraded and weedy, and very fire-prone. The majority of rare taxa management is focused on reducing fuel loads to minimize the risk of fire, as well as outplanting common natives to reduce invasive vascular plants, which includes *Leucaena leucocephala, Urocholoa maxima, Hiptis Spp., Leonotis nepetifolia, Verbesina encelioides and Melinis repens* coverage in the area. Overall, Lower Ohikilolo is dominated by *U. maxima* and *M. repens* which requires substantial labor to manage. Thus NRS will not manage the entire MU to the same level. Weed control will be focused only around the rare plant populations and surrounding areas, which consist mostly of weedy grasses and scattered native shrubs. However, as a result of recent OANRP weeding actions and common native outplantings, the Weed Control Areas (WCAs) are increasingly being dominated by common native shrub and plant populations including the *Dodonea viscosa, Abutilon incanum, Erythrina sandwicensis, Sida fallax* and *Waltheria indica*.

Native Vegetation Types

Waianae Vegetation Types
Lowland Dry Shrubland/ Grassland
Canopy includes: *Erythrina sandwicensis, Myoporum sandwicense, Dodonaea viscosa, Santalum ellipticum, Melanthera tenuifolia, Hibiscus brackenridgei* subsp. *mokuleianus* Understory includes: *Heteropogon contortus, Sida fallax, Eragrostis variabilis, Abutilon incanum, Leptecophylla tameiameiae, Euphorbia celastroides, Waltheria indica, Bidens* sp.

NOTE: For MU monitoring purposes vegetation type is listed based on theoretical pre-disturbance vegetation. Alien species are not noted.

Vegetation Types at Lower Ohikilolo



Ohikilolo Lower MU.


E. celastroides var. *kaenana* patch.


Picture taken from the upper section of the *H. brackenridgei* subsp. *mokuleianus* site, showing the terrain of the MU.

MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Euphorbia celastroides* var. *kaenana*	MMR-D	Makua	MFS	Wild
Plant	*Hibiscus brackenridgei*	MMR-A MMR-F,G	Makua	MFS	Wild Augmentation

	subsp. *mokuleianus*				
Plant	*Melanthera tenuifolia*	MMR-D	Ohikilolo	GSC	Wild

MFS= Manage for Stability GSC= Genetic Storage Collection

Other Rare Taxa at Ohikilolo Lower MU

Organism Type	Species	Status
Plant	*Capparis sandwicensis*	Species of concern
Plant	*Lobelia niihauensis*	Endangered
Plant	*Silene lanceolata*	Endangered
Plant	*Spermolepis hawaiiensis*	Endangered

Rare Resources at Ohikilolo Lower

Hibiscus brackenridgei subsp. *mokuleianus*

Euphorbia celastroides var. *kaenana*

Spermolepis hawaiiensis

Melanthera tenuifolia

Locations of Rare Resources at Ohikilolo Lower

Map removed to protect rare resources. Available upon request

MU Threats to MIP Taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes
Goats	All	No	Yes	Yes
Rats	All	Yes	No	Yes
Ants	All	Yes	No	Toxicants exist, but are not effective for all species
Weeds	All	No	Yes	Yes
Fire	All	No	Yes	Yes

*Note: 'Localized Control' refers to management in a discrete portion of the MU, such as directly around a rare taxa site, as opposed to 'MU Scale Control, which refers to management across the entire MU.

Management History

- 1970: Fire from military training burns Makua Valley
- 1984: Fire from military training burns Makua Valley
- 1995: Escaped prescribed fire in Makua burns part of the valley
- 1998: Fire burns part of Ohikilolo Lower MU.
- 1998: Live fire training ceased as a result of a lawsuit by Malama Makua.
- 2000: Perimeter fence completed; fence separates Makua Valley from the adjoining Ohikilolo Ranch, home to a large goat population.
- 2001: *H. brackenridgei* subsp. *mokuleianus* and *E. celastroides* var. *kaenana* found at MU.
- 2001: Grass control begins, with goal of reducing fuel load directly around the recently discovered rare taxa. Intensive management of three fuel breaks around the Upper and Lower Akoko and Hibiscus patch begins. Efforts take hundreds of hours per year and are currently on-going.
- 2003: Escaped prescribed fire in Makua burns half of the valley.
- 2003: A breach in the fence allows goats to cross over into Makua Valley. Goats are removed and fence is repaired.
- 2005: Augmentation of *H. brackenridgei* subsp. *mokuleianus* begins with outplantings.
- 2006: Breach in the fence is repaired and goats are caught.
- 2006: One immature *Cenchrus setaceus* found in Lower Akoko patch. ICA MMR-CenSet-01 created. No plants seen on subsequent visits, despite intensive weed control in area.
- 2007-2008: Needed repairs are made in the Ohikilolo ridge fence, goats continue to breach some areas of the fence. Fires from Farrington Hwy. side of the patches burn up to ridge and threaten patches.
- 2011: *Cenchrus setaceus* plants found along fenceline and in Lower and Upper Akoko patches. New ICA-02 was added and management efforts have increased including periodic aerial sprays.
- 2011-2012: Surveys conducted in 2011 and early 2012 revealed a large infestation of CenSet on the ocean-facing cliffs at the western end of Ohikilolo ridge. The core of the infestation is a gulch just south of Makua Cave. OISC assists with surveys, and begins control on portion of infestation found on private land to the south, in Keaau. ICA MMR-CenSet-02 created.

- 2012: Aerial sprays of MMR-CenSet-02 begin.
- 2014: *H. brackenridgei* subsp. *mokuleianus* are outplanted along the road and around the pavilion.
- 2015-2016: Access restricted due to UXO incident and areas re-cleared by EOD personnel (including beach sections).
- 2015: Hiking traffic to Makua Cave and Ohikilolo Ridge areas significantly increases due to social media and increased public hiking interest.
- 2015: Common natives planted in significant numbers at the *E. celastroides* var. *kaenana* patches.
- 2016: Lower portion of Ohikilolo fence replaced and entirety of MMR fenced.
- 2016: Plantings of *H. brackenridgei* subsp. *mokuleianus* along fence near range control discontinued due to maintenance issues.

Ungulate Control

Identified Ungulate Threats: Pigs and Goats

Threat Level: High

Primary Objective:

- Maintain all of Makua valley as pig and goat free.

Secondary Objective:

- Control pigs and goats if they affect endangered plants in this MU.

Strategy:

- Ohikilolo ridge fence creates a barrier for goat access from Ohikilolo Ranch and Makaha Valley. Pig activity in the Ohikilolo Lower area has historically been minimal, and no fence was built to limit pig activity in the MU.
- Conduct snaring and trapping (as feasible) in MMR primarily in the lower Makua forested areas until pig sign no longer detected.
- Conduct snaring (as needed) inside the Ohikilolo fenceline until goat sign no longer detected.

Monitoring Objectives:

- Conduct Ohikilolo Ridge/Melten fence checks quarterly (Blue team) and monitor fence for fire damage and vandalism.
- Monitor for pig and goat sign while conducting management actions in the MU.

