

## Ecosystem Restoration Management Plan

MIP Year 13-16, Oct. 2016- Sept. 2021

### MU: Pualii, PualiiNoMU

#### Overall MIP Management Goals:

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

#### Background Information

Location: Southern Waianae Mountains

Land Owner: State of Hawaii, DOFAW (Honouliuli Forest Reserve)

Land Managers: DOFAW, OANRP, OPEPP, OSEPP

Acreage: 25 acres

Elevation Range: 1800-2775 ft.

Description: Pualii MU is located in the Southern Windward Waianae Mountains and consists of two major drainages, North Pualii and South Pualii. Overall the area is characterized by steep vegetated slopes and cliff especially at higher elevations. Much of the MU is dominated by alien vegetation. There are only small pockets of native vegetation worthy of intensive management. The alien dominated areas were included in the MU boundary to capture the rare elements and unique native habitat at the heads of North and South Pualii as well as a native dry-mesic forest stand on the north face of North Pualii gulch.

The fenced portion of North Pualii consists of a non-native dominated southern facing (*Eucalyptus* sp. and *Schinus terebinthifolius* mostly) and a mixed native and non-native north face. The lower slope and gulch bottom of the north face contains a fairly intact, diverse dry-mesic forest canopy (dominated by *Sapindus oahuensis* and *Antidesma pulvinatum*) and open talus/soil understory. The left fork of North Pualii contains an intact *Planchonella sandwichensis* stand and an adjacent draw used for various reintroductions.

The fenced portion of South Pualii is the head of the gulch above a large dry waterfall. It contains a small patch of diverse mesic forest transitioning to an ohia shrubland cliff habitat. A small *Pisonia* stand located just outside the fence in South Pualii contains a remnant population of *Achatinella concavospira* snails.

Other rare resources outside the South Pualii fence include a few large wild *Urera kaalae* trees near the large waterfall and a ridgeline with scattered *Schiedea ligustrina*.

Infrastructural resources include two 250 gallon water catchments and tanks on adjacent ridges atop North and South Pualii, a landing zone at the crestline above South Pualii, and a small PU fence in the adjacent Napepeiaooolelo Gulch to the south. The small PU fence once contained a wild *Hesperomannia oahuensis* population. Currently, a small patch of *Dissochondrus biflorus* grass (a Species of Concern) is the only rare taxon still in the Napepeiaooolelo fence.

The MU is accessed via Kunia Road through the Kunia Loa development and the northern start of the Honouliuli Contour Road. The 25 acre fence was installed by The Nature Conservancy in 2006. Majority of rare plant reintroductions were done by TNC in the 2004-2006 period. OSEPP translocated most of the

*A. concavospira* snails to the Palikea enclosure in 2014-2015. OPEPP continues to use the North Pualii fence gulch bottom for reintroductions of *Urera kaalae* and *Solanum sandwicense*.

**Native Vegetation Types**

| Waianae Vegetation Types   |  |
|--|--|
| Mesic mixed forest   | <p><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>Sapindus oahuensis</i>, <i>Antidesma platyphyllum</i>, <i>A. pulvinatum</i>, <i>Bobea</i> spp. and <i>Santalum freycinetianum</i>.</p> <p><u>Understory includes:</u> <i>Alyxia stellata</i>, <i>Bidens torta</i>, <i>Coprosma</i> spp., <i>Microlepia strigosa</i> and <i>M. speluncae</i></p> |
| NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted. |  |

**Mixed Mesic and Dry-Mesic Vegetation Types at Pualii**



North Pualii at center top of photo, South Pualii at left of photo above large cliff face





Intact *Planchonella sandwichensis* stand with photopoint marker



South Pualii Diverse Mesic Forest Patch

**MIP/OIP Rare Resources at Pualii**

| Organism Type | Species  | Pop. Ref. Code | Population Units | Management Designation | Wild/ Reintroduction      |
|---------------|--|----------------|------------------|------------------------|---------------------------|
| Plant         | <i>Cenchrus agrimonioides</i><br><i>var. agrimonioides</i> | PUA-A          | Pualii North     | GS                     | Both                      |
| Plant         | <i>Hesperomannia oahuensis</i>                             | PUA-A          | Pualii North     | MFS                    | Reintroduction            |
| Plant         | <i>Phyllostegia mollis</i>                                 | PUA-A          | Pualii North     | MFS                    | Reintroduction (failed)   |
| Plant         | <i>Flueggea neowawraea</i>                                 | PUA-A          | Pualii North     | GS                     | Reintroduction (failed)   |
| Arthropod     | <i>Drosophila montgomeryi</i>                              | PUA-A          | Pualii North     | MFS                    | Wild, possibly extirpated |
| Snail         | <i>Achatinella mustelina</i>                               | N/A            | Pualii North     | GS                     | Wild                      |

