

Ecosystem Restoration Management Plan

MIP Year 12-16, Oct. 2015 – Sept. 2020

OIP Year 9-13, Oct. 2015 – Sept. 2020

MU: Kaluakauila Gulch

Overall MIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate and weed threats in the next five years to allow for stabilization of IP taxa.

Background Information

Location: Waianae Mountains, northern rim of Makua Military Reservation

Land Owner: U.S. Army

Land Managers: Oahu Army Natural Resources Program, Division of Forestry and Wildlife

Acreage: 110 acres

Elevation Range: 800-1750 feet

Description: The Northwest facing slope of Kaluakauila Gulch extending from the rim of Makua Valley to the gulch bottom of Kaluakauila stream. The MU consists mostly of steep rocky slopes with several large cliff faces. Soil thinly covers rocky areas and soils are considerably hydrophobic. The MU is bisected into two primary work sites by a large waterfall which divides the upper and lower management areas. Kaluakauila Stream is an intermittent stream with some perennial seeps. Several smaller intermittent streambeds also dissect the northwest face of the MU. The Northern rim of Makua Valley consists of exposed, weathered basalt. Talus slopes dominate the lower slope and gulch bottom areas. Winter rains produce small but significant flash flooding events which are responsible most of the erosion along the streambeds.

Two vegetation types intergrade at Kaluakauila. Along the ridges and crestline area, a mix of native and non-native elements comprise a lowland dry shrubland/grassland community. Large patches of *Heteropogon contortus* grass and *Dodonaea viscosa* still persist along the ridgeline dividing Kaluakauila Gulch from Makua Valley, especially in the rockier areas where *Heteropogon contortus* can effectively compete against other alien grasses which need more soil. This vegetation type can also be seen on the makai line of the unit, which is largely dominated by non-native grass, mainly *Urochloa maxima*. Not much management is being done in this area, although a historical *Hibiscus brackenridgei* subs. *mokuleianus* genetic storage population exists.

In the gulches and slopes a diversity of native and non-native trees and shrubs comprise the mixed dry forest community. Significant stands of *Diospyros* spp. trees form the core of the two upper and lower Kaluakauila dry forest patches. Non-native grasses (mostly *Urochloa maxima*) and shrubs (*Leuceana leucocephala*) dominate the landscape between forest patches. *Aleurites moluccana* dominates the gulch bottom area of this community.

The native dry forest community is extremely rare on Oahu (less than 2% remains) and disappearing across the state. Stabilizing the dry forest habitat from further degradation in order to allow rare plant

species to thrive is the most feasible goal in the long-term given the amount of weeds already present and the small size of the native forest patches.

Native Vegetation Types

Wai'anae Vegetation Types	
Lowland Dry Shrubland/Grassland	<u>Canopy includes:</u> <i>Erythrina sandwicensis</i> , <i>Myoporum sandwicense</i> , <i>Dodonaea viscosa</i> , <i>Santalum ellipticum</i> , <i>Hibiscus brackenridgei</i> subsp. <i>mokuleianus</i> . <u>Understory includes:</u> <i>Heteropogon contortus</i> , <i>Sida fallax</i> , <i>Eragrostis variabilis</i> , <i>Abutilon incanum</i> , <i>Leptecophylla tameiameia</i> e. <i>Bidens sp.</i>
Dry forest	<u>Canopy includes:</u> <i>Diospyros sp.</i> , <i>Myoporum sandwicense</i> , <i>Erythrina sandwicensis</i> , <i>Reynoldsia sandwicensis</i> , <i>Rauwolfia sandwicensis</i> , <i>Santalum ellipticum</i> , <i>Psydrax odoratum</i> , <i>Nestegis sandwicensis</i> and <i>Myrsine lanaiensis</i> . <u>Understory includes:</u> <i>Dodonaea viscosa</i> , <i>Sida fallax</i> , <i>Bidens sp.</i>
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.	

Terrain and Vegetation Types at Kaluakauila



Ridgeline separating Kaluakauila Gulch and Makua Valley (background)



Looking makai into Kaluakauila Gulch



Dry forest community at Kaluakauila

MIP/OIP Rare Resources at Kaluakauila

Organism Type	Species	Pop. Ref. Code	Management Designation	Wild/ Reintroduction/ Future Planting
Plant (MIP)	<i>Neraudia angulata</i>	MMR-F, G, H*	MFS	Reintroduction
Plant (MIP)	<i>Melanthera tenuifolia</i>	MMR-F	MFS	Wild
Plant (MIP)	<i>Nototrichium humile</i>	MMR-A, J, L*, M*, N*	MFS	Wild
Plant (MIP)	<i>Euphorbia celastroides</i> var. <i>kaenana</i>	MMR-B	GSC	Wild
Plant (OIP)	<i>Abutilon sandwicense</i>	MMR-B MMR-C	GSC	Reintroduction
Plant (MIP)	<i>Hibiscus brackenridgei</i> subsp. <i>mokuleianus</i>	MMR-C, D, E*	GSC	Reintroduction
Plant (MIP)	<i>Delissea waianaensis</i>	MMR-D	GSC	Reintroduction

