2010 Status Report For the Makua and Oahu Implementation Plans

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EXECUTIVE SUMMARY

This report serves as the annual status report to the Implementation Team (IT), and participating landowners on the Makua* Implementation Plan (MIP) Year-6 actions and Oahu Implementation Plan (OIP) Year-3 actions that occurred between 1 September 2009 and 31 August 2010 and also serves to report compliance to the U.S. Fish and Wildlife Service. The Oahu Army Natural Resources Program (OANRP) has just completed implementing its sixth year of the Makua Implementation Plan Addendum (2005) and the third year of the Oahu Implementation Plan (2008). The Makua Implementation Plan (MIP) was finalized in May 2003. In January 2005, the Army completed an Addendum which emphasized management for stability of three population units (PUs) per plant taxon in the most intact habitat and 300 individuals of *Achatinella mustelina* in each genetically identified Evolutionarily Significant Unit (ESU). The 2007 Makua Biological Opinion (BO) issued by the U.S. Fish and Wildlife Service (USFWS) required that the Army provide threat control for all Oahu Elepaio pairs in the Makua action area (AA) and stabilization for 28 plant and one snail species. An amended BO was issued in 2008 that covers additional measures necessary as a result of the 2007 Waialua fire that destroyed individuals and habitat for *Hibiscus brackenridgei* subsp. *mokuleianus*. The OIP was finalized in October 2008, this document outlines stabilization measures for 23 additional plant taxa, the Oahu Elepaio and several extant Koolau *Achatinella* species. For Elepaio, the Army's requirement is to conduct predator control for 75 nesting pairs.

<u>Year 3 of the Oahu Implementation Plan</u>

At the end of June 2010, a Finding of No Significant Impact was issued for the programmatic Environmental Assessment for OIP management. OANRP completed construction of the Ekahanui Subunit III MU which protects eight acres of habitat for *Abutilon sandwicense*. Construction began on an 8.9 acre fence to protect the Waimano population unit of *Cyanea st.- johnii*. In addition, the Waieli subunit III fence was constructed as well as over half of the Manuwai MU fence. Stabilization work for many MIP and OIP taxa is slated for these two fences. Weed control was conducted over approximately 60 hectares within MIP and OIP MUs. In addition, over this reporting period, OANRP have invested in new technique development including the use of a wood chipper in weed control and the application of herbicide ballistic technology. Over this reporting period, OANRP reintroduced 26 individual plants of taxa covered in the OIP and 314 individuals of taxa that are OIP and MIP overlapping taxa. In addition, OANRP assisted a UH Graduate Student with the planting of 730 *Schiedea kaalae*, a taxon covered in both the MIP and OIP. These numbers are a substantial increase since last year, despite greenhouse sanitation issues with snails. OANRP collected from 95 sites of IP species (collections were made on multiple occasions from some of these sites) and completed 927 rare plant observations during this reporting period. OANRP conducted predator control to protect nests within 81 elepaio territories.

<u>Year 6 of the Makua Implementation Plan</u>

Last year, construction of MIP fences was stalled, awaiting completion of Section 106 consultation in accordance with the National Historic Preservation Act. Approval to move forward on a handful of fences was obtained in March and Section 106 consultation letters were prepared and transmitted for many more. The 1.9 acre Napepeiauolelo fence was completed to protect extant *Hesperomannia arbuscula* and a three acre fence was finished, enclosing *Sanicula mariversa*. In addition, the OANRP fence crew completed construction of and initiated ungulate removal from the 23-acre Kaluaa and Waieli Subunit III fence. OANRP have also constructed approximately one-half of the Manuwai fence, totaling 2.6 kilometers of fencing. Extremely steep terrain may require contracting a one kilometer portion of what remains to be completed of the Manuwai unit. Supplemental fencing was installed to protect the Waianae Kai Makai PUs of *Nototrichium humile* and *Neraudia angulata* and OANRP are confident that goats can no longer penetrate the unit. Weed control was conducted over approximately 60 hectares

*Hawaiian diacriticals are not used in this document except in some appendices in order to simplify formatting. Please refer to Appendix 1 *Spelling of Hawaiian Names*.

within MIP and OIP MUs. In addition, over this reporting period, OANRP have invested in new technique development including the use of a wood chipper in weed control and the application of herbicide ballistic technology. Over this reporting period, OANRP outplanted 622 individuals of taxa covered in the MIP and 314 individuals of taxa that are OIP and MIP overlapping taxa. In addition, OANRP assisted a UH Botany graduate student in planting 612 *Schiedea obovata* and 150 *Schiedea nuttallii* within IP MUs as part of an inbreeding and outbreeding study but these will not be considered part of the managed PUs until study results are known. OANRP collected from 95 sites of IP species (collections were made on multiple occasions for some of these sites) and completed 927 rare plant observations during this reporting period. For *Achatinella mustelina*, six of the eight sites slated for management in the MIP have over 300 individuals. Vegetation Monitoring belt transects were installed in three more IP MUs, Ohikilolo, Makaha and Kaluaa and Waieli bringing the total MUs with monitoring in place to six. Six 5-year Ecosystem Restoration Management Unit plans were written this year, bringing the total prepared to fourteen including those prepared last year. An ERMUP will be prepared for the last two actively managed and fenced MUs over the next reporting period along with plans for units where fences are soon to be completed.

Landowner/Agency Communications

The Army continues to work cooperatively under a Memorandum of Understanding (MOU) with both the Board of Water Supply (BWS) and the U.S. Navy for work in Makaha Valley and at Lualualei Naval Magazine.

The Trust for Public Lands transferred ownership of Honouliuli Preserve to the State of Hawaii on 31 March 2010. The Army contributed over three million dollars via the Army's Compatible Use Buffer Program toward the purchase of the Preserve. The Title for the preserve reserves the right for the Army to continue using Honouliuli to conduct IP related management. Honouliuli is currently unencumbered state land managed by the Department of Land and Natural Resources, Land Division. The Army applied for a permit from the Land Division in May 2010 and anticipates obtaining the permit in October after it goes before the Board of Land and Natural Resources. The Nature Conservancy of Hawaii's lease for management of Honouliuli was appraised for approximately $300,000, which was put into an endowment to be used toward the future management of the preserve.

Negotiations for agreements with other landowners to allow the Army to carry out MIP and OIP work are progressing. OANRP is operating under a signed 3-year license agreement with Kamehameha Schools (KS) for work in the MUs on KS lands. A fully-executed 20-year license is anticipated in September 2010. This long-term license will allow the Army to pursue MIP and OIP fencing on KS lands. In February 2010, the Army obtained a six month right of entry to monitor *Hibiscus brackenridgei* populations on Dole Food Company land; renewal is being pursued. The Army is in the final stages of negotiating a license agreement with Hawaii Reserves Inc. for work at the Koloa MU.

Finally, the Army continues to work toward an agreement to continue conservation work on State of Hawaii lands. The Army is awaiting a response letter from DLNR explaining the fee that the State wants to apply to the Army's work. The Army will then take the justification for the fee to Army Environmental Command for approval and authorization. At this point, the Army would like to enter into a simple MOU with the State of Hawaii for proposed MIP and OIP work. After that document is signed, the proposal is to negotiate a more detailed real estate agreement, such as a right of entry or license, tiered off of this umbrella MOU. Currently the Army holds a current NARS special use permit, a State of Hawaii Threatened and Endangered Species Permit and has submitted a Conservation District Use Permit Application which is slated for issuance early in the 2011 calendar year.

The Army continues to provide support for partner agencies including the Oahu Invasive Species Committee and the Koolau Mountains Watershed Partnership. The Army is also a member of the Koolau Mountains Watershed Partnership and the newly formed Waianae Mountains Watershed Partnership.

Fire

OANRP are authorized by RCUH to take part in fire mop-up operations. Currently, 16 staff are trained to work with the Army Wildland Fire or State of Hawaii, Division of Forestry and Wildlife crews in a fire response capacity. During this reporting period, OANRP helped coordinate fire fighting resources, assisted with mop-up operations and funded helicopter support to extinguish the Makua Valley fire that occurred in July 2010. A summary report for this fire is included as Appendix 2.

Propagation and Seed Storage

All seed collections are processed and stored at the OANRP Seed Lab at the Schofield Barracks East Range facility by OANRP staff. Seeds are germinated there and seedlings grown in growth chambers. Research on dormancy continued in the last year and is discussed in Determining Physical Dormancy in Hard-Seeded Species as Appendix 3. An update and discussion on determining the re-collection intervals for IP species is included as Appendix 4. A new facility for the OANRP Seed Lab, with an adequate back-up power generator to run the growth chambers, freezers and refrigerators during a power loss, a dedicated laboratory area for making agar media and expanded workspace for processing collections, is currently being designed. Plans are to build this facility in fiscal year (FY) 2012. OANRP use shade-houses at the State's Pahole Rare Plant Facility and the Schofield Barracks facility for vegetative propagation, to grow larger plants for reintroductions and to hold living collections for genetic storage. The Lyon Arboretum Micropropagation Lab is used to maintain and clone important collections for genetic storage, reintroductions and to germinate seeds from immature fruit.

Nursery Sanitation

Since November 2008, OANRP have been contending with an infestation of five alien snail taxa in the shade-houses at Pahole and Schofield. Considering the potential consequences of introducing alien snails to natural areas, OANRP made the decision not to reintroduce plants until they were considered "snail-free". This has severely affected production, delayed reintroduction projects, and required the diversion of hundreds of hours of staff time to clean the facilities, search infested benches, and develop control techniques.

The snails were first observed in the shade-houses following the delivery of plants from two local nurseries (Laau Hawaii and Hui Ku Maoli Ola) that had been contracted by OANRP to grow plants for restoration projects. Laau Hawaii had observed an unknown species of small alien snails at their facility and alerted OANRP to the potential that the plants (palapalai) that had already been delivered (and outplanted) were infested. OANRP staff searched the delivered plants remaining at the nursery and the nursery at Laau Hawaii and confirmed the presence of *Liardetia doliolom* at both sites. Following the delivery of plants to be used on restoration projects in Kahuku, Kahanahaiki and Kaluakauila, two other new alien snail species were observed at the Schofield and Pahole facilities (*Zonitoides arboreus, Succinea tenella*). Surveys of the nursery (Hui Ku Maoli Ola) that was contracted to grow the plants found *Succinea tenella*.

In June 2009, OANRP, with the help of USDA-ARS Biologist Robert Hollingsworth, initiated studies to determine the most effective methods for detecting the presence of and eradicating snails while minimizing phytotoxic effects to the plants. Phytotoxicity and efficacy trials were conducted with five different molluscicides, Slug-Fest (All Weather Formula RTU, OR-CAL Inc., Crop Services Production), a liquid metaldehyde, was the most effective while being less toxic to plants and humans. Two searching methods were tested to find the quickest, most efficient way to check for the presence/absence of snails. By August 2009, there was a 95% decline in the detection of alien snails. In October 2009, many plants were determined to be clean and over 3,000 plants were reintroduced in this report year.

All snails have been eradicated from the facilities except *Zonitoides arboreus*. Currently only a few benches are suspected to have lingering individuals of *Z. arboreus*. All benches are isolated from each other using barriers of salt pellets to prevent movement onto clean areas. All plants are inspected for presence of snails using lettuce bait and infested plants are treated regularly using metaldehyde. The remaining infested stock will be cloned and replaced with clean stock in the coming year. All plants to be used in reintroductions in the coming year have been inspected at least once a month for a year or more and no snails have been found.

Research

During this reporting period, intensive effort was spent refining the barrier for *Euglandina* with respect to endangered snail enclosures. A variety of barriers were tested to determine their effectiveness. Also, additional work was conducted with *Euglandina* detection dogs. The research section also covers resource monitoring results related to the newly installed snap trap grid at Kahanahaiki. In addition, a safe and effective *Sphagnum* moss control method was found. OANRP are in the final stages of securing a special local label for applying Sluggo in forest settings for protection of rare native seedlings and the research chapter includes an update on this process.

OANRP continues to support work by researchers from the University of Hawaii on taxa covered by the MIP/OIP. In the last year, OANRP has worked to facilitate research by Lauren Weisenberger (*Schiedea*), Dr. Cliff Morden (*Chamaesyce, Stenogyne kanehoana*), Melody Euaparadorn (*Chamaesyce celastroides* var. *kaenana*-her research proposal is Appendix 5) and Richard Pender (*Cyanea superba* subsp. *superba*, *Delisssea waianaeensis*). OANRP also contributed leaf collections from the nursery stock of *Viola chamissoniana* to Dr. Chris Havran (Campbell University). Research on threats to MIP/OIP taxa are discussed in detail in the Species Status Summary for each taxon.

Funding and staffing levels

There are currently a total of 50 staff comprising three field crews, a fence crew, a nursery and seedbank management crew and various foundational support staff; similar to last year's staffing. The Army received \$3.5 M for MIP and \$4.4 M for OIP in FY2010. The \$4.4 M for the OIP includes \$2M for the Lihue fence construction. The OANRP is still hiring to achieve the staffing level for the MIP and OIP. The major difficulties associated with increasing staff numbers are the lack of senior staff to orient new hires in the field, finding qualified hires, and the lack of space to house this large number of field crew and field supplies.

Designs for the OIP office building and a Seed Conservation Laboratory are expected in April 2011. Construction of the OIP office building is planned for FY 2011 and for the Seed Laboratory in FY 2012. With the addition of these buildings, OANRP will have the space necessary to increase staffing to full OIP and MIP levels.

OANRP continue to utilize the scheduling database. This year OANRP used the data summaries to guide field actions more efficiently and to analyze time expenditures by program area. This detailed tracking allows senior program staff to realign and reprioritize program priorities and create more realistic plans. Over the next year OANRP will begin to use the data to refine and update cost estimates.

Table I. Status summary of MIP plant species for Year-6. Final MIP numbers are presented this year (**--** indicates that the population was not known during IP preparation, **n/a** = the population unit is being started via reintroduction). **Bold** = reached that stabilization goal. The genetic storage goal for a PU is considered met if collections have been secured from all available founders which, in some cases, are less than 50. If greater than 50 founders are known, genetic collections will not be considered complete until at least 50 are represented.

Makua Implementation Plan					
Taxon Code	**Population Unit**	**# plants in Final MIP**	**Status mature/immature/ seedling (# mature goal) includes augmentations**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
Alectryon macrococcus var. *macrococcus*	Kahanahaiki to West Makaleha	8	35/7/0 (50)	0	Partial
	Makua	15	20/0/0 (50)	1 (individuals represented by airlayers)	Partial
	Central Kaluaa to Central Waieli	53-58	17/6/0 (50)	0	Partial
	Makaha	77	**63/5/2 (50)**	0	Partial
Cenchrus agrimonioides var. *agrimonioides*	Kahanahaiki to Pahole	37	**358/52/118 (50)**	**52**(clones + seed)	Partial
	Central Ekahanui	20	**87/22/39 (50)**	16 (ind w/ clones)	Partial
	Makaha and Waianae Kai	12	8/0/0 (50)	4 (ind w/ clones)	Partial
Chamaesyce celastroides var. *kaenana*	Makua	40	**125/2/0 (25)**	**59 (>50 seeds)**	**Yes**
	Kaena	375-525	**300/0/0 (25)**	**55 (>50 seeds)**	n/a
	Kaena East of Alau	26	26/1/0 (50)	20 (>50 seeds)	n/a
	Puaakanoa	157	**132/16/0 (25)**	7 (>50 seeds)	n/a
Chamaesyce herbstii	Kapuna to Pahole	170	**64/87/1 (25)**	13 (>50 seeds)	Partial
	Makaha (reintro)	n/a	19/124/26 (25)	n/a	**Yes**
	West Makaleha (reintro)	0	0/0/0	n/a	No
Cyanea grimesiana ssp. *obatae*	Pahole to W Makaleha	13	40/15/4 (100)	**10 (>50 seeds)**	**Yes**
	Central Kaluaa	2	24/17/0 (100)	**1 (>50 seeds)**	**Yes**
	Palikea (South Palawai)	28	97/30/1 (100)	**13 (>50 seeds)**	**Yes**
	Makaha	--	1/0/0 (100)	**1 (>50 seeds)**	**Yes**
Cyanea	Kapuna to W	66	41/18/0 (75)	16 (>50 seeds)	Partial

Makua Implementation Plan					
Taxon Code	**Population Unit**	**# plants in Final MIP**	**Status mature/immature/ seedling (# mature goal) includes augmentations**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
longiflora	Makaleha				
	Pahole	114	63/64/11 (75)	42 (>50 seeds)	**Yes**
	Makaha and Waianae Kai	7	3/8/0 (75)	2 (>50 seeds)	**Yes**
Cyanea superba ssp. *superba*	Kahanahaiki	1	48/285/67(50)	**3 of 3 available founders**	**Yes**
	Central and East Makaleha (reintro)	n/a	0/0/0 (50)	n/a	No
	Makaha (reintro)	n/a	0/95/0 (50)	n/a	**Yes**
	Pahole to Kapuna (reintro)	0	**121/183/9 (50)**	n/a	**Yes**
Cyrtandra dentata	Pahole to Kapuna to West Makaleha	300	**577/615/238 (50)**	**50 (>50 seeds)**	Partial
	Kawaiiki	50	15/31/39 (50)	0	No
	Opaeula	26	16/12/0 (50)	0	No
	Kahanahaiki	97	**65/142/0 (50)**	22 (>50 seeds)	**Yes**
Delissea waianensis	Kahanahaiki to Keawapilau	10	**171/47/0 (100)**	**11 (>50 seeds)**	**Yes**
	Ekahanui	14	**127/163/0 (100)**	**6 (>50 seeds)**	**Yes**
	Kaluaa	1	**181/142/2 (100)**	**5 (>50 seeds)**	**Yes**
	Manuwai (reintro-Palikea gulch stock)	n/a	0 (reintro to begin after fence completed)	**6 (>50 seeds)**	**Yes**
Dubautia herbstobatae	Ohikilolo Makai	700+	**358/0/0 (50)**	0	**Yes**
	Ohikilolo Mauka	1300+	**382/6/0 (50)**	1 (>3 clones)	**Yes**
	Makaha	--	36/1/0 (50)	12 (>3 clones)	No
Flueggea neowawrae	Kahanahaiki to Kapuna	6	7/64/0 (50)	2 (>3 clones)	Partial
	Central and East Makaleha	6	5/0/0 (50)	2 (>3 clones)	No
	Makaha	5	10/25/0 (50)	2 (>3 clones)	Partial
	Manuwai	1	0/0/0 (50)	n/a	No
Gouania vitifolia	Keaau	new	**60/1/0 (50)**	36 (>50 seeds)	No