MFS= Manage for Stability      GS= Genetic Storage

**Other Rare Taxa at Pualii**

| Organism Type | Species  | Status   |
|---------------|--|--|
| Plant         | <i>Abutilon sandwicense</i>                          | Endangered (reintroduction)                        |
| Plant         | <i>Asplenium unisorum</i>                            | Endangered   |
| Plant         | <i>Asplenium dielfalcatum</i>                        | Endangered   |
| Plant         | <i>Bobea sandwicensis</i>                            | Endangered   |
| Plant         | <i>Chrysodracon forbesii</i>                         | Endangered (wild)                                  |
| Plant         | <i>Delissea waianaensis</i>                          | Endangered (reintroduced)                          |
| Plant         | <i>Dissochondrus biflorus</i>                        | Rare on island                                     |
| Plant         | <i>Gardenia brighamii</i>                            | Endangered (reintroduced)                          |
| Plant         | <i>Neraudia melastomifolia</i>                       | Endangered (wild)                                  |
| Plant         | <i>Sideroxylon polynesianum</i>                      | Vulnerable (from Napepeiaolelo)                    |
| Plant         | <i>Solanum sandwicense</i>                           | Endangered (reintroduced)                          |
| Plant         | <i>Schiedea ligustrina</i>                           | Species of Concern                                 |
| Plant         | <i>Sicyos lanceoloideus</i>                          | Endangered (wild and reintroduced)                 |
| Plant         | <i>Stenogyne kanehoana</i>                           | Endangered (reintroduced)                          |
| Plant         | <i>Tetramolopium lepidotum</i> var. <i>lepidotum</i> | Endangered (reintroduced)                          |
| Plant         | <i>Urera glabra</i>                                  | Vulnerable (reintroduced)                          |
| Plant         | <i>Urera kaalae</i>                                  | Endangered (wild and reintroduced) (OPEPP managed) |
| Snail         | <i>Achatinella concavospira</i>                      | Endangered (wild)                                  |
| Snail         | <i>Auriculella ambusta</i>                           | Species of Concern                                 |
| Arthropod     | <i>Drosophila flexipes</i>                           | Vulnerable   |



### Rare Resources at Pualii



Reintroduced stand of *Abutilon sandwichensis*



TNC reintroductions: *Tetramolopium lepidotum* subsp. *lepidotum*. outplants at left in South Pualii. *Delissea waianaensis* outplants at right, North Pualii.

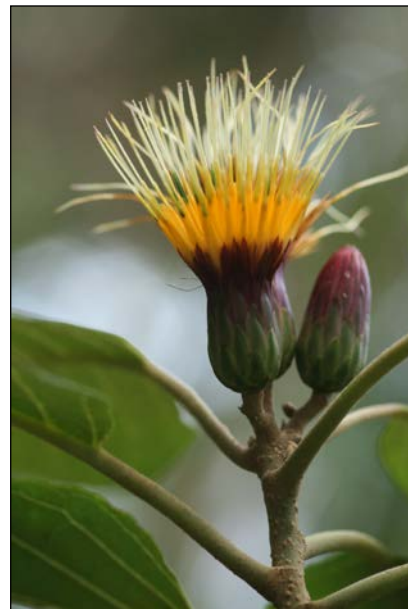




*Drosophila montgomeryi* laying eggs in a rotting trunk of *Urera kaalae*, Pualii.



*Phyllostegia mollis* with inflorescence



*Hesperomannia oahuensis*

### Locations of Rare Resources at Pualii

Map removed to protect rare resources

### MU Threats to MIP/OIP MFS Taxa

| Threat           | Rare Taxa Affected  | Management Strategy   | Current Status, 2017   |
|------------------|---|---|--|
| Ungulates        | All   | Fenced MU   | No animals within fence  |
| Rats             | All   | Localized control around <i>Hesperomannia oahuensis</i>   | Trap grid maintained regularly   |
| Ants             | <i>Drosophila</i> sp.                                       | Control Big-headed ants found in North Pualii within fence. Big-headed ants negatively impact <i>Drosophila</i> sp. | Infestation delineated, control imminent   |
| Weeds            | All   | Rare taxa sites primarily, across MU secondarily  | Regular maintenance required several times per year  |
| Fire             | All   | No control  | No control necessary at this time  |
| Black Twig Borer | <i>Flueggea neowawraea</i> ,<br><i>Abutilon sandwicense</i> | No control  | No control necessary at this time. All <i>F. neowawraea</i> outplants have died. OANRP currently does not manage <i>A. sandwicense</i> in this MU. |

|                      |  |                               |   |
|----------------------|--|-------------------------------|---|
| Slugs                | <i>Hesperomannia oahuensis</i>                     | Affected rare taxa sites only | Monitor rare plants; no control needed currently  |
| Jackson's Chameleons | <i>Drosophila</i> spp.,<br><i>Achatinella</i> spp. | No control                    | No control necessary at this time for <i>Drosophila</i> spp. All <i>Achatinella</i> spp. have been moved. |

### Management History

- 2006: The 25 acre fence was installed by The Nature Conservancy after previous survey work detected numerous rare species and a remnant, but intact dry-mesic forest community.
- 2004-2006: Numerous rare plant reintroductions done by TNC.
- 2006: TNC ends management of Honouliuli Preserve. Area transferred to DOFAW as a forest reserve.
- 2006: OANRP collaborates with TNC to manage MU.
- 2010-2014: OANRP reintroduces *Hesperomannia oahuensis* and *Phyllostegia mollis* to Pualii. *P. mollis* reintroductions all fail to recruit and die. *H. oahuensis* reintroduction thrives.
- 2013: First mature *H. oahuensis* observed.
- 2013-2014: OANRP surveys Pualii for *Drosophila* spp., small population of *D. montgomeryi* detected in North Pualii *Urera kaalae* outplanting/wild site. *Drosophila flexipes* detected in gulch bottom of fence area near crossing style.
- 2014-2016: Goats detected along crestline and in South Pualii. Control efforts initiated.
- 2014-2015: OSEPP translocated most of the *A. concavospira* snails to the Palikea snail enclosure.
- 2015: *Urera glabra* outplanted in gulch. First *H. oahuensis* fruit/seed collected from hand pollinated plants at site
- 2015-2016: OPEPP continues to use the North Pualii fence gulch bottom for reintroductions of *U. kaalae* and *Solanum sandwicense*.
- 2016: First *H. oahuensis* recruit discovered in area of dehisced achene.