MFS= Manage for Stability

*= Population Dead

GSC= Genetic Storage Collection

Other Rare Taxa at Kaluakauila

Organism Type	Species	Status
Plant	<i>Euphorbia haeleeleana</i>	Endangered
Plant	<i>Schiedea hookeri</i>	Endangered
Plant	<i>Schiedea kealiae</i>	Endangered
Plant	<i>Bonamia menziesii</i>	Endangered
Plant	<i>Chrysodracon forbesii</i>	Endangered
Plant	<i>Bobea sandwicensis</i>	SOC
Bird	<i>Asio flammeus sandwichensis</i>	State Endangered
Bird	<i>Chasiempis ibidis*</i>	Endangered
Mammal	<i>Lasiurus cinereus semotus</i>	Endangered

*population extirpated

Rare Resources at Kaluakauila



Euphorbia haeleeleana



Hibiscus brackenridgei subsp. *mokuleianus*



Melanthera tenuifolia



Neraudia angulata

Locations of Rare Resources at Kaluakauila

Map removed to protect rare resources

Threats to MIP/OIP MFS Taxa

Threat	Rare Taxa Affected	Management Strategy	Current Status, 2017
Pigs	All	Across MU	No animals within fence
Weeds	All	Rare taxa sites primarily, across MU secondarily	Regular maintenance required several times per year
Black Rat	Unknown	No control	Unknown
Slugs	<i>Delissea waianaensis</i>	Affected rare taxa sites only	Surveys done as needed
Ant	<i>Neraudia angulata</i>	No control	Surveys conducted before sling load operations or as needed
Black Twig Borer	<i>A. sandwicense</i> , <i>N. angulata</i>	No control	Annual surveys during rare plant monitoring
Fire	All	Along fencelines and rare taxa sites	Regular maintenance required several times per year

Management History

- 1970: Large military fire burns Makua Valley
- 1984: Large military fire burns Makua Valley
- 1995: Rare plant surveys are conducted, though no management is being done
- 1995: Escaped prescribed fire in Makua burns to forest edge of Kaluakauila.

- 1997-2009: Rat control initiated and expanded to protect *E. haelealeana* fruits and forest.
- 2001: Fence completed, ungulates removed. Heavy rains blow out fence, pigs re-enter MU and removed via snaring.
- 2001-2017: Grass and weed control in forest patches. Catchments installed.
- 2003: Escaped prescribed fire burns into Kaluakauila MU as well as burning most of Makua Valley. Damage to Kaluakauila includes: 2 *B. sandwicensis* with burn damage, fire w/in 28m of *N. humile*, 100 acres elepaio critical habitat burned, 6 acres of Oahu Plant Critical Habitat burned, fire w/in 20m of *B. menziesii*, fire w/in 30m of *E. haelealeana*, perimeter of native forest patches burned, about a km of the fence burned.
- 2005: White phosphorus fire burns Makua after escaping from fire break road
- 2006: Arson fire burns to forest edges, destroying a *H. brackenridgei* reintroduction along the western edge of the fence and a portion of a *E. celastroides* var. *kaenana* wild population.
- 2006: *Cirsium vulgare* (thistle), a highly invasive herb, is found in the lower forest patch. Also, *Syzygium jambos* (rose apple), is found on the northeastern edge of the fence, in the gulch. Both are removed and ICAs are created.
- 2007-2014: Slug, ant and arthropod surveys conducted. Low slug numbers detected.
- 2009: Rat tracking tunnels deployed (no activity detected).
- 2010: Fire started inside the range fence between the range control building and Ukanipo Heiau burns into Kaluakauila MU. Damage includes: about 90 *M. tenuifolia* burned, 3 *B. sandwicensis* singed, fire burned within 10m of *E. haelealeana* and forest perimeter was burned.
- 2011: Assisted with Range Division Intetrated Vegetation Management Plan by working with contractor to spray fuel breaks at Kaluakauila in January and May.
- 2013: Rat control efforts halted due to change in priorities.
- 2015-2016: OANRP staff are prohibited from entering Makua Military Reservation.
- 2016: Rat control resumes by the State (DOFAW) around wild *Euphorbia haelealeana* populations in the Upper and Lower patches.