Makua Implementation Plan					
Taxon Code	**Population Unit**	**# plants in Final MIP**	**Status mature/immature/ seedling (# mature goal) includes augmentations**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
	Makaha (reintro- Waianae Kai stock)	new	0/0/0 (2 in waianae kai)	0	No
	Makaleha or Manuwai (reintro)	new	0/0/0	n/a	No
Hedyotis degeneri var. *degeneri*	Kahanahaiki to Pahole	161	**186/204/100 (50)**	32 (>50 seeds)	Partial
	Alaiheihe and Manuwai	60	21/2/0 (50)	**26 (>50 seeds)**	No
	Central Makaleha and West branch of East Makaleha	47	23/33/4 (50)	**28 (>50 seeds)**	No
Hedyotis parvula	Ohikilolo	67	**120/28/40 (50)**	**78 (>50 seeds)**	**Yes**
	East Makaleha (reintro)	0	0/0/0 (50)	0	No
	Halona	64-79	**97/35/19 (50)**	**62 (>50 seeds)**	**Yes**
Hesperomannia arbuscula	Pahole NAR	7	0/15/0 (75)	n/a	**Yes**
	Haleauau	--	1/0/0 (75)	0	**Yes**
	Makaha	14	3/3/0 (75)	1 plant represented in nursery	**Yes**
	Pualii	n/a	0/24/0 (75)	n/a	**Yes**
Hibiscus brackenridgei ssp.*brackenridgei*	Makua	7	**30/35/23 (50)**	**29 (>3 clones)**	Partial
	Haili to Kawaiu	4	0/1/0 (50)	**7 (>3 clones)**	No
	Kaimuhole to Palikea Gulch	8	13/153/5 (50)	19 (>3 clones)	No
	Keaau	--	3/7/0 (50)	3 (>3 clones)	No
Melanthera tenuifolia	Ohikilolo	2016	**1233/0/0 (50)**	13 (>50 seeds)	**Yes**
	Kamaileunu and Waianae Kai	1285-1955	**883/269/297 (50)**	0	No
	Mt. Kaala NAR	250	**300/0/0 (50)**	0	No
Neraudia angulata	Makua	31	48/38/5 (100)	**13 (>3 clones)**	**Yes**
	Manuwai	12	0/0/0	**2 (>3 clones)**	No
	Waianae Kai Mauka	46	16/4/0 (100)	4 (>3 clones)	No
	Kaluakauila	n/a	**125/3/0 (100)**	n/a	**Yes**

Makua Implementation Plan					
Taxon Code	**Population Unit**	**# plants in Final MIP**	**Status mature/immature/ seedling (# mature goal) includes augmentations**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
	(reintro)				
Nototrichium humile	Kaluakauila	200-400	**198/35/0 (25)**	4 (>3 clones)	**Yes**
	Makua (south side)	120-140	**62/1/0 (25)**	0	Partial
	Kaimuhole and Palikea Gulch (Kihakapu)	54	**55/4/0 (25)**	22 (>3 clones)	No
	Waianae Kai	200-320+	**199/105/0 (25)**	2 (>3 clones)	Partial
Phyllostegia kaalaensis	Keawapilau to Kapuna	4	0/0/0 (50)	**1 (3 clones)**	**Yes**
	Makaha (reintro)	n/a	0/1/0 (50)	n/a	**Yes**
	Manuwai (reintro)	n/a	0/0/0 (50)	n/a	No
	Pahole	10-15	0/0/0 (50)	**2 (3 clones)**	**Yes**
Plantago princeps var. *princeps*	Ohikilolo	14	11/0/0 (50)	10 (>50 seeds)	**Yes**
	Ekahanui	23	29/37/7 (50)	**49 (>50 seeds)**	Partial
	North Mohiakea	30	10/16/2 (50)	**12 (>50 seeds)**	Partial
	Halona	50-100	29/43/0 (50)	22(>50 seeds)	No
Pritchardia kaalae	Ohikilolo	165	**77/1024/12 (25)**	11 (>50 seeds)	**Yes**
	Ohikilolo East and West Makaleha (reintro)	n/a	0/209/0 (25)	n/a	**Yes**
	Makaleha to Manuwai	141	**102/10/2 (25)**	14 (>50 seeds)	No
Sanicula mariversa	Ohikilolo	143	3/112/0 (100)	19 (>50 seeds)	**Yes**
	Keaau	141	11/300/40 (100)	31 (>50 seeds)	**Yes**
	Kamaileunu	26	11/637/343 (100)	34 (>50 seeds)	**Yes**
Schiedea kaalae	Pahole	3	37/12/13 (50)	**2 (>50 seeds)**	**Yes**
	Maakua	4	10/0/0 (50)	4 (>50 seeds)	No
	South Ekahanui	0	28/0/0 (50)	**13 (clones/seeds)**	**Yes**
	Kaluaa and Waieli (reintro)	2	**72/6/0 (50)**	**1 (>50 seeds)**	**Yes**
Schiedea nuttallii	Kahanahaiki to Pahole	47-48	**130/22/115 (50)**	**32 (clones/seeds)**	**Yes**

Makua Implementation Plan					
Taxon Code	**Population Unit**	**# plants in Final MIP**	**Status mature/immature/ seedling (# mature goal) includes augmentations**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
	Kapuna-Keawapilau ridge	3	0/0/0	0 (no founders available)	**Yes**
	Makaha (reintro)	n/a	21/0/0 (50)	n/a	**Yes**
Schiedea obovata	Kahanahaiki to Pahole	0	**191/358/297 (100)**	**5 (>50 seeds)**	**Yes**
	Keawapilau to West Makaleha	3	**261/412/829 (100)**	**72 (>50 seeds)**	Partial
	Makaha (reintro)	n/a	0/0/0	n/a	**Yes**
Tetramolopium filiforme	Kalena	--	9/0/6 (50)	7 (>50 seeds)	No
	Ohikilolo	5000+	**2542/582/21 (50)**	39 (>50 seeds)	**Yes**
	Puhawai	12	3/2/0 (50)	**5 (>50 seeds)**	n/a
	Waianae Kai	0	30/8/8 (50)	0	No
Viola chammisoniana ssp *chammisoniana*	Ohikilolo	250	**435/10/0 (50)**	2 (>50 seeds)	**Yes**
	Puu Kumakalii	20	44/0/0 (5 0)	11 (>50 seeds)	**Yes**
	Halona	3	41/3/0 (50)	2 (>50 seeds)	No
	Makaha	50	37/2/0 (50)	0	Partial

Table II. Status summary of OIP plant species for Year-3. Bold = reached that stabilization goal

Oahu Implementation Plan					
Taxon Name	**Population Unit**	**# of plants in Final OIP (mature/immature /seedling)**	**Status mature/immature/ seedling (# mature goal)**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
Abutilon sandwicense	Kaawa to Puulu	36/88/6	47/72/2 (50)	0 (>50 seeds)	No
	Kaluakauila	0/4/0	0/13/0 (50)	n/a (>50 seeds)	**Yes**
	Makaha Makai	73/27/6	**73/27/6 (50)**	8 (>50 seeds)	No
	Ekahanui and Huliwai	14/30/0	14/27/11 (50)	6 (>50 seeds)	Partial
Chamaesyce rockii	Helemano	7/1/0	7/1/0 (50)	0 (>50 seeds)	**Yes**
	Kawainui to Koloa and Kaipapau	48/25/4	37/13/2 (50)	0 (>50 seeds)	No
	Waiawa and Waimano	15/0/0	15/0/0 (50)	0 (>50 seeds)	No
Cyanea acuminata	Helemano-Punaluu Summit Ridge to North Kaukonahua	59/13/7	**59/13/7 (50)**	4 (>50 seeds)	No
	Kahana and South Kaukonahua	2/0/0	2/0/0 (50)	0 (>50 seeds)	No
	Makaleha to Mohiakea	85/33/0	**103/43/0 (50)**	0 (>50 seeds)	Partial
Cyanea crispa	Kawaiiki	2/4/0	2/4/0 (50)	0 (>50 seeds)	No
	Kahana and Makaua	6/0/0	7/7/0 (50)	3 (>50 seeds)	No
	Wailupe	5/1/0	5/1/0 (50)	**5 (>50 seeds)**	No
Cyanea koolauensis	Kaipapau, Koloa and Kawainui	51/25/6	**55/16/6 (50)**	0 (>50 seeds)	No
	Kaukonahua	11/1/0	14/2/0 (50)	0 (>50 seeds)	No
	Opaeula to Helemano	10/3/0	13/8/0 (50)	0 (>50 seeds)	Partial
Cyanea st.-johnii	Helemano	6/0/0	4/1/0 (50)	**4 (>50 seeds)**	**Yes**
	Ahuimanu-Halawa Summit Ridge	14/0/20	8/3/0 (50)	3 (>50 seeds)	No
	Waimano	14/5/0	14/5/0 (50)	4 (>50 seeds)	No
Cyrtandra subumbellata	Kaukonahua	2/0/1	0/0/0 (50)	0 (>50 seeds)	No
	Kahana	8/7/0	8/7/0 (50)	0 (>50 seeds)	No
	Punaluu	200/0/0	**201/0/0(50)**	0 (>50 seeds)	No

Oahu Implementation Plan					
Taxon Name	**Population Unit**	**# of plants in Final OIP (mature/immature /seedling)**	**Status mature/immature/ seedling (# mature goal)**	**Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)**	**Ungulate free**
Cyrtandra viridiflora	Helemano and Opaeula	45/15/6	39/13/6 (50)	5 (>50 seeds)	Partial
	Kawainui and Koloa	21/5/1	16/4/0 (50)	1 (>50 seeds)	No
	South Kaukonahua to Kipapa Summit	0/2/0	2/0/0 (50)	0 (>50 seeds)	No
Eugenia koolauensis	Kaunala	48/93/6	**59/111/137 (50)**	0 (>1 clone)	**Yes**
	Oio	18/56/0	22/17/15 (50)	1 (>1 clone)	**Yes**
	Pahipahialua	57/234/1	**50/33/377 (50)**	2(>1 clone)	**Yes**
Gardenia mannii	Haleauau	2/0/0	4/0/0 (50)	0	Partial
	Helemano and Poamoho	18/0/0	14/0/0 (50)	0	No
	Lower Peahinaia	37/1/0	37/1/0 (50)	0	No
Hesperomannia arborescens	Kamananui to Kaluanui	54/45/14	**56/46/14 (50)**	0	No
	Kaukonahua	76/51/122	**76/56/124**	0	No
	Lower Opaeula	9/15/0	9/15/0	0	No
	Palikea Gulch	0/0/0	0/0/0	0	No
Huperzia nutans	Kahana and North Kaukonahua	6/0/0	5/0/0 (50)	0	No
	Koloa and Kaipapau	3/0/0	3/2/0 (50)	0	No
	South Kaukonahua	1/0/0	1/0/0 (51)	0	No
Labordia cyrtandrae	East Makaleha to North Mohiakea	84/16/2	85/17/0 (100)	10 (>3 clones)	Partial
	Manana	1/0/0	1/0/0 (100)	0	No
Lobelia gaudichaudii ssp. *koolauensis*	Kaukonahua	3/45/2	1/29/1 (100)	**3 (>50 seeds)**	No
	Kipapa	0/100/20	0/100/20 (100)	0	No
	Waiawa to Waimano	0/200/0	0/200/0 (100)	0	No
Melicope lydgatei	Kawaiiki and Opaeula	43/0/0	42/0/0 (50)	0	No
	Kaiwikoele-	3/0/0	3/0/0 (50)	1 (>3 clones)	No

Oahu Implementation Plan					
Taxon Name	Population Unit	# of plants in Final OIP (mature/immature /seedling)	Status mature/immature/ seedling (# mature goal)	Genetic Storage (> 50 seeds from 50 individuals, >3 clones in propagation from 50 individuals)	Ungulate free
	Kawainui Ridge				
Myrsine juddii	Kaukonahua to Kamananui-Koloa	455/0/0	**455/0/0 (75)**	0	Partial
Phyllostegia hirsuta	Haleauau to Mohiakea	6/12/0	8/10/0 (100)	1 (>3 clones)	No
	Laie and Puu Kainapuaa	0/0/0	0/0/0 (100)	0	No
	Hapapa to Kaluaa	11/9/7	3/10/1 (100)	2 (>3 clones)	Partial
Phyllostegia mollis	Ekahanui	36/0/0	4/0/0 (100)	**1 (3 clones)**	Partial
	Kaluaa	38/11/0	17/7/0 (100)	0	**Yes**
	Pualii	0/0/0	0/0/0 (100)	**1 (3 clones)**	**Yes**
Pteris lidgatei	Helemano	0/2/2	0/2/2 (50)	0	n/a
	Kawaiiki	3/0/0	3/0/0	0	n/a
	South Kaukonahua	6/0/0	6/0/0(50)	0	No
Sanicula purpurea	North of Puu Pauao	0/21/0	0/21/0 (100)	0	No
	Poamoho Trail Summit	2/10/12	2/10/12 (100)	0	No
	Schofield-Waikane Trail Summit	2/25/0	2/40/0 (100)	0	No
Schiedea trinervis	Kalena to East Makaleha	180/196/318	**179/198/318 (150)**	48 (>50 seeds)	Partial
Stenogyne kanehoana	Haleauau	1/0/0	1/0/0 (100)	**1 (>3 clones)**	**Yes**
	Kaluaa	0/79/0	7/57/0 (100)	**1 (>3 clones)**	**Yes**
	Makaha (reintro)	n/a	0/0/0 (100)	n/a	No
Viola oahuensis	Helemano and Opaeula	162/145/22	**163/146/22 (50)**	0	Partial
	Kaukonahua	25/0/0	25/0/0 (50)	0	No
	Koloa	36/9/6	31/8/6 (50)	0	No

Table III. Status summary *Achatinella mustelina* for Year-6. Bold = reached that stabilization goal. Goal for MIP snails is 300 total (all age classes) per ESU. No *ex situ* numerical goal define so none bold.

Makua Implementation Plan					
Taxon Name	**Evolutionarily Significant Unit (ESU)**	**# snail in Final MIP**	**Status adult/subadult/ juvenile (goal)**	***ex situ* #s adult/subadult/juvenile (# of sites represented)**	**Ungulate free**
Achatinella mustelina	ESU A (Kahanahaiki/Pahole)	105	**274/52/65 (300)**	0/0/2 (1)	**Yes**
	ESU B1 (Ohikilolo)	300	**293/37/42 (300)**	0/10/1 (2)	**Yes**
	ESU B2 (East/Central Makaleha)	40	**289/114/68 (300)**	0/1/0 (1)	No
	ESU C (SBW/Alaiheihe/ Palikea)	50	33/10/3 (300)	0/17/2 (3)	Partial
	ESU D1 (North Kaluaa to SBS, Kaala)	86	**184/91/105 (300)**	0/8/2 (2)	Partial
	ESU D2 (Makaha)	17	118/26/22(300)	0/2/6 (1)	**Yes**
	ESU E (Puu Kaua/Ekahanui)	12	**315/72/77 (300)**	0/0/5 (1)	**Yes**
	ESU F (Puu Palikea/Mauna Kapu)	40	**330/86/46 (300)**	0/3/0 (1)	**Yes**

Table IV. Status summary Koolau *Achatinella* spp. for Year-3. Bold = reached that stabilization goal. Goal for OIP snails is 300 total (all age classes) per GU. No *ex situ* numerical goal defined so none bold.

Oahu Implementation Plan					
Species	**Geographic Unit (GU)**	**# snails in OIP**	**Status**	***ex situ* #s adult/subadult/juvenile (# of sites represented)**	**Ungulate free**
Achatinella apexfulva	n/a	0	Lab (Poamoho Trail)	0/2/0 (1)	No
Achatinella bulimoides	n/a	2	5	9/19/4 (1)	No
Achatinella byronii/decipiens	GU A (East Range)	6	6	0	No
	GU B (Puu Pauao)	16	16	0	No
	GU C (Poamoho)	69	259	0	No
	GU D (Punaluu Cliffs)	3	7	0	No
	GU E (North Kaukonahua)	175	**445**	0/5/1 (1)	No
Achatinella lila	GU A (Poamoho Summit)	39	15	0/287/129 (1)	No
	GU B (Peahinaia Summit)	11	11	0	Partial
	GU C (Opaeula-Punaluu Summit)	45	66	0	No
Achatinella livida	GU A (Crispa Rock)	60	86	0	No
	GU B (Northern)	5	9	0	No
	GU C (Radio)	83	37	8/44/2 (1)	No
Achatinella sowerbyana	GU A (Kawainui Ridge)	2	0	0	No
	GU B (Kawaiiki Ridge)	3	29	0	No
	GU C (Opaeula-Helemano)	344	**370**	2/6/0 (1)	**Yes**
	GU D (Poamoho Summit and Trail)	302	**319**	0	No
	GU E (Poamoho Pond)	90	35	0	No

	GU F (Poamoho-North Kaukonahua Ridge)	2	2	0	No
	GU G (Lower Peahinaia)	40	5	2/2/4 (1)	No

Table V. Status summary Oahu Elepaio for 2010.

Oahu Implementation Plan		
Site Name	**# of pairs protected from rats**	**# fledglings documented**
Ekahanui	30	3
Moanalua	17	7
Palehua	18	4
Schofield Barracks West Range	22	25
TOTALS	**87**	**39**

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APPENDICES

APPENDICES (CONTD.)