## **Ungulate Control**

Species: *Sus scrofa* (pigs) and *Capra hircus* (goats)

Threat Level: High (pigs and goats)

Management Objectives:

- Maintain ungulate free enclosure.

Strategy and Control Methods:

- Snaring along crestline and portions of South Pualii outside of the fence to prevent goats from jumping in the fence.
- Maintain fence line.
- Conduct ground and aerial hunts for goats opportunistically.
- Conduct quarterly fence checks or as needed after extreme weather events.
- Note any pig sign while conducting day to day actions within fenced MU.
- If any pig or goat activity detected within the fence implement hunting and/or additional snaring program.

Discussion: Pigs are somewhat frequent visitors outside the fence area due to low and ineffective hunting pressure. Goats are also now an ongoing threat given their presence along the crestline and into South Pualii. Small goats have been trapped inside the South Pualii fence area. The Pualii fence was not built to keep out goats since goats were not a threat at the time of construction. However, parts of the fence where goats may be able to jump the fence, have been modified to stand taller by adding another panel in order to prevent goats from breaching the fenceline.

Special emphasis will be placed on checking the fence after extreme weather events and any vandalism on adjacent fences or resources. The area where the fence crosses the gulch bottom of South Pualii is prone to heavy stream/debris flows and fence blowouts. Fence may be altered in the future to have a hypalon to prevent heavy stream flows impacting the fence.

Pigs have infrequently made their way into the fence, particularly from the north fence line where debris piles up along the contouring fence line. The last pig observed inside the fence was in 2014 flowing a fence blowout in the stream. No pigs have been observed inside since. Debris should be periodically cleared during fence checks to keep small squares effective at eliminating ingress. At some point, fickle fencing may be warranted along this section if pig populations rise significantly.

## Weed Control

Weed Control actions are divided into 4 subcategories:

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

These designations facilitate different aspects of MIP/OIP requirements.

### Vegetation Monitoring

No vegetation monitoring planned at this time given few MIP/OIP targets and the degraded status of MU.

### Surveys

Potential Vectors: OANRP staff, pigs/goats, birds, hikers/hunters, 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:

- Quarterly survey of one LZ (if used).
- Note unusual, significant or incipient alien taxa during the course of regular field work.
- Any significant alien taxa found will be researched and evaluated for distribution and life history. If found to pose a major threat, control will begin and will be tracked via Incipient Control Areas (ICAs)

Discussion: Surveys are designed to be the first line of defense in locating and identifying potential new weed species. There are no surveys planned for roads or trail transects since NRS does not frequently work in the Pualii MU. However, action surveys for the road (past the main Kunia Loa Ridge road) and the main trails may be implemented in the future if NRS increases use.

### 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 Objective:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU.

#### Strategy and Control Methods:

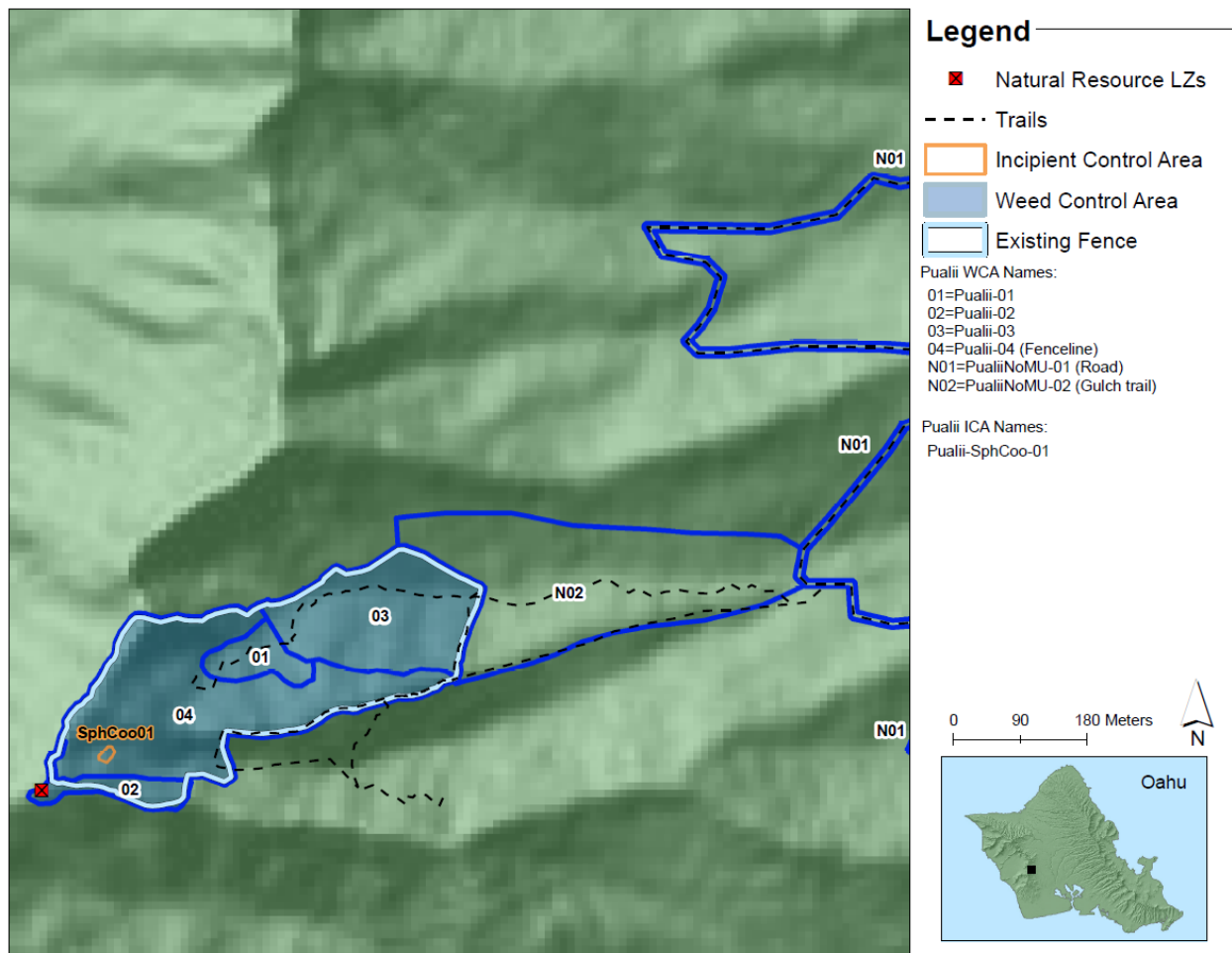
- Visit ICAs at stated re-visitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.
- If unsuccessful in preventing immature plants from maturing, increase ICA re-visitation interval.

**Discussion:** Only one incipient, *Sphaeropteris cooperi*, has been identified by OANRP in the MU. OANRP will continue to monitor and consider control on other possible incipient taxa when appropriate. Return visits will be scheduled in order to prevent immature individuals from reaching maturity.

**Summary of Target Taxa and ICAs**

| Taxon                        | ICA Code         | Control Discussion   |
|------------------------------|------------------|--|
| <i>Sphaeropteris cooperi</i> | Pualii-SphCoo-01 | Scattered individuals in the drainage of South Pualii. Few large, mature individuals have been found. Due to its documented invasive capability, it is a priority for control. |

**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.

**OIP/MIP Goals:**

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



Management Objectives:

- Reduce alien cover in both understory and canopy across the MU, working towards goal of 50% or less alien vegetation cover.
- Increase native cover in both understory and canopy across the MU, working towards a goal of 50% or more native vegetation cover.
- All portions of the MU are within 50m of rare taxa. However, weeding efforts will focus mainly on the rare taxa that are MFS.

Discussion: Weed control began in Pualii with the efforts of TNC. *Passiflora suberosa*, which is pervasive throughout the MU, was cleared out of the many *Pisonia* dominated gulches, and *Psidium cattleianum* was thinned from areas with native canopy. Hundreds of endangered plants were planted in this MU by TNC, and more followed by OANRP. Other natives such as *Urera kaalae* were reintroduced into the area by OPEPP to increase *Drosophila* habitat that had some existing wild *Urera*. OANRP continues to focus around rare plant taxa and around native forest patches.

**Summary of Target taxa**

| Taxa   | Management Designation | Notes  |
|--|------------------------|--|
| <i>Angiopteris evecta</i>                              | Control<br>Locally     | Scattered immature individuals along streambed in South Pualii below <i>Hesperomannia oahuensis</i> reintroduction. Control when found. Take GPS points when observed in MU to inform management strategy.   |
| <i>Blechnum appendiculatum</i>                         | Control<br>Locally     | Widespread in MU. Control in native dominated areas and areas with endangered plant species. This habitat-altering, invasive fern forms dense mats if left unchecked.  |
| <i>Clidemia hirta</i>                                  | Control<br>Locally     | Not widespread, occasionally found in patches throughout the MU.   |
| <i>Cyclosorus dentatus</i><br>and <i>C. parasitica</i> | Control<br>Locally     | Concentrated around the gulch bottom/trails in disturbed areas. Control as needed along trails and in reintroduction areas.  |
| <i>Ehrharta stipoides</i>                              | Control<br>Locally     | Widespread along crestline and South Pualii ridgeline. Control along fence line near reintroduction area and LZ. Take GPS points when observed outside of known core areas in MU.  |
| <i>Erigeron karvinskianus</i>                          | Control<br>Locally     | Widespread across MU. Control near reintroduction areas and wild endangered plant locations.   |
| <i>Eucalyptus</i> spp.                                 | Control<br>Locally     | Widespread across MU. Control near native dominated areas by drilling holes and inserting 100% RangerPro into the tree.  |
| <i>Grevillea robusta</i>                               | Control<br>Locally     | Widespread in MU. Target for IPA treatment in native dominated area (north face, North Pualii and near Plasan stand). Selectively control trees as part of WCA efforts. IPA method using Aminopyralid (Milestone) is effective in controlling <i>Grevillea robusta</i> . |
| <i>Heliocarpus popayanensis</i>                        | Control<br>Locally     | Not common in MU as area is a bit dry for this large tree species. Zero tolerance within WCAs. Effective IPA method known.   |
| <i>Melinis minutiflora</i>                             | Widespread             | This grass invades open areas, especially fence lines, and forms fuels which are a fire risk. Control when grass prohibits staff from thoroughly inspecting the fence.   |
| <i>Oplismenus hirtellus</i>                            | Widespread             | Dominant grass in the understory. It thrives in shade and can form dense mats. Control around rare taxa to encourage recruitment. Treat regularly to maintain at low levels.   |
| <i>Montanoa hibiscifolia</i>                           | Control<br>Locally     | Known to create monotypic stands in mesic forests. Occasionally found in fence. Zero tolerance within WCAs.  |
| <i>Passiflora edulis</i>                               | Control<br>Locally     | Occasionally found in fence. Zero tolerance within WCAs.   |
| <i>Passiflora suberosa</i>                             | Widespread             | Widespread vine in MU. It has a WRA of 12 (very high), roots from multiple   |

|                                |                    |  |
|--------------------------------|--------------------|--|
|                                |                    | nodes, smothers surrounding vegetation, and is labor-intensive to remove. Control around rare taxa as part of WCA efforts.   |
| <i>Paspalum conjugatum</i>     | Control<br>Locally | Concentrated around the gulch bottom/trails in disturbed areas. Control as needed along trails and in reintroduction areas.  |
| <i>Psidium cattleianum</i>     | Widespread         | Widespread and often forming dense patches in select areas of the MU. Control in native dominated areas.   |
| <i>Psidium guajava</i>         | Widespread         | Widespread throughout the MU but only in localized patches. Control in native dominated areas.   |
| <i>Rivinia humilis</i>         | Widespread         | Becoming widespread outside the fence in North Pualii. This weed quickly recolonizes areas from which it has been weeded, reducing the benefit of control efforts. Zero tolerance in fence area.                                     |
| <i>Rubus rosifolius</i>        | Widespread         | Control in native dominated areas and near rare resources.   |
| <i>Schefflera actinophylla</i> | Control<br>Locally | Scattered throughout the MU as saplings and recruiting across widespread area. It is a priority for control whenever found. Effective IPA control method known.  |
| <i>Spathodea campanulata</i>   | Control<br>Locally | Scattered individuals across MU. Few large mature individuals found. Priority for control in native dominated areas given active recruitment across MU. Effective IPA control method known.  |
| <i>Syzygium cumini</i>         | Control<br>locally | This tree has a wide distribution. It thrives on slopes and in gulches, and forms dense shade. Large trees are difficult to kill, and often require multiple treatments. It should be gradually removed from native dominated areas. |
| <i>Trema orientalis</i>        | Control<br>Locally | Scattered mature individuals, but recruiting across widespread area. Priority for control.   |
| <i>Triumfetta semitriloba</i>  | Control<br>Locally | Not common in MU. It thrives in disturbed areas. Pull during weed control efforts and along trails, LZ, and fence lines.   |
| <i>Urochloa maxima</i>         | Widespread         | Zero tolerance within WCAs and along fence lines, trails, and DZs and LZs. Poses a fire risk from producing high fuel loads.   |

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 Pualii.

#### Taxa Considerations for Restoration Actions:

| Native Taxon                   | Outplant? | Seedsow/ Division/<br>Transplant? | Notes  |
|--------------------------------|-----------|-----------------------------------|--|
| <i>Acacia koa</i>              | Yes       | Seedsow                           | Tree. Fast growing. Known to grow from seed sows.                  |
| <i>Bidens torta</i>            | Yes       | Seedsow                           | Fast growing. Known to grow from seed sows.                        |
| <i>Metrosideros polymorpha</i> | Yes       | No                                | Tree. Slow-growing. Grow from cuttings or seed.                    |
| <i>Pipturus albidus</i>        | Yes       | Seedsow/Transplant                | Small tree. Fast growing. Known to grow from seed sows.            |
| <i>Pisonia brunoniana</i>      | Yes       | No                                | Small tree. Fast growing. Grow from cuttings.                      |
| <i>Sapindus oahuensis</i>      | Yes       | No                                | Tree. Grow from cuttings or seed.                                  |
| <i>Urera glabra</i>            | Yes       | No                                | Tree. Grow from cuttings.  |
| <i>Urera kaalae</i>            | No        | No                                | Tree. Grow from cuttings or seed. Only grown and planted by OPEPP. |

#### WCAs: Pualii-01 (North Pualii, *Planchonella* stand and adjacent reintroduction gulch)

Veg Type: Dry-Mesic Forest

OIP/MIP Goal: 25% or less alien cover (rare taxa in WCA).

Targets: Alien canopy trees at edges of WCA and alien understory weeds in gulch and *Planchonella* stand.

Notes: Alien canopy was largely removed from this WCA. Large beautiful *Planchonella* stand remains. Continued effort needed at boundaries of WCA for *Casuarina* sp. at top, western edge of gulch near *Asplenium unisorum* and northwestern edge along *Pisonia brunoniana* patch near fence line to crestline. IPA treatment also needed for *G. robusta* stand also in this fence line area bordering the *Planchonella* stand. Handpulling needed for recruits of various canopy species in this WCA, including *T. orientalis*, *S. actinophylla* and *S. terebinthifolius*. Understory treatment mainly needed in gulch area for periodic control of *R. rosifolius*, *U. maxima*, *P. suberosa*, *B. asiatica*, and other weeds. Growing *E. karvinskianus* patch at top edge of WCA adjacent to *A. unisorum* patch. Water on site in 55 gallon barrel and two six gallon jugs at old dropzone along western edge of WCA. Weeding around introduced and wild *Urera* plants are needed to maintain healthy *Drosophila* habitat. Although *Phyllostegia mollis* outplantings failed at this site, continue to control weeds around WCA (understory and canopy) for possible reintroductions of *P. mollis* again in the future.

**WCA: Pualii-02 (South Pualii, *Hesperomannia* reintroduction area)**

Veg Type: Dry-Mesic Forest

OIP/MIP Goal: 25% or less alien cover (rare taxa in WCA).

Targets: Alien canopy trees at edges of WCA and alien understory weeds in reintroduction area. Occasional ICA work in gulch bottom below reintroduction.

Notes: Hiking to this WCA takes about 45 mins to 1 hour, so the main priority for this WCA is to control weeds around the *H. oahuensis* outplants. *Psidium cattleianum* and *S. terebinthifolius* were largely removed from this WCA. Continue *S. terebinthifolius* control along bottom edge of WCA to avoid trees getting too large and ripping out slope. Continue grass control (*U. maxima*, *M. minutiflora*, *P. conjugatum* and *E. stipoides*) in reintroduction area, along fence line and area to the south. Continue *C. hirta* control and other understory weeding to increase open ground opportunities for rare plant recruitment. TNC rare plant reintroductions still in the area as well as *Hesperomannia oahuensis* and recruits require careful understory weed control during sweeps. *Sphaeropteris cooperi* and *A. evecta* have been found in the gulch bottom below the reintroduction area around the year 2010. Annual visits are needed to ensure that these incipient species do not reappear. Water catchment available for grass control. In addition, Landing Zone (LZ) located in this WCA must be maintained as needed to continue helicopter landing/use. LZ should be clear from tall grass and trees/branches that encroach the LZ.

**WCA: Pualii-03 (North Pualii, North facing slope, gulch bottom area below Pualii-01 to lower fence bottom.)**

Veg. Type: Dry-Mesic Forest

OIP/MIP Goal: 25% or less alien cover (rare taxa in WCA).

Targets: Minimal understory alien control (mainly *B. appendiculatum*). Alien canopy control includes *S. terebinthifolius*, *Eucalyptus* spp., *G. robusta*, *T. orientalis*, *S. campanulata* and *P. cattleianum*.

Notes: This native dominated and open understory stand of mesic-dry forest is bordered by the gulch bottom and a planting of *Eucalyptus* along the upper elevation WCA boundary approximately 100-150 m off the gulch bottom. *Sapindus oahuensis* and *Antidesma pulvinatum* are the dominant native canopy trees with occasional large *Nestegis sandwicensis* and *Rauvolfia sandwicensis*. Canopy weeding should target the remaining *S. terebinthifolius* and other canopy weed trees as well as some IPA work along the upper elevational border to buffer the native dominated stand below. A few large *T. orientalis* can also be found in that upper elevational boundary area and should be targeted as well to prevent ongoing recruitment in native dominated areas. Canopy weeding can be accomplished in about 6 trips with a few staff over the



next three years. After that, only maintenance weeding is needed to prevent recruits of *S. actinophylla*, *S. terebinthifolius*, and other canopy weeds from re-establishing.

Understory weeding can be limited to hand pulling or treating alien canopy recruits, treating patches of *C. parasitica*, as well as an approximately 10 x 15m patch of *B. appendiculatum*. *R. rosifolius* and *P. suberosa* should also be treated in the two sunnier gap draws along the north face of this WCA (which are closer to the lower fence line) to preserve the potential for additional rare outplantings in those draws.

The gulch bottom area has a few disturbed zones which are dominated by alien weeds. Semi-annual grass sprays are needed to control guinea grass and other understory weeds. Seed sowing or transplanting *Pisonia* recruits is needed on an ongoing basis each winter season to re-colonize the weedier gulch bottom areas to prevent a cycle of weed treatment with little to no native recruitment.

Since there are no IP taxa located in this WCA, weeding efforts in the understory have been assisted by volunteers in this area for the past few years. Volunteers focus weeding around common native plants and weed from the fenceline up to the *A. sandwicense* outplantings.

#### **WCA: Pualii-04 (Fence line, between Pualii-02 and Pualii-03)**

Veg. Type: Dry-Mesic Forest

OIP/MIP Goal: 50% or less alien cover (no rare taxa in WCA).

Targets: Alien canopy control along the fence line includes *S. terebinthifolius*, *Eucalyptus* spp., *G. robusta*, *T. orientalis*, *S. campanulata* and *P. cattleianum*.

Notes: *Psidium cattleianum*, *S. terebinthifolius* and *G. robusta* largely removed from this WCA to prevent trees from potentially falling and damaging the fence. Continue *S. terebinthifolius* control also along bottom edge of WCA to avoid trees getting too large and ripping out slope. Continue grass control (*U. maxima*, *M. minutiflora*, and *P. conjugatum*) along fence line to keep trail clear. Target any priority weed taxa such as *A. evecta*, *Heliocarpus popayanensis*, *S. actinophylla*, *Sphaeropteris cooperi*, *S. terebinthifolius* and *T. orientalis*.

#### **WCA: Pualii-NoMU-01 (Road to trail head)**

Veg. Type: Dry-Mesic Forest

OIP/MIP Goal: None

Targets: Weed control along road to trail head. Grass and fallen branches should be removed/maintained.

Notes: Continue grass control (*U. maxima*, *M. minutiflora* and *P. conjugatum*) along road to keep trail clear. Cut and remove any fallen branches or trees. Survey for any new alien/incipient species annually. Partnership with the State Forest Reserve staff (DOFAW) to maintain road as needed.

#### **WCA: Pualii-NoMU-02 (Gulch trail to fenceline)**

Veg. Type: Dry-Mesic Forest

OIP/MIP Goal: None

Targets: Weed control along gulch trail from Pualii-NoMU-01/road to Pualii fence enclosure.

Notes: Cut and remove any fallen branches or trees along trail. Survey for any new alien/incipient species when using trails. Spray grass if needed (*U. maxima*, *M. minutiflora* and *P. conjugatum*) along trail to keep trail clear. Sweep gulch for target canopy species, particularly *T. orientalis*, annually.

## Small Vertebrate Control

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

Threat level: High

Seasonality/Relevant Species Biology: Trapping during *Hesperomannia oahuensis* reproductive period, which tends to be from March to August. Rodent damage has been seen commonly on *H. oahuensis* during all stages of the reproductive period. Rodent damage is seen on stems, and can be fatal.

Management Objectives:

- Protect *H. oahuensis* flowers, fruits, and stems from damage during reproductive period.
- Observe less than two kills per trap during the January to June period using Goodnature A24 counters.

Strategy and Control Methods:

- Small localized trapping grid around *H. oahuensis* using 4 Goodnature A24s and 24 Victor snap traps.
- Monitor rare plant populations to determine impacts by rodents.

Discussion: Currently rodent control is only around the *H. oahuensis* reintroduction site during the reproductive period. All Victor snap traps will be replaced with Goodnature A24s to protect *H. oahuensis* year-round. OANRP staff will check A24s every 4 months. In addition, A24s may be added around *Drosophila* habitat in order to ensure no rodent damage occurs on native plant host species.

## Slug Control

Species: Unknown

Threat level: Low

Seasonality/Relevant Species Biology: Slugs are not known to cause negative impact *Hesperomannia oahuensis*.

Management Objectives:

- During annual rare plant monitoring, look for seedling recruitment and slug herbivory.

Strategy and Control Methods:

- If slug herbivory is observed during rare plant monitoring, Slug Control Areas (SLCAs) will be defined around rare taxa. Prior to any slug control, an experienced malacologist will survey areas for slug densities and native snails during the day and at least one night.
- FerroxxAQ every 6 weeks is applied to these SLCAs. FerroxxAQ is not applied within 20 m of known populations of native snails.

Discussion: Currently, there is no implemented slug control in this MU. Although there are species of the Campanulaceae family present at Pualii, this MU is not a MFS PU for the IPs. In addition, slugs are not known to negatively affect *Hesperomannia oahuensis*. However, slugs have negatively affected *Urera sp.*, which are important plant-host species for *Drosophila montgomeryi*. Therefore, SLCA may be implemented. In addition, during annual rare plant monitoring, OANRP staff will inspect plants for herbivory. If present, damage will be noted and the protocols for creating a SLCA will be followed.



## Ant Control

Species: *Pheidole megacephala* (Big headed ants)

Threat level: Moderate to High

Seasonality/Relevant Species Biology: Big headed ants have year-round brood production in tropical and sub-tropical areas but are especially active from April-September

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.

Strategy and Control Methods:

- Sample ants at human entry points using the standard survey protocol (see discussion below) and *Drosophila* sites a minimum of once a year (see table below). Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- Sample ants at campsite, LZ, rare taxa sites, DZ, and fencelines to track changes in existing ant densities and to alert OANRP to any new introductions.

**Ant Survey Site Table**

| Site description                   | Reason for survey  |
|------------------------------------|--|
| <i>Drosophila</i> restoration area | <i>Drosophila</i> are preyed upon by ants as larvae, pupae, and adults |

Discussion:

Although ants have not been formally surveyed in Pualii MU, Big headed ants were observed historically (in 2006) by TNC staff. Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of hemipteran pests), and birds. It is therefore important to know their distribution and density in areas with conservation value. Since 2006, we sample ants in high risk areas using the following method:

Standard Survey Protocol: 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.

Big-headed ants were detected in the bottom of North Pualii gulch around *Urera kaalae* outplanting sites in 2016 while surveying for *Drosophila*. This is a widespread tramp ant. Reintroduction of *Drosophila montgomeryi* is anticipated in this area. The infestation was delimited with baits in early 2017 and control planned for summer 2017. Eradication of these ants throughout the MU is not possible, however control of the population in the gulch may prove important for *Drosophila* recovery. Any pesticides used for the ants will be carefully evaluated to ensure *Drosophila* are not impacted.

## Fire Control

Threat Level: High

Seasonality/Potential Ignition Sources: Fire may occur whenever vegetation is dry. Generally this happens in summer, but may occur at other times of the year, depending on variations in weather pattern. *Urochloa maxima* has a high fire index, and is found along the fence line. This site is vulnerable to fires ignited in adjacent agriculture lots located just below the MU.

Management Objectives:

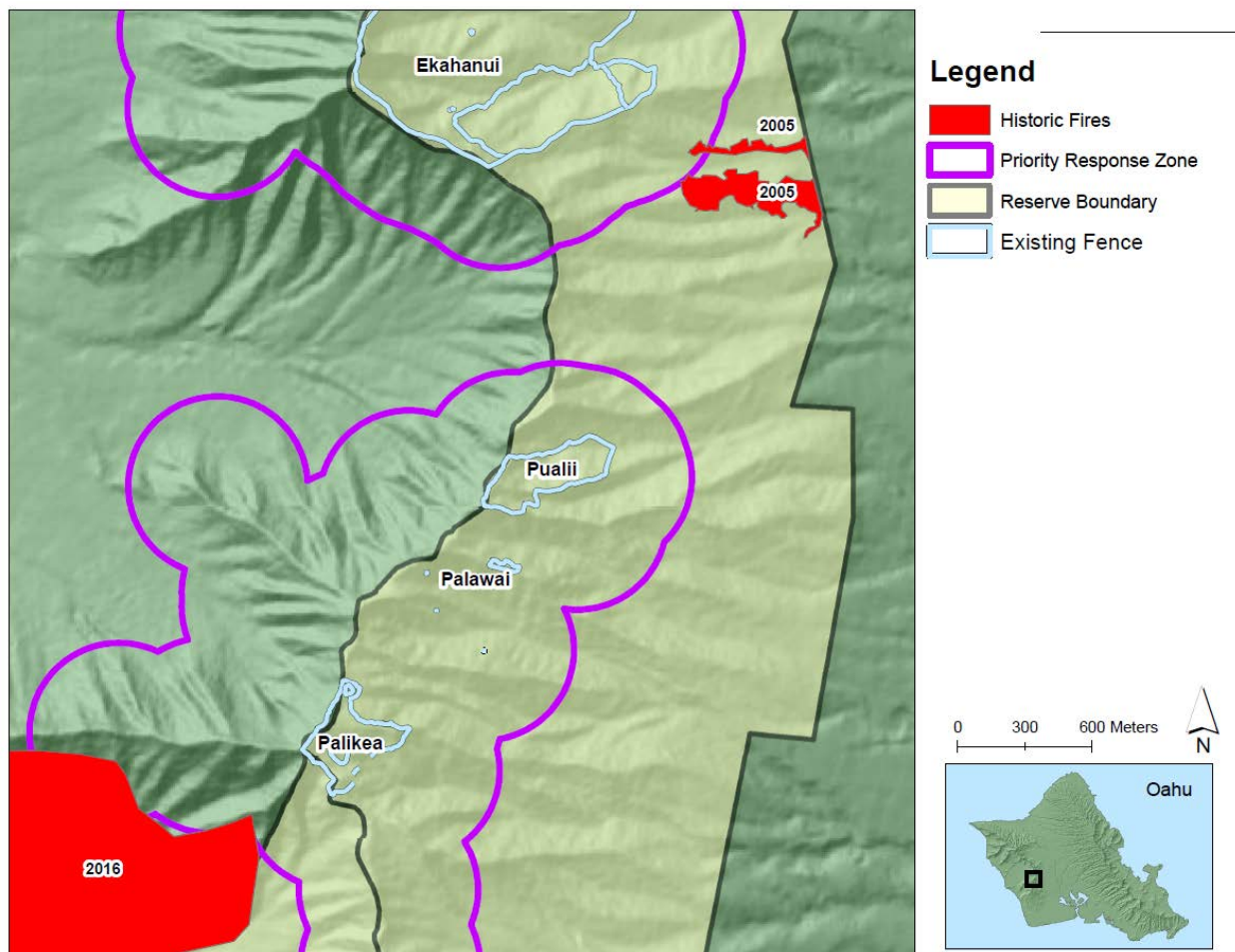
- To prevent fire from burning any portion of the MU at any time.

Strategy and Control Methods:

- Reduce fuel loads along the fence line and road.
- Target *U. maxima* throughout the MU.

Discussion: The threat of fire is high due to the hot and dry climate during the summer, and closely adjacent agriculture lots located near the MU. Additionally, fires have occurred by other closely located MUs. Removal of the most fire prone weed *U. maxima* remains a high priority within the MU and along the fence line as well as the road. Partnership with the State Forest Reserve staff (DOFAW) to maintain road as needed.

### Fire Management Map



**Action Table**

| Action Type                 | Actions  | MIP Year 13<br>Oct 2016-<br>Sept2017 |   |   |   | MIP Year 14<br>Oct 2017-<br>Sept2018 |   |   |   | MIP Year 15<br>Oct 2018-<br>Sept2019 |   |   |   | MIP Year 16<br>Oct 2019-<br>Sept2020 |   |   |   | MIP Year 17<br>Oct 2020-<br>Sept2021 |   |   |   |
|-----------------------------|--|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--------------------------------------|---|---|---|
|                             |  | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 |
|                             |  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>General Survey</b>       | LZ Survey- Survey South Pualii LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>ICA Pualii-SphCoo-01</b> | Monitor and control SphCoo at site below HesOah reintroduction annually.   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Pualii-01</b>            | Conduct weed sweeps across reintroduction area and native forest patches, focusing on understory/canopy weeds. Sweep 1-2x per year.  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Pualii-02</b>            | Conduct weed sweeps across reintroduction area and native forest patches, focusing on understory/canopy weeds. Sweep 1-2x per year.  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
|                             | Control weedy grasses along ridge, LZ, fenceline, and across reintroduction zone 2-4 times a year, or as needed. Target all grasses, particularly EhrSti.                                  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Pualii-03</b>            | Conduct weed sweeps across TNC reintroduction area and native forest patches, focusing on understory/canopy weeds. Sweep annually. Focus on GreRob, TreOri, SchTer and Passub.             |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
|                             | Control under- and mid-story weeds in gulch bottom, from fence to beginning of rare plant reintroductions (Abusan). Always target saplings of TreOri, SchAct, and SchTer. Outreach action. |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
|                             | Control weeds along fenceline, as needed.  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Pualii-04</b>            | Control weeds along fenceline, as needed.  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>PualiiNoMU-01</b>        | Control grass/herbaceous weeds, clear downed trees along the Honouliuli contour  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |

| Action Type             | Actions  | MIP Year 13<br>Oct 2016-<br>Sept2017 |   |   |   | MIP Year 14<br>Oct 2017-<br>Sept2018 |   |   |   | MIP Year 15<br>Oct 2018-<br>Sept2019 |   |   |   | MIP Year 16<br>Oct 2019-<br>Sept2020 |   |   |   | MIP Year 17<br>Oct 2020-<br>Sept2021 |   |   |   |
|-------------------------|--|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--------------------------------------|---|---|---|--------------------------------------|---|---|---|
|                         |  | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 | 4                                    | 1 | 2 | 3 |
|                         | road, from the ranch gate to the water catchment, as needed. Use the power sprayer, chainsaw, weedwhack. Alternate this action between teams if significant level of work. Goal: maintain road. Assist with State. |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>PualiiNoMU-02</b>    | Sweep gulch for target canopy spp, particularly TreOri, annually. Keep access trail clear.   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Ungulate Control</b> | Maintain fence integrity   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
|                         | Elimination of any pig ingress into the fence with use of snares and traps.  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Rodent Control</b>   | Implement localized rodent control if determined to be necessary for the protection of rare plants using A24 traps.  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Ant Control</b>      | Conduct surveys for ants at 2 human entry points   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
|                         | Implement control if deemed necessary  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
| <b>Slug Control</b>     | Monitor slug activity at rare plant population(s)  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |
|                         | If slugs found to exceed acceptable levels during monitoring, maintain slug bait at sensitive plant population(s)  |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |                                      |   |   |   |