Ungulate Control

Species: *Sus scrofa* (pigs)

Threat Level: Low

Management Objectives:

- Maintain entire unit as ungulate free.
- Remove all ungulates from unit if sign is present.

Strategy and Control Methods:

- Exclusion of all ungulates from MU via large-scale fencing. The fence was completed in 2001.
- Conduct quarterly fence checks, and monitor after major weather events.
- Note any pig sign while conducting day to day actions within fenced MU.
- If any pig activity is detected, work with Ungulate Manger to implement hunting or snaring.

Discussion: Due to the very large waterfalls along the gulch bottom, a complete fence check requires considerable time and effort. Controlling the guinea grass along the westernmost makai line using aerial spraying of glyphosate and a pre-emergent herbicide would make checking that line considerably easier. An initial cut would likely be required to facilitate spraying (as well as remove fuel loads). Checking the makai line could then be done far more quickly. Alternatively, cursory aerial inspections could also be done for the crest line and the makai line as needed.

The bottom fenceline was strategically placed on the south side of Kaluakauila gulch, rather than gulch bottom, to avoid damage from flooding. However, fence blowouts do occur at the base of the intermittent side streams on an irregular basis. These hog-wire sections need to be reinforced with hog panels and checked after extreme rainfall events. Additional panels may need to be placed upslope of the main fenceline to prevent rockfall from damaging the main fenceline itself.

Debris also frequently piles up along gulch bottom sections as these sections are built parallel to the slope. Removal of these debris piles is periodically necessary to prevent small pigs from passing through the larger holes in the panels and fence mesh.

The crestline fenceline is subjected to a considerable amount of pitting from winds and corrosion due to the salt air. Portions of this line should be carefully inspected and replaced before failure. Replacement or repairs will be done as needed.

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

Currently there is no plan for MU-scale vegetation monitoring in Kaluakauila. Since the majority of the MU is covered in weeds (*U. maxima*, *L. leucocephala*, etc.) and only few forest patches are being actively managed, large-scale belt plot monitoring would not represent the vegetation composition in the areas where most of the work is being done. Instead, considerations are underway for gigapan monitoring of target taxa and/or point-intercept vegetation monitoring in select high priority areas (Upper Patch and Lower Patch).

Surveys

Potential Vectors: OANRP activity, hikers/hunters, pigs/goats, alien birds, wind

Management Objective:

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

Strategy and Control Methods:

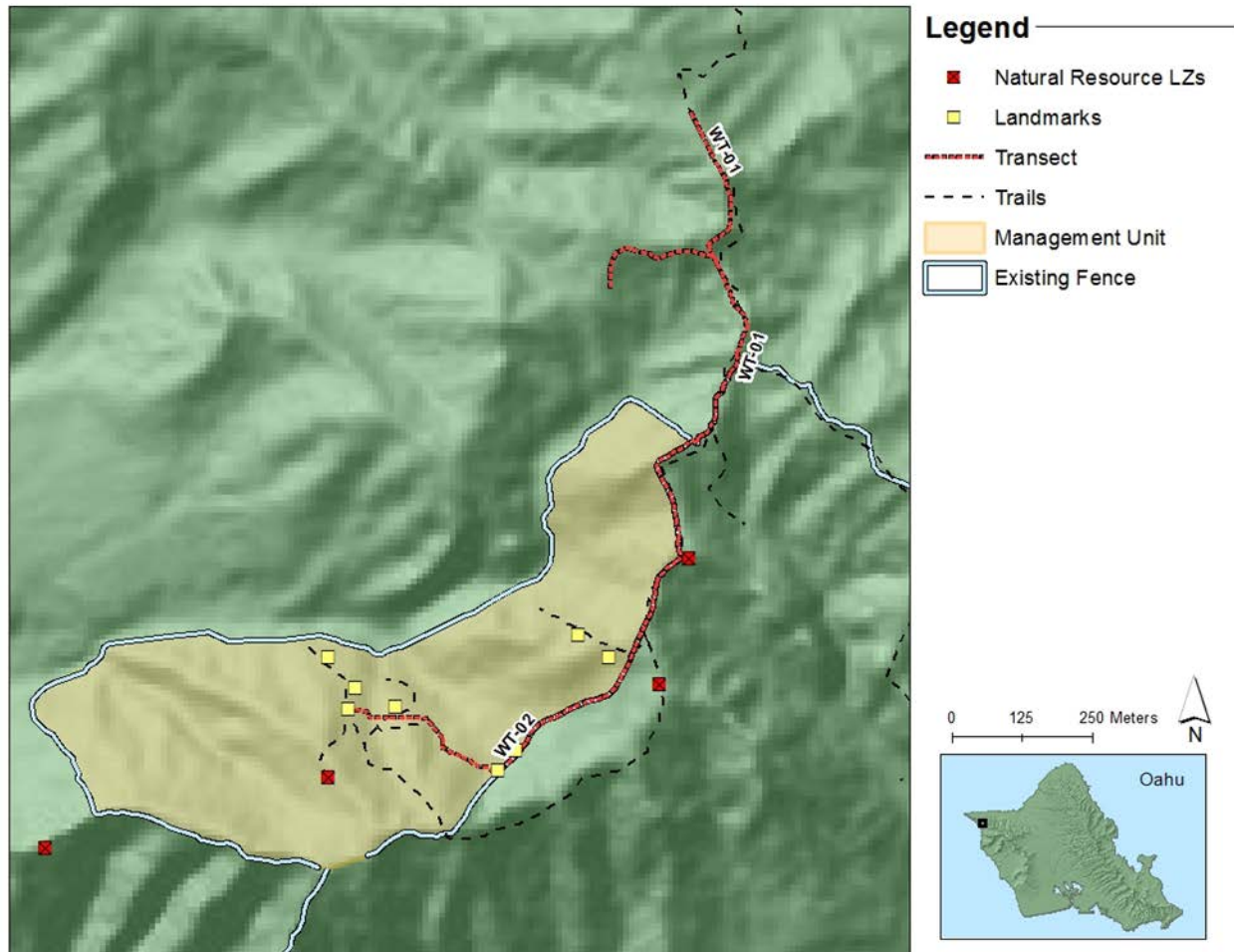
- Note unusual, significant, or incipient alien taxa during the course of regular field work. Map and complete Target Species form to document sighting.
- Survey of all of Kuaokala Road from Peacock Flats to the Kaena Point Satellite Tracking Station once every other year. GPS roads driven to document extent of survey in a given year.
- Survey LZs and campsites used in the course of field work, not to exceed once per quarter.
- Survey weed transects annually. These include WT-Kaluakauila-01, which begins at the trailhead and ends at the crossover to the Upper Patch and WT-Kaluakauila-02, which follows the trail from the Upper Patch to the Lower Patch catchment.

Discussion:

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

In Kaluakauila LZs are not used often, since the MU can be reached easily via Kuaokala Road. However, in times of outplanting LZs may be used to shuttle staff close to the worksite. Camping also occurs during a large outplanting. The campsites used are close to the road and infrequent, therefore, scheduled campsite surveys do not occur.

Fence and Survey Locations Map



Incipient Taxa Control

All weed control geared towards eradication of a particular invasive weed is tracked via Incipient Control Areas, or ICAs. Each ICA is species-specific and geographically defined. One infestation may be divided into several ICAs or one ICA, depending on infestation size, topographical features, and land ownership. Some ICA species are incipient island-wide, and are a priority for ICA management whenever found. Others are locally incipient to the MU, but widespread elsewhere. In either case, the goal is eradication of the ICA. The goals, strategies, and techniques used vary between ICAs, depending on terrain, surrounding vegetation, target taxon, size of infestation, and a variety of other factors.

Management Objectives:

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

- Evaluate any invasive plant species newly discovered in MU, and determine whether ICA-level control is warranted. Factors to consider include distribution, invasiveness, location, infestation size, availability of control methods, resources, and funding.

Strategy and Control Methods:

- Species and ICAs are listed in the table below. History and strategy is discussed for each species.
- Monitor the progress of management efforts, and adjust visitation rates to allow staff to treat plants before they mature. Remember that one never finds 100% of all plants present.
- Use aggressive control techniques where possible. These include power spraying, applying pre-emergent herbicides, clearcutting, aerial spraying, and frequent visits.

Summary of ICAs

Taxon	ICA Code	Control Discussion
<i>Cirsium vulgare</i>	MMR-Cirvul-02	This ICA is located in a drainage within Kaluakauila Gulch on the Northwest side of Makua Valley. A population of Cirvul had previously been recored from Ohikilolo, on the Southeast side of the valley. However, it is not clear where the Kaluakauila individual dispersed from. NRS found two immature individuals in 2006. The plants were pulled out and the area around was searched. None were found. NRS plans to re-survey the area thoroughly two more times in two years. It is highly probable that NRS will be able to eradicate <i>C. vulgare</i> from this ICA.

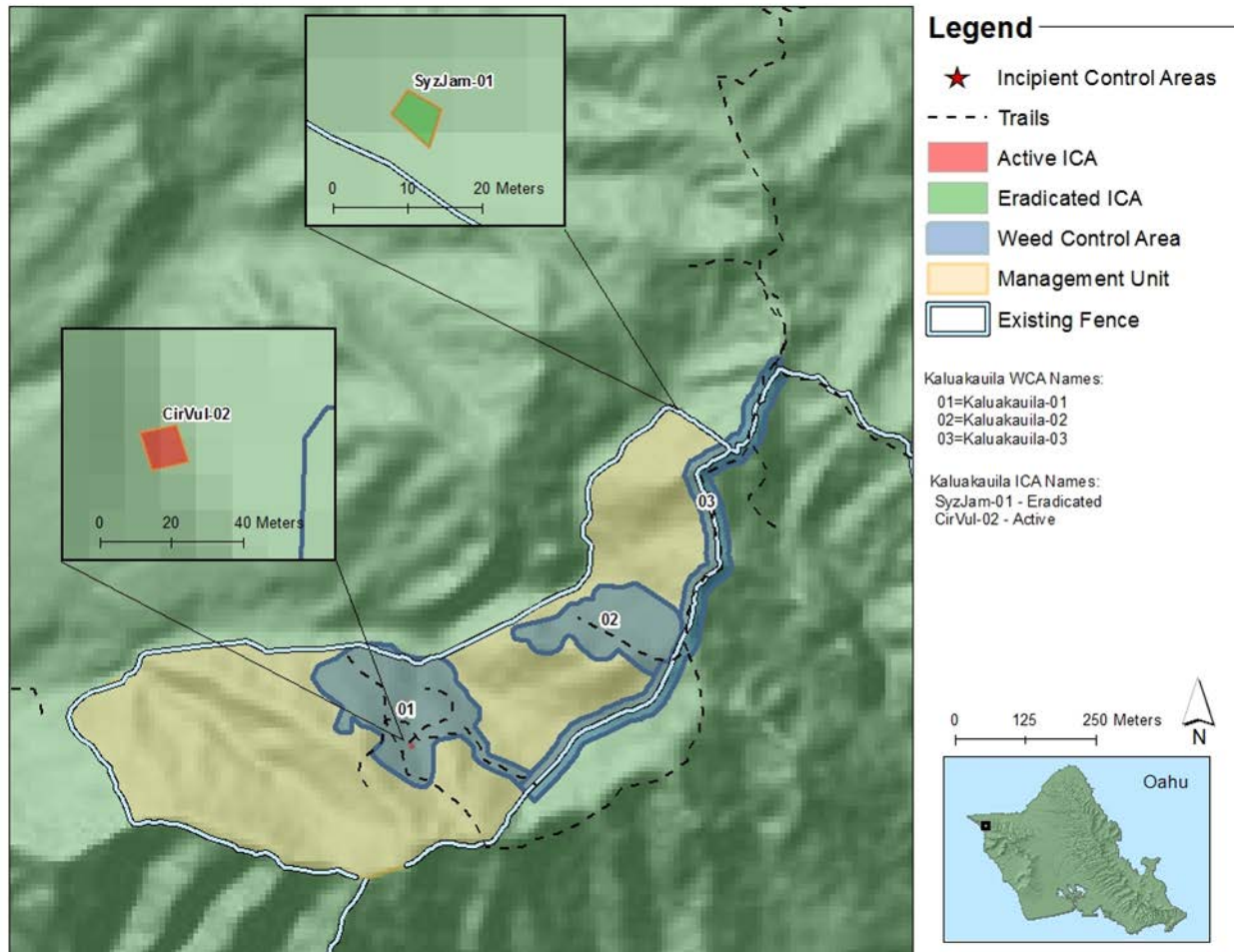
ICAs Eradicated at Kaluakauila: Syzigium jambos (MMR-Syzjam-01)

Incipient Weed Photos



Cirsium vulgare left: flowers; right: habitat. Photo: Forest & Kim Starr

Incipient and Weed Control Areas Map



Ecosystem Management Weed Control

All weed control geared towards general habitat improvement is tracked in geographic units called Weed Control areas, or WCAs. The goals, strategies, and techniques used vary between WCAs, depending on terrain, quality of native habitat, and presence or absence of rare taxa.

MIP/OIP Goals:

- Within 2m of rare taxa: 0% alien vegetation cover 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:

- Achieve less than 25% perennial weed cover within 2m of IP taxa. Weed cover around rare taxa visually assessed qualitatively on a quarterly basis.
- Implement quarterly weed control to ideally achieve 50% or less of canopy and perennial understory weed cover in WCA-01 and WCA-02. Weed cover visually assessed qualitatively on a quarterly basis.

- As feasible, conduct fire pre-suppression efforts in the spring and fall each year to reduce fuel loads and fire threats (see Fire Control section).
- Keep grass (*U. maxima*) levels low (visually estimated below 10%) in WCA-01 and WCA-02.

Discussion: Weed control efforts in Kaluakauila have been focused in forest patches around outplantings. These patches consist of native and non-native overstory and understory. Outside the forest patches the unit consists entirely of weedy grass (*Uromax*) and shrubs (*Leuleu*), which readily move in to the patches if not kept in control. Strategies for removal include targeting canopy species (*Grerob*, *Alemol*, *Schter*, etc.), especially where native canopy exists and can fill light gaps. Grass is controlled around the perimeter of and within the patches to prevent spreading. Herbaceous understory weeds (*Rivhum*, *Bleapp*, *Agerip*, *Passub*, etc.) are removed, especially around rare taxa. Qualitative assessments on weed abundance have been ongoing by NRS staff and weeding occurs as needed.

Common reintroductions will be used to complement weeding efforts. Common reintroductions can include seed sowing, divisions, transplanting of seedlings already found in the field, and outplanting of greenhouse grown plants. The first common reintroduction is slated to begin in November 2017, which will include greenhouse-grown cuttings and plants from seed. NRS is currently experimenting with which species and methods are best for Kaluakauila.

Fire is a constant threat to rare taxa in Kaluakauila and fuel load suppression is ongoing to lessen the threat. Fuel load suppression is further discussed in WCA-03, as this WCA was created as a fire break to prevent flames burning over the ridge from Makua into Kaluakauila.

The table below summarizes invasive weeds found at Kaluakauila, excluding ICA species. While the list is by no means exhaustive, it includes the species targeted/prioritized for control. The distribution of each taxon is estimated as: Widespread (moderate to high densities of individuals, common across MU), Scattered (low densities across all or much of the MU), or Restricted (low or high densities, all in one discrete location).

Summary of Target Taxa

Taxa	Distribution	Notes
<i>Ageratina riparia</i>	Scattered	Scattered in light gaps on newly disturbed forested areas. It is a priority to clear, especially around rare plant populations.
<i>Anredera cordifolia</i>	Restricted	Found in a single location in Kaluakauila-02. Has the ability to climb and could potentially cover large areas. Surveys will be done to determine distribution and evaluate potential threat posed to habitat.
<i>Grevillea robusta</i>	Scattered	Large individuals scattered throughout the forest patches. Can be controlled using Incision Point Application (IPA) with Milestone®.
<i>Cenchrus setaceus</i>	Potentially widespread	Absent within the unit, but found on neighboring ridges in Makua. A priority to control if ever found within the unit. Any plants found would be targeted as an ICA.
<i>Leuceana leucocephala</i>	Widespread	A major component across the entire MU. Often forms dense monotypic stands and can grow to canopy height. Can be controlled with IPA using Milestone® or a 40% mixture of Garlon4® and biodiesel.
<i>Melia azedarach</i>	Scattered	Large trees scattered throughout the forest patches.
<i>Melinis minutiflora</i> and <i>repens</i>	Scattered	On the edge of the forest patches. <i>M. repens</i> doesn't form the dense, biomass-rich piles created by <i>M. minutiflora</i> . Both taxa are targeted within the forest patches and in fuelbreaks.
<i>Mesosphaerum pectinatum</i>	Widespread	Found at high densities, especially during the rainy season. Removal is necessary near outplantings.
<i>Passiflora suberosa</i>	Widespread	Widespread throughout the MU, especially in forest patches (Kaluakauila-01 and Kaluakauila-02).

<i>Rivinia humilis</i>	Widespread	Widespread throughout the MU as an understory groundcover. Removal is necessary near outplantings.
<i>Schinus terebinthifolius</i>	Scattered	Large trees and younger shrubs scattered in forest patches.
<i>Syzigium cuminii</i>	Widespread	Large trees, especially in forest patches and ridges. Control near outplantings.
<i>Urochloa maxima</i>	Widespread	A major component across the entire MU. It is a priority to control to reduce fuel load in the event of a fire.

Restoration activities are discussed in the notes section for each WCA. The table below contains specific notes on what native taxa and what type of stock may be appropriate for projects at Kaluakauila.

Taxa Considerations for Restoration Actions

Native Taxon	Outplant?	Seedsow/ Division/ Transplant?	Notes
<i>Carex wahuensis</i>	Yes	Seedsow/Division	Sedge. Grow from seed. Seed sows slow to germinate but effective.
<i>Dodonea visoca</i> *	Yes	No	Small tree. Grow from seed.
<i>Erythrina sandwicensis</i> *	Yes	No	Tree. Fast-growing. Grow from seed.
<i>Microlepia strigosa</i>	Yes	Division	Fern. Survives transplanting in mesic environments.
<i>Myoporum sandwicense</i> *	Yes	No	Tree. Grow from cuttings or seed.
<i>Polyscias sandwicensis</i>	Yes	No	Tree. Grow from cuttings or seed.

* Outplanting slated for November 2017

WCA: Kaluakauila-01 (Lower patch)

Veg Type: Dry forest

IP Goal: Within 50m of rare taxa: 25% or less alien vegetation cover

Targets: All perennial weeds including *Schinus terebinthifolius*, *Leucaena leucocephala*, *Grevillea robusta*, *Urochloa maxima*, *Melinis minutiflora*, and *Rivinia humilis*.

Notes:

Several rare taxa are present including, *Hibiscus brackenridgei* subs. *mokuleianus*, *Melanthera tenuifolia* and *Nototrichium humile*. A few failed reintroductions are in the Lower Patch and are not a priority to weed around.

The lower patch is dominated at its center by a dense stand of *Diospyros ssp*. Large *Erythrina sandwicensis*, *Sapindus oahuensis*, and *Euphorbia haelealeana* are also significant native components. *L. leucocephala* has been significantly reduced although it still recruits readily and control is ongoing.

Most of the weeding effort has been directed toward the control of *U. maxima* and other grasses in order to reduce fuel loads and increase shrub and canopy tree recruitment. *U. maxima* control should also focus on the cliff area below the WCA and to the western makai end to reduce the ability of any fire to move into the core dry forest area.

Annual weeds such as *Hyptis* ssp. are largely uncontrollable given their high density during the rainy season. *Hyptis* should be pulled or treated only around rare outplantings unless a better control method is found.

In addition to weeding outplantings, *S. terebinthifolius* needs to be controlled around *N. humile* plants and general weed control is also needed around the declining *Melanthera tenuifolia* population.

WCA: Kaluakauila-02 (Upper Patch)

Veg Type: Dry forest

MIP Goal: Within 50m of rare taxa: 25% or less alien vegetation cover

Targets: All perennial weeds including *Schinus terebinthifolius*, *Leucaena leucocephala*, *Grevillea robusta*, *Urochloa maxima*, *Melinis minutiflora*, and *Rivinia humilis*

Notes:

Several rare taxa present including a large number of *N. humilis*. The upper patch is dominated at its center by a dense stand of *Diospyros* spp. Large *Erythrina sandwicensis*, *Sapindus oahuensis*, *Polyscias sanwicensis* and *Euphorbia haeleeleana* are also significant native components. *L. leucocephala* has been significantly reduced although it still recruits readily and control needs to be ongoing. *A. moluccana* dominates most of the shallow gulches within the upper patch and maintains a good canopy for *N. angulata* outplantings and other native understory plants.

Most of the weeding effort has been directed toward the control of grasses in order to increase shrub and canopy tree recruitment. Grass control should also focus on the area to the east of the WCA near the stream bed to reduce the ability of any fire to move into the core dry forest area.

In addition to weeding outplantings, *S. terebinthifolius* needs to be controlled around the wild *N. humile* and *N. angulata* outplants. Grass and fern control is also needed for the *D. waianaensis* population close to the gulch bottom.

WCA: Kaluakauila-03 (Grandma's Hill)

See fire control section

Veg Type: Dry forest

MIP Goal: Act as a buffer within 50m of rare plant taxa to reduce fuel loads and prevent the spread of fire.

Targets: Non-native grasses and other fire prone weeds, including *Urochloa maxima* and *Acacia farnesiana*.

Notes:

The WCA extends from Grandma's Hill to the first drainage (cross-over to Lower Patch) and is composed of ridgetop weedy species, mainly *U. maxima*. The main goal of this WCA is to have a proactive effort in reducing fuel loads around populations of rare plants in the event that a fire may occur in the area. A 50 m buffer allows significant area for rare plants and surrounding habitat to survive and regenerate. In addition to keeping fuel loads low, a clear fenceline facilitates fence checks and hiking along the fenceline.

Small Vertebrate Control

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

Threat Level: High for *Rattus spp* for *Neraudia angulata* and *Abutilon sandwicense*. Unknown for *Mus*.

Seasonality/Relevant Species Biology: Rats may cue in to different foods at different times of the year, and sometimes exclusively target certain food sources. During very dry periods, rat damage has been seen on the stems of *N. angulata*.

Management Objectives:

- Maintain low levels of rat/mouse populations to a level that facilitates stabilized or increasing plant populations across the MU by the most effective means possible.
- Monitor rare taxa populations for rat damage; promptly initiate control if damage is noted.

Strategy and Control Methods:

- Monitor rare plant (*N. angulata* and *A. sandwicensis*) populations, as well as other native species to determine impacts by rodents.
- If rats are detected, deploy localized A-24 grid. Check bait and carbon dioxide cannisters every four months.

Discussion: Currently no rodent control is conducted by OANRP at Kaluakauila, since rodents are not deemed a threat to MFS populations at this time. The State (DOFAW) is currently managing an A24 grid in the Upper and Lower Patches around *E. haleleleana* to promote seedling recruitment and protect trees from damage. If MFS populations of *N. angulata* and *A. sandwicense* are determined to be adversely impacted by rodents, OANRP will evaluate the use of localized rodent control for the protection of these species. Given the small size and dry habitat, a grid of A-24 traps might effectively reduce rate numbers to allow for even greater regeneration of fruiting canopy species like *Diospyros spp*.

Slug Control

Species: *Veronicella cubensis*, *Deroceras laeve*

Threat Level: Unknown

Seasonality/Relevant Species Biology: Wet season (September-May)

Management Objectives:

- During annual rare plant monitoring, look for seedling recruitment and slug herbivory
- If damage seen, eradicate slugs locally to ensure germination and survivorship of *Delissea waianaensis*.

Strategy and Control Methods:

- Define Slug Control Areas (SLCAs) around rare plant populations if determined present with beer traps.
- Control slugs if determined to be a priority by the rare plant manager.

Discussion: During annual rare plant monitoring, plants will be inspected for herbivory. If present, this will be noted. Indication that slugs are responsible includes the following: lower leaves closer to the ground are more damaged, slime is present, leaf margins are consumed before the interior of the leaf (unless the midrib is resting on the ground while the margins are curled).

Sample slugs in the vicinity using baited beer traps. If the number of slugs captured per trap over two weeks exceeds one slug per trap, and, if no rare native snails are present, apply Sluggo monthly until slug numbers are reduced.

Ant Control

Species: *Anoplolepis gracilipes*, *Cardiocondyla emeryi*, *Cardiocondyla wroughtoni*, *Monomorium floricola*, *Ochetellus glaber*, *Paratrechina bourbonica*, *Pheidole megacephala*, *Plagiolepis alluaudi*, *Solenopsis papuana*, *Technomyrmex albipes*

Threat Level: High for *A. gracilipes*, *M. floricola* and *P. megacephala*. Much is unknown about the threats to rare taxa by *M. floricola* and *P. megacephala*. There is no known control method for *A. gracilipes*.

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

Management Objectives:

- Prevent spread of ant species into areas where not already established. Conduct annual surveys during the summer to determine what ant taxa are present in the MU.
- Implement control if incipient, high-risk species are found or if needed for *Drosophila* conservation.
- Detect incursions of new ant species prior to establishment.

Strategy and Control Methods:

- Sample ants at human entry points using the standard survey protocol (Plentovich and Krushelnycky 2009) and *Drosophila* host plant sites as needed (see table below). Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- If incipient species are found and deemed to be a high threat and/or easily eradicated locally (<0.5 acre infestation), begin control.
- Look for evidence of ant tending of aphids or scales on rare plants during annual rare plant monitoring.

Ant Survey Site Table

Site description	Reason for survey
Ridge top	High risk of accidental ant introduction via NRS staff or hikers
Upper Patch Catchment	High risk of accidental ant introduction via NRS staff
Lower Patch Catchment	High risk of accidental ant introduction via NRS staff
Grandma's Hill	High risk of accidental ant introduction via NRS staff
Kaku Pleomele	<i>Drosophila</i> are sensitive to high ant abundance
Parking spot	High risk of accidental ant introduction via NRS or public vehicles

Discussion: 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. From 2008-2014 ants were sampled in high risk areas using the following method:

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

No further surveys are planned for Kaluakauila, since many unwanted species were discovered during previous surveys. Long-legged ant species that were categorized as high risk in other areas have already

established populations in the MU, probably due to the low elevation. Because NRS staff and hikers travel the area repeatedly, transport of these ants could easily spread to other management units. The probability of transporting long-legged ant species to new MUs is the highest during sling load operations. If sling load operations could pose a possibility for transporting unwanted species from Kaluakauila to a new area, NRS staff will survey ant species at Kaluakauila DZs and LZs in the methods mentioned above one month before the operation. If incipient species are discovered, treatment will begin (Amdro or Maxforce). Sampling will be done a second time, two weeks later, and a second treatment will be applied if needed.