CHAPTER 1: ECOSYSTEM MANAGEMENT

Notable projects from the 2009-2010 reporting year are discussed in the Project Highlights section of this chapter. The reporting year is defined as 1 September 2009 through 31 August 2010. Threat control efforts are summarized for each Management Unit (MU) or non-MU land division. Ungulate control, weeds control, and outreach program data is presented with a minimum of discussion. For full explanations of project prioritization and field techniques, please refer to the 2007 Status Report for the MIP and OIP.

In 2008-2009, Ecosystem Management Unit Restoration Plans (ERMUP) were written for eight MUs: Palikea, Kahanahaiki, Ohikilolo (Upper), Ohikilolo (Lower Makua), Ekahanui, Helemano, Kaala, and Kaluakauila. The ERMUPs detail all relevant threat control in each MU over the next five years. The ERMUPs are working documents; OANRP has modified them slightly since last year. These changes, as well as the completion status of all proposed actions, are included in the ERMUP 2010 Status Update Tables. The entire ERMUPs are not re-printed here; please refer to the 2009 Status Report for the MIP and OIP for complete copies of these plans.

This year, six additional ERMUPs were written for the following MUs: Lower Ohikilolo, Makaha, Kaena, Upper Kapuna, Pahole, and Kahuku Training Area (KTA). Note that the KTA plan covers several small MUs located in KTA, Oio, Kaunala, and Pahiphaialua, as well as some KTA actions which are not in any MU. These plans are included here, following the ERMUP 2010 Status Update Tables.

1.1 PROJECT HIGHLIGHTS

1.1.1 Ungulate Control Program

Summary

- The OANRP was able to complete (MIP) Keaau/Makaha, Napepeiauolelo, Waianae Kai (*Nototrichium humile* PU), Waieli Subunit III, and (OIP) Ekahanui Subunit III in the 2010 reporting year.

- At this time, Waianae Kai [*Neraudia angulata* WAI-A] (120/500 m), Manuwai Subunit I/II (2,629/5,184 m) and Waimano (669/800 m) have partially been completed.

- All totaled about 5, 500 m of fence were built during the reporting year, enclosing about 56 acres (the two bigger units are only partially complete so their acreage is not reported here).

- Cultural resource 106 surveys have been completed for (MIP) East and West Makaleha, Kahanahaiki Subunit II, Kapuna snail exclosure, Lower Opaeula, Hapapa snail exclosure, Makaha Subunit II and (OIP) Kamaili, Koloa, Poamoho snail exclosure.

- Both the MIP Programmatic Supplemental and OIP Programmatic EAs have been signed with a Finding of No Significant Impact.

- An MOU between the Army and DLNR needs to be signed prior to any other new fences being constructed on State lands (units listed in tables).

- A programmatic CDUP needs to be obtained prior to the construction of any fences not included on DLNR or federal lands (units listed in the tables above). The CDUA has been submitted and public meetings are scheduled. We expect the CDUP to be complete by the beginning of 2011.

- A twenty-year license agreement between the Army and Kamehameha Schools is complete but still pending from Hawaii Reserves Inc. (Koloa) and City and County of Honolulu Board of Water Supply (Kamaili and Makaha Subunit II).

- OANRP is proposing to complete the partially completed fences listed above and initiate and/or complete construction on at least three of the following fences; Koloa, Kawailoa, Makaha Subunit II, Kamaili, Lower Opaeula, and Kahanahaiki Subunit II by end of reporting period. All compliance documents (CDUP, 106, license agreement etc.) are being pursued at this time.

- OANRP proposes to complete the 106 cultural surveys for both Keaau II (Hibbra), Kaipapau, Kawailoa, and Manana.

- The proposed Lihue MU fence, which will enclose Mohiakea and North and South Haleauau Units, will be started by the beginning 2011. The line has been surveyed for cultural resources and the prime contractor has been awarded. A subcontractor has yet to be selected.

MIP Management Unit Status

Management Unit	Fenced	Ung. Free	Acreage Protected/ Proposed	Est. Year	CDUP	106	MOU	License Agree.	# MFS PUs		Notes	Current Threats
									MIP	OIP		
ARMY LEASED AND MANAGED LANDS												
Kahanahaiki I	Yes	Yes	64/64	1998					7	0	Complete.	None
Kahanahaiki II	No	No	0/30	2013		X			6	0	Proposed for construction in 2013 but may be promoted to 2011 if other fences can't be built on time. Snaring is performed to reduce pig pressure.	Pig
Kaluakauila	Yes	Yes	104/104	2002					3	0	Complete. Fence is in need of some modification but still tight.	None
L. Ohikilolo	Yes	Yes	70/70	2000					2	0	The Ohikilolo ridge fence and the strategic fence are both complete. Since July 2006, 11 goats have been able to breach the fence. All have been removed and the fence was modified to prevent more ingress. No pigs have been observed.	Pig Possibly
L.Opaeula	No	No	0/26	2011		X		X	1	3	A 20 Year license agreement and 106 surveys are complete. Awaiting CDUP.	Pig
Ohikilolo	Partial	No	3/574	2002 2013					10	0	Ohikilolo ridge fence is complete, excluding goat ingress from south. Six smaller ungulate free PU fences are also complete. Goats were eliminated from Makua in 2002. A large rock fall that damaged the ridge fence has been repaired and no goats have been observed or caught in snares. A route has yet to be determined for the closure of the Ohikilolo MU to exclude pigs.	Pig
Puu Kumakalii	No	-	-	-	-	-	-	-	2	0	None needed but will be included within the proposed Lihue fence.	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES												
E. Makaleha	No	No	0/231	2012		X			7	3	Cultural 106 surveys completed Awaiting MOU. Limited goat control has been conducted in the past.	Pig/Goat Cattle
Ekahanui I	Yes	Yes	44/44	2001					6	3	Complete.	None
Ekahanui II	Yes	No	165/159	2009					5	3	Complete and 13 pigs were removed over 26 hunts. Three more have been caught in snares and snaring continues. The completed fence is several acres larger than the original proposed MU fence.	Pig

Management Unit	Fenced	Ung. Free	Acreage Protected/ Proposed	Est. Year	CDUP	106	MOU	License Agree.	# MFS PUs		Notes	Current Threats
									MIP	OIP		
Haili to Kealia	No	-	-	-	-	-	-	-	1	0	As per DOFAW staff 'no fence needed'. Plants are dead.	None
Kaena	No	-	-	-	-	-	-	-	1	0	None	None
Kaluaa/Waieli I	Yes	Yes	110/99	1999					4	2	Completed by TNCH. There have been several breaches and a total of 15 pigs have been removed. Skirting was installed around the existing fence to deter incursions. The completed fence is several acres larger than the original proposed MU fence.	None
Kaluaa/Waieli II	Yes	Yes	25/17	2006					2	0	Completed by TNCH. The completed fence is several acres larger than the original proposed MU fence.	None
Kaluaa/Waieli III	Yes	No	43/11	2010		X			1	0	Completed and several eradication hunts have been conducted removing three sows and one boar. Snaring operations have commenced. The completed fence is larger than the original proposed MU fence.	Pig
Keaau I	No	No	0/33	2012					1	0	Proposed fence for *Hibiscus brackenridgei* ssp. *mokuleianus*. Supplemental EA to the MIP complete. Awaiting Cultural 106 surveys and MOU.	Pig/Goat
Keaau II	No	No	0/29	2012					1	0	Proposed fence for *Gouania vitifolia*. Supplemental EA to the MIP complete. Awaiting Cultural 106 surveys and MOU.	Pig/Goat
Keaau/Makaha	Yes	Yes	1/3	2009		X			1	0	Complete and ungulate free.	None
Manuwai I	Partial	No	0/166	2011		X			7	1	Should be completed by November 2010, about ¾ complete.	Pig/Goat
Napepeiauolelo	Yes	Yes	1	2009		X			1	1	Complete.	None
Pahole	Yes	Yes	215/215	1998					16	0	Complete.	None
Palikea I	Yes	Yes	23/21	2008					4	0	Complete. Subunit II has been abandoned in favor of Napepeiauolelo. The completed fence is a couple of acres larger than the original proposed MU fence.	None
Kapuna I/II	Yes	Yes	32/182	2007					1	0	Complete. The completed fence differs in configuration than originally proposed fence, which explains the proportion presented.	None
Kapuna III	Yes	Yes	56/182	2007					5	0	Complete. The completed fence differs in configuration than originally proposed fence, which explains the proportion presented.	None

Management Unit	Fenced	Ung. Free	Acreage Protected/ Proposed	Est. Year	CDUP	106	MOU	License Agree.	# MFS PUs		Notes	Current Threats
									MIP	OIP		
Kapuna IV	Yes	No	342/224	2007					8	0	Complete, but NARS staff are continuing pig eradication campaign by alternating between volunteer hunts and snaring. The completed Kapuna fences encompass much more acreage than the original MIP fences, which explains the proportion presented.	None
Waianae Kai	Partial	3/4	8/9	2008 2010		X			5	0	The *Hesperomannia arbuscula* and *Gouania vitifolia* PU fences were completed in 2008. The *Nototrichium humile* PU fence was completed this year. The proposed PU fence for *Neraudia angulata* population WAI-A is scheduled for completion by end of 2010. The Nerang WAI-D PU has been abandoned due to no plants on site.	Pig/Goat
W. Makaleha	Partial	No	7/93	2012		X			7	0	Cultural 106 surveys are complete. Awaiting MOU to be signed before building MU fence. Limited goat control has been conducted in the past. The *Schiedea obovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free.	Pig/Goat
BOARD OF WATER SUPPLY												
Kamaileunu	Yes	Yes	5/2	2008	X	X			1	0	Both of the *Sanicula mariversa* PU fences at Kamaileunu and Kawiwi are completed and ungulate free.	None
Makaha I	Yes	Yes	85/96	2007					10	1	Complete and ungulate free after the removal of 27 pigs.	None
Makaha II	No	No	0/66	2011		X			4		Completed 106 surveys but awaiting CDUP and license agreement. Completed *Cyanea longiflora* PU fence.	
DOLE FOOD COMPANY, INC.												
Kaimuhole	No		0/100	2020					4	0	An ROE is complete for rare plant monitoring. OANRP has scoped out a line and a 106 survey is partially complete. At this time, Castle and Cooke is unwilling to discuss any fencing and are looking to sell the land. OANRP is hopeful if there is a sale then the new landowner will be interested in working towards mutually beneficial goals.	Pig/Goat

Shading in the table above indicates that ungulate management is needed for the MU and specific compliance documents are needed. The X's denote that compliance documents and authorizations are complete.

OIP Management Unit Status

Management Unit	Fenced	Ung. Free	Acreage Protected/ Proposed	Est. Year	CDUP	106	MOU	License Agree.	# MFS PUs MIP	OIP T1	OIP T2	OIP T3	Notes	Current Threats
ARMY LEASED AND MANAGED LANDS														
Kaala	Partial	No	183/183	2012		X				3			Strategic fences complete. Pigs still inside possibly able to get around strategic fences, a total of 16 caught since Dec. 2008. A line has been scoped for the Waianae Kai side and 106 surveys complete, awaiting MOU prior to construction. The proposed Lihue fence will connect to this unit.	Pig
Kaunala	Yes	Yes	5/5	2006						1			Complete.	None
Kawaiiki I/II	No	No	0/11	2017				X			2		OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig
Kawailoa	No	No	0/7	2011				X		1			OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig
Lihue	Partial	No	4/1800	2011		X			4	6			106 surveys complete and money allocated to primary contractor for the awarding of the secondary contractor who will construct. Six PU fences complete.	Pig/Goat
L. Opaeula II	No	No	0/24	2016				X		1			OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig
Oio	Yes	Yes	4/4	2006						1			Complete.	None
Opaeula / Helemano	Yes	Yes	273/273	2007				X		1			Complete. Two pigs were able to breach Opaeula fence in 2010 but were promptly captured with assistance from KMWP.	None
Pahipahialua	Yes	Yes	2/2	2006						1			Complete.	None
S. Kaukonahua I	No	No	0/95	2013						3	3	1	OIP EA complete, awaiting 106 cultural surveys. Snaring is performed to reduce pig pressure.	Pig
S. Kaukonahua II	No	No	0/95	2015							2		OIP EA complete, awaiting 106 cultural surveys.	Pig
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES														
Huliwai	No	No	0/1	2013						1			OIP EA complete, awaiting 106 cultural surveys	Pig
Ekahanui III	Yes	Yes	8/8	2010		X				1			Complete.	None

Management Unit	Fenced	Ung. Free	Acreage Protected/ Proposed	Est. Year	CDUP	106	MOU	License Agree.	# MFS PUs				Notes	Current Threats
									MIP	OIP				
										T1	T2	T3		
Kaipapau	No	No	0/273	2012						4	1		OIP EA complete. Awaiting MOU and 106 surveys.	Pig
Kaleleiki	Yes	Yes	2/2	1998						1			Completed by DLNR.	None
Manana	No	No	0/19	2012						1			OIP EA complete. Awaiting MOU and 106 surveys.	Pig
Manuwai II	Partial	No	0/138	2011		X			1	1			Should be completed by early 2011, about ½ completed.	Pig/Goat
N. Kaukonahua	No	No	0/31	2014						3	1		OIP EA complete. Awaiting 106 cultural survey and MOU.	Pig
Poamoho I	No	No	0/5	2015						1	4		OIP EA is completed. Awaiting MOU and 106 surveys.	Pig
Poamoho III	No	No	0/18	2016							1	1	OIP EA is completed. Awaiting MOU and 106 surveys.	Pig
Poamoho IV	No	No	0/2	2016							1		OIP EA is completed. Awaiting MOU and 106 surveys.	Pig
Wailupe	No	No	0/22	2019							1		OIP EA complete, awaiting 106 cultural surveys. Awaiting MOU and 106 surveys.	Pig
Waimano	Partial	No	0/4	2010		X				1			Both OIP EA and cultural resource surveys are complete. The line is all cleared, materials are on site, and fence construction has started.	Pig
N. Pualii	Yes	Yes	20/20	2004					1	1			Complete.	None
BOARD OF WATER SUPPLY														
Kamaili	No	No	0/7	2011		X				1			Both OIP EA and cultural resource surveys are complete. Awaiting license agreement and CDUP.	Pig/Goat
HAWAII RESERVES INC.														
Koloa	No	No	0/160	2011		X				4	2		Both OIP EA and cultural resource surveys are complete. Awaiting 20 year license agreement.	Pig
KAMEHAMEHA SCHOOLS														
L. Poamoho	No	No	0/156	2015				X		1			OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig
Poamoho II	No	No	0/60	2016				X			2		OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig

Management Unit	Fenced	Ung. Free	Acreage Protected/ Proposed	Est. Year	CDUP	106	MOU	License Agree.	# MFS PUs				Notes	Current Threats
									MIP	OIP				
										T1	T2	T3		
Waiawa I	No	No	0/136	2017				X			1	1	OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig
Waiawa II	No	No	0/136	2019				X			1		OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey and CDUP.	Pig
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION														
North Halawa	No	No	0/4	2015						1			Scoped out a line and in conversation with DOT about construction.	Pig
KUALOA RANCH INC.														
Kahana	No	No	0/23	2018							1		OIP EA is complete. Kualoa Ranch Inc. is the landowner and supports fence construction.	Pig
U. S. FISH AND WILDLIFE SERVICE														
Kipapa	No	No	0/4	2019								1	OIP EA is complete.	Pig

Shading in the table above indicates that ungulate management is needed for the MU and specific compliance documents are needed. The X's denote that compliance documents and authorizations are complete.

1.1.2 Public Outreach Program

1.1.2.1 Volunteers

During the reporting period 1-September, 2009 – 31-August, 2010 the OANRP Outreach Program continued existing and developed additional volunteer-based projects at appropriate sites within OIP and MIP management areas, and at the two OANRP baseyards. Table 1 summarizes project trips. See Appendix 1-1 for photographs of project trips.

- Total volunteer hours for field days = 3415
  (includes driving time to and from trailhead, safety briefing, hiking time to and from work site, and gear cleaning time at end of day)

- Total volunteer hours at work site = 1299
  (includes actual time spent weeding, planting, or monitoring)

- Total field volunteer trips = 57

- Total baseyard volunteer hours = 885

    - Baseyard projects:
        - Propagule processing
        - Nursery maintenance
        - Baseyard landscaping
        - Greenhouse snail monitoring
        - Herbarium organization
        - Outreach Material preparation and filing

- Maintained a volunteer database of 630 total volunteers, and communicated regularly with active volunteers on a daily basis.

Volunteer field trips for FY 2010

Management Unit	Projects	Total Number of Trips
Kahanahaiki	Invasive weed control	14
	Common native plant monitoring	6
	Water catchment, step, and fence cross-over construction	1
	Common native seed collection	1
Kaala	Invasive weed control	4
	Incipient weed control	13
	Assist with *Sphagnum* research	1
	Assist with checking/setting snares	1
Palikea	Incipient weed control	4
	Invasive weed control	1
	Achmus predator control	1
Makaha	Invasive weed control	2
West Makaleha	Invasive weed control	2
KTA- Pahipahialua	Invasive weed control/Common native transplants	2
KTA- Kaunala	Invasive weed control	2
	Common native transplants/water catchment construction	1
Ekahanui	Invasive weed control	1

1.1.2.2 Educational Materials

Developed and produced educational materials focused on natural resource issues specific to Oahu Army training areas (see Appendix 1-1 for examples).

- Displays:
  - "Kahuli, Oahu's Forest Gems" – three-panel display poster focused on Kahuli tree snails, used for Earth Day activities during the month of April;
  - "Match the Stomach Contents" – a display illustrating native resources that are consumed by both rats and Jackson chameleons, used for Earth Day activities during the month of April;
  - Three-dimensional rat and Jackson chameleon game, with "stomach contents" inside each box that can be pulled out and identified (goes with the display described above). Also used for Earth Day activities during the month of April.