Management Responses:

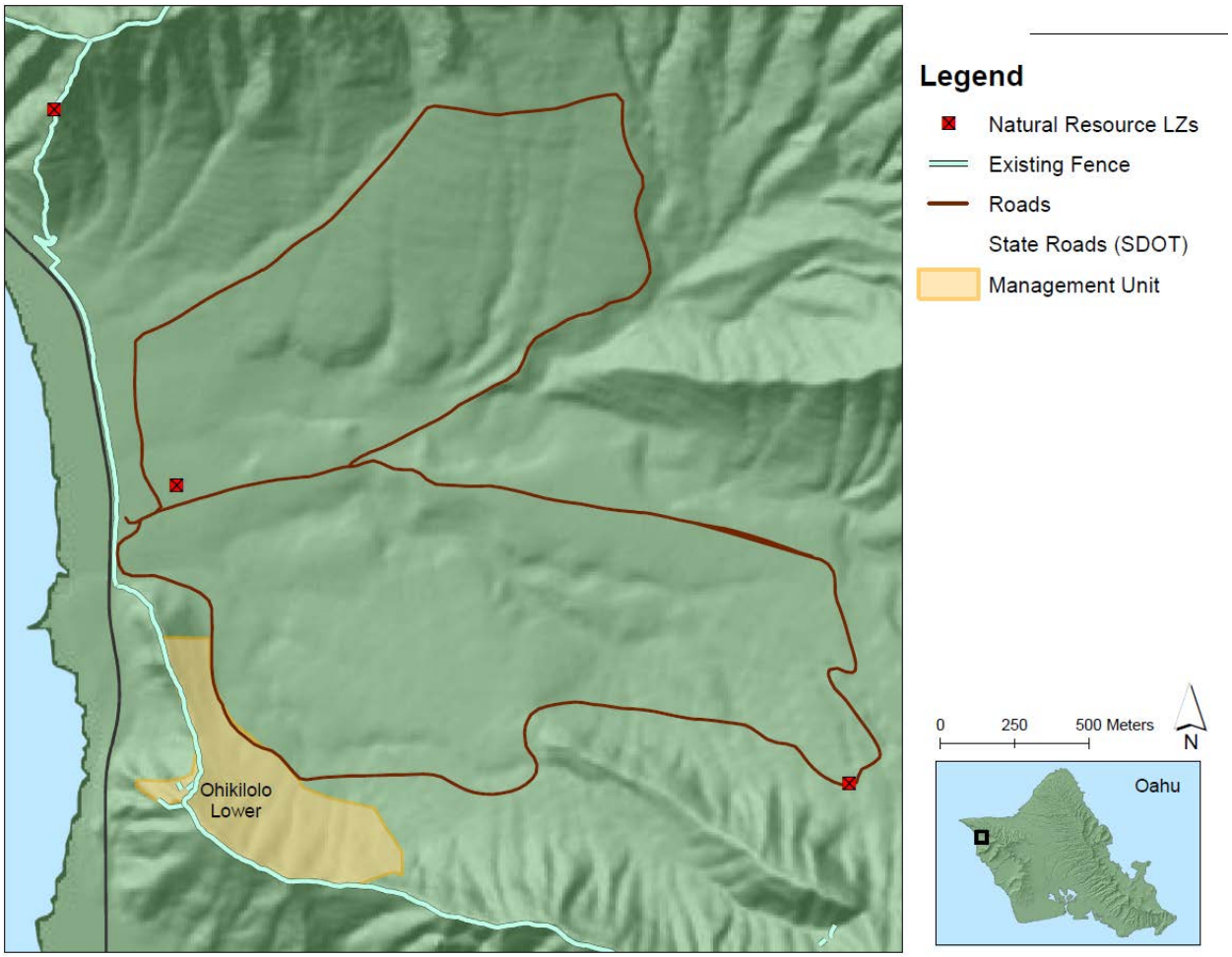
- Implement pig control via snaring if localized damage to plants is observed.

Maintenance Issues

- The major threats to the Ohikilolo Ridge fence include fire, vandalism, and erosion. Snares have been repeatedly vandalized (hung on the fence) by hikers in the area. Camp fires have also been set in the Keeau, Ohikilolo cabin and Ohikilolo Ridge area.
- The small strategic fence above Makua Cave is still accessible to goats. Control of goats through snaring is needed to protect this remnant cliff habitat community, the *Melanthera* plants that may

still be there, and to reduce the potential for goats to spread CenSet. Access in this area is difficult given the steep terrain.

Ungulate Management and Survey Locations at Ohikilolo Lower



Weed Control

Weed Control actions are divided into 4 subcategories:

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

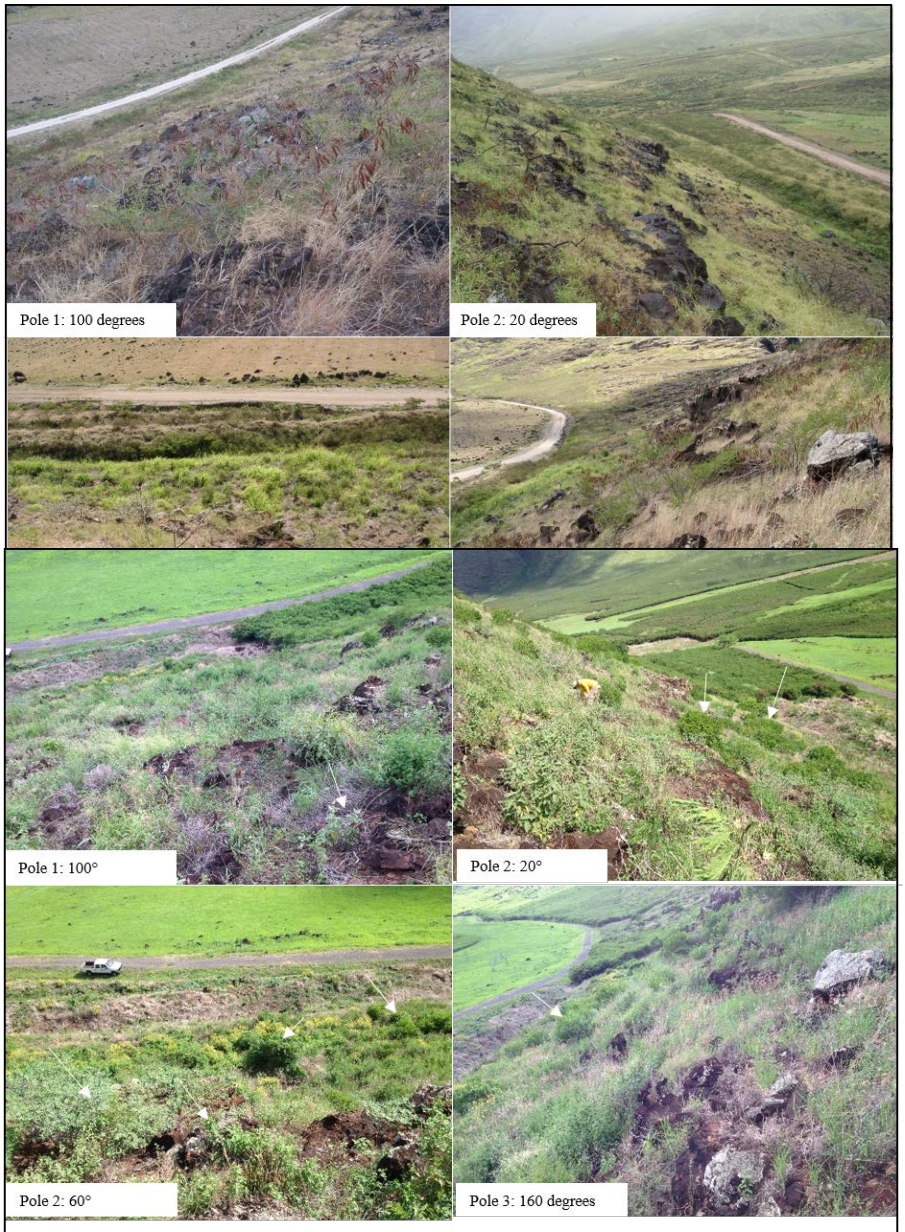
These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

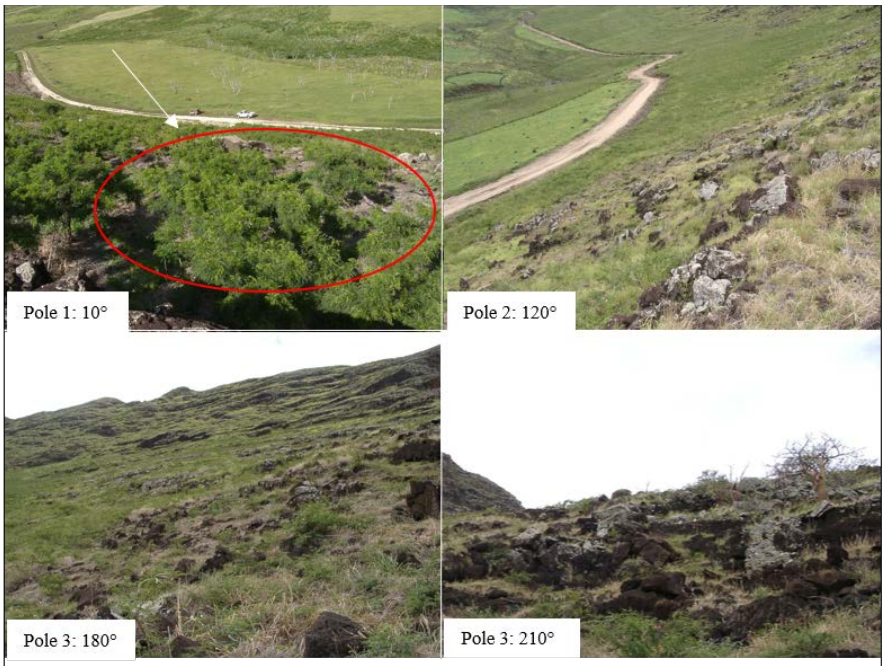
Objectives:

Due to the small size and highly degraded nature of MU, transect protocols implemented at other MUs are not appropriate here. Recruitment of new rare taxa seedlings and increase of native plant vegetation will be monitored to determine if time intervals between scheduled weeding are sufficient. Initial photopoint monitoring of the re-vegetation areas began in 2001 to monitor the change of native shrub cover in WCA-01, -02 and -03 (See pictures below). Monitoring of native shrub cover change for WCA-01, -02, and -03 using Gigapan imagery was then initiated in 2016. Baseline results are included in Appendix A at the end of this document. We assume current alien vegetation management practices are sufficient to decrease fuels and increase the rare plant populations.

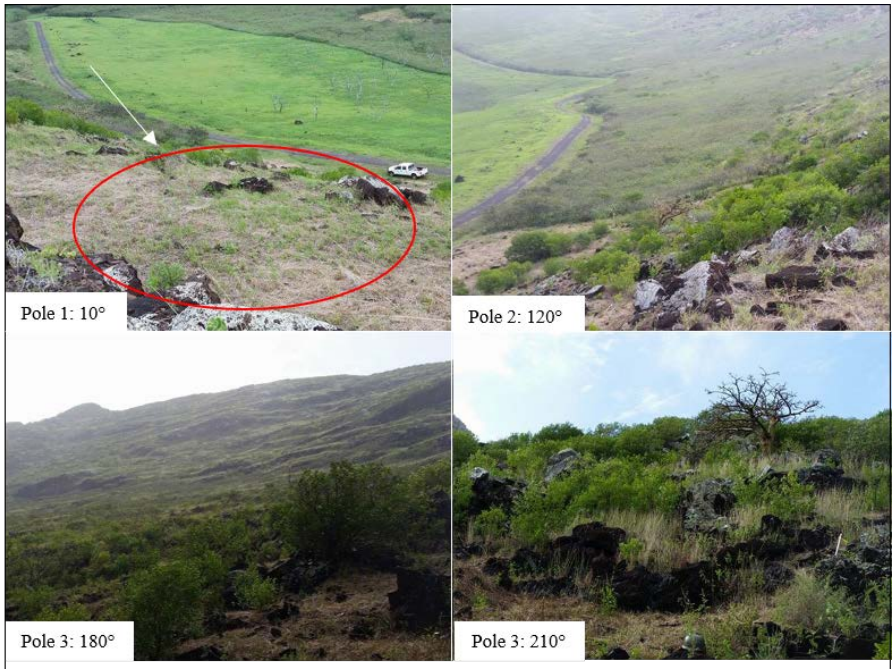
Photopoint Monitoring Ohikilolo Lower



WCA-01. Photopoints are taken at specific locations (Total of 3) in WCA using designated degrees (i.e. 20°, 60°, 100°, 160°). Pictured above are some of the photopoints taken in 2014. Arrows indicate *Waltheria indica, Abutilon indica* and *Dodonea viscosa* recruitment.



WCA-02. Photopoints are taken at specific locations (Total of 3) in WCA using designated degrees (i.e. 10°, 120°, 180°, 210°). Pictured above are some of the photopoints taken in 2002. Arrow in picture of Pole 1: 10° is highlighting an area that was dominated by *Leucaena leucocephala*.



WCA-02. Photopoints are taken at specific locations (Total of 3) in WCA using designated degrees (i.e. 10°, 120°, 180°, 210°). Pictured above are some of the photopoints taken in 2015. Arrow in picture of Pole 1: 10° is highlighting an area that was dominated by *Leucaena leucocephala*. Now same area is clear of *L. leucocephala* and has *Dodonea viscosa* recruitment.

WCA-03. Photopoints are taken at specific locations (Total of 8) in WCA using designated degrees (i.e. 20°, 30°, 90°, 140°, 270°, 300°, 340°). Pictured above are some of the photopoints taken in 2002. Area was dominated by *Urochloa maxima* and *Leucaena leucocephala.*

WCA-03. Photopoints are taken at specific locations (Total of 8) in WCA using designated degrees (i.e. 20°, 30°, 90°, 140°, 270°, 300°, 340°). Pictured above are some of the photopoints taken in 2015 (except Poles 1 and 5 pics taken in 2014). Area once was dominated by *Urochloa maxima* and *Leucaena leucocephala,* but now vegetation is majority *Dodonea viscosa.*

Surveys

Army Training: Yes

Other Potential Sources of Introduction: Recreational hikers (trespassing), Natural Resource Management staff, Makua access events, close proximity to road.

Survey Locations: Roads, Fences, and LZ's.

Management Objective:

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

Monitoring Objectives:

- Firebreak road survey annually
- Survey army LZs annually
- Annual surveys of fencelines and main access trail. Additionally, during course of regular planned actions for endangered taxa, unusual weeds encountered will be noted.

Management Responses:

- New weeds found during surveys along the firebreak road and LZs will be added as ICAs if they are deemed a serious threat to the MU.

Incipient Taxa Control (ICAs)

Management Objective:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2019.
- Cooperate with range maintenance staff for control of *C. setaceus* in areas with prohibited access to OANRP staff or areas managed exclusively by range staff with goal of eradication.

Monitoring Objective:

- Visit ICAs at stated re-visitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.
- Use binoculars and spotting scopes to survey buffer areas for *C. setaceus* annually (or more frequently as needed).

Management Responses:

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

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

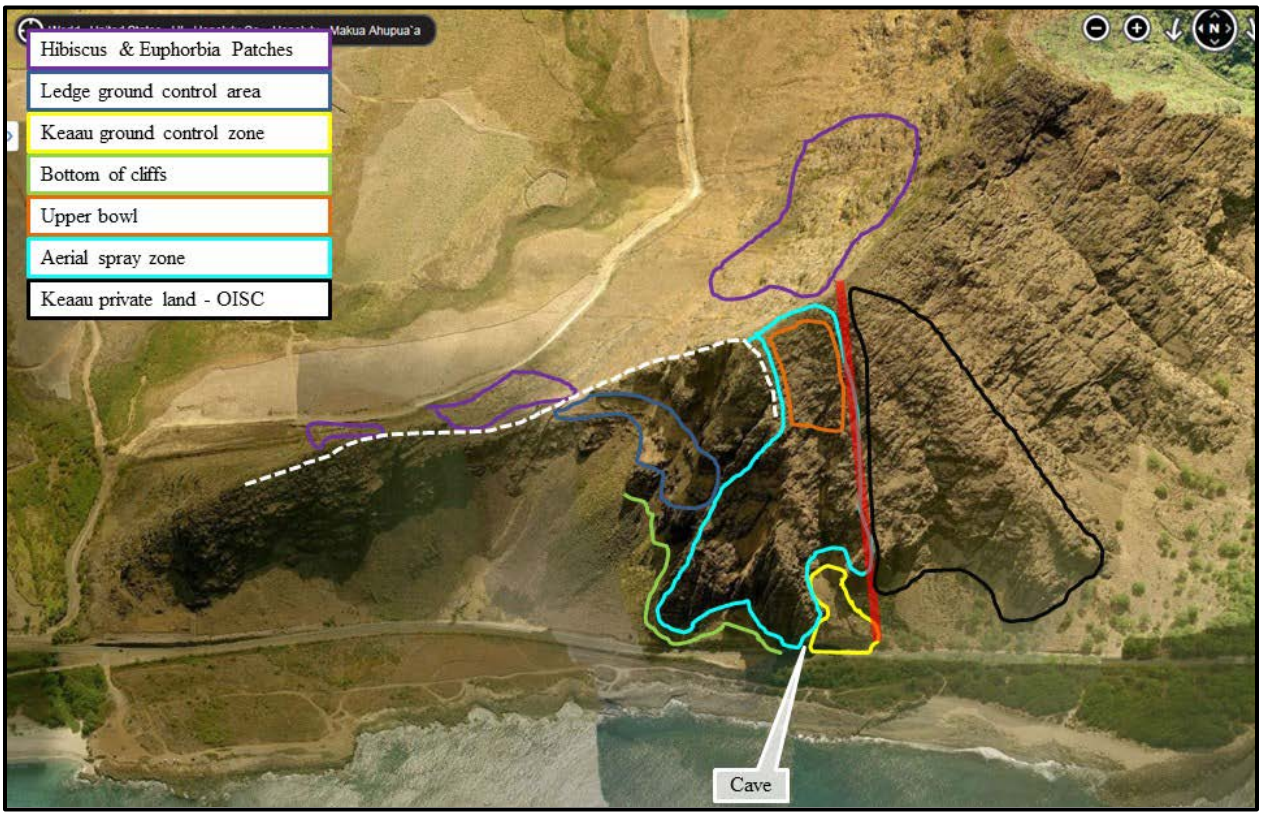
The table below summarizes invasive taxa at Ohikilolo Lower. This MU was described in Appendix 3.1 of the MIP, which lists significant alien species and ranks their potential invasiveness and distribution. This table supplements Appendix 3.1 by identifying target species for Ohikilolo Lower. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in the 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).

There are currently three ICAs identified for one species, *C. setaceus*, in this MU. In 2006, one immature plant was found in the Lower Akoko Patch; ICA MMR-CenSet-01 was created to track follow-up control, but no plants were seen and the ICA was declared eradicated. In 2011, staff found another plant along the fence above the Upper Akoko Patch, and later surveys revealed a large infestation centered outside the MU, on the ocean-facing cliffs of Ohikilolo ridge. This is ICA MMR-CenSet-02. While the source of the infestation is not known, it is possible that recreational hikers may have introduced it when hiking to a

cave or along the fence; C. setaceus is common along the popular Lanikai and Diamond Head trails. Control efforts are on-going and include ground sweeps and aerial sprays. Aerial sprays are necessary in order to target *C. setaceus* plants that are growing on cliffs and extremely steep areas. More thorough surveys are needed in the future to assess the distribution and spread of *C. setaceus*. Although much of the terrain is steep and hazardous to survey by hiking, scoping from vantage points with binoculars and spotting scopes will be the most efficient and effective means to survey.

The aerial image below shows MMR-CenSet-02, and outlines different geographic regions within the ICA. These divisions are helpful when planning actions and field work, particularly since the ICA is so large.

Staff conducted a buried seed trail of *C. setaceus* and found that it does not form a persistent seed bank. No seeds germinated after one year. Therefore, to achieve eradication of an ICA, regular checks must find no plants for at least 2-3 years, which is several times seed longevity, and accounts for the fact that plants may escape detection on any one visit.



Aerial image of the *C. setaceus* infestation.

This year, staff found two outlier locations of C. setaceus along the firebreak road; these are ICAs MMR-CenSet-03 and MMR-CenSet-04. Control activities for all ICAs are detailed in the Action Table at the end of this plan.

The table below summarizes target taxa considerations at Ohikilolo Lower.

Summary of Target Taxa

Taxa	Management Designation	Notes	No. of ICAs
Acacia farnesiana	Widespread	While this taxon can grow into a tree, it is usually shrub-sized in Ohikilolo Lower. Covered in thorns, it is removed whenever found during weed sweeps. It has been removed from all WCAs.	0

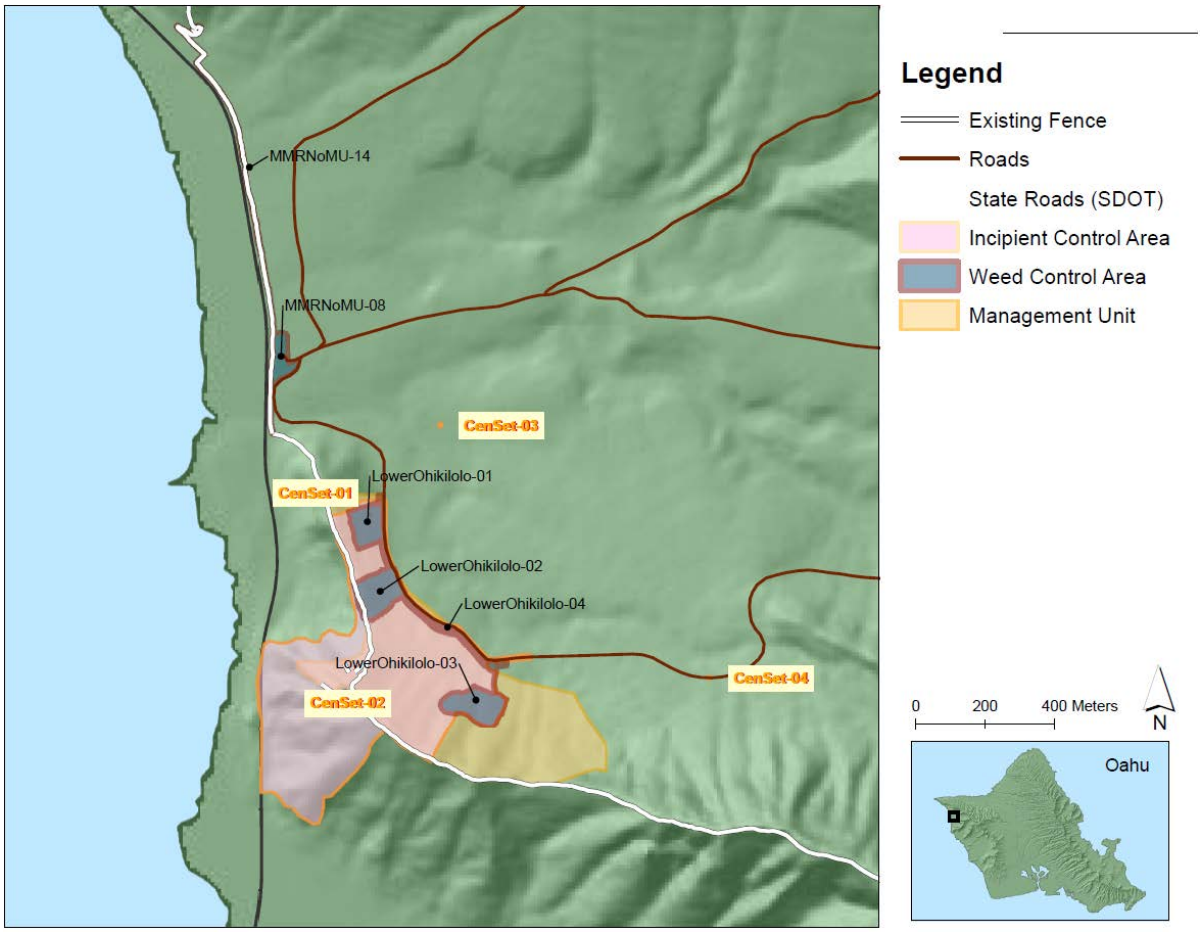
Caesalpinia decapetala	Incipient	One plant was seen growing out of fill along the firebreak road. This ICA has now been eradicated, with no plants seen for more than 10 years. This thorny vine can take over entire gulches. Staff will look for new locations during road surveys.	1 extirpated
Cenchrus setaceus	Incipient	This is one of the most invasive grasses in Hawaii. It is adapted to fire, and thrives in marginal, rocky habitat. It is a high priority for control.	1 extirpated, 3 active
Desmanthus virgatus	Widespread	*D. virgatus* forms dense thickets, and has colonized areas around rare taxa. It is easily controlled via clip and drip treatment of basal stems with Garlon 4 (20% dilution in biodiesel).	0
Kalanchoe pinnata	Widespread	This species' common name is 'Never-die.' It is a drought-tolerant succulent, and thrives on rocky substrates. It appears to use the same habitat as *E. celastroides* and may reduce available habitat for seedling germination. Research is needed to identify effective control measures for this taxon.	0
Leonotis nepetifolia	Widespread	This weedy mint thrives in disturbed areas, and forms dense banks that completely cover open areas. When this annual plant dies, the stalks remain standing for months. When weed control first began at this MU, this taxon was not common, but the weed control regime appears to favor it and other fast-growing annuals.	0
Leucaena leucocephala	Widespread	This is the most common woody plant in the MU. *L. leucocephala* is well-adapted to fire and resilient to disturbance. It can be controlled using a 40% dilution of Garlon 4 Ultra in biodiesel, or using IPA with Milestone.	0
Melinis repens	Widespread	This short statured grass thrives on rocky substrates and is major threat around rare taxa locations. It is removed either via glyphosate sprays or handpulling.	0
Stapelia gigantea	Widespread	A spreading succulent, this taxon was rare in the MU in 2001 and has since spread across rocky areas around *E. celastroides* sites. It appears to use the same habitat as *E. celastroides* and may reduce available habitat for seedling germination. Research is needed to identify effective control methods for this taxon.	0
Urochloa maxima	Widespread	The dominant vegetation in the MU, this grass is well-adapted to fire and has a high burn index. Eliminating it around rare taxa is a priority for reducing fire threat.	0
Verbesina encelioides	Widespread	This fast-growing aster flowers and spreads prolifically. It recently showed up in the MU, and is expected to become more prevalent in weeded areas as it colonizes bare ground.	0

Staff working around *E. celastroides*

Helicopter spraying of *C. setaceus* on cliffs

Ground surveys and sweeps for *C. setaceus* on cliffs

Incipient and Weed Control Areas



Ecosystem Management Weed Control (WCAs)

MIP Goals:

- Within 2m of rare taxa: 0% alien vegetation cover without harming rare taxa
- Within 50m of rare taxa: 0% alien canopy, 10% or less alien grasses, 25% or less alien understory
- Throughout the remainder of the MU: 50% or less alien vegetation cover

Management Objectives:

- Across WCAs, maintain alien cover levels of less than 50%, and work towards native cover levels of more than 50%.
- The remainder of the MU (tan/hatched area on map above) is designated as Priority 2. No objectives are currently identified for this area, which is dominated by *U. maxima* and *L. leucocephala*.

Management Responses:

- Increase/expand weeding efforts if shorter intervals are needed between weeding efforts

Weed control in Lower Ohikilolo by OANRP has mostly been conducted around populations of wild and reintroduced rare plants. The overall weed management strategy for the MU is focused on fuel reduction of large patches of *U. maxima* and *M. repens*. A 20m buffer around the outside of each WCA has been proposed, but contracting of the project has not been completed. Herbicide control of weeds is varied, with Fusilade, a grass-specific herbicide, used around rare taxa, along with hand-pulling weeds. Glyphosate is applied to the remainder of the WCA; while Oust, a pre-emergent herbicide, is applied downslope of rare taxa to suppress the seed bank after initial knockdown of weeds using Roundup/RangerPro. To prevent re-sprouts of *Leucaena leucocephala* in and around the extended buffer area of the WCA, Garlon and/or Milestone is applied. Much of the native cover in Lower Ohikilolo is dominated by *Dodonaea viscosa, Waltheria indica*, *Abutilon incanum*, *Sida fallax*, and a limited number of *Santalum ellipticum and Erythrina sandwicensis. Dodonaea viscosa* are numerous and more abundant throughout the MU due to weeding efforts and the absence of fires, and provide shade in monotypic areas of *U. maxima*. The MU is very weedy except for patches around *D. viscosa*. After spraying and treating for *U. maxima*, invasive weeds such as *L. leucocephala, Leonotis nepetifolia*, *M. repens*, and *Acacia farnesiana*, become dominant and encroach onto the rare and native taxa. The weed structure has changed to fast-maturing weeds, which has heightened the need for restoration plantings, as constant clearing only continues to select for weedy herbs and grasses. Additionally, a weed mat experiment has been conducted in order to help suppress weeds around the *E. celastroides* var. *kaenana* and *H. brackenridgei* subsp. *mokuleianus* plants, with limited success. In addition to weed mat, common native plants such as *D. viscosa, E. sandwicensis, and Myoporum sandwicense* have been outplanted to reduce weed control efforts. *D. viscosa* also has also recruited naturally in the WCA's more than other native taxon.

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 are suited to Ohikilolo Lower.

WCA: Lower Ohikilolo-01 (Lower Akoko Patch, 2.5 acres)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 25% non-native cover

Targets: All weeds, particularly *U. maxima, L. leucocephala,* and *L. nepetifolia.*

Notes: *Euphorbia celastroides* var. *kaenana* is centered in the middle of the WCA. This area is very steep with many exposed rock faces. The bottom of the WCA tapers off to a relatively flat area with two long mounds of soil near the road. Weedy grasses are prevalent throughout the WCA, especially near the top and bottom. The WCA is very dry with limited overstory and is dominated by non-native understory of *U. maxima, L. leucocephala, L. nepetifolia, M. repens,* and *A. farnesiana,* and the natives *W. indica, A. incanum, S. fallax*. Woody taxa are limited to the native *D. viscosa* and *E. sandwicensis.* Treatment of most weeds is done by backpack spraying and handpulling around managed taxa. A change in weed composition from *U. maxima* and *M. repens* to monotypic *L. nepetifolia* has recently occurred following the application of Oust near the bottom of the patch. Incorporating weedwacking into chemical control of weeds in this WCA is effective at reducing fuel load, but it is very labor-intensive and results are short-lived. While a majority of the WCA surrounding rare plant populations is very rocky and difficult to outplant common species, the bottom section of the patch near the road has more soil. Future plans to control fuel load and invasive grass expansion into the rare plant zone include outplanting *M. sandwicense*, *Scavola taccada* and *D. viscosa* near the bottom of the patch to provide a native plant barrier and ideally shade out weedy grasses.

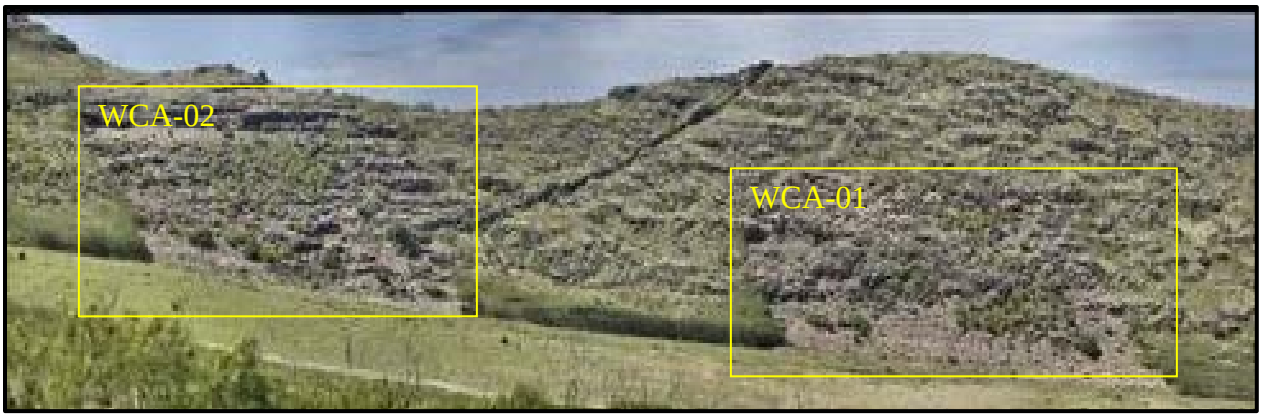
WCA: Lower Ohikilolo-02 (Upper Akoko Patch: 3.5 acres)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 25% non-native cover

Targets: All weeds, particularly *U. maxima, L. leucocephala, D. virgatus, A. farnesiana,* and *L. nepetifolia*.

Notes: *Euphorbia celastroides* var. *kaenana* is centered in the middle of this WCA. This area is very steep with exposed rock faces leading up to the ridgeline and fence. Near the top of the WCA, there is a large flat shelf. The WCA is very dry and rocky, and is bordered by thick, invasive shrubland and grasses. Large *D. viscosa* are filling in the WCA following control of monotypic *U. maxima*. The WCA is dominated by non-native *U. maxima, L. leucocephala, L. nepetifolia, M. repens, A. farnesiana* and the natives *W. indica, S. ellipticum, A. incanum*. Woody taxa are limited to the native *E. sandwicensis* and *D. viscosa*. Weeds are controlled by backpack spraying herbicide and handpulling/careful spraying around managed taxa. A successional emergence of weed replacement is typical after backpack spraying with herbicide. *Leonotis nepetifolia* and *Verbesina encelioides* quickly invade bare ground, making control of these weeds most difficult. Suppression of weeds by chemical treatment has been aided with the addition of ~600 common outplants, including *E. sandwicensis, M. sandwicense,* and *Scaevola taccada* focused near the bottom of the WCA and *D. viscosa* along the flat plateau above the catchment tank. The long-term strategy is to fill in bare areas left by chemical control with common outplants and eventually reduce grass cover and herbicide application in the MU. Grass control around common native outplants is critical for their survival. To aid in control of grass, installation of rubber mulch weed rings will be tested for effectiveness around *M. sandwicense*. Future outplantings should prioritize *M. sandwicense,* as it has grows wide quickly, which suppresses grassy species more effectively, and shown high survival in the past. *Stapelia gigantean* and *Kalanchoe crenata* are invasive weeds that colonizing rocky areas favored by EupCelKae. Trials are needed in the future to identify control methods for these species, as there overall ground cover seems to be increasing. Small fires are common on the makai side of the ridge behind WCA-2. To prevent these fires from jumping the ridge down into the WCA, we will control grasses on the ridge area with Oust and glyphosate and keep it as bare as possible to create a fire break. Most of our common outplanting efforts are focused on this WCA, with future plans to expand to other WCAs in the MU.



Left: WCA-2, Upper Patch. Right: WCA-1, Lower Patch.

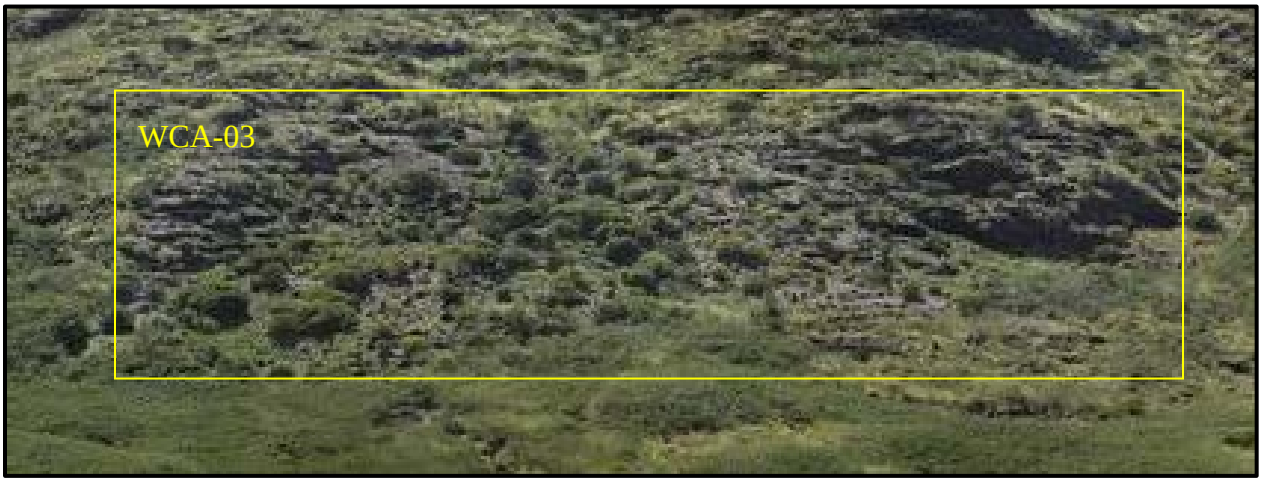
WCA: Lower Ohikilolo-03 (Hibiscus Patch, 3.6 acres)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 25% non-native cover

Targets: *U. maxima*

Notes: *Hibiscus brackenridgei* subsp. *mokuleianus* is centered in this WCA, which is the largest in the MU. The topography is a combination of rocky cliff faces and rocky slopes, with a mix of rocky and deep soils. Hand weeding and careful herbicide weeding is done around emerging seedlings, as well as backpack spraying for large grass areas. This WCA is dominated by the grasses *U. maxima* and *M. repens*. The WCA contains more mature *D. viscosa* than the other WCAs, most of which have recruited since weed control began. As with the other WCAs in this MU, the area is very dry, steep, and rocky. Additional weeds include *L. leucocephala, L. nepetifolia, M. repens, Bidens pilosa, A. farnesiana* and *Ageratina adenophora*. Upslope areas closer to the ridgeline have recovered well from the 2003 fire with native shrubs now dominating the community. Weed control is aided with the addition of ~100 common outplants concentrated around the upper portion of the WCA near the most recent wild and outplanted *H. brackenridgei* subsp. *mokuleianus*. Future outplantings will include *M. sandwicense* in the lower right portion of the WCA, as there is a small water seep there and it is usually difficult to control invasive grass in the area. Over the next five years, plans for common outplantings include filling in gaps between existing natives across the lower part of the WCA. Provided the outplantings grow quickly, these native plants will be able to establish and shade out invasive grasses.



H. brackenridgei subsp. *mokuleianus* patch of wild and reintroduction plants (WCA-3)

WCA: Lower Ohikilolo-04 (Lower Ohikilolo Roadside, 1.5 acres)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 50% non-native cover

Targets: *U. maxima, L. leucocephala, L. nepetifolia*

Notes: This WCA spans the roadside stretches beneath WCA-01, -02, and -03. These areas are dominated by *U. maxima* and *L. nepetifolia*. The purpose of this MU is to expand the road fuel break and provide additional protection to the entire MU from fire originating from within the firebreak road. Additional weeds include *L. leucocephala,, M. repens*, *B. pilosa*, *A. farnesiana* and *A. adenophora*. Trials of herbicide mixtures have also been conducted along this WCA. Control of weeds in this WCA is generally done using a powersprayer on an as needed schedule. Annual road surveys are conducted to monitor the spread of target weeds across theWCA. In 20XX, the Army began consistently mowing a wide band along the inside of the firebreak road directly across from WCAs 01, 02 and 03. This mowed area further reduces fuel loads in the MU. As a result, controlling grass in WCA-04, outside the firebreak road, has become less important for fire threat minimization.

Taxa Considerations for Restoration Actions

Native Taxon	Outplant?	Seedsow/ Division/ Transplant?	Notes
Abutilon incanum	Unknown	Unknown	Herb. Consider testing utility of this species in restoration plantings, particularly in areas around rare taxa.
Dodonea viscosa	Yes	No	Small Tree. Continue dense outplantings. *D. viscosa* forms dense shade which reduces weed growth. It is recruiting naturally in the WCAs.
Erythrina sandwicensis	Yes	No	Tree. Continue outplanting. While this tree is deciduous and does not suppress weeds as well as other taxa on this list, it is an important component of dry forest ecosystems.
Heteropogon contortus	Yes	Yes	Grass. (not sure we want to plant any grasses, including native ones, into area??)
Myoporum sandwicense	Yes	No	Small Tree. Continue outplanting. This species casts dense shade, suppressing weeds. The leaves are thick, and may be a poor fire carrier.
Psydrax odorata	Yes	No	Tree. (not sure we should include this taxon, almost none left in region. But could be useful in Hibiscus patch)
Santalum ellipticum	Yes	No	Small Tree. Continue outplanting. This species casts dense shade, suppressing weeds. The leaves are thick, and may be a poor fire carrier.
Scaevola taccada	Yes		Shrub. Continue outplanting as a green fuelbreak along roadsides.
Sida fallax	Unknown	Unknown	Herb. Consider testing utility of this species in restoration plantings, particularly in areas around rare taxa.

Waltheria indica	Unknown	Unknown	Herb. Consider testing the efficacy of seed sows of this fast-growing plant. May suppress weeds, particularly in areas around rare taxa.

Rodent Control

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

Threat level: Unknown

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 plants (*E. celestroides* var. *kaenana* and *H. brackenridgei* subsp. *mokuleianus*) populations to determine impacts by rodents.

MU Rodent Control:

- Currently no rodent control is conducted by OANRP around these taxa 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.

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: Two; *Euphorbia celastroides* var. *kaenana* population containing two separate patches

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.

Management Objective:

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

Monitoring Objective:

- Sample ants at *E. celastroides* var. *kaenana* population including along the road and fenceline. Use samples 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 deterring effective pollinators), and birds. It is therefore important to know their distribution and density in areas with conservation value. Standardized surveys have not yet taken place but will be considered in the future.

Slug Control

Species: Unknown

Threat level: Unknown

Control level: Unknown

Seasonality: N/A

Number of sites: Currently, no sites within this MU

Primary Objective:

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

Monitoring Objectives:

- Monitor rare plants (*E. celestroides* var. *kaenana* and *H. brackenridgei* subsp. *mokuleianus*) populations to determine impacts by slugs.

MU Slug Control

- There is currently no slug control conducted by OANRP around these taxa since slugs are not considered a threat at this time. If rare plants are determined to be impacted by slugs, OANRP will evaluate the use of slug control for the protection of these species.

Fire Control

Threat Level: High

Available Tools: Fuelbreaks, Visual Markers, Helicopter Drops, Army Wildland Fire Crew.

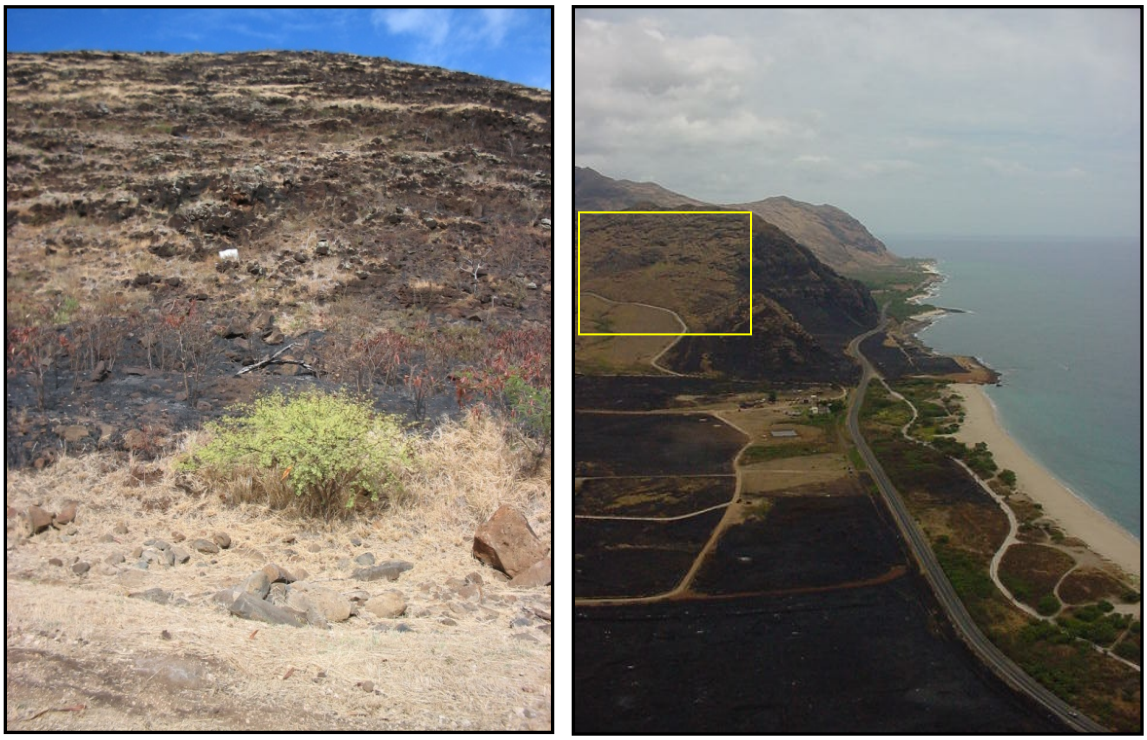
Management Objective:

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

Preventative Actions

Fire control in the Ohikilolo Lower MU is focused on fuel-break construction and management. Backpack spraying of herbicide is used to control grasses and weeds while reducing the fuel load of the area. The threat of fire is high due to the large fuel load and hot, dry climate, and many fires are intentionally set by vandals along Farrington Highway, near the MU. These fires are set regularly and have a high risk of burning over Ohikilolo Ridge and into the MU. Future weed control along the ridge above the upper akoko patch, on the outside of the MU fence, will be implemented during scheduled WCA spraying to limit the risk of fire burning over the ridge. Removal of the most fire prone weeds (*A. farnesiana, L. leucocephela* and *U. maxima)* remains a high priority within the MU. Sprayed areas with large patches of dead grass are also weedwhacked to reduce standing dead vegetation and create a buffer around endangered taxa. Plans are in place to cut an additional 20m buffer, maintained as bare ground, extending the entire weed control area around each managed plant population. To create a green fuel

break buffer for the *E. celestroides* var. *kaenana* patch and decrease power spraying efforts along the road, *S. taccada* plants were outplanted along the bottom edge of this patch. If the outplanted *S. taccada* are successful in suppressing *U. maxima*, more *S. taccada* and other common native plant species will be planted in the future. OANRP will focus on maintaining good communication with the Wildland Fire Working Group to facilitate positive on-the-ground fire response in the event of another fire.



Left: *E. celastroides* area burned by 2003 Makua fire. Right: Lower Ohikilolo fire view from the North.

View of 2011 Ohikilolo Lower fire from C-Ridge

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 filled with hatch marks 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 Type	Actions	MIP Year 12 Oct 2016-Sept2017				MIP Year 13 Oct 2017-Sept2018				MIP Year 14 Oct 2018-Sept2019				MIP Year 15 Oct 2019-Sept2020				MIP Year 16 Oct 2020-Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct gigapan monitoring of shrub cover every 3-5 years.																				
General Survey	RS-MMR-01: Survey both north/south firebreak and side roads. All roads used for training should be included - avoid sites with UXO. Record route with GPS track. If see any soil/fill stockpiles, survey carefully around them and note location.																				
	LZ-MMR-077: Survey Makua Range Control LZ whenever used, not to exceed once per quarter. If not used, do not need to survey. Range control LZ survey																				
ICA	MMR-CenSet-02: Survey Makua for CenSet, define/modify boundaries of infestation, identify core areas, identify areas with scattered plants, and identify any outliers.																				
	MMR-CenSet-02: Sweep walkable areas and control plants found quarterly, transitioning to 2x/year during winter. High priority spots: Upper and Lower ChaCelKae patches; slopes/ledges on makai side of ridge by upper cave; fencelines; bowl on Keaau side of Makua Cave. 2nd priority spots: Hibiscus patch; bottom of cliffs below Melten cliffs. Pick and remove from field any potentially viable fruit.																				
	MMR-CenSet-02: Spray steep portion of infestation aerially, 2-4x per year. Avoid areas near rare plants and areas where hazardous to use heli. Use ball sprayer. Use spotters in heli and/or on ground to guide pilot.																				

Action Type	Actions	MIP Year 12 Oct 2016-Sept2017				MIP Year 13 Oct 2017-Sept2018				MIP Year 14 Oct 2018-Sept2019				MIP Year 15 Oct 2019-Sept2020				MIP Year 16 Oct 2020-Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	MMR-CenSet-02: Treat cliffside plants with HBT or alternate technique from ground and air. This method is experimental. Use on plants cannot reach with other tools.																				
	MMR-CenSet-02: Survey following regions with binoculars/spotting scope or ground surveys annually for outlying CenSet: 1. Zone between Upper and Lower Chamaesyce patches; 2. Zone between Hibiscus and Upper Chamaesyce patches.																				
	MMR-CenSet-02: Assist OISC with this action as requested. Control plants on the Keaau, private land portion of the infestation via handpulling. Herbicide not allowed by landowner. Pick and remove from field any potentially viable fruit.																				
General WCA	Water catchments: repair/maintain as needed. 3 catchments in MU.																				
Lower Ohikilolo-01: Lower Eupcelkae	Control grasses and herbaceous weeds across entire WCA (excluding marked rare plant zones) quarterly, as needed. Goals: maintain low fuel levels, encourage native recruitment. Primary control methods: spraying, weedwhacking. Only use Oust downslope of rare taxa as Oust will kill ALL germinating seeds.																				
	Control weeds in marked rare plant zones quarterly/as needed. Exercise extreme care when working/spraying around rare taxa and seedlings; NO Oust.																				
	Control woody weeds (LeuLeu, Acafar) across the entire WCA annually. Goal: reduce/maintain coverage at 0%.																				
	Take photopoints in Lower Patch 1x/yr. Use Master Photo sheet to re-take photos.																				

Action Type	Actions	MIP Year 12 Oct 2016-Sept2017				MIP Year 13 Oct 2017-Sept2018				MIP Year 14 Oct 2018-Sept2019				MIP Year 15 Oct 2019-Sept2020				MIP Year 16 Oct 2020-Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Lower Ohikilolo-02: Upper Eupcelkae	Control grasses and herbaceous weeds across entire WCA (excluding marked rare plant zones) quarterly, as needed. Goals: maintain low fuel levels, encourage native recruitment. Primary control methods: spraying, weedwhacking. Only use Oust downslope of rare taxa as Oust will kill ALL germinating seeds.																				
	Control weeds in marked rare plant zones quarterly/as needed. Exercise extreme care when working/spraying around rare taxa and seedlings; NO Oust.																				
	Control woody weeds (LeuLeu, Acafar) across the entire WCA annually. Goal: reduce/maintain coverage at 0%.																				
	Take photopoints in Upper Patch 1x/yr. Use Master Photo sheet to retake photos.																				
Lower Ohikilolo-03: Hibbra patch	Control grasses and herbaceous weeds across entire WCA (excluding marked rare plant zones) quarterly, as needed. Goals: maintain low fuel levels, encourage native recruitment. Primary control methods: spraying, weedwhacking. Only use Oust downslope of rare taxa as Oust will kill ALL germinating seeds.																				
	Create/maintain buffer fuel break around entire LowerOhikilolo-03. ADD NEW WCA IF THIS ACTION COMPLETED (Need to contract)																				
	Control weeds in marked rare plant zones quarterly/as needed. Exercise extreme care when working/spraying around rare taxa and seedlings; NO Oust.																				
	Control woody weeds (LeuLeu, Acafar) across the entire WCA annually. Goal: reduce/maintain coverage at 0%.																				
	Take photopoints in Hibiscus Patch 1x/yr. Use Master Photo sheet to re-take photos.																				
Lower Ohikilolo-04: Roadway	Control grasses, broadleaves along road corridor quarterly, as needed; not priority when grass being maintained within firebreak. Goal: maintain fuel break along road. Use powersprayer.																				

Action Type	Actions	MIP Year 12 Oct 2016-Sept2017				MIP Year 13 Oct 2017-Sept2018				MIP Year 14 Oct 2018-Sept2019				MIP Year 15 Oct 2019-Sept2020				MIP Year 16 Oct 2020-Sept 2021			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Rodent Control	Monitor rare plants for predation by rodents																				
	Implement localized rodent control if determined to be necessary for the protection of rare plants																				
Ant Control	Sample ants at *Euphorbia celastroides* var. *kaenana* population																				
	If ants exceed acceptable level begin control																				
Restoration	Outplant commons into Upper Akoko and Hibbra patch																				
Ungulate Control	Melten MMR-D fence: Fence maintenance (as needed)																				
	Melten MMR-D fence: Fence monitor																				

Hatching=Quarter Schedule