

1.3.6 Upper Kapuna

Ecosystem Restoration Management Plan

MIP Year 7-11, Oct. 2010 – Sept. 2015

MU: Upper Kapuna

Overall MIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, rodent, arthropod, slug, snail, fire, and weed threats to support stable populations of IP taxa. Implement control methods by 2015.

Background Information

Location: Northern Waianae Mountains

Land Owner: State of Hawaii

Land Manager: State of Hawaii; Natural Area Reserves

Acreage: 425 acres

Elevation Range: 1400-2550ft

Description: Upper Kapuna is located at the northern end of the Waianae Mountains and includes the upper sections of Kapuna and Keawapilau Gulches. The Gulches face North and Northeast. Along with Pahole Gulch, Kapuna and Keawapilau make up the Pahole NAR. Pahole gulch is a separate MU. The Upper Kapuna MU has moderate to steep upper ridge and gulch systems that lead to crests shared with West Makaleha, Pahole Gulch, and Makua Valley. There is a mix of native and alien forests throughout the MU. The lower elevations of the MU are dominated by weeds with the exception of patches of a diverse lowland mesic forest. The upper elevations and crests include a native forest dominated by *Acacia koa*, *Metrosideros sp.*, and *Dicronopteris linnearis*.

Native Vegetation Types

Waianae Vegetation Types
Mesic mixed forest
<u>Canopy includes:</u> <i>Acacia koa</i> , <i>Metrosideros polymorpha</i> , <i>Nestegis sandwicensis</i> , <i>Diospyros</i> spp., <i>Pouteria sandwicensis</i> , <i>Charpentiera</i> spp., <i>Pisonia</i> spp., <i>Psychotria</i> spp., <i>Antidesma platyphyllum</i> , <i>Bobea</i> spp. and <i>Santalum freycinetianum</i> .
<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 mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.
NOTE: For MU monitoring purposes, vegetation types will be 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.

Primary Vegetation Types at Kapuna

Mesic Gulch



Mesic Ridge



Mesic Mid-Slope



Mesic Mid-Slope



MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/Reintroduction
Plant	<i>Alectryon macrococcus</i> var. <i>macrococcus</i>	KAP-A	Kahanahaiki to West Makaleha	MFS	Wild
Plant	<i>Chamaesyce herbstii</i>	KAP-A, B, C, E	Kapuna to Pahole	MFS	Both
Plant	<i>Cyanea longiflora</i>	KAP-B PIL- B, C, D, E	Kapuna to West Makaleha	MFS	Both
Plant	<i>Cyrtandra dentata</i>	KAP-A, B, C, PIL-A, B,C,D	Pahole to Kapuna to West Makaleha	MFS	Wild
Plant	<i>Cyanea superba</i> subsp. <i>superba</i>	KAP-A, B	Pahole to Kapuna	MFS	Reintroduction
Plant	<i>Delissea waianaensis</i>	KAP-A*, B*, C, D	Kahanahaiki to Keawapilau	MFS	Both
Plant	<i>Flueggea neowawraea</i>	KAP-A, B† PIL-A	Kahanahaiki to Kapuna	MFS	Both
Plant	<i>Hesperomannia arbuscula</i>	KAP-A* PIL-A	Pahole NAR	MFS	Reintroduction
Plant	<i>Phyllostegia kaalaensis</i>	KAP-A*, B* PIL-A*, B*	Keawapilau to Kapuna	MFS	Both
Plant	<i>Schiedea kaalae</i>	KAP-A	Pahole	MFS	Reintroduction
Plant	<i>Schiedea nuttallii</i>	PIL-A*, B†	Kapuna-Keawapilau Ridge	MFS	Both
Plant	<i>Schiedea obovata</i>	PIL-A*, B, C	Keawapilau to West Makaleha	MFS	Both
Snail	<i>Achatinella mustelina</i>	KAP-A, B, C	ESU-A	KAP-C is MFS	Wild

MFS= Manage for Stability

* = Population Dead

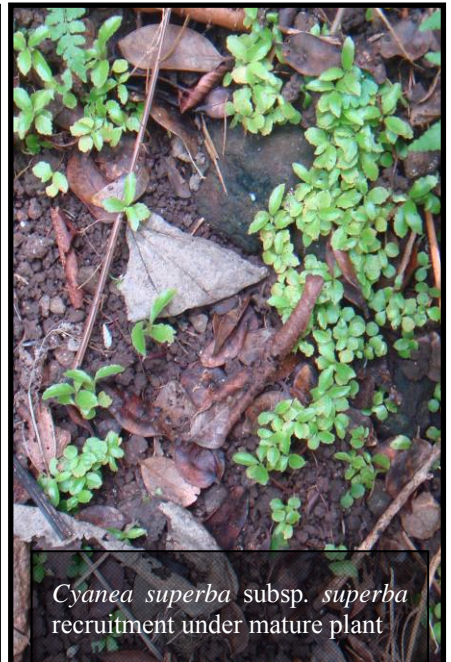
GSC= Genetic Storage Collection

† = Reintroduction not yet done

Other Rare Taxa at Upper Kapuna MU

Organism Type	Species	Status
Plant	<i>Pteralyxia macrocarpa</i>	Candidate
Plant	<i>Cyanea calycina</i>	Candidate
Plant	<i>Colubrina oppositifolia</i> (State reintroduction)	Endangered
Plant	<i>Caesalpinia kavaiensis</i> (State reintroduction)	Endangered

Rare Resources at Upper Kapuna MU



Locations of Rare Resources at Upper Kapuna

Map removed, available
upon request

MU Threats to MIP/OIP MFS Taxa:

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	MU fenced-checked quarterly for damage.
Rats	<i>A. macrococcus</i> var. <i>macrococcus</i> , <i>Achatinella mustelina</i> <i>C. longiflora</i> , <i>C. superba</i> var. <i>superba</i> , <i>D. waianaensis</i>	Yes	No	Localized bait and snap grids used when damage seen. MU wide snap trap grid being tested in other MUs.
Predatory snails: <i>Euglandina rosea</i> , <i>Oxychilus alliarius</i>	<i>Achatinella mustelina</i>	Yes	No	Hand-removal of snails possible, however <i>Achatinella mustelina</i> managed in another MU for this ESU of snails.
Ants: <i>Solenopsis papuana</i> and <i>Tetramorium simillimum</i>	Unknown, possibly a threat to native snails, arthropods, plants and birds	Yes	No	Hydramethylnon (Amdro, Maxforce, Siege) available, but most effective on <i>Solenopsis</i>
Slugs	<i>C. longiflora</i> , <i>C. dentata</i> , <i>C. superba</i> subsp. <i>superba</i> , <i>D. waianaensis</i> , <i>H. arbuscula</i> , <i>P. kaalaensis</i> , <i>S. nuttallii</i> , <i>S. obovata</i> , <i>S. kaalae</i>	Yes	No	Not yet available. Revised label for Sluggo under review by Hawaii Department of Agriculture

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
	<i>waianaeensis</i> , <i>H. arbuscula</i> , <i>P. kaalaensis</i> , <i>S. nuttallii</i> , <i>S. obovata</i> , <i>S. kaalae</i>			Department of Agriculture
Weeds	All	No	Yes	Yes
Fire	All	No	Yes	Yes

Management History

- 1993: OANRP staff began *P. cattleianum* control
- 1997/1998 OANRP cooperate with NARS staff to build 1-Acre and Stream Site fences.
- 2004: OANRP begin consistent weeding in WCAs.
- 2006: OANRP cooperate with NARS staff to re-read Welton vegetation plots and extinct species survey (with 1 OANRP staff and volunteers) to determine relevance and usefulness.
- 2008: Fence of Subunit I/II and III completed.

Ungulate Control

Identified Ungulate Threats: Pigs and goats (goats are a low threat level, but are present in gulches to the east)

Threat Level: High

Primary Objective:

- Maintain Subunit I/II and III as ungulate free.
- Remove all ungulates from Subunit IV and maintain as ungulate free.

Strategy:

- Assist NARS crew within Unit IV to remove all pigs as requested.
- Maintain subunits I/II and III ungulate free by maintaining the fences.

Monitoring Objectives:

- Conduct quarterly Subunit fence checks and in cooperation with NARS crew.
- Note any pig sign while conducting day to day actions within fenced MU.
- Document pig sign during vegetation monitoring transects.

Management Responses:

- If any pig activity is detected within Subunit I/II, III or IV, assist NARS staff in implementation of hunting and/or snaring program.

Fence Completions:

- All three sub-unit fences within the MU were completed in 2008.

Maintenance Issues:

The three sub-units combine to make the 425 acre Upper Kapuna MU. Regular fence checks by OANRP and NARS staff will insure maintenance of the fence that runs around the perimeter of the MU. Major threats to the fence include fallen trees, blow-outs at gulches from floods, and vandalism. Since the completion of Unit IV in 2008, there have been a few instances of vandalism to the fence. There are two major gulch crossings. Special emphasis will be placed on checking the fence after extreme weather events, any vandalism on adjacent fences, and during pig hunting seasons.

Weed Control

Weed Control actions are divided into 4 subcategories:

- 9) Vegetation Monitoring
- 10) Surveys
- 11) Incipient Taxa Control (Incipient Control Area - ICAs)
- 12) Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

Objectives:

- Conduct MU monitoring every three years to track the change in vegetation cover given current management strategy.

MU Vegetation Monitoring

Baseline vegetation monitoring will be conducted for the Kapuna MU beginning in MIP year 8. MU monitoring will be conducted every three years and will provide OANRP with trend analyses on vegetation cover and species diversity.

Surveys

Army Training: None

Other Potential Sources of Introduction: OANRP, pigs that breach the fence, birds, public hikers,

Survey Locations: Mokuleia Trail Access Road, Mokuleia Trail, LZ (see map below).

Management Objective:

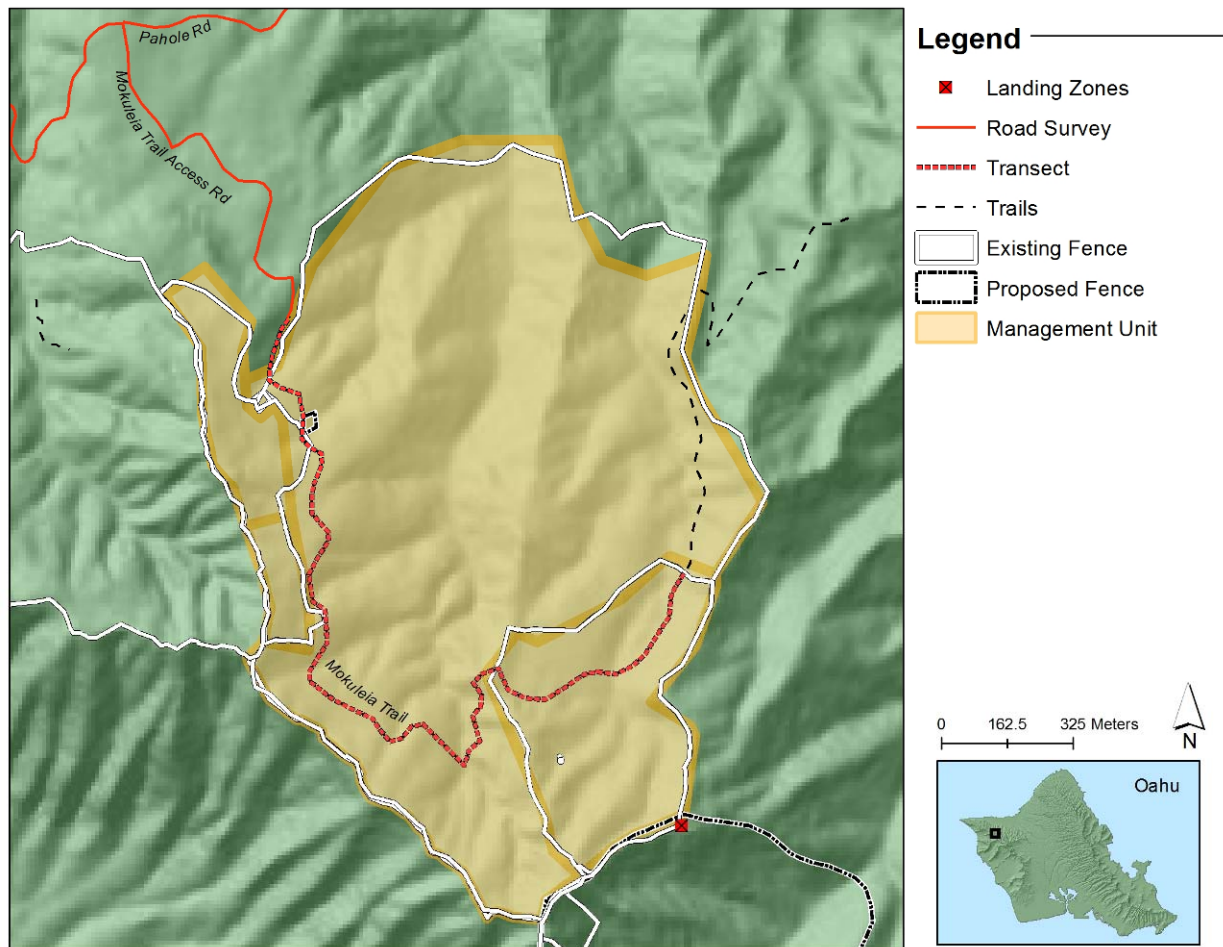
- Prevent the establishment of any new invasive alien plant or animal species through regular surveys along roads, landing zones, fencelines, trails, and other high traffic areas (as applicable).

Monitoring Objectives:

- Note unusual, significant or incipient alien taxa during the course of regular field work.
- Quarterly survey of LZ (if used)
- Survey weeds along access road biennially, and trail annually.

There are currently no weed surveys in Upper Kapuna, however the following two have been added: a survey along a section of the Mokuleia trail, and a road survey of the Mokuleia Trail Access Road. Implementation of these surveys will begin in MIP Year 7. OANRP also put emphasis on looking for significant weeds during fence checks. OANRP will continue to communicate about and work with NARS staff on significant or incipient alien taxa in the MU.

Survey Locations at Upper Kapuna



Incipient Control Areas (ICAs)

Management Objective:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2015.
- Conduct seed bank persistence studies for all high priority incipient weeds by 2015.

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.

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. OARNP will compile this information for each ICA species.

The table below summarizes incipient invasive taxa at Upper Kapuna. Appendix 3.1 of the MIP lists significant alien species and ranks their potential invasiveness and distribution. Each species is given a weed management code: 0 = not reported from MU, 1 = incipient (goal: eradicate), 2 = control locally. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in an MU. OARNP supplemented and updated Appendix 3.1 with additional target species identified during field work and communication with NARS staff. In many cases, the weed management code assigned by the MIP has been revised to reflect field observations. Vegetation monitoring will better define the range and abundance of many of the species listed below; codes may be revised again after monitoring. ICAs are not designated for every species in the table below; however, occurrences of all species in the table should be noted at Upper Kapuna. ICAs have been designated for taxa in cells with bolded and underlined text.

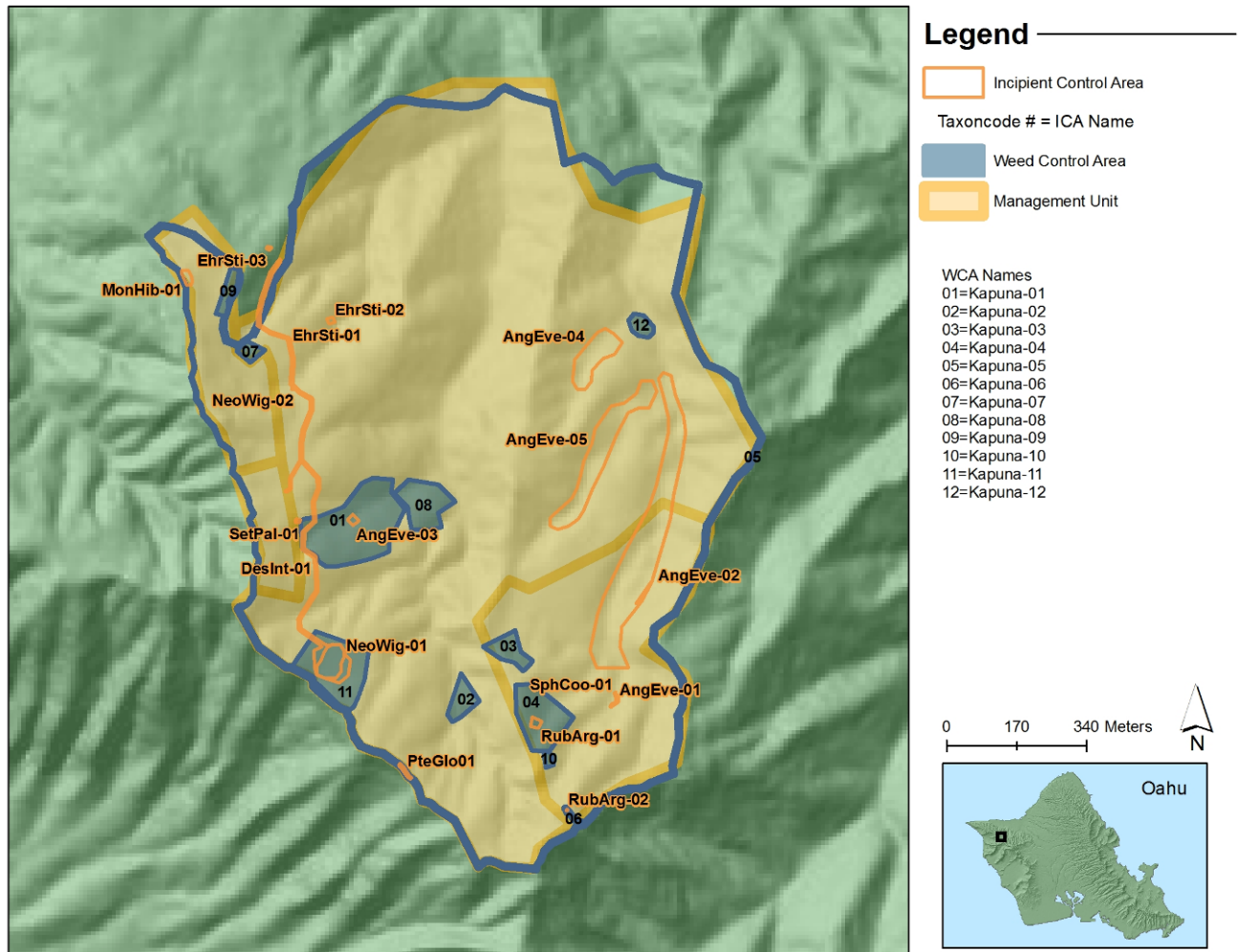
OARNP have been very diligent about regular re-visitation of ICAs throughout the MU. While most are visited quarterly and are treated before more individuals become mature, some species persist and may need more frequent visitation or new control methods in order to reach complete eradication. OARNP would also like to discuss with NARS staff the use of Oust, a pre-emergent herbicide, at *Ehrharta stipoides*, *Neontonia wightii* and possibly other ICAs. Use of this herbicide would be minimized and restricted to known ICA areas.

Summary of Potential ICA Target Taxa

Taxa	MIP Weed Code		Discussion/Notes	No. of ICAs
	Original	Revised		
<u><i>Angiopteris evecta</i></u>	<u>0</u>	<u>1</u>	<u>Investigating most effective method for killing mature individuals. Once all matures killed, revisitation schedules will be set to biannually or annually as seedlings/immatures take longer than one year to mature.</u>	<u>5</u>
<i>Blechnum appendiculatum</i>	2	2	Widespread. Local control may be conducted, but further investigation of control methods is needed.	
<i>Coffea arabica</i>	2	0	Not frequently seen. Will target in weed sweeps if seen.	
<i>Desmodium incanum</i>	2	2	Treat at Hunter Cabin in conjunction with other ICA control, but otherwise widespread on trail and not specifically targeted	
<u><i>Desmodium intortum</i></u>	<u>0</u>	<u>1</u>	<u>Plants treated quarterly. Along Mokuleia Trail, from trailhead to Hunter Cabin. Low numbers found consistently</u>	<u>1</u>
<u><i>Ehrharta stipoides</i></u>	<u>1</u>	<u>1</u>	<u>Zero tolerance for this weed in the MU. All new populations will be treated as ICAs. Significant progress in most recently found population; only 2 immature individuals seen since initial treatment of large clump in 2008. Discuss use of Oust with NARS biologist at this site (pre-emergent herbicide).</u>	<u>3</u>
<i>Ficus macrophylla</i>	0	1	OARNP will target this weed during weed sweeps or as seen incidentally within the MU.	
<i>Fraxinus uhdei</i>	2	2	Widespread at Mokuleia trailhead, but not across the MU. Will target in WCAs.	
<i>Grevillea robusta</i>	2	2	Not targeted by OARNP. NARS staff are currently treating large trees. Will continue communication with NARS staff to assess help	

Taxa	MIP Weed Code		Discussion/Notes	No. of ICAs
	Original	Revised		
			needed.	
<i>Montanoa hibiscifolia</i>	<u>0</u>	<u>1</u>	<u>New site found 2010. OARNP will survey more around this area and treat as an ICA. All new locations of this plant within the MU will be treated as ICAs.</u>	<u>1</u>
<i>Neontonia wightii</i>	<u>0</u>	<u>1</u>	<u>Neowig-01 ICA was under control until recent observations of the weed spreading outside of previous known boundaries. Persistent control has been conducted in attempt to manage this weed at this site, but control may need to be re-evaluated in the future due to its spread. Numbers of immature found at the second site are slowly declining. Discuss use of Oust (pre-emergent herbicide) with NARS biologist at this lower site.</u>	<u>2</u>
<i>Pterolepis glomerata</i>	<u>0</u>	<u>1</u>	<u>New site found 2010.</u>	
<i>Rubus argutus</i>	<u>1</u>	<u>1</u>	<u>Need to investigate alternative control methods in addition to digging roots and tubers that break and re-establish. While no new matures found, OARNP are continually retreating plants.</u>	<u>2</u>
<i>Ricinus communis</i>	2	1	Not widespread and rarely seen. Will target in if seen during weed sweeps in WCAs, or incidentally.	
<i>Schefflera actinophylla</i>	0	1	1 plant found and treated, and will gps/remove any others.	
<i>Setaria palmifolia</i>	<u>1</u>	<u>1</u>	<u>1 immature first observed by OARNP along the Mokuleia Trail in 2009 and no plants found since. Can discontinue ICA completely when conduct seed bank persistence studies on this species. Zero tolerance for this weed in the MU. All new sites will be treated as ICAs.</u>	<u>1</u>
<i>Sphaeropteris cooperi</i>	<u>1</u>	<u>1</u>	<u>Few individuals found. There will be a zero tolerance for this fern in the MU.</u>	<u>1</u>
<i>Triumfetta semitriloba</i>	0	2	Currently targeting in all WCAs and along fencelines during fence checks. There are many individuals scattered throughout the MU which will be killed opportunistically in WCAs.	
<i>Toona ciliata</i>	1	2	This weed will continue to be controlled locally where found in WCAs. May consider more aggressive control if large stands found.	

Incipient and Weed Control Areas at Upper Kapuna



Ecosystem Management Weed Control (WCAs)

MIP Goals:

- Within 2m of rare taxa: 0% alien vegetation cover or except where causes harm.
- 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:

- Define priority 1 and 2 zones in MU, to help prioritize effort over this very large and highly variable MU
- Set percent cover goals for the short term once the vegetation monitoring is complete.
- Work with NARS staff to determine possible new weeding locations to meet short term and MIP goals.

- In WCAs within 50m of rare taxa, work towards achieving 25% or less alien vegetation cover in understory and canopy.

Management Responses:

- Increase/expand weeding efforts if MU vegetation monitoring (conducted every 3 years) indicates that goals are not being met.

Weed control in Kapuna by OARNP has mostly been conducted around populations of wild and reintroduced rare plants. Since the completion of all subunit fences, OARNP and NARS staff have chosen WCAs to ensure that the areas with the potential for greatest rehabilitation, and best habitat for rare species are selected for weed control efforts. There are still some MIP species that are not covered sufficiently under the current WCAs; these species include *C. dentata* and *C. herbstii*. OARNP will work with NARS staff to create new WCAs around populations of these plants. For *C. dentata* in particular, an area with a high density of plants will be selected as this species is scattered throughout the MU and it is unfeasible to weed each and every location. OARNP will continue to work with NARS staff to determine priority WCAs for control, expansion, or elimination. Completion of the vegetation monitoring in MIP Year 8 may also be useful in highlighting such areas. OARNP follow NARS 6% cover reduction limit during each sweep. Regular follow-up at each WCA will be emphasized. Accurate GPS boundaries of WCAs are still needed.

Much of the native cover in Upper Kapuna MU is patchy and *P. cattleianum* monotypic stands dominate in some areas. To control monotypic *P. cattleianum* stands, individuals on the outside edge of the stand are targeted first. Individuals that are on the leading edge of a stand, encroaching into native dominated areas are also targeted. This technique ensures that immature plants on the outside edge of stands will not be ‘released’ and flourish in the absence of larger center trees; also allowing for a gradual removal of the stand over a series of visits. Overall, large light gaps created by removing *P. cattleianum* are to be avoided in areas sensitive to such changes in light levels. However, in Kahanahaiki MU, OARNP have successfully transformed monotypic *P. cattleianum* stands into koa dominated canopy by clear-cutting stands.

A common native outplanting plan has not been established for any WCA in Upper Kapuna, but will be considered with input from NARS staff where appropriate.

In all WCAs, weeds that have been designated by the NARS biologist as a specific target will be controlled during weed sweeps.

WCA UpperKapuna-01 (Chaher/Hesarb/Delsub Gulch)

Veg Type: Mesic Mid-Slope/Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: Overstory targets include *Grevillea robusta*, *Schinus terebinthifolius*, and *P. cattleianum*. Several *Toona ciliata* have also been targeted in the gulch bottom. Prevalent understory weeds in this WCA include *Buddleia asiatica*, *B. appendiculatum*, *Christella parasitica*, *Clidemia hirta*, *Lantana camara* and *Rubus rosifolius*. *B. asiatica* is a particular problem at the north end of the WCA around the *S. kaalae* reintroduction where canopy is lacking.

Notes: Weed control sweeps will be conducted across the area, from below the waterfall, up gulch, towards the trail, annually. These sweeps include weed control around *C. herbstii* and *C. dentata* populations. Understory weeds are targeted, and overstory weeds are targeted for gradual removal (6%/visit). *B. asiatica*, *Passiflora sp.* and other non-native weeds are more aggressively targeted around

the *S. kaalae* (and now dead *P. kaalaensis*) reintroductions. Recruitment of *Pipturus albidis* and other native shrubs has been noted as non-native weeds are continually cleared. *C. hirta* patches are also a priority target, especially along trails. Weed sweeps across most of the WCA are a priority, however it is also important to resweep weedier areas with greater frequency throughout the year to reduce the speed of reinvasion in the areas with more native cover.

WCA UpperKapuna-02 (Stream Site)

Veg Type: Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: Understory weeds including *C. hirta*, *R. rosifolius*, *C. parasitica*, *P. cattleianum*, and *B. asiatica* are primary targets for this WCA. Overstory target is mostly *P. cattleianum*.

Notes: This small WCA is throughout reintroductions of *Cyanea superba* subsp. *superba* and *Chamaecybe herbstii* in a small fence in Kapuna stream. Understory weed control is mostly conducted here. Weed control will be conducted annually across the enclosure, including a small buffer outside the fence.

A good deal of ground around the reintroductions is covered with the invasive fern, *B. appendiculatum*. OARNP do not treat *B. appendiculatum* in this site as there are no known tools appropriate for use around rare plants. This year however, NARS staff manually dug out strips of *B. appendiculatum* and transplanted *Cyanea superba* subsp. *superba* seedlings into these small soil trenches. OARNP will be interested to see results from this trial.

WCA UpperKapuna-03 (Schnut/Cyalon)

Veg Type: Mesic Ridge/Mesic Mid-Slope

MIP Goal: Less than 25% non-native cover

Targets: Most prevalent overstory weed in WCA is *P. cattleianum*. Other overstory targets include *G. robusta* (targeted by NARS staff), and *S. terebinthifolius*. The most common understory targets include *C. hirta*, *P. cattleianum*, *R. rosifolius*, and *L. camara*.

Notes: This WCA targets habitat surrounding wild *C. longiflora* and a historic site of *S. nuttallii*. Weed control in the past targeted thick patches of *C. hirta* and understory *P. cattleianum*. Native overstory is patchy and overstory weed control should be prioritized around areas with the highest levels of native canopy first. Gradual removal of *P. cattleianum* should begin along the fenceline on the ridgecrest and continue downslope toward the steeper cliffs where *C. longiflora* are found. Removal of *P. cattleianum* from the crestline may be most effective using chainsaws to clear-cut the weed. Seed from nearby *A. koa* should be able to fill in gaps created by removing *P. cattleianum*. This more aggressive approach will be discussed with NARS staff before implementation. The slope below the ridge is steep and fragile and OARNP will be extra careful around areas surrounding *C. longiflora* individuals where seedlings and immature individuals may be found.

The WCA is bordered by a large patch of *M. minutifolia* to the northwest. Treatment of this grass will be evaluated for its potential impact to the area.

Weed control in this WCA is very similar to weed control in UpperKapuna-04, and comprehensive control throughout these two areas will be established. Further discussion of this issue can be found in the WCA UpperKapuna-04 discussion.

WCA UpperKapuna-04 (Keawapilau Cyalon)

Veg Type: Mesic Ridge/Mesic Mid-Slope

MIP Goal: Less than 25% non-native cover

Targets: Most prevalent overstory weed in WCA is *P. cattleianum*. Other overstory targets include *G. robusta*, and *S. terebinthifolius*. The most common understory targets include *C. hirta*, *P. cattleianum*, and *L. camara*.

Notes: In this WCA, native canopy is patchy. Weed control has primarily been focused throughout the more native patches on the north side of the ridge crest around the wild *C. longiflora*. The reintroduced *C. longiflora* are lower on the slope in the WCA in a small fence full of native ferns (free of pigs for several years).

At this reintroduction, very little weed control has been conducted outside of the fences as the canopy is predominately *P. cattleianum*. Native understory is still recovering from presence of pigs from the subunit. Gradual removal of overstory *P. cattleianum* in this area will be necessary in order to restore this portion of the WCA. A large patch of *C. hirta* will be targeted directly around the small fences to reduce prevalence inside the fence. As native understory begins to return in the surrounding area, more weeds will be controlled around those native plants.

Many of the wild *C. longiflora* individuals in this WCA are on steep areas, and under non-native canopy. Continual maintenance and expansion of native areas, and very careful, gradual removal of non-native species around rare plants will be the strategy for this WCA.

This WCA is on the northeast facing slope of the ridge that divides Kapuna and Keawapilau Gulches. While there are several smaller WCAs on this slope (UpperKapuna-03, and 10), OARNP should consider the entire slope while weeding. Along this slope, there are several sites of *C. longiflora* individuals, OARNP reintroductions of *S. obovata*, and historic sites of *Schiedea nuttallii* and *Delissea waianaensis*. Overall, this slope is a high priority for weed control and restoration. A good assessment of the large *P. cattleianum* patches that divide the WCAs has been made and GPSed. The edges of these *P. cattleianum* stands will be treated where encroaching into the native areas of WCAs; thus working towards slowly reducing the size of *P. cattleianum* patches. This area may also have potential for use of the chipper in removing stands of *P. cattleianum*. Evaluation of the feasibility for chipper use will be conducted and discussed with NARS staff.

WCA UpperKapuna-05

Veg Type: Mesic Ridge

MIP Goal: Less than 50% non-native cover

Targets: *P. cattleianum* may be treated in order to keep the fenceline corridor clear. All other weed species negatively affecting the fenceline or the fence corridor will be targeted. *T. semitriloba* will be targeted along the fence at the Makua/Pahole/Kapuna fence corner to keep the fence corridor clear of this weed.

Notes: This WCA was established along the Eastern fenceline to track fence clearing weed control in preparation for fence building in this area. Dense stands of cut immature *P. cattleianum* were sprayed. The integrity of the fence is checked quarterly, and this WCA has been expanded to run along the entire MU fenceline (including subunit fencelines) as a means of tracking any weed control/corridor maintenance conducted during fence checks.

WCA UpperKapuna-06 (Schobo/Hesarbu Reintroduction)

Veg Type: Mesic Ridge

MIP Goal: Less than 25% non-native cover

Targets: Overstory weeds targeted in this WCA include *P. cattleianum*, *S. terebinthifolius*, and *G. robusta*. However, the canopy of this small WCA is mostly native with the exception of some small monotypic *P. cattleianum* stands. The understory weeds targeted in the area include *Ageratina adenophora*, *C. hirta*, *R. rosifolius*, and *Stachytarpheta dichotoma*. *M. minutiflora* and small amounts of other grasses are patchy throughout the WCA and will be treated as needed.

Notes: Weed control is conducted in this WCA around reintroductions of *S. obovata* and *H. arbuscula*. This WCA is in the southern most corner of the Kapuna Subunit III fence along the same ridge as WCAs 03, 04 and 10. Mostly understory weeds will be treated here. There is a large patch of *B. appendiculatum* in one corner of the reintroduction. Control will begin when a control method suitable to rare taxa sites is determined. Where patches are small and isolated, the clip and drip method has anecdotally been noted effective and will be implemented. There are a few isolated patches of *P. cattleianum* stands on the ridge crest above the reintroduction, and these will be targeted for complete removal. *P. cattleianum* stands will also be treated where encroaching in to the WCA. Grass sprays throughout the WCA will be conducted as needed.

WCA UpperKapuna-07 (1 Acre Fence)

Veg Type: Mesic Mid-Slope

MIP Goal: Less than 25% non-native cover

Targets: This lower elevation WCA has a high level of non-native cover. There is a large suite of understory weeds including *R. rosifolius*, *L. camara*, *S. dichotoma*, and thick clumps of *Christella dentata* and *C. paracitica*. Overstory weeds surrounding the small fence that comprises the WCA include a large amount of *S. terebinthifolius*, and a growing population of *F. uhdei*. When unmanaged, the *Paspalum conjugatum* can form a dense thicket across the WCA.

Notes: Weed control has not been conducted in this reintroduction in several years. The site is enclosed by a fence (approximately 1 acre), where there are several reintroductions of rare plants including *D. waianaensis* and *C. superba* subsp. *superba*. OANRP will perform weed control in this WCA at NARS staff direction, however there are no regularly planned visits for now.

WCA UpperKapuna-08 (Wild Delwai)

Veg Type: Mesic Ridge/Mesic Mid-Slope/Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: Previous weed control in the area focused on canopy weeds including *S. terebinthifolius*, *P. cattleianum*, and *G. robusta*. A single *Schefflera actinophylla* was also controlled during one weed sweep. Understory weeds included small *S. terebinthifolius* and *C. hirta*.

Notes: This WCA shares a boundary and is continuous with WCA-01. Weed control takes place in this WCA to maintain and improve habitat for recruitment of *D. waianaensis*. The area is dominated by native species, and annual weed control is sufficient to maintain a low level of weeds. As per

communication with the NARS specialist, large weedy trees in the gulch will also be targeted in order to align goals with NARS staff weed control projects.

WCA UpperKapuna-09 (Delsub Reintroduction)

Veg Type: Mesic Mid-Slope

MIP Goal: Less than 25% non-native cover

Targets: Overstory in this WCA is mostly comprised of *S. terebinthifolius*. Non-native ferns such as *C. parasitica*, and thick *P. conjugatum* can become dense in the understory around the rare plants reintroduced at this site.

Notes: This WCA was established for weed control around a reintroduction of *D. waianaeensis*. One of the most significant weed control efforts has been grass spray of *P. conjugatum* and *Oplismenus hirtellus* throughout the reintroduction area. Due to the high level of non-native canopy, overstory weed control will be conducted very gradually. Grass sprays will be conducted every 6 months until grass levels are significantly reduced in the reintroduction area, after which grass control can be expanded to outlying areas. Subsequent understory weed control for colonizing weeds that fill in open space created by grass control will be conducted annually. *Microlepis strigosa* is prevalent near and around the reintroduced plants and has high potential to fill in areas following grass control. Potential for expansion of this WCA will also be investigated if field surveys or discussions with the NARS biologist indicate appropriate.

WCA UpperKapuna-10 (Wild Schobo/Cyalon)

Veg Type: Mesic Ridge

MIP Goal: Less than 25% non-native cover

Targets: *C. hirta*, *R. rosifolius* and *P. cattleianum* are the most common understory weeds in this WCA. *P. cattleianum* accounts for the majority of the non-native canopy.

Notes: Weed control is directed around *S. obovata* and *C. longiflora* in this small WCA. These taxa occur on a small, steep cliff. Understory weeds that can be safely targeted will be controlled on this cliff. There is a large stand of *P. cattleinaum* at the bottom of the WCA that will be pushed back to prevent further encroachment into the suitable habitat for these rare taxa. Weeds above the cliff should also be targeted to reduce the source of weedy seeds above the area.

WCA UpperKapuna-11 (Hunter Cabin LZ clearing)

Veg Type: Mesic Mid-Slope

MIP Goal: N/A

Targets: *P. cattleianum* and *P. guajava* dominates the surrounding canopy area while the LZ consists primarily of *P. conjugatum*.

Notes: OARNP assists in maintaining this WCA for the integrity of the emergency LZ located here. Currently, OARNP performs minimal maintenance in this area as NARS staff has remained diligent in maintaining the integrity of the LZ. If future discussions with the NARS specialist request additional assistance from OARNP then actions will be scheduled accordingly. OARNP will continue to visit/monitor the site quarterly for the *D. intortum* and *N. wightii* ICAs located within the WCA (refer to ICA section for further details).

WCA UpperKapuna-12 (Fluneeo reintroduction)

Veg Type: Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: Canopy consists of *A. moluccana*, *P. guajava* and *S. terebinthifolius*. Understory targets include *T. semitriloba*, *R. rosifoliosus*, *C. parasitica* and grasses.

Notes: This WCA is predominantly non-native with a few native canopy components. OARNP efforts will focus on providing habitat for the reintroduced *Flueggea neowawraea*, which includes maintaining abundant canopy light gaps and controlling incoming grasses and understory weeds. *T. semitriloba* is abundant and will be controlled aggressively within the WCA.

Rodent Control

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

Threat level: High

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 and tree snails.

Monitoring Objective:

- Monitor rare plant populations and *A. mustelina* populations to determine impacts by rodents.

Rodent Control:

- Potentially threatened resources are widespread throughout the Kapuna MU. Rare plant populations have been impacted by rodents in the past but no rodent control is currently in place. Outplanted *P. kaalaensis* were damaged during an outbreak of mice in the spring of 2007. Rodent control was implemented until the mouse threat subsided. Rats are known fruit and seed predators of *A. macrococcus* var. *macrococcus*, *C. longiflora*, *C. superba* subsp. *superba*, *C. dentata*, *D. waianaeensis*, and predators of *A. mustelina*. If rare plants or tree snails are determined to be impacted adversely by rodents OARNP will evaluate the use of localized rodent control for the protection of rare species.

Predatory Snail Control

Species: *Euglandina rosea* (rosy wolf snail), *Oxychilus alliarius* (garlic snail)

Threat level: High

Control level: No control taking place currently

Seasonality: Year-Round

Number of sites: N/A

Acceptable Level of Activity: No control program planned currently

The only current control option for predatory snails is labor intensive visual searches for snails, followed by hand removal. Surveys confirm *E. rosea* is present in this Management Unit, however, it is unknown whether *O. alliarius* is also established. Surveys for the latter snail would be beneficial for identification of threats to *A. mustelina*. There is some evidence that the diet of *O. alliarius* in a laboratory setting is restricted to prey smaller (<3 mm shell size) than *A. mustelina* (Meyer and Cowie *in press*)¹¹. However, University of Hawaii researcher Dr. N. Yeung has observed *O. alliarius* consuming larger prey in the field (see photo below). The vast majority of Pacific island land snails are small, with either adult or juvenile stages of < 3 mm in shell length. This combined with the observational feeding data indicates that *O. alliarius* is a potential threat to many of Hawaii's native land snails.

No actions for predatory snail control are planned this year.



Oxychilus alliarius feeding on a 7 mm *Auriculella* species from Mt. Kaala. Photo courtesy of N. Yeung

Ant Control

Species: *Solenopsis papuana*, *Tetramorium simillimum* confirmed

Threat level: Low

Control level: Only for new incipient species

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

Number of sites: Two: Hunter's Cabin and Mokuleia Trailhead, KAP-A and C *Achatinella mustelina* sites

Acceptable Level of Ant Activity: Acceptable at current levels

Primary Objective:

¹¹ Meyer, WM and RH Cowie. *In press*. Feeding preferences of two predatory snails introduced to Hawaii and their conservation implications. *Malacologia*

- Eradicate incipient ant invasions restricted to a small area and control species that are a major threat to native species.

Management Objective:

- If incipient species are found (<0.5 acre isolated infestation) eradication will be attempted
- Control or eradicate ant species that pose a serious threat to native species (e.g. *Wasmannia auropunctata*)

Monitoring Objective:

- Continue to sample ants at human entry points (hunter's cabin, Mokuleia Trailhead) a minimum of once a year. Use samples to track changes in existing ant densities and to alert OARNP to any new introductions.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. It is therefore important to know their distribution and density in areas with conservation value. This can be accomplished using a survey methodology developed by S. Plentovich (UH Manoa). Ant sampling took place in Kapuna on 4/8 and 4/29 in 2008 using the invasive ant monitoring protocol appearing in Appendix 6-1 (this document).

Two species were found: *Solenopsis papuana* and *Tetramorium simillimum*. The first occurred in moderately high numbers (>25 foragers per bait) while the latter occurred in low numbers (<5 per bait). Control is not recommended at this time because both are widespread throughout Oahu. In a non-random survey of upland areas *S. papuana* was the most frequently encountered ant species. In addition, there was a high degree of overlap among tree snails and *S. papuana*, possibly indicating some level of tolerance (Appendix 6-2, this document) *Tetramorium simillimum* species is limited to disturbed areas and has not been found in undisturbed forest.

Slug Control

Species: *Deroceras leave*, *Limax maximus*, *Meghimatium striatum* confirmed

Threat level: High

Control level: Localized

Seasonality: Wet season

Number of sites: *Schiedea nuttallii* (2 sites), *S. obovata* (3 sites), *Cyanea longiflora* (5 sites), *C. superba* var. *superba* (2 sites), *Cyrtandra dentata* (7 sites), *Delissea waianaensis* (4 sites)

Primary Objective:

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

Management Objective:

- If additional Special Local Needs labeling for Sluggo is approved by USFWS and HDOA, begin discussion with NARS biologist to identify areas where application would benefit native plants without harming nontarget snails.

Monitoring Objectives:

- Annual census monitoring of slug densities during wet season.
- Annual census monitoring of plant species vulnerable to slug predation

Effective molluscicides have been identified (Sluggo) and initial control programs are ongoing in Kahanahaiki under an Experimental Use Permit (EUP). The results from molluscicide tests in Kahanahaiki will be used to inform future slug control efforts.

Fire Control

Threat Level: Medium-high

Available Tools: Fuelbreaks, Helicopter Drops, Wildland Fire Crew, Red Carded Staff

Management Objective:

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

Preventative Actions:

Upper Kapuna MU falls in the MMR Action Area and is considered medium to high risk of fire due to the close proximity to Makua Valley where the fire threat is high. Fire prevention to this MU depends on fire measures put in place in Makua Valley. As with all other fire prone MUs, the following preventative actions are important: fire prevention signage, trail and LZ maintenance, and reduction of grass and other fuel loads on ridges and fencelines.

The BO, which is a re-initiation of the 1999 review by the U.S. Fish and Wildlife Service (FWS) of Army training in Makua, details several different options for reducing fire threat. Which options are required depends in part on the weapons/ munitions used during training. For now, OARNP 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 catastrophic Makua brushfire that could potentially threaten Upper Kapuna MU. OARNP will maintain red-carded staff to assist with fire response.

Action Type	Actions	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014				MIP Year 11 Oct 2014- Sept2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct baseline vegetation monitoring across MU																				
	Conduct MU vegetation monitoring every 3 years																				
General Survey	Survey 2397 South Fenceline LZ whenever used, no more than once per quarter. If not used, do not need to survey.																				
	RS-MOKFR-01: Survey road from Peacock Flats gate turnoff to Mokuleia trailhead biennially.																				
	RS-MOKFR-01: GPS Mokuleia trail access road; update GIS shape.																				
	WT-KAPUNA-01: Survey Mokuleia Trail from trailhead to where trail exits Subunit III fence on east side; annually.																				
ICA	UpperKapuna-Angeve-01: Monitor/control Angeve in gulch with Cyrden PIL-C. Check every 6 months, transition to annual. Foliar spray of G4 works well; to reduce non-target drift, cut off large fronds of mature plants and treat when new croziers appear (applies to all Angeve ICAs below).																				
	UpperKapuna-Angeve-02: Monitor/control Angeve along Mokuleia trail in Banana gulch																				
	UpperKapuna-Angeve-03: Monitor/control Angeve in Hesarb gulch																				
	UpperKapuna-Angeve-04: Monitor/Control Angeve in Monsta Patch, 1600ft elev in Keawapilau																				
	UpperKapuna-Angeve-05: Monitor/control Angeve at NEW SPOT																				

Action Type	Actions	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014				MIP Year 11 Oct 2014- Sept2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	UpperKapuna-Desint-01: Monitor/control DesInt along Mokuleia trail, from trail head to Hunter Cabin, quarterly.																				
	UpperKapuna-Ehrsti-01: Monitor/treat trail for EhrSti quarterly. Focus on blue-flagged hotspots. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.																				
	UpperKapuna-Ehrsti-02: Monitor/treat Talbert's EhrSti patch quarterly.																				
	UpperKapuna-Ehrsti-03: Monitor/control EhrSti at Julia's patch above Mokuleia trailhead quarterly.																				
	UpperKapuna-Monhib-01: Monitor/Control MonHib along Pahole Rim and Makua East Rim, quarterly as needed. Focus on keeping MonHib from spreading into Upper Kapuna (already scattered in Pahole).																				
	UpperKapuna-Neowig-01: Monitor/control NeoWig at Hunter's Shelter quarterly.																				
	UpperKapuna-Neowig-02: Monitor/control NeoWig at clearing within subunit I/II fence along Mokuleia trail quarterly.																				
	UpperKapuna-Pteglo-01: Monitor/control Pteglo along Kapuna fenceline above hunter shelter quarterly to twice a year. Pick and remove from field any potentially mature fruit. Consider using pre-emergent herbicides																				
	UpperKapuna-Rubarg-01: Monitor/control Rubarg at CyaLon PIL-B. Use spades to dig roots/runners out of ground. Treat with 40% G4																				

Action Type	Actions	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014				MIP Year 11 Oct 2014- Sept2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	UpperKapuna-Rubarg-02 : Monitor/control Rubarg at Schobo PIL-C reintro. Use spades to dig roots/runners out of ground. Treat with 40% G4																				
	UpperKapuna-Setpal-01: Monitor/retreat Setpal site near subunit I/II fence annually during Mokuleia Trail weed survey.																				
	UpperKapuna-Sphcoo-01: Monitor/control SphCoo in CyrDen PIL-C gulch annually																				
General WCA	GPS boundaries of all current WCAs																				
	Define priority 1 and 2 areas in MU after baseline vegetation monitoring is conducted																				
UpperKapuna-01 (Chaher/Hesarb/De Iwai Gulch)	Conduct weed control sweeps across entire area, from below waterfall, up gulch, towards trail, annually. Ensure that sweep around rare taxa/ Chaher above waterfall. Target understory weeds and gradual removal (6%/visit) of canopy weeds. Always target Trisem in Upper Kapuna.																				
	Conduct weed control right around rare plant reintro sites below waterfall every 6 months. Control both understory and canopy weeds.																				
UpperKapuna-02 (Stream Site)	Conduct weed control targeting understory species annually, focusing around reintroductions. Can work both inside and outside fence. Some gradual canopy removal, but light levels should be preserved for health of reintroductions. Understory dominated by Bleapp; control methods are very aggressive, do not conduct Bleapp control at this time (confer with State).																				

Action Type	Actions	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014				MIP Year 11 Oct 2014- Sept2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
UpperKapuna-03 (Schnut/Cyalon)	Conduct understory and canopy weed control across WCA every 6 months. Focus effort around rare plant sites, native forest patches. Work to connect sites. Target understory weeds, especially Clihir, and remove canopy weeds gradually to minimize light level changes.																				
UpperKapuna-04 (Keawapilau Cyalon)	Conduct understory and canopy weed control across WCA every 6 months. Focus effort around rare plant sites, native forest patches. Work to connect sites. Target understory weeds, especially Clihir, and remove canopy weeds gradually to minimize light level changes.																				
UpperKapuna-05	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed. Always target Trisem in Upper Kapuna, particularly in at Pahole/Makua/Kapuna join.																				
UpperKapuna-06 (Schobo Reintroduction)	Conduct weed control across reintroduction area, targeting understory species, gradual removal of overstory weeds, every 6 months/year.																				
	Control weedy grasses across reintroduction site, as needed.																				
UpperKapuna-08 (Wild Delwai)	Conduct weed control sweeps across entire WCA annually. Goal is to maintain/improve habitat for recruitment of Delsub. Area dominated by native species. Target both understory and canopy weeds. Control canopy weeds targeted by NARS in gulch bottom.																				
UpperKapuna-09 (Delwai Reintroduction)	Conduct understory/ canopy weed control across reintro site annually. Remove canopy weeds gradually (6%/visit), targeting Schter. Do not control large Grerob, as state																				

Action Type	Actions	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014				MIP Year 11 Oct 2014- Sept2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	conducting trials - wait for all clear from state.																				
	Control weedy grasses across reintroduction site, as needed every 6 months. Targets: Pascon, Melmin. Avoid non-target effects on native ferns; use Fusilade preferentially.																				
	Fly in water tank for grass spray																				
UpperKapuna-10 (Wild Schobo/Cyalon)	Conduct weed control around Schobo B, Cyalon D, annually. Rare taxa on a small, steep cliff. Target understory weeds, gradual canopy control on and below cliff. Push Psicat stand back from cliff.																				
UpperKapuna-11 (Hunter Cabin LZ clearing)	Assist the state in maintaining area for LZ, as needed.																				
UpperKapuna-12 (Fluneo reintroduction)	Conduct understory/canopy weed control around reintroduction site every 6 months. Goal is to manage Fluneo, which requires lots of sun. Control canopy weeds aggressively at site.																				
	Control weedy grasses across reintroduction site, as needed.																				
Ungulate Control	Subunit I/II: Monitor fence integrity quarterly																				
	Subunit III: Monitor fence integrity quarterly																				
	Subunit IV: Monitor fence integrity quarterly																				
	Assist NARS staff to create and check ungulate transect(s) in Subunit IV																				

Action Type	Actions	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014				MIP Year 11 Oct 2014- Sept2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Assist NARS with hunts (as needed until ungulates removed)																				
Rodent Control	Monitor rare plants and tree snails for predation by rodents																				
	Implement localized rodent control if determined to be necessary for the protection of rare plants and tree snails																				
Ant Control	Conduct surveys for ants at 2 human entry points (Hunter’s Cabin, Mokuleia Trailhead)																				
	Implement control if deemed necessary																				
Slug Control	Monitor slug activity at rare plant population(s) <i>Schiedea nuttallii</i> , <i>S. obovata</i> , <i>Cyanea longiflora</i> , <i>C. superba</i> subsp. <i>superba</i> , <i>Cyrtandra dentata</i> , <i>Delissea waianaeensis</i>																				
	If slugs found to exceed acceptable levels during monitoring, maintain slug bait at sensitive plant population(s)																				

Hatched=Quarter Schedule