- Signage:
  - "OANRP in Makua Valley" – a three-panel display highlighting the natural resources in Makua, threats to these resources, and what the OANRP does to protect them. This large three-panel display sign will be part of an interpretive area at Makua; construction to begin in early FY 2011;
  - "Makua Valley View Plane" sign – a panoramic view of the valley highlighting both natural and cultural resources found at Makua, for the purpose of visitor education; also part of the planned interpretive area at Makua;

  - "What's Going On Here" sign – an informational sign describing staff and volunteer efforts to control *Sphagnum palustre*, an invasive moss, along the boardwalk at the summit of Kaala;
  - "Puu Kaua is Sacred" sign – an informational sign about Puu Kaua Heiau, requesting visitors to respect this important cultural site.

- Presentations:
  - Revision of natural resources section of the Environmental Compliance Officer training class;
  - Career Fair presentation used at Leilehua High School.

- Other:
  - Active participants in the "Partnership to Protect Hawaii's Native Species," a collaborative working group between OANRP and other federal and state agencies (e.g. USFWS, CGAPS, DLNR) to educate the public about the devastating effects of rats on Hawaii's native species, and options to help control this threat. An outcome from 2010 was the development of a website. McNeil/Wilson Communications developed the website. OANRP Outreach provided input, photos, text, and editing for the website and is currently helping to maintain it. URL: www.removeratsrestorehawaii.org

1.1.2.3 Internships

Developed internships at OANRP and with cooperating agencies and organizations.

- Interns from Hawaii Youth Conservation Corp (HYCC) contributed a total of 434 volunteer hours in June.

- Evaluated and scored 29 applicants, interviewed 5 applicants, and awarded four individuals with 12-week, paid OANRP summer internships. OANRP Outreach coordinated orientation and training for these interns, then placed them with field & nursery crews to gain valuable career skills and experience in the field of natural resource management.

- Wrote four project descriptions for potential interns from the UH Environmental Practicum course, offered fall semester, 2010. Potential interns matched with these projects will be determined in FY 2011.

- Coordinated and provided a field day for one USFWS intern working for the Partnership to Protect Hawaii's Native Species (see information on this partnership in "Educational Materials" section above).

1.1.2.4 Troop Education

Developed and produced educational materials and presentations for Army troops highlighting the relationship between troop training activities and the natural resources on Army training lands. Additionally, provided field opportunities for troops to participate in natural resource conservation service projects.

- Revised and implemented a 45 min. presentation for the eight Environmental Compliance Officer (ECO) training courses held on Oahu in FY2010; approximate number of soldiers attending = 290

- Coordinated and led a group of 10 soldiers from Signal Company 396 (Schofield Barracks) on a service project controlling invasive strawberry guava trees in Kahanahaiki.

1.1.2.5 Outreach Events

Conducted outreach to disseminate information on natural resources specific to Army training lands at local schools, community events, and conferences. These are summarized in table 2. See Appendix 1-1 for photos.

- Total # of outreach activities = 20

- Total # of people served (approximated) = 3712

Outreach activities for FY 2010

Event	**Approx. # of people served**	**Audience**
Schofield Hoolaulea	100	General public - Schofield
Makua Valley tour - UH Law students	70	U.H. students and professor
Leilehua High School Career Day-presentations	50	Two classes of H.S. students and teachers
Volunteer Recognition Holiday Event	30	General public
Makua Valley tour, part 1 - Mililani Middle School	90	Middle school students and teachers
Makua Valley tour, part 2 - Mililani Middle School	90	Middle school students and teachers
Kahanahaiki VIP tour	37	NRCC participants
Kahanahaiki VIP tour	20	DOD Endangered Species Conf. participants
Oahu Agriculture & Environmental Awareness Day	500	Elementary students and teachers
Earth Day in Kailua	75	General public
University of Hawaii Manoa Earth Day	300	UH students
Schofield Earth Day	250	General public - Schofield
Waimanalo Career Day	90	Middle school students and teachers
Hawaii Conservation Alliance Endangered Species Day at the Zoo	300	General public
Honouliuli Dedication Ceremony	100	Conservation community; elected officials, press
2010 Conservation Conference - Display (during conference)	1100	Conference participants
2010 Conservation Conference - Display (during Open House)	100	General public

1.1.2.6 Public Relations

Wrote articles, press-releases, and bulletins; provided coordination and accurate information to the local, state, regional, and national media and agencies (see Appendix 1-1 for examples).

- **ARTICLES:**

Title	Publication	Print Date
Nursery Set Up in Waianae Range	MidWeek	30-Sep-09
Photo of the Month Contest Winner - Kapua Kawelo, OANRP	Natural Selections	1-Oct-09
Endangered *Cyanea superba* Responds Positively to the Strategic Management Efforts of the Army Garrison Hawaii's Natural Resources Program	Natural Selections	Nov-09
Reintroduced *Pritchardia kaalae* flowers for the first time	EMP, Vol 47	Nov-09
Sorry Miss Jackson, I am for real	EMP, Vol 47	Nov-09
Rat Attack, a Series - part 1	EMP, Vol 47	Nov-09
Army Hawaii Environmental Division's year in review	Public Works Digest	Nov/Dec 2009
Oahu Army Natural Resources Program looks back on a year of challenges, innovation, firsts	Public Works Digest	Nov/Dec 2009
New tiny taxa	EMP, Vol 48	1-Feb-10
The View from Above: Aerial Surveys in Schofield Barracks West Range Reveal the Extent of Weed Spread	EMP, Vol 48	1-Feb-10
Rat Attack, a Series - part 2	EMP, Vol 48	1-Feb-10
The View from Above: Aerial Surveys in Schofield Barracks West Range Reveal the Extent of Weed Spread	Natural Selections	Feb-10
Reintroduced *Pritchardia kaalae* flowers for the first time	Natural Selections	Mar-10
A Dog "Tail" of Two Snails	Hawaii Army Weekly	29-Mar-10
Sorry Miss Jackson, I am for real	Natural Selections	Apr-10
Paintball for Conservation: a new perspective from a natural resource warrior	EMP, Vol 49	1-May-10
Rat Attack, a Series - part 3	EMP, Vol 49	1-May-10
Rats Threaten Native Species, Army Steps Up Attack	Honolulu Civil Beat	15-Jun-10
Helicopters Dropping Poison: Coming Soon To A Forest Near You?	Honolulu Civil Beat	15-Jun-10
Back From The Dead, An 'Extinct' Native Tree Thrives	Honolulu Civil Beat	16-Jun-10
Recovery and Restoration of Kahanahaiki Valley, part 1	Hawaii Public Radio	13-Jul-10

○ Recovery and Restoration of Kahanahaiki Valley, part 2	Hawaii Public Radio	14-Jul-10
○ Mauka Matchmakers	EMP, Vol 50	1-Aug-10
○ Schofield Barracks rainwater harvesting project to demonstrate Garrison water and energy savings	EMP, Vol 50	1-Aug-10
○ A Chipper Outlook on Weeds	EMP, Vol 50	1-Aug-10
○ Feathers, flowers and flak: protecting endangered species in Schofield Barracks west range	EMP, Vol 50	1-Aug-10
○ Makua Military Reservation Fire burns 486 acres	Hawaii Army Weekly	6-Aug-10

- Edited/produced/distributed the Ecosystem Management Program (EMP) Bulletin, a quarterly newsletter highlighting achievements made by the Army Environmental Division both on Oahu and Hawaii Island. The EMP is distributed to a comprehensive list of state, non-profit, federal, and educational institutions, and OANRP volunteers. Articles from this publication are frequently picked up by other Army publications.

1.1.2.7 Outreach Program Recognition

Received national recognition of OANRP Outreach program and volunteers.

- Registered a planned volunteer work day in Kahanahaiki for National Public Lands Day (Sept. 2009). Received cash award to purchase supplies for field nursery, to be constructed and maintained with volunteer effort. Volunteer work day was promoted on NPL website.

- Nominated OANRP volunteer for the President's Volunteer Service Award, Silver Level. Volunteer received presidential certificate of appreciation.

1.1.3 Weed Control Program

1.1.3.1 MIP/OIP Goals

The stated MIP/OIP goals for weed control are:

- 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

Given the wide variety of habitat types, vegetation types, and weed levels encompassed in the MUs, these IP objectives sometimes seem inappropriate. In discussions with the IT in 2009, the following clarifications were made:

- The IT stated that the percent cover goals apply to both canopy and understory vegetation. Optimal cover of native vegetation is unknown.
- The 0% alien cover goal within 2m of rare taxa is inappropriate for many taxa and MUs. OANRP will not focus on reaching this goal, particularly in the canopy. OARNP will continue to prioritize understory weed control efforts around rare taxa, with the aim of maximizing rare taxa health. Notes to this effect are detailed in the ERMUPs.
- OARNP will continue to work towards achieving 25% or less alien vegetation cover within 50m of rare taxa, excepting elepaio.
- OARNP propose prioritizing zones for the 50% or less alien cover goal in select MUs. This goal is appropriate in some MUs. In others, however, the starting point is so degraded that achieving this goal seems unrealistic, prohibitively expensive, and would require much more than the 30 years outlined in the IPs. In degraded MUs, OARNP will designate Priority 1 and 2 areas. Priority 1 areas will include rare taxa locations and appropriate habitat, as well as areas with a fair amount of native vegetation cover. Priority 2 areas will include the remainder of the MU, particularly zones which are weed dominated. Staff weed control effort will be focused in Priority 1 areas, where OANRP will continue to work towards the 50% goal. In Priority 2 areas, staff will not expect to reach the 50% goal within 30 years, and will minimize staff effort, at least over the next five years. However, OARNP will work in Priority 2 areas as Priority 1 actions are completed or become routine, or if staffing and funding levels increase. Staff will explore the use of volunteer groups and aggressive weed control techniques in Priority 2 areas.
- MUs where priority 1 and 2 designations are proposed include Makaha, Upper Kapuna, and Ekahanui.
- Any additional changes which OARNP would like to propose to the IT will be discussed by MU in ERMUPs.

1.1.3.2 Management Unit WCA Summary

Only weed control efforts from Weed Control Areas (WCAs) are summarized in this table. Incipient control efforts are not included. The goal of weed control is not necessarily to reach 100% coverage across all WCAs in a MU every year. Goals are further elucidated in the ERMUPs. Note that WCAs are not necessarily drawn to encompass all of a MU; rather, WCAs identify priority weeding areas within the MU and serve to focus and direct effort in the most critical locations first. High priority areas include rare taxa locations, future reintroduction sites, native taxa dominated forest, and fuel breaks. See the 2009 Status Update for the Makua and Oahu Implementation Plans, Appendix 1-2, for additional information on control techniques (http://www.botany.hawaii.edu/faculty/duffy/DPW/2009_OIP/default.htm).

This year, data is summarized for the reporting period of 1 September 2009 through 31 August 2010, corresponding to the federal fiscal year. Next year, data will be summarized by MIP year, from 1 October 2010 through 30 September 2010, which will correspond more cleanly with the IPs and ERMUPs.

An error in the program generating the MU WCA Weed Control Summary table was discovered this year. This means that data from this reporting year cannot be accurately compared to data from previous Status Updates. OANRP apologizes for the inconvenience, and is constantly working to create the most accurate reports possible.

MU WCA Weed Control Summary, 2009/09/01 through 2010/08/31

Management Unit	MU area (ha)	Total WCA area (ha)	% WCA area in MU	Area weeded (ha)	% of MU weeded	Comments
Ekahanui	19.93	13.89	69.7%	2.6	13.1%	Control efforts focused around rare species locations, particulary new reintroductions.
Ekahanui No MU	N/A	4.82	N/A	3.94	N/A	Limited weed control is conducted outside the MU. This effort is along trails and roads to maintain/improve ease of access to the MU and minimize weed spread.
Haili to Kealia	13.38	21391 m^2	16.0%	999m^2	0.75%	Weed control focused around rare taxa.
Helemano and Opaeula	110.17	109.81	99.7%	5.30	4.8%	In Opaeula, staff focused effort in areas that hadn't been swept in the past. In Helemano, control began in the eastern part of the fence, where topography is relatively gentle. Staff also conducted a scoping trip to the western, gulch end of the exclosure; weed control on the gulch slopes will be challenging, and novel approaches should be explored.
Huliwai No MU	N/A	621m^2	N/A	43 m^2	N/A	Weed control focused around rare taxa
Kaala	74.38	47.66	64.1%	5.34	7.2%	*Hedychium gardnerianum* continues to be the primary weed target at Kaala. Effort focused on two WCAs on the east side of the MU. These have not been fully swept before, and were highest priority. In addition, volunteer effort was used to sweep part of the area closest to the boardwalk.
Kaena	6.42	2.70	42.1%	1.69	26.3%	Weed control effort was expanded this year, to include a new WCA around a 'new' *Chamaesyce celastroides* var. *kaenana* site.

Management Unit	MU area (ha)	Total WCA area (ha)	% WCA area in MU	Area weeded (ha)	% of MU weeded	Comments
Kahanahaiki	25.45	20.96	82.4%	4.53	17.8%	68 weed control trips were taken to Kahanahaiki this year, with 841 hours spent weeding. Many of these were volunteer trips, and many others were part of the *P. cattleianum* chipper control project. Staff efforts continue to focus around rare taxa, reintroductions, and native forest patches. Vegetation monitoring in 2009 indicated that alien cover was at 36% in the understory and 53% in the canopy. This is close to the MIP goal of 50% or less alien cover across the MU. This year, aggressive weed control was conducted in Kahanahaiki. Hopefully, by the time vegetation monitoring is again conducted in 2012, alien cover will be well below 50%.
Kaleleiki	7959 m^2	7959 m^2	100%	2355m^2	29.6%	One trip was made to this *Eugenia koolauensis* population.
Kaluaa and Waieli	62.55	26.68	42.6%	1.46	2.3%	Control efforts focused around rare taxa locations. A significant amount of time was spent on the Hapapa Bench clearing area for a snail exclosure. In the coming year, OANRP will generate a restoration plan for the snail exclosure area, as a lot of weedy canopy was removed, drastically changing light levels.
Kaluaa No MU	N/A	8479 m^2	N/A	11m^2	N/A	Limited weed control is conducted outside the MU. Control is targeted around rare taxa that fall outside the Kaluaa and Waieli MU and the access road to the Kaluaa trailhead.
Kaluakauila	41.68	8.68	20.8%	2.90	6.9%	Control efforts focused on grass control and *Leucaena leucocephala* control around rare taxa. The ridgeline fuelbreak was maintained.
Kamaili	2.57	18398 m^2	71.5%	381m^2	1.5%	One trip was made to this *Abutilon sandwicensis* population
Kaunala	1.98	2.01	102%	0.24	12.0%	OANRP developed a weed priority list for this alien-dominated MU. Staff efforts focused around rare taxa, and volunteer efforts began in areas with no *E. koolauensis*. Volunteers are also transplanting common natives into the fence, to facilitate habitat restoration.

Management Unit	MU area (ha)	Total WCA area (ha)	% WCA area in MU	Area weeded (ha)	% of MU weeded	Comments
Lower Ohikilolo	28.75	4.34	15.1%	3.62	12.6%	Staff conducted 25 weed control visits this year, maintaining low vegetation levels in the WCA/fuelbreaks throughout the year. This is a labor intensive project; staff spent 245.5 hours at Lower Ohikilolo. The use of Oust, a preemergent herbicide, has helped to improve efficiency, but it can only be used in certain areas, to minimize non-target effect.
Makaha	60.87	44.28	72.8%	1.43	2.35%	Weed control efforts continue to focus around rare plant sites in the southern part of the exclosure.
MMR No MU	N/A	28.00	N/A	0.76	N/A	Minimal work is done outside of MUs in MMR. This year, time was spent maintaining the Reveg Road, on the border of Kahanahaiki.
Mohiakea	172.38	35686 m^2	2.1%	236 m^2	0.01%	Access to Mohiakea is limited (SBW). Weed control is targeted around rare taxa only. This MU will likely be subsumed into the larger Lihue MU.
Napepeiauolelo No MU	N/A	9253 m^2	N/A	663 m^2	N/A	One control trip was made to this area, around *Hesperomannia arbuscula*.
North Haleauau	171.66	8189 m^2	0.5%	113 m^2	0.007%	Access to North Haleauau is limited (SBW). Weed control is targeted around rare taxa only, particularly *Achatinella mustelina*. This MU will likely be subsumed into the larger Lihue MU.
Ohikilolo	232.54	84.46	36.3%	2.50	1.1%	In the Ohikilolo Ridge (upper) half of this MU, control efforts continued across native dominated forest and around rare taxa. The Forest Exclosure was swept for alien grass. In the Lower Makua half of this MU, an UXO area, staff were successful in gaining access. Weed control was conducted in native dominated forest. Most of this MU is steep cliff, where standard weed control techniques are not feasible.
Oio	1.33	1.63	122.2%	1.54	115.5%	Due to the poor health of the *E. koolauensis* population at this site, OANRP has been hesitant to commit many resources to this site. Control efforts focused on treating a short list of low-density target weeds across the entire site, but reducing overall time spent in the area. It is unclear if this site will remain a manage for stability location for *E. koolauensis*, and therefore whether management will continue in the future.

Management Unit	MU area (ha)	Total WCA area (ha)	% WCA area in MU	Area weeded (ha)	% of MU weeded	Comments
Pahipahialua	5995 m²	5995 m²	100%	295 m²	4.9%	OANRP developed a weed priority list for this alien-dominated MU. Staff efforts focused around rare taxa, and volunteer efforts began in areas with no *E. koolauensis*. Volunteers are also transplanting common natives into the fence, to facilitate habitat restoration. Common natives outplanted several years ago are healthy.
Pahole	87.96	30.16	34.3%	4.48	5.1%	Control efforts focus around rare taxa sites. Staff conducted 30 trips to the MU, and spent 106 hours conducting weed control. Several new WCAs were drawn this year to facilitate data tracking of *Montanoa hibiscifolia* control.
Pahole No MU	N/A	8.65	N/A	7.13	N/A	Control outside of the MU is limited to a reintroduction site, a *Montanoa hibiscifolia* site outside the exclosure, the Nike facility and the Pahole road. Staff continue to maintain the road for safety and ease of access.
Palikea	9.95	10.95	110.1%	3.46	34.8%	This year staff conducted 24 weed control trips, and spent 175 hours controlling WCAs. More time has been spent in the northern part of the MU.
Palikea No MU	N/A	51061 m²	N/A	9m²	N/A	Minimal effort is spent on weed control outside the MU. Staff targeted *Sphaeropteris cooperi* north of the fence.
Puaakanoa	10.70	7046 m²	6.6%	3360m²	3.1%	Weed control efforts focused on fuel reduction around the *Chamaesyce celastroides* var. *kaenana*. Fire is a major threat to the MU.
Pualii	7.99	2.57	32.2%	0.88	11.0%	OARNP focused control efforts around rare taxa sites and reintroductions.
Puu Kumakalii	5.63	12002 m²	21.3%	26m²	0.05%	Little weed control is possible in this steep, cliff-dominated MU. The only control done in this MU this year was to maintain an LZ.
SBE No MU	N/A	4.10	N/A	0.07	N/A	Control efforts focus on maintaining weed free areas at the East Baseyard, to reduce the potential for staff to act as weed vectors. No control was conducted in a large WCA at the coquí infestation, as that project is now complete.
SBW No MU	N/A	1.55	N/A	1.46	N/A	Control efforts focus on maintaining weed free areas at the West Baseyard, to reduce the potential for staff to act as weed vectors.

Management Unit	MU area (ha)	Total WCA area (ha)	% WCA area in MU	Area weeded (ha)	% of MU weeded	Comments
Upper Kapuna	73.65	15.59	21.2%	1.12	1.5%	Control efforts continued to focus around rare taxa and reintroductions. Staff conducted 18 trips to the MU and spent 139 hours conducting control in WCAs.
Waianae Kai Neraudia Mauka	5289 m²	25897 m²	489.7%	94m²	1.7%	Some fenceline clearing was conducted in this MU. Other weed control efforts will wait until the fence is constructed.
West Makaleha	38.11	2.62	6.9%	0.29	0.8%	Weed control efforts focused around rare taxa. *Rubus argutus* continues to be a very challenging target at this MU. Trials are needed to determine more effective control techniques.
West Makaleha No MU	N/A	3157 m²	N/A	728m²	N/A	Some trail maintenance was conducted outside of the MU.
TOTAL	N/A	497.64	N/A	60.25	N/A	Some WCAs are not intended to be controlled every year, particularly those in sensitive habitat. Others, like the ones in Lower Ohikilolo which facilitate fuel break maintenance, are maintained quarterly and are swept in their entirety. Via the ERMUPs, staff hope to more accurately show how priorities are set for different WCAs.

Effort is primarily focused around rare taxa and patches of native forest, but these areas are still quite degraded, particularly in mesic and dry forest in the Waianae Mountains. Vegetation monitoring (discussed in the ERMUPs) indicates that even in some of the best preserved MUs in the Waianae Mountains, alien vegetation cover still reaches well above 50%. Controlling weeds in forests such as these requires a major input of time and effort. Also, different types of weed control are not easily comparable. For example, targeting mature *Grevillea robusta* across Kahanahaiki results in large areas swept, while treatment of a variety of alien species directly around a rare taxon site results in a small area swept, despite equivalent amounts of time. This should be taken into account when considering the total area weeded over the last year. In the 2008-2009 report year, OARNP spent 2,651.40 person hours over 267 visits conducting weed control in WCAs. This year 3,255.95 hours were spent over 353 visits. This is an increase of 604.55 hours and 86 visits. OARNP plans to maintain and hopefully increase weed control effort in WCAs in the future. The ERMUPs will be used to direct effort.

Effort data for the 2009-2010 report year is summarized in the table below. Only the MUs where most effort was spent are included in the table. The 19 MUs vary in size, habitat quality, and number of IP taxa present. However, they do comprise the largest and most diverse MUs where OANRP works, except Manuwai and East Makaleha, where threat control efforts are just beginning. Both person hours and number of visits are used to indicate where the majority of staff effort was spent. Each MU is ranked twice, once by effort (person hours), and once by number of visits.

Effort Spent in Select MUs, 2009/09/01 through 2010/08/31

MU	Effort (Person Hours)	# of Visits	Ranking by Effort	Ranking by Visits
*Kahanahaiki**	*840.85*	*68*	*1*	*1*
Kaala*	357.50	22	2	6
Lower Ohikilolo	*245.50*	*25*	*3*	*3*
Ekahanui	202.50	23	4	5
Kaluaa and Waieli	186.00	19	5	7
Makaha*	180.50	18	6	8
Palikea*	175.40	24	7	4
Ohikilolo	148.30	17	8	10
Upper Kapuna	*138.50*	*18*	*9*	*9*
Pahole	106.50	30	10	2
Kaena	97.00	4	11	15
Kaluakauila	91.75	17	12	11
Oio*	68.00	4	13	16
West Makaleha*	62.50	9	14	12
Helemano and Opaeula	56.00	2	15	19
Pahole No MU	43.00	5	16	14
Pahipahialua*	40.50	3	17	18
Puaakanoa	38.00	4	18	17
Pualii	36.50	7	19	13

* = MUs which received help from the public outreach program
italics indicate that ranking is unchanged between effort and visits

(dark grey)	= ERMUP written for MU
(light grey)	= ERMUP writted for Helemano only

Much more effort was spent in Kahanahaiki than any other MU this year. This is due to the high number of IP taxa in Kahanahaiki, multiple volunteer trips, and the chipper project (described below in New Weed Control Techniques: Chipper). Volunteer trips also made important contributions in the Kaala, Makaha, Palikea, West Makahleha, and Pahipahialua MUs. Next year, OARNP plans on expanding volunteer trips into the Kaluaa and Waieli MU. For the most part, the MUs where the most hours were spent were the same as the MUs where the most visits were conducted. The exceptions to this are Pahole and Kaena. A similar amount of time was spent in each MU, but at Pahole, many short visits were conducted, while at Kaena, four long visits were conducted. A new *C.celastroides* population was found at Kaena, and weed control was expanded to include initial knockdown of *L. leucocephala* at this site.

1.1.3.3 Weed Survey Updates: New Finds

No new significant weed pests were discovered on along weed transects, or at camp sites.

Significant weed pests were discovered at three landing zones (LZs) this year.

- LZ 089. *Panicum maximum* was found at the Poamoho Monument LZ, on the Koolau summit. *P. maximum* prefers drier, sunnier habitats, and is unlikely to become widespread at Poamoho, but staff will remove it in the coming year.
- LZ 157. *Schefflera actinophylla* was found at the Waimano *Cyanea st. johnii* LZ, close to the Koolau summit. This is the first time a survey was conducted at this LZ. The windward valleys closest to the LZ include Waihee and Kaalaea, both of which are widely infested with *S. actinophylla*. When weed control is implemented at this site, *S. actinophylla* will be a primary weed target.
- LZ 152. *Ardesia elliptica* was found at the Puu Pane LZ on Kamaohanui ridge in the Waianae mountains. This is the first time a survey was conducted at this LZ. *A. elliptica* is widespread in Schofield Barracks West Range (SBW), but is not documented from areas to the north. This species is bird-dispersed and may already be established in the Kaala Natural Area Reserve (NAR).

Significant new weed pests were detected along several road surveys this year.

- Kaala Road Survey: *Desmodium intortum, Diplazium esculentum, Ehrharta stipoides, Leptospermum scoparium* and *Begonia foliosa* were all seen for the first time. Of these, *B. foliosa* was already known from the area, but had not been seen on the road before. Staff are scoping the extent of the other three taxa, and are investigating control options. Only one *L. scoparium* was found, and it was removed. There is a population of *L. scoparium* less than a kilometer to the south, on Kumaipo ridge, and this is likely the source for the roadside plant. *L. scoparium* does have wind-dispersed seed. The Kumaipo infestation needs to be removed to prevent further spread of *L. scoparium*.
- Kaluaa Road Survey: This year is the first time the Kaluaa access road has been surveyed. Both *Schefflera actinophylla* and *Falcataria moluccana* are widespread along the road. Both are serious pests, appear to be colonizing abandoned agricultural fields, and have already been found in the Kaluaa and Waieli MU.
- Kahuku Bravo Road Survey: this year is the first time the Bravo road in KTA was surveyed. No significant pests were found on the survey.
- Pahole Road Survey: A pasture weed, *Macrotyloma axilare* var. *glabrum*, was identified for the first time this year. *M. axilare* is very similar in appearance to *Neonotonia wightii*, another vining bean. It likely has been present along the road for some time. *Albizia chinensis* was found along the Pahole Road prior to the road survey. It was removed and is being monitored as an Incipient Control Area (ICA).
- North SBW Firebreak Road Survey: This is the first time this road has been surveyed. Part of the road passes by maintained buildings with ornamental plantings. A number of concerning weed species was found along this road survey, including *Callitris* sp., *Chrysophyllum oliviforme, Citharexylum caudatum, Citharexylum spinosum, Crocosmia* x *crocosmiiflora, Hedychium coronarium, Fraxinus uhdei, Pterolepis glomerata, Pimenta dioica, Caesalpinia decapetala,* and *Schefflera actinophylla*. Staff will evaluate whether any of these species require control. Of particular concern is *P. glomerata*, which could be a major pest at Kaala.

1.1.3.4 Weed Survey Incidental Observation Form

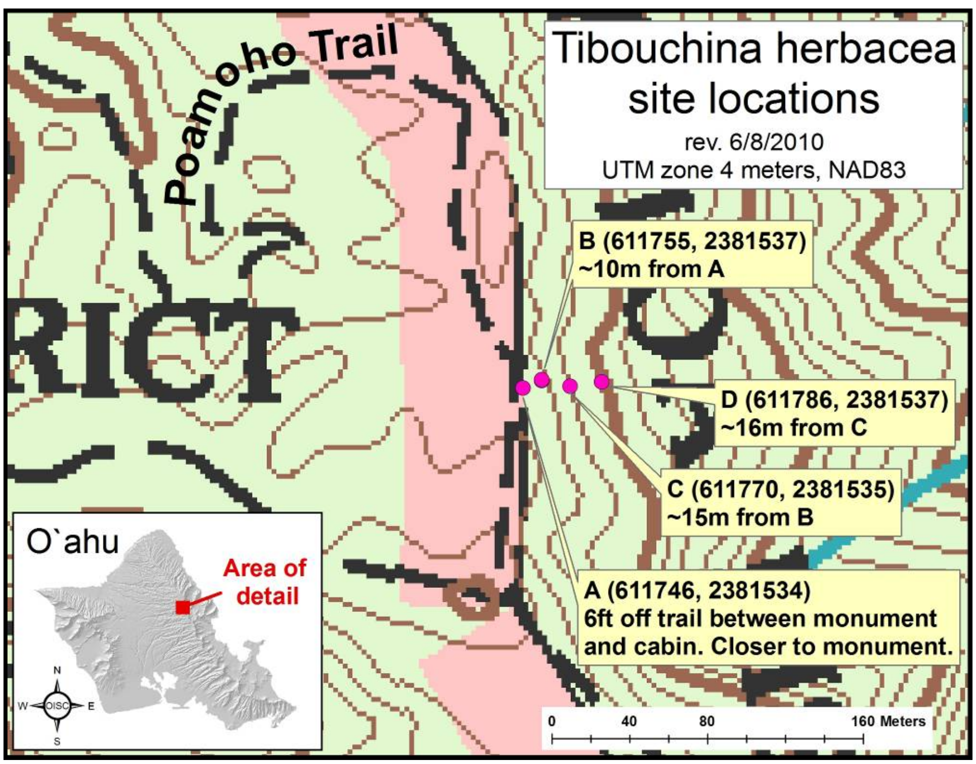
To better track incidental observations of invasive taxa, OANRP created a Target Species Form, Appendix 1-2. In the past, new or unusual weed sightings by staff have been recorded in personal field notes, which are difficult to search and query. This form will prompt the observer to provide complete information about the sighting, provide written documentation of the observation, supplement GIS records taken, and provide greater follow-through by prompting staff to consider whether control options are warranted. In the coming year, OANRP plan to add the form to the Army Database, to allow for greater data manipulation. The Target Species Form was recently completed and has been used thus far to document a population of *Acacia mearnsii* in Ekahanui (rare in the southern Waianaes), and several *Citharexylum spinosum* on Schofield Barracks West Range (SBW). Both species are being evaluated for distribution and potential control.

1.1.3.5 Invasive Species Updates

1.1.3.5.1 Tibouchina herbacea, Cane Tibouchina

- On 6 August 2008, OANRP discovered *Tibouchina herbacea* on the Koolau summit trail in the Poamoho region. OANRP are coordinating control efforts with the Oahu Invasive Species Committee (OISC), the Koolau Mountain Watershed Partnership (KMWP), and the State.
- This year, OISC created a google site to coordinate control efforts conducted by all of these cooperating agencies. The site contains background information about *T. herbacea*, flyers produced by OANRP and OISC, a protocol for checking the Poamoho site, a reporting form to track control efforts, a datasheet summarizing control efforts, maps of the Poamoho site, and photos of lookalike taxa (*Phyllostegia*). It is an effective way to share data between disparate organizations. OISC's leadership is greatly appreciated.

Map of known *T. herbacea* sites at Poamoho, from the OISC google site

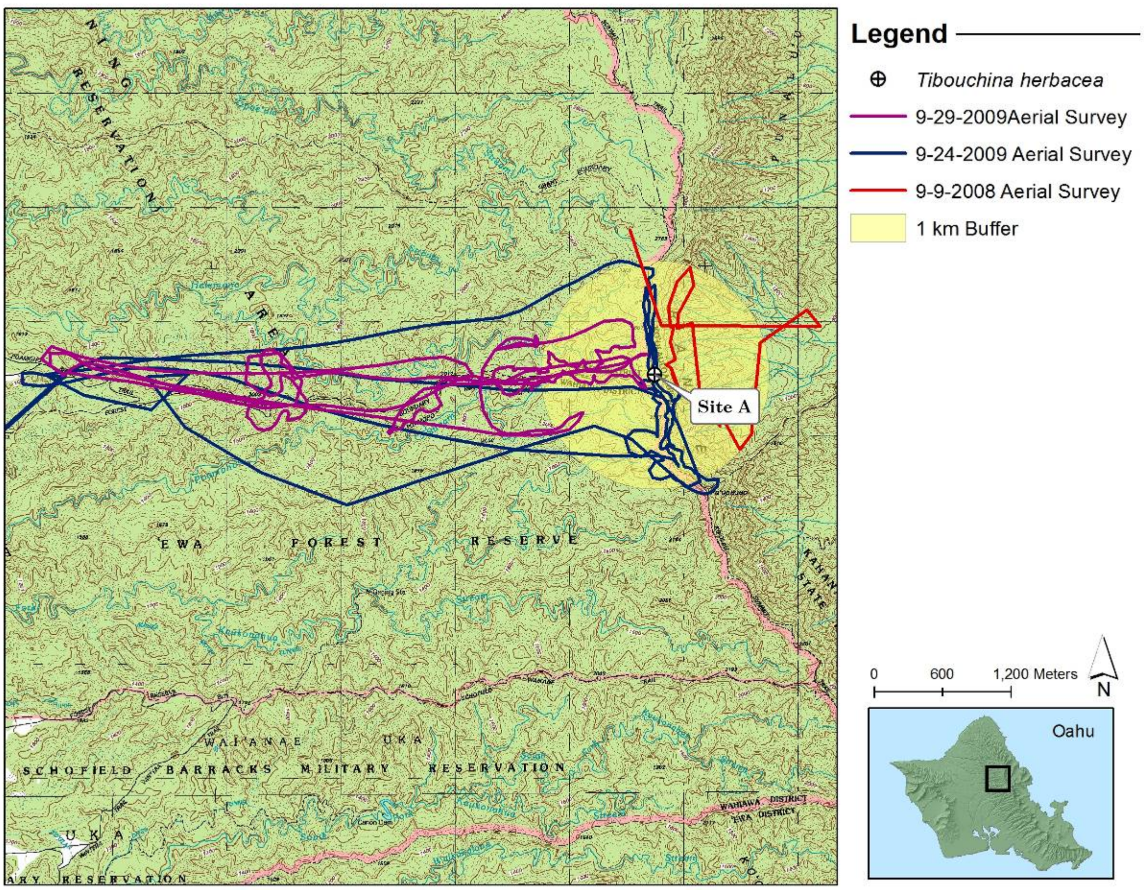


- OANRP staff did not find any additional *T. herbacea* this year. However, staff from partner agencies located and killed 18 *T. herbacea* (16 immature, 2 mature). All plants found were within 50m of the original plant (location A), on the windward side of the Poamoho trail, at one of four discrete sites.

Seven trips were made to the control area; of these, OANRP staff conducted one trip. To date, only 19 plants have ever been found at the Poamoho site.

- OANRP did conduct one aerial survey for *T. herbacea* this year, in Sept. 2009. This survey targeted the summit crest for a kilometer in either direction from the known site. Conditions were excellent, and the helicopter pilot was able to hover less than 20m above the ground and move very slowly, allowing staff to pick out individual *Phyllostegia grandiflora*. No *T. herbacea* were detected.
- Given that aerial surveys this year and in previous years have not located additional stands of *T. herbacea* and all plants found have been close to the original plant, it seems likely that this original plant was mature and is the source of all other known plants. Additional on-the-ground buffer surveys should be conducted in an 800m radius of the known plant sites, as *T. herbacea* is very cryptic. OANRP will work to coordinate this survey with cooperating agencies in the coming year.

Aerial surveys conducted at Poamoho



1.1.3.5.2 *Corynocarpus laevigatus, Karakanut*

- Last year, we discussed the only known Oahu population of the invasive tree *Corynocarpus laevigatus*. Located in Palehua, there are several elepaio territories in and around the infestation. Surveys conducted by staff and Dr. Eric VanderWerf identified plants and areas where *C. laevigatus* control would be acceptable, as well as areas where it wouldn't. No control has been conducted to date. Due to the slow spread exhibited, staff felt that there was no rush to begin control.
- Staff plan to implement initial control of *C. laevigatus* in the coming year. Staff will re-consult with Dr. Eric VanderWerf prior to beginning control. Initial control will target outlier trees and any trees whose removal will not significantly impact elepaio habitat; these will be specifically identified by Dr. VanderWerf .
- OANRP will work towards creating a plan for growing and planting common native trees to supplement *C. laevigatus* and provide additional habitat for elepaio. No control beyond initial control will be conducted until such a plan has been created, reviewed by Dr. VanderWerf and other elepaio experts, and implemented.

1.1.3.5.3 Cordia alliodora, Ecuador Laurel, Salmwood

- Last year, Oahu Early Detection (OED) staff identified a potentially invasive tree, *Cordia alliodora*, at the beginning of the Board of Water Supply (BWS) road in Makaha Valley. The Makaha locality is one of only two known locations on Oahu (Waimea Valley is the other). This taxon is documented as strongly invasive in Vanuatu and Tanzania, and is on watch lists in Samoa and Tonga.[1][2][3][4] While it has not been rated using the Hawaii Weed Risk Assessment protocol, it does have many characteristics which suggest it could be highly invasive in Hawaii. Native to Central America, *C. alliodora* is found in habitats there from 0-1500m elevation, has wind dispersed seed, sprouts from lateral roots, thrives in low fertility soils, and is drought and fire tolerant.[5][6] Plants as young as two years may flower, although most plants mature between five and ten years.[7] One tree may produce up to a million seeds in a year, but it is unclear how long seeds persist in the seedbank.[8]

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[1] Wikipedia. "Cordia Alliodora." 2010. http://en.wikipedia.org/wiki/Salmwood

[2] McKenzie, P. (ed.); Brown, C. (ed.); Jianghua, S. (ed.); Jian, W. (ed.). 2005. "Coutnry report on the forestry invasive species situation in Vanuatu. *The unwelcome guests. Proceedings of the Asia-Pacific forest invasive species conference Kunming, Yunnan Province, China 17 - 23 August 2003*. Seris title: RAP Publication – 2005/18. http://www.fao.org/docrep/008/ae944e/ae944e0a.htm

[3] US Forest Service, Pacific Island Ecosystems at Risk (PIER). Accessed 14 Sept 2010. "Cordia Alliodora." http://www.hear.org/pier/species/cordia_alliodora.htm

[4] Darwin Initiative Project "Combating Invasive Alien Plants Threatening the East Usambara Mountains, Tanzania". 2006. http://www.tropical-biology.org/research/dip/species/Cordia%20alliodora.htm

[5] PIER, 2010.

[6] Darwin Initiative Project, 2006

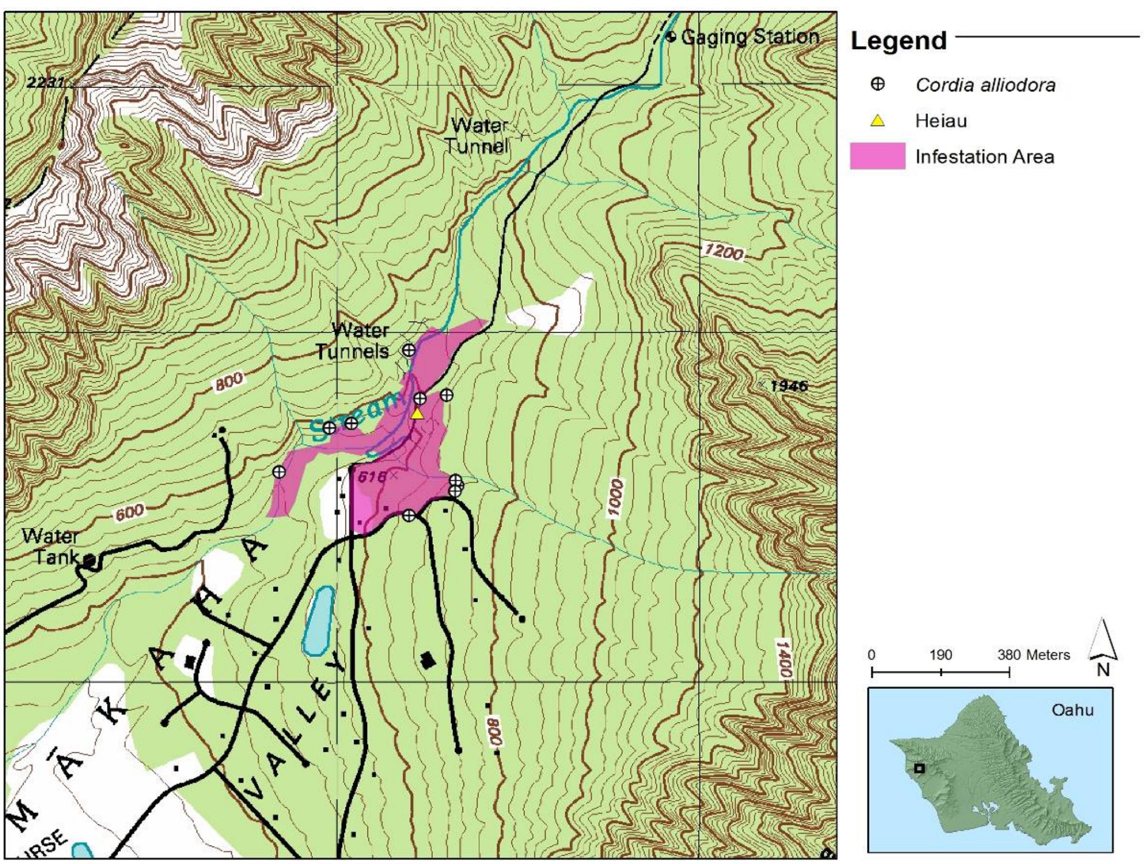
[7] Darwin Initiative Project, 2006.

[8] Darwin Initiative Project, 2006.

Distinctive fuzzy meristem on *C. alliodora*

- On 12 October 2009, OANRP and BWS staff conducted a survey of the *C. alliodora* infestation. The survey delineated the extent of the infestation, which centered around the Kaneaki Heiau. The infestation stretched up and down gulch from the heiau, as well as to the east of the heiau. Some plants are growing out of the heiau. The total size of the infestation is approximately 33.4 acres. While some of this area is sparsely populated with *C. alliodora*, portions of it contain very dense *C. alliodora* stands. No aerial surveys were conducted, but staff are confident that the core of the infestation was accurately mapped.

  Map of *Cordia alliodora* infestation



- Currently, no control actions are planned for the infestation. OED is evaluating the results of their Oahu road surveys, and it is unknown whether or not *C. alliodora* will be recommended as highest priority control for OISC. However, this species does seem to be highly invasive, with a highly restricted local distribution, in an easily accessed area. At the conclusion of the October 2009 survey, OANRP and BWS agreed that control of the infestation would be highly desirable. Effective control techniques are unknown; trials are needed.
- OANRP will share results of the survey with OED and OISC, and recommend control efforts. Buy in from community members and the heiau organization is vital. The site is very accessible to volunteer groups, and a majority of control could be done using volunteer assistance. If federal funds are spent removing plants from the heiau portion of the infestation, a Section 106 consultation will be required.

1.1.3.6 Invasive Species: Seed Research

Seed characteristics were studied for two alien species *Crocosmia* x *crocosmiiflora*, and *Juncus effusus*. Results are detailed in Appendix 1-3. Staff found that *C. crocosmifolia* does not form a persistent seed bank, while *J. effusus* does. OANRP plans to conduct similar such trials on additional alien species in the coming years. These data are highly useful in scheduling visits to control sites and maximizing weed control effort.

1.1.3.7 Invasive Species: Sphagnum palustre Control Plan

Trials by the Research Specialist identified an effective control method for *S. palustre* using an organic product with clove oil as an active ingredient, St. Gabriel's moss killer. As a result, control of *S. palustre* at Kaala has commenced. A draft control plan which details both logistical and biological components of control is included in Appendix 1-4.

The infestation is divided into three Incipient Control Areas (ICAs): SBW-SphPal-01, which covers the Army-managed area to the south and east of the boardwalk; Kaala-SphPal-01, which includes a satellite population along the radio tower road on State-managed land; and Kaala-SphPal-02, which includes a narrow corridor along the boardwalk on State-manged land. Control efforts at Kaala-SphPal-01 and -02 have been discussed with the NARS Specialist. In June 2009, control was conducted at Kaala-SphPal-01 (384m², 4.5 person hours). Follow up has been minimal; incidental observations indicate control was successful. The ICA will be visited again in October 2010. No control has been conducted at Kaala-SphPal-02 yet, but efforts are scheduled to begin in the coming year. This year, efforts focused directly along the boardwalk in SBW-SphPal-01. Staff conducted five control trips with volunteers to this ICA this year, spending a total of 114.5 person hours treating 967m² of thick *S. palustre*. In the coming year, efforts will shift towards controlling *S. palustre* away from the boardwalk, and hope to complete initial treatment of the entire ICA in the next one to two years.

1.1.3.8 New Weed Control Techniques: Chipper

This year, staff conducted very aggressive *P. cattleianum* control in Kahanahaiki, using a chipper to mulch slash from dense monocultures. Please read Appendix 1-5 for a complete description of this project, and Appendix 1-6 for a discussion of general chipper use. Plots installed in Kahanahaiki in 2002 suggested that clearcutting *P. cattleianum* stands in the Maile Flats portion of Kahanahaiki resulted in the creation of large light gaps which were preferentially colonized by *Acacia koa*. Based on the results of these plots, OANRP decided to pursue this weed control strategy. In June and July of 2010, staff cleared and chipped *P. cattleianum*, *Grevillea robusta,* and *Schinus terebinthifolius* from 0.89 acres. OANRP hopes to replicate the results of the initial plots, and replace *P. cattleianum* with *A. koa* as the dominant canopy in the area via natural recruitment and supplemental outplanting. The goals of this project are to reduce alien vegetation cover, make headway towards meeting the 50% alien cover or less MIP goal, foster recruitment of native pioneers, restore the area to native-dominated vegetation, and restore habitat for rare taxa.

1.1.3.9 Restoration Techniques: Common Native Reintroduction

Sanitation issues continue to factor heavily into the common native plant reintroduction program. Contractor growers whom OARNP have worked with in the past have alien snails in their greenhouses. OANRP are experimenting with a variety of options, discussed below.

- *Working with contractors/growers to implement invasive snail protocols.* OANRP are particularly interested in working with La'au Hawaii, a nursery specializing in native ferns, on this. At La'au Hawaii's greenhouses, only low numbers of one alien snail (*Liardetia* sp.) have been found in the past. Management is open to learning more about invasive snail sanitation protocols.
- *Growing common natives with OANRP staff.* Staff will begin propagating a small number of common natives in OANRP greenhouses this year. Plans to grow up to two benches of common plants per year will be pursued.
- *Experimenting with field nurseries.* Preparation work has been done to install a field nursery at Kahanahaiki, including site selection, construction of a water catchment, and ordering of materials. The nursery will be set up in the fall of 2010. The utility of the field nursery will be compared to the ease of growing plants at the Nike greenhouse. *Acacia koa* grown as part of these experiments will be planted in both Kahanahaiki and Ohikilolo. Hopefully, this trial will identify time requirements, potential stumbling blocks, and logistics required for field nurseries.
- *Sowing appropriate native seed.* Seed sowing is attractive in that it requires minimal effort compared to growing and planting. However, not all species are well suited to expect high germination from seed sows. This year, OANRP continued an ongoing trial with *Bidens torta* at Kahanahaiki. Results to date are discussed in Appendix 1-7, and have been highly successful. The trials did not track germination rates, but focused on percent cover of *B. torta* as a measure of success. High cover levels of *B. torta* were observed in both weeded and unweeded plots, but cover levels were higher in all weeded plots. Soaking seed prior to sowing did not increase cover levels, but rather appeared to decrease it. Given the success of these results at the Maile Flats test site, OARNP will incorporate *B. torta* seed sows in the Maile Flats region into regular management actions. Staff also started a similar trial using *Pipturus albidus*, however little germination has been seen. OANRP will revise the approach for *P. albidus*.
- *Transplanting wild seedlings from large, natural clumps of seedlings to open areas.* Taking advantage of locally abundant common native seedlings, transplanting allows OANRP to introduce common natives into degraded areas. OANRP continues to experiment with species, size class, and planting techniques to determine optimal transplanting protocols. Survivorship data from transplanting efforts is still being collected, and has not yet been analyzed. Observations suggest that for *A. koa*, small seedlings, below 5cm, survive transplanting better than larger individuals. Trials at Kahuku suggest that *Carex* species handle transplanting well, though larger plants tend to have better survival than smaller plants.

In the coming year, staff plan to analyze data collected during planting and monitoring of common native reintroductions and transplanting, to develop a better understanding of species survival and growth rates. This information will be used to guide selection of species for reintroduction, as well as identify which techniques (outplanting, transplanting) are most effective for each species.

1.1.3.10 Range Maintenance, Construction, and Stryker Transformation Projects

1.1.3.10.1 Drum Road

- Construction of the Drum Road was completed this year. OANRP facilitated a tour of Drum Road at the request of the Koolau Mountain Watershed Partnership. The majority of the road is paved, except one section which was left unpaved at the request of the landowner.
- The entire Drum Road, from Helemano Gate just outside Wahiawa to McCormick Gate in Pupukea, and from Pupukea Gate to Charlie One Gate in Kahuku was surveyed for weeds this year. No unusual or significant new species were found. However, two species new to the road were observed, *Coffea arabica* and *Lolium multiflorum*. *L. multiflorum*, perennial rye grass, was hydroseeded along the road as an erosion control measure. It is short-lived, and shouldn't persist in the area. *C. arabica* is known from Waimea Valley nearby; it is very likely that *C. arabica* is spreading successfully on its own from Waimea to the road.
- No new *Melochia umbellata* sites were detected along Drum Road, besides the previously known sites in KTA. OANRP staff worked closely with USACE and construction contractors to minimize the risk of moving potentially contaminated soils from *M. umbellata* sites to other locations; these efforts appear to have been successful. Staff will continue to look for *M. umbellata* on Drum Road surveys, as seeds may take more than a year to germinate.

1.1.3.10.2 Kahuku Training Area (KTA) Projects

- OANRP reviewed a REC for a project to widen a trail into a 4WD dirt road in KTA. The trail included a section on the Koolau Summit Trail. Staff recommended against approving the project. Subsequently, the project was dropped.
- In September 2009, staff conducted a site survey and educational session with USACE and Watts Construction at the site of the Combined Arms Collective Training Facility (CACTF) at KTA. Located in an alien plant dominated area, no rare taxa or significant weeds were located in the project area. Next to the project area is an old *Pennisetum setaceum* site; staff emphasized that the area should be off-limits. Several common native species were found on site, including *Wikstroemia* sp., and *Santalum freycinetianum*. Neither is federally listed, but the *S. freycinetianum* does have cultural uses. Staff from DPW Cultural Resources encouraged that the plants be left in place, and OANRP supported this request. The *Wikstroemia* at KTA includes hybrids or several possible varieties, some of which may be uncommon. Unfortunately, these plants were in the middle of the construction site.

1.1.3.10.3 Seed Mixes and Weeds

- OANRP reviewed a proposed seed mix for a road project in the Schofield Barracks, Helemano Military Reservation area. The contractor adjusted the proposed mix to exclude kikuyu grass, and include more innocuous species.
- The Department of Transportation (DOT) has developed invasive species savvy contract language. OANRP was not able to review it last year, as hoped, but look forward to reviewing it in the coming year, and encouraging the Army to adopt similar such language.

1.1.3.11 Interagency Coordination

1.1.3.11.1 Oahu Early Detection (OED)

- OED continues to provide species identification services to OANRP. Over the past year, OANRP has submitted 26 samples to OED. Of these, two were new island records (*Petrorhagia velutina, Epidendrum nocturnum,*), and two others were rare on Oahu (*Erythrina subumbrans, Brexia madagascariensis,*). One common garden species was found naturalizing in a wild setting for the first time (*Ficus pumila*). One species was controlled (*Albizia chinensis*), and several others will be monitored as candidates for future control (*Erythrina subumbrans, Brexia madagascariensis, Callitris columellaris, Cupressus lusitanica, Ficus pumila*). One orchid (*Epidendrum nocturnum*) was found on Puu Kaua; it is endangered in its natural Caribbean habitat. By being able to get identification for unknown species, OANRP has greatly improved weed survey results. OANRP will continue to support OED for their identification work.

1.1.3.11.2 Oahu Invasive Species Committee (OISC)

- Due to major budget cutbacks, OISC has prioritzed work on *Miconia calvescens*, *Rubus discolor*, and a few other targets, with little effort spent on low priority species. OANRP continues to assist OISC by providing data and updates on other incipient species of interest found on Army land, such as *Melochia umbellata, Buddleia madagascariensis,* and *Acacia mangium*. OANRP also has donated some helicopter time to OISC. OANRP continues to participate in the strategy, planning, and control meetings held by OISC.
- In Feburary, OANRP Ecosystem Restoration Program Manager Jane Beachy presented a paper at the 2010 Island Invasives: Eradication and Management Conference in Auckland, New Zealand. The paper and presentation were a joint effort with OISC Operations Manager Rachel Neville and OISC Vertebrate Specialist Chelsea Arnott. Titled "*Eleutherodactylus coqui* Control on O'ahu: Successful Control of an Incipient Invasive Amphibian," the presentation described coquí eradication efforts at Schofield Barracks East Range (SBE). The paper is currently undergoing revision prior to being published in the conference proceedings. In August 2010, an altered version of the presentation was presented at the 2010 Hawaii Conservation Conference. Documenting the successful eradication of coquí from SBE was important, as it is one of two successful eradications of coquí from a wild, untended site. Sharing the methods that led to success will aid other organizations in planning similar control efforts.

1.1.3.11.3 College of Tropical Agriculture and Human Resources, CTAHR, Dr. James Leary, Invasive Weed Management

- OARNP continues to collaborate with Dr. James Leary on the development of Herbicide Ballistic Technology, HBT. This method, currently being researched and tested by Dr. Leary, involves focused delivery of small amounts of herbicide to target plants via paintball equipment.
- Trials of HBT continue at KTA. Early trials with imazapyr had mixed results and were not very effective on the target species (*Schinus terebinthifolius*, *Leptospermum scoparium, Schefflera actinophylla,* and *Psidium cattleianum*). Trials with triclopyr had more success, but did not result in complete control. This year, another set of trials were installed in May 2010. A rigorous design was used, with the aim of determining whether the poor kill observed in previous trials was due to the active ingredient and its ability to translocate throughout the plant, the direction of application, or the location of application. Two species were treated, *P. cattleianum* and *L. scoparium*. The treated plants were monitored in August 2010, after three months, and will be monitored again in another three months. All *P. cattleianum* treated exhibited dramatic signs of toxicity; of 16 plants treated, only four were not completely defoliated. Results for *L. scoparium* were much less promising; little defoliation was observed. The trial will be monitored for a year, and results will be written up at that time. At this time, it appears that both chemistry and application direction affect control efficacy. Finding a formulation that translocates more actively would improve efficacy. Dr. Leary is developing a new formulation to test; when this batch of projectiles is ready, staff will work with Dr. Leary to install another trial.
- Last year, OANRP scoped the extent of the *Hedychium gardnerianum* infestation in the back of SBW. The area of the infestation is limited, but it is located in such a remote region, that OANRP is looking for novel techniques to treat it. A trial to treat the *H. gardnerianum* is planned with Dr. Leary in October 2010. HBT (imazapyr) efficacy on *H. gardnerianum* was demonstrated on Kauai.

- Dr. Leary re-submitted a proposal to the DOD Legacy office to further research HBT. OANRP will continue to support him in this process.
- OANRP, in conjunction with Dr. Leary and PCSU, drafted a Standard Operating Procedure (SOP) for HBT; see Appendix 1-8. The completion and approval of this SOP is necessary for OANRP adoption of this tool.
- OANRP and Dr. Leary installed control trials using the product Milestone in August 2010. The results of these trials are pending. The active ingredient in Milestone is an aminopyrilid, and other trials by Dr. Leary indicate that it is highly effective on *Falcataria moluccana* at extremely low doses. The August trials focused on *S. actinophylla* and *Syzigium cumini*. OANRP look forward to monitoring and expanding Milestone trials in the coming year.

1.1.3.12 Educational Opportunities

This year, the Ecosystem Restoration Program Manager (ERPM) had the opportunity to work with the New Zealand Department of Conservation (DOC) for two weeks and attend the Island Invasives: Ecosystem and Management conference for a third week. Listed are some highlights from this experience:

- Reviewing DOC literature relating to weed control, specifically handbooks used by all staff to guide weed control efforts. The need to restore native vegetation – not just eradicate alien taxa – was highlighted. Weed control techniques and chemicals were recommended for most alien target taxa. Protocols for choosing common plants for reintroduction in a variety of different habitats were described. Managers could refer directly to these guides when developing management plans and did not need to conduct their own research. Research into novel control techniques, herbicides, etc was conducted by a separate division.
- Learning about which herbicides, active ingredients, and surfactants were most effective on weeds shared by New Zealand and Hawaii.
- Restoration via common native plantings in both dune and river valley ecosystems.
- Biosecurity practices for conducting field operations on a pristine, or close to pristine offshore island. All staff gear was inspected and left in a clean room until departure, then was loaded directly into the boat. All inspections were documented in writing.
- Observing weed control sites in dune ecosystems. This project was similar to the intensive WCA weed control conducted by OARNP.
- Spraying gorse and other weeds along a road with a power sprayer. The power sprayer rig was rigged for easy operation by one person, and incorporated a remote control hose reel. This greatly increased efficiency of staff.
- Aerial spraying of several different woody weeds along a stream corridor. The helicopter spray rig allowed for very accurate application of herbicide. Also, the pilot could track the area sprayed in real time with a GPS monitor installed in the helicopter, allowing the pilot to spray large areas without leaving any gaps.
- Monitoring a contract pine control project to determine if the contractor met the specification of the contract (97% kill of all plants in a given area).
- Learning about weed control projects on other islands in the Pacific.
- Experiencing the unique flora and fauna of New Zealand.

1.2 Ecosystem Restoration Management Unit Plan 2010 Status Update Tables

The 2010 Status Update Tables included here summarize all actions proposed in the eight ERMUPs included in the 2009 Status Report for the MIP and OIP. Hatched cells denote the quarters in which an action is planned. 'X's indicate if an action was completed in a given quarter. Comments are included in the tables where appropriate. New actions are included, and are planned from 2010-2011 on. Some changes to proposed action schedules are made; if substantive, these changes are discussed in the comments column.

This year, vegetation monitoring was completed for the Ohikilolo (Upper) MU. A short discussion of results is included with the Ohikilolo (Upper) status update table.

1.2.1 Ekahanui

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Monitoring	Conduct vegetation monitoring every 3 years																					
General Survey	Survey Ekahanui Crestline LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Not used.																
	Survey Ekahanui Trailhead LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.	X		X	X																	
	Survey north Ekahanui LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Not used.																
	Survey North Eka Fenceline LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Not used.																
	Survey Puu Kaua LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Not used.																
	Create weed surveys along ungulate transects					Create when ungulate surveys created																
	Read surveys along ungulate transects					Read when created																
ICA	Conduct surveys and create ICAs for species designated, but not yet targeted for eradication (see Target Taxa Table in MU plan)					No new ICAs created this year.																
	Treat any new ICAs quarterly until frequency of re-visitation is no longer needed.					Will begin to schedule once ICAs formed																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General WCA	Evaluate list of revised species (AcaMea, ChrOli, DicChi, FicMac, HelPop, KalPin, MelQui, PanMax, PimDio, SchAct, SetPal, SpaCam, SphCoo) to assess control/eradication potential. Review monitoring weed presence data to aid in evaluation.					Need general review of MU with team/weed specialist to work out specifics. Meeting to be se in early 2011.																
	GPS all boundaries of WCAs. Use landmarks to mark in field																					
	GPS and maintain trails		X			Mainatain as needed																
Ekahanui-01 Airplane Ridge	Conduct weed control around all Cenagr A groups annually. Control both understory and canopy weeds; remove canopy weeds gradually.	X				Need two trips to treat all sites.																
	Evaluate need for alien grass control; control if necessary.																					
Ekahanui-03 Small *S. kaalae* fences	Control understory and canopy weeds across this area, focusing on Schkaa and native forest patches and possible reintro sites. Remove canopy gradually.																					
	Scope expanding WCA to include nice forest habitat in gulch. GPS boundary changes.					Conduct as time allows																
Ekahanui-04 Upper Cliffs to Crestline	Conduct weed sweeps through this steep area, focusing around rare plants (Plapri, Tetlep) and snail trees, annually. Control understory and canopy weeds, targeting Psicat and Schter for gradual removal.				X																	

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control grasses throughout WCA as needed, annually. Grasses: Melmin, Pascon, Setgra. Grasses appear to be slow to recover here. May need to access area via multiple points: ridgetop, base of Plapripri A cliff, ridge above Cenagr reintro.					Water flown in this year. Water available to spray in future.																
Ekahanui-05 Reintroduction Zone	Conduct weed control across WCA. Sweep whole area 1x/year. Target reintros across all the subgulches (2D, 2C) and on fenceline (Cenagr). Focus on understory weeds, Passub, and gradual canopy removal.		X		X																	
	Evaluate potential for chipper use within WCA					Will look to evaluate potential sites in 2011																
Ekahanui-06 Palai Gulch	Conduct weed control through gulch every 6mo/year, focusing on understory species around reintros. Elepaio in area; don't weed canopy. Some canopy weeding may occur if work with Elepaio specialist.	X		X																		
	Control grasses, particularly Oplhir, through WCA annually.				X																	
Ekahanui-07 Silk Oak Ridge	Conduct gradual control of canopy, targeting Psicat and Grerob. Low priority project. Possible interactions with elepaio breeding habitat. Use volunteer assistance. Do in conjunction with common reintros.					Low priority. Will scope area if get time to see if can strategically remove specific trees higher on ridge closer to area with more native canopy																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ekahanui-08 South Fenceline	Control weedy grasses through WCA, from camp/DZ, down fence to saddle, inside fence downslope, and outside fence downslope. Goal is to remove Panmax and reduce fuel loads. Control every 6mo/year.			X																		
	Maintain camp/DZ and LZ as needed so functional; keep clear of trees/shrubs.					Mainatain as needed																
Ekahanui-09 Alectryon	Conduct weed control annually around Alemac D, Achmus trees, native forest patch. Target understory and gradual canopy removal.					Control when go to monitor/airlayer plants																
	GPS boundaries and scope area on the ground.					Will do when monitor next																
Ekahanui-10 Fenceline	Clear/maintain fence. Remove downed trees, spray grass, treat thick understory, as needed.	X				Will do as needed as per evaluation during fence check																
	Keep contour trail along fenceline clear as needed.					Will do as needed																
Ekahanui-11 Cenagragr EKA-C site	Conduct weed control around Cenagr C reintro as long as plants are still alive (reintroduction site discontinued). Control understory and canopy at both reintro groups. Target Psicat.					Will do small amount of weed control when monitor plants																
Ekahanui-12 Amastra fence	Conduct weed sweep across WCA annually, from silky oak dz to south fence. Control understory, gradual removal of canopy weeds. Focus on Amastra fence site.																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ekahanui-13 New Cenagragr EKA-D Site	Conduct weed control around potential Cenagr reintro site, native forest patches. Focus on understory weeds and opening up canopy gradually.				X	Haven't outplanted yet.																
	Control grass across WCA, particularly Panmax. Treat as needed.					Will fly in water/sprayer with reintroductions																
Ekahanui-14 Abutilon	Conduct understory/canopy weed control around Abusan, any nice forest patches, annually. Area highly degraded. Control tree weeds gradually to prevent major light changes. Consider common reintros.			X																		
Ekahanui NoMU-01	Conduct weed control at DelSub Eka-A exclosure. Focus only close to Delsub; this not an MFS location. Control understory weeds, grasses, some canopy (don't change light levels), keep fence clear of Schter.			X		Will treat as needed during fence checks/pop monitoring																
Ekahanui NoMU-02	Maintain/clear contour trail north of Ekahanui fence. Goal is to facilitate access to trail, particularly for potential fire response. Use volunteers as much as possible.					Communicate with DOFAW about maintenance																
Ekahanui NoMU-03	Control weedy grasses, remove tree falls along Ekahanui access trail every 3-6months, as needed. Target Panmax and Setpal.					Will control as needed																
Ekahanui NoMU-04	Assist with Weed Control /Grass spray along Ekahanui Access Road, around LZ;					Communicate with DOFAW about maintenance																
Ungulate	Monitor Subunit I fence integrity			X	X																	

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Control	Monitor Subunit II fence integrity	X			X																	
	Check snares in Subunit II quarterly until pig removed	X	X	X																		
	Remove Subunit II snares when last pig removed					Ongoing																
	Install transect in Subunit I																					
	Install transect in Subunit II																					
	Read Subunit I ungulate transect																					
	Read Subunit II ungulate transect																					
	Construct Subunit III in 2013																					
Rodent Control	Restock bait grids at: AchMus.EKA-A, EKA-C, EKA-E (Mamane and Myrsine Ridge) every 6 weeks (until snap grid installed)	X	X	X	X																	
	Restock bait at: PlaPriPri.EKA-C every 6 weeks (until snap grid installed)	X	X	X	X																	
	Run tracking tunnels in Ekahanui 6 times per year (until snap grid installed)	X		X																		
	Restock bait in Elepaio territory during breeding season 2x/month		X	X																		
	Monitor ground shell plots once/year		X																			
	Install/deploy wooden snap trap box grid across MU																					
	Run snap grid as often as needed during initial knockdown phase																					
	Run snap trap grid 2x/month through rare snail and plant zone and 1x/month outside of the Elepaio breeding season					Frequency will in part be determined by the acceptable level of rat activity.																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Run entire snap trap grid 2x/month within the Elepaio breeding season					Frequency will in part be determined by the acceptable level of rat activity.																
Slug Control	Monitor slug activity at *Cyanea grimesiana* subsp. *obatae* via traps baited with beer	X				Not to be continued																
Predatory Snail Control	Determine if any *E. rosea* of *O. alliarus* snails are present at the *A. mustelina* sites					Ongoing																
	Implement control as improved tools become available					Ongoing																
Ant Control	Conduct annual surveys for ants at locations TBD																					
	Implement control if deemed necessary					Evaluation ongoing																

Hatched=Quarter Planned
X=Action Pau

1.2.2 Helemano

Action Type	Actions	OIP Year 2 Oct 2009-Sept 2010				Comments	OIP Year 3 Oct 2010-Sept2011				OIP Year 4 Oct 2011-Sept2012				OIP Year 5 Oct 2012-Sept2013				OIP Year 6 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General Survey	Survey Helemano near SetPal Bowl LZ whenever used, not to exceed once per quarter. If not used, do not need to survey. Can ask Blue Team to do.					Checked as used. Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
	Survey Mid-Southern Helemano LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Checked as used																
	Survey CyaStJ LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Checked as used																
	Survey Southern Helemano LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Checked as used																
	Survey for Palm grass across MU, identify distribution, and develop management goals. May NOT be treated as an ICA in western half of MU. Consider Rodeo as a control method around streams. Contact HAVO re. their treatment of Setpal.					Surveyed in MIP Year 5, Q2. Additional surveys required in the northeastern part of the MU, above the waterfall. Can be partnered with control work in Helemano-03.																

Action Type	Actions	OIP Year 2 Oct 2009-Sept 2010				Comments	OIP Year 3 Oct 2010-Sept2011				OIP Year 4 Oct 2011-Sept2012				OIP Year 5 Oct 2012-Sept2013				OIP Year 6 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Conduct aerial survey of Psicat in lower portion of exclosure, below waterfall, to assist in guiding control efforts.					One survey done in early 2009. Reschedule surveys as needed to facilitate Psicat control work, particularly in WCAs Helemano-02, 06, 07, and 08																
ICA	KLOA-Angeve-01. Monitor/control AngEve in Helemano Gulch every 6 months to a year. Foliar spray of G4 works well; to reduce non-target drift, cut off large fronds of mature plants and treat when new croziers appear.					Begin checks next year.																
	KLOA-SetPal-02. Monitor/control Setpal at Peahinaia trail site quarterly. Dig out plant and remove from field, along with any potentially viable fruit. Flag locations of mature plants with pink to facilitate follow-up.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
	KLOA-SetPal-10. Survey for SetPal in and around this ICA; determine if SetPal better targeted as an ICA or WCA in Helemano-03. After surveys, discuss with JB to develop treatment schedule.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																

Action Type	Actions	OIP Year 2 Oct 2009-Sept 2010				Comments	OIP Year 3 Oct 2010-Sept2011				OIP Year 4 Oct 2011-Sept2012				OIP Year 5 Oct 2012-Sept2013				OIP Year 6 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	KLOA-SetPal-10. Monitor/control Setpal at Helemano Bowl quarterly. Spray plants. If only few plants present, dig out plant remove from field, along with any potentially viable fruit. Flag locations of mature plants with pink to facilitate follow-up.				X	Only visited MU once. Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
	KLOA-SetPal-11. Survey for SetPal in and around this ICA; determine if SetPal better targeted as an ICA or WCA in Helemano-03. After surveys, discuss with JB to develop treatment schedule.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
	KLOA-SetPal-12- Monitor/control Setpal at western Peahinaia trail site every 6 months. Dig out plant and remove from field, along with any potentially viable fruit. Flag locations of mature plants with pink to facilitate follow-up.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
	KLOA-SetPal-13. Monitor/control Setpal at Helemano fence/peahinaia trail jnc every 6 months. Dig out plant and remove from field, along with any potentially viable fruit. Flag locations of mature plants with pink to facilitate follow-up.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
	KLOA-SetPal-16. Monitor/control Setpal along Lower Helemano stream twice a year. Use herbicide approved for use near waterways. Flag locations of hot spots with pink to facilitate follow-up.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																

Action Type	Actions	OIP Year 2 Oct 2009-Sept 2010				Comments	OIP Year 3 Oct 2010-Sept2011				OIP Year 4 Oct 2011-Sept2012				OIP Year 5 Oct 2012-Sept2013				OIP Year 6 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	KLOA-SetPal-17. Monitor/control Setpal along mid Helemano stream twice a year. Use herbicide approved for use near waterways. Flag locations of hot spots with pink to facilitate follow-up.					Work in MU limited this year due to weather, heli support scheduling conflicts, range scheduling conflicts																
General WCA	Create WCA boundaries, GPS, and name. This will allow for more accurate planning of efforts in the MU.					Re-organized WCA divisions and re-drew all WCAs after May 2009 trip. GPSing of boundaries will be ongoing.																
Helemano-01 North Gulch	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.				X	Only visited MU once. Finished sweeping this WCA. Will re-sweep in OIP Year 7																
Helemano-02 Peahinaia Trail Cliffs	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.					Revised schedule, to reflect new WCAs drawn. This WCA is very steep and will be treated once more walkable areas are controlled.																
Helemano-03 Peahinaia Trail Bowl	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.																					
Helemano-04 Upper Helemano	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.																					

Action Type	Actions	OIP Year 2 Oct 2009-Sept 2010				Comments	OIP Year 3 Oct 2010-Sept2011				OIP Year 4 Oct 2011-Sept2012				OIP Year 5 Oct 2012-Sept2013				OIP Year 6 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Helemano-05 Southern Helemano	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.																					
Helemano-06 Lower southern Helemano	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.																					
Helemano-07 Lower northern Helemano	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.																					
Helemano-08 Mid northern Helemano	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.					Control will begin in OIP Year 7																
Helemano-09 Champion Trail	Conduct weed sweeps for Psicat and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.					Control will begin in OIP Year 7																
Ungulate Control	Monitor fence integrity				X	Repaired rust areas with new panels																

Hatched=Quarter Planned
X=Action Pau

1.2.3 Kaala

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General Survey	Survey transect on Kaala summit, east of boardwalk quarterly.	X	X																			
	Hedgar, Conduct field trial to determine time required by Hedgar to go from seed to mature plant.	X	X		X																	
	Hedgar, Develop/test long distance control methods for Hedgar: ball sprayer, HBT, etc.			X	X																	
	Survey Kaala campsite whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Kaala LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Hedgar, Aerial survey of HedGar at Kaala. Conduct annually. Note any other potential target weeds as well. Add weed locations to target species shape on GIS. Use info to direct weed control at Kaala.	X	X																			
ICA	ElaGra-SBW-01, Monitor/control ElaGra south of FAA exclosure. Tree was treated once, but some branches still foliated. Need to retreat. Once treated, monitor for death.	X				Treated known plant. Monitor to ensure dies.																

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	FesAru-SBW-01, Monitor/control FesAru through entire ICA quarterly. Coordinate control efforts with National Guard mowing schedule. Focus control efforts along road. Treat with Roundup and monitor effectiveness.	X	X	X	X																	
	SetPal-SBW-01, Monitor/control SetPal along spur fence from FAA twice a year. Handpull and remove plants from the field.		X		X																	
	AntOdo-SBW-01, Monitor/control AntOdo near trailhead quarterly. Experiment with spraying plants.	X	X	X	X																	
	JunEff-SBW-01, Monitor/control Juneff along boardwalk core quarterly. Handpull plants and remove from field; take to H power for incineration.	X	X			Outreach																
	CroCro-SBW-01, Monitor/control CroCro along boardwalk and access trail. Focus on keeping CroCro out of bog. Work only on Army side of boardwalk. Pursue control on State side with State. Pick and remove from field any potentially viable fruit.	X	X	X		Outreach																
	JunEff-SBW-02, Monitor/control JunEff at Wing Fence every 6 months. Handpull plants and remove from field; take to H power for incineration.					Outreach																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	JunEff-SBW-03, Monitor/control JunEff at northeast site (south of FAA) every 6 months. Handpull plants and remove from field; take to H power for incineration.		X			Outreach																
	JunEff-SBW-04, Monitor/control JunEff at west outlier off boardwalk every 6 months. Handpull plants and remove from field; take to H power for incineration.					Outreach																
	CroCro-SBW-02, Monitor/control CroCro at site on southwest of FAA. Experiment with chemical control. Pick and remove from field any potentially viable fruit.	X		X		Outreach																
	CroCro-SBW-03, Monitor/control CroCro at site on southeast of FAA. Experiment with chemical control. Pick and remove from field any potentially viable fruit.					Outreach																
	CroCro-SBW-04, Monitor/control CroCro at site on northwest side of FAA. Experiment with herbicide control. Pick and remove from field any potentially viable fruit.					Outreach																
	CroCro-SBW-05, Monitor/control CroCro at LZ side of FAA. Experiment with chemical control. Pick and remove from field any potentially viable fruit. Experiment with backhoe/manual control.			X		Outreach																

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	CroCro-SBW-06, Monitor/control CroCro on state side of boardwalk at trailhead. Focus on keeping CroCro out of bog. Pick and remove from field any potentially viable fruit.					Outreach																
	JunEff-Kaala-05Monitor/control Juneff along State side of boardwalk core. Handpull plants and remove from field; take to H power for incineration. Communicate with state for all activities here. Once initial control complete, check with state on monitoring schedule.					Check with state for further monitoring																
	JunEff-SBW-06, Monitor/control Juneff around Radio tower, on state side of Kaala. Handpull plants and remove from field; take to H power for incineration. Communicate with state for all activities here. Once initial control complete, check with state on monitoring sc		X			Check with state for further monitoring																
	SphPal-SBW-01. Survey extent of Sphpal infestation on Army side of boardwalk. Create GIS map of infestation area, and any satellites.																					
	SphPal- SBW-01, Install management trails running roughly perpendicular to the boardwalk, 140°, every 5m, across the length and width of the infestation.																					

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	SphPal- SBW-01, Control Sphpal along boardwalk, on Army side of MU. Spray with St. Gabriel's moss killer. Exercise care to prevent the spread of Sphpal via footwear or gear.			X	X																	
	SphPal-Kaala-02. Control Sphpal along boardwalk, on State side of MU. Control only in boardwalk corridor, (1-2m from boardwalk). Spray with St. Gabriel's moss killer. Exercise care to prevent the spread of Sphpal via footwear or gear.																					
	SphPal-Kaala-01, Monitor/control sphagnum along radio tower road. Communicate with State about work at this site. Utilize handpulling and St. Gabriel's moss killer for control.																					
	Install and take photopoints in the Sphpal infestation.																					
	DesInt-Kaala-01, Monitor/control DesInt along Kaala road quarterly. NEED TO FINALIZE AXNS WHEN LEARN WHERE EXACTLY THIS IS		X																			
Kaala-01 Boardwalk	Control weeds across remainder (NON priority ginger area) of WCA once every 5 years. Target Psicat, Melqui, any other canopy weeds found, any unusual weeds found. Treat Clihir as second priority. Outreach to cover easy terrain. Team to cover steep ter		X			planned for MIP year 11																

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control grass in ICA to facilitate better detection and control of JunEff. Weedwhack or use Rodeo (if label suitable for bogs). Do action as needed; at least once in 2009					Do as needed.																
	Control weeds across priority ginger area of WCA once every 3 years. Target Hedgar (top priority), Psicat, Melqui, and any other canopy weeds found. Record number/reproductive status of Hedgar found. Treat Clihir as second priority. Outreach to cover	X	X	X																		
	WCA very large; idenifty priority ginger control areas. Geographically designate priority ginger area and remainder area.					Data analysis																
	Monitor common reintros planted quarter 4 2007 and quarter 2 2008 annually at SBW-Juneff-01. Species include: Cibcha, Cibmen. PUBLIC OUTREACH	X		X																		
	Plant common natives to revegetate disturbed area at SBW-JunEff-01. Use CibCha, Cibmen, Cibgla, DiaSan, MacAng, and other appropriate species. Planting should happen in quarters 3, 4. PUBLIC OUTREACH				X																	

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Kaala-02 Zombie tunnels	Control weeds across entire WCA once every 3 years. Target Hedgar (top priority), Psicat, Melqui, and any other canopy weeds found. Record number/reproductive status of Hedgar found. Treat Clihir as second priority.					Rescheduled for 2011																
	Monitor common reintros planted quarter 2 2008 and quarter 2 2009 every 3-6 months, then annually at SBW-JunEff-03 site. Species include: Cibcha, Cibmen, Athmic. PUBLIC OUTREACH quarter 2 2009			X																		
	Plant common natives to revegetate disturbed area at SBW-JunEff-03. Use CibCha, Cibmen, Cibgla, DiaSan, MacAng, and other appropriate species. Planting should happen in quarters 3, 4. PUBLIC OUTREACH																					
Kaala-03 Lower Rainbow Ridge	Control weeds across entire WCA once every 3 years. Target Hedgar (top priority), Psicat, Melqui, and any other canopy weeds found. Record number/reproductive status of Hedgar found. Treat Clihir as second priority.	X		X	X	Also planned for MIP year 11																
Kaala-04 Rainbow Ridge to Blue Trail	Control weeds across entire WCA once every 3 years. Target Hedgar (top priority), Psicat, Melqui, and any other canopy weeds found. Record number/reproductive status of Hedgar found. Treat Clihir as second priority.				X																	

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Clear/maintain fence . Remove downed trees, spray grass, treat thick understory, as needed.					Do as needed.																
Kaala-05 Blue Trail to Kamaohanui	Control weeds across entire WCA once every 3 years. Target Hedgar (top priority), Psicat, Melqui, and any other canopy weeds found. Record number/reproductive status of Hedgar found. Treat Clihir as second priority. WCA very steep; use aerial surveys,																					
Kaala-06 North of Boardwalk	Control weeds across entire WCA once every 3 years. Target Hedgar (top priority), Psicat, Melqui, and any other canopy weeds found. Record number/reproductive status of Hedgar found. Treat Clihir as second priority. Coordinate all visits with State NA																					
Kaala-07 FAA exclosure	Control all Hedgar inside of the FAA exclosure. Obtain permission prior; submit letter to gain access. Visit every other year.																					
Kaala-08 Radio Tower Reintros	Control weeds across WCA every 6 months/year. Focus efforts around reintroductions.		X																			
	GPS boundaries of the WCA. Clear with NARS staff.					Do one time																
Ungulate Control	Conduct hunting operations and scoping for sign and activity	X	X	X	X																	
	Monitor transect.				X																	
	Pink and blue trail check and reset snares and trap	X	X	X	X																	

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Transect check and reset snares and trap	X	X	X	X																	
	Kalena ridge check and reset snares and trap	X	X	X	X																	
	Trinervis ridge check and reset snares and trap	X	X	X	X																	
	310 transect check and reset snares and trap	X	X	X	X																	
	Strategic fence off transect 860 monitor fence				X																	
	Kaala strategic-shelf fence monitor fence	X	X	X	X																	
	Small section off Haleauau monitor fence	X	X	X	X																	
	Haleauau line monitor fence	X	X	X	X																	
	Rainbow ridge monitor fence	X	X	X	X																	
Rodent Control						No actions for this category																
Predatory Snail Control	Determine if any *E. rosea* or *O. alliarus* snails are present at *A. mustelina* sites / implement control					No *Euglandina* found. *O. alliarus* present at boardwalk.																
Ant Control	Conduct surveys at human entry points annually	X																				
	Inplement control if necessary																					

hatched=planned Qtr
X=pau

1.2.4 Kahanahaiki

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Monitoring	Read MU monitoring transects (every 3 years). First reading in Year 5 of MIP																					
General Survey	Read transect on West fenceline quarterly																					
	Read transect on South fenceline quarterly																					
	Survey Kahanahaiki overlook LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
ICA	MMR-AcaMea-01: Monitor/control AcaMea at Black Wattle site every 6 months. Handpull small plants, Garlon larger plants. Pick and remove from field any potentially viable fruit.	X		X																		
	MMR-AcaMea-02: Monitor/control AcaMea by Schwepps trail/Pahole crossover every 6 months. Pick and remove from field any potentially viable seed.					Changed frequency to annually																
	MMR-AchAsp-01: Monitor/control AchAsp at lowest gulch site every 6 months. Pick and remove from field any potentially viable fruit.			X																		
	MMR-AchAsp-02: Monitor/control AchAsp at middle gulch site every 6 months. Pick and remove from field any potentially viable fruit.			X																		
	MMR-AchAsp-03: Monitor/control AchAsp at top gulch site every 6 months. Pick and remove from field any potentially viable fruit.			X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	MMR-AngEve-01: Monitor/Control AngEve in Kahanahaiki gulch, from Schwepps crossover through lower Flueno reintro annually. Prevent any plants from reaching maturity.			X																		
	MMR-AxoCom-01: Monitor/control AxoCom at switchbacks quarterly. Spray with Roundup.			X																		
	MMR-Casgla-01: Monitor/control CasGla through all walkable portions of the ICA annually. CasGla tends to grow from root nodules; may require retreatment.		X	X																		
	MMR-Casgla-01: Control CasGla growing on steep slope: will require safety lines, possibly rapelling gear. Conduct intial knockdown in 2009. Monitor/control annually starting in 2010																					
	MMR-DicChi-01: Survey area to get full extent of population. GPS. Update ICA if needed.																					
	MMR-DicChi-01: Monitor/control DicChi at NE quad site quarterly. This specis is Roundup resistant; use Garlon/handpull/or any other creative options.																					
	MMR-EhrSti-02: Monitor/treat along Makua fenceline from below pink trail to chippersite, and top part of Schwepps trail leading up to Makua fenceline, quarterly. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.			X																		
	MMR-RubArg-01: Control/monitor RubArg at black wattle site quarterly. Use spades to dig roots/runners out of ground. Treat with 40% G4	X	X	X	X																	

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	MMR-RubArg-04: Monitor/control Rubarg at SE quad annually. Use spades to dig roots/runners out of ground. Treat with 40% G4.	X																				
	MMR-SalOcc-01: Monitor/control SalOcc in NE quad quarterly. Revisitation rate may be changed when we learn more about controlling this species.																					
	MMR-SalOcc-02: Research life history info on SalOcc. When can an ICA be declared extinct?	X																				
	MMR-SphCoo-01: Monitor/control SphCoo in gulch annually. Prevent any plants from reaching maturity. Adjust WCA boundaries as needed.			X																		
	MMR-TriSem-02: Monitor/control Trisem at C-ridge corner. Pick and remove from field any potentially viable fruit.	X	X	X	X																	
	MMR-TriSem-03: Monitor/control Trisem at Pisonaia patch quarterly. Pick and remove from field any potentially viable fruit.	X	X	X	X																	
	MMR-TriSem-04: Monitor/control Trisem in SE quad quarterly. Pick and remove from field any potentially viable fruit.	X	X	X	X																	
	MMR-TriSem-05: Monitor/control Trisem on orange trail every 6 months. Pick and remove from field any potentially viable fruit.		X	X	X																	
	MMR-TriSem-06: Monitor/control Trisem above switchbacks every quarterly. Pick and remove from field any potentially viable fruit.	X	X	X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	MMR-TriSem-07: Monitor/control Trisem at Chipper Site quarterly. Pick and remove from field any potentially viable fruit.		X	X																		
	MMR-TriSem-08: Monitor/control Trisem close to Army Snail Jail. Pick and remove from field any potentially viable fruit.	X	X	X																		
	MMR-TriSem-09: Monitor/control Trisem along rat grid side trail. Pick and remove from field any potentially viable fruit.		X	X																		
Kahanahaiki-01 Black Wattle	Control weedy grasses across site every 6 months/year. Target Melmin. Focus around native elements; exercise caution around native shrubs																					
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
Kahanahaiki-02 Ptemac/Generals	Control weeds across reintro zone (Alemac, Flueno, Delsub, Cyasup) every 6 months. Target understory weeds and gradual control of canopy weeds.			X																		
	Control canopy and select understory weeds across WCA every 2 years. Focus around native forest patches. Target Schter, Clihir, etc. Portions of this WCA are very steep.																					
	Evaluate site as potential chipper location.																					
Kahanahaiki-03 Ethans	Conduct weed sweeps through reintros (common and rare) and native forest patches every 6 months. Control understory weeds, gradually remove canopy weeds, target Psicat monocultures (not gradual). Work to connect reintros and native patches and push into less native areas.			X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control weedy grasses across WCA every 6 months/year.																					
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
Kahanahaiki-04 Aunty Barbara's	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
	Control weedy grasses across WCA every 6 months/year. Target Pascon, Oplhir. Focus around reintro areas first.		X		X																	
	Conduct weed control across WCAs, focusing around Cyasup/Delsub/common reintros (Note Fluneo reintro has own action), every 6 months. Target understory, target Psicat monocultures, gradually remove other canopy elements. Expand weeded areas to fill WCA.		X	X																		
Kahanahaiki-05 Schwepps to Ethan's	Conduct understory/canopy weed control across WCA. Area is split by a cliff; sweep along fence above cliff, sweep between cliff and Schwepps trail. Target Schter for gradual removal. Prioritize areas around reintros.			X																		
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
	Control weedy grasses across WCA annually or as needed.																					
Kahanahaiki-06 Gulch	Conduct understory/canopy control from waterfalls to Camp Joe every 6 months/year. Target understory species, gradual removal of canopy. Exercise care when working around Cyrden.		X																			

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Kahanahaiki-07 NW Quad	Conduct weed sweeps across entire WCA, every 1-2 years. Target understory, gradual canopy removal, Psicat monocultures annihilation.			X																		
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
	Control weedy grasses across WCA annually.																					
	Control Monhib every 6 months. Target known hotspots in gulch.																					
Kahanahaiki-08 NE Quad	Conduct weed sweeps across entire WCA, every 2-3 years. Target understory, gradual canopy removal, Psicat monocultures annihilation.				X																	
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.			X		No future actions scheduled, how often should this be checked?																
	Re-GPS boundaries of WCA: in particular, define southern boundary of WCA, from top of switchbacks, above waterfall, to orange trail.					No future actions scheduled, shaded for quarter 1, 2012 since that is next scheduled weeding time, not entered in scheduling db																
	Control weedy grasses across WCA annually.		X																			
	Control Monhib every 6 months. Target known hotspots in gulch.																					
Kahanahaiki-09 MW Quad	Conduct weed sweeps across entire WCA, every 1-2 years. Target understory, gradual canopy removal, Psicat monocultures annihilation. Focus on native elements first, and expand out.			X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control weedy grasses across WCA annually.	X																				
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
	Control Monhib every 6 months. Target known hotspots in gulch.			X																		
	Control Psicat monocultures using chainsaw/chipper method. Target large stands where can operate and pull chipper. Chipper not appropriate for small (less than 5x5m) stands, and most effective in large stands. Control all appropriate stands once. Control at least 3 months after peak fruiting.			X	X																	
	Take photopoints in chipper area quarterly for the first year, then every 6 months.																					
Kahanahaiki-10 ME Quad	Conduct weed sweeps across entire WCA, every 2-3 years. Target understory, gradual canopy removal, Psicat monocultures annihilation.	X	X	X																		
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.			X		No future actions scheduled, how often should this be checked?																
	Control weedy grasses across WCA annually.	X		X																		
	Conduct weed control around Cenagr reintro site every 6 months, as needed.	X																				
	Conduct weed control around Schobo/Schnut reintro site every 6 months, as needed. If reintro fails, discontinue this action.	X		X																		
	Control Monhib every 6 months. Target known hotspots in gulch.																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control Psicat monocultures using chainsaw/chipper method. Target large stands where can operate and pull chipper. Chipper not appropriate for small (less than 5x5m) stands, and most effective in large stands. Control all appropriate stands once.			X																		
	Take photopoints in chipper area quarterly for the first year, then every 6 months. If need to install additional photopoints, do so prior to chipper destruction.																					
Kahanahaiki-11 SW Quad	Conduct weed sweeps across entire WCA, every 1-2 years. Target understory, gradual canopy removal, Psicat monocultures annihilation.				X																	
	Control weedy grasses across WCA annually.	X																				
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.																					
Kahanahaiki-12 SE Quad	Conduct weed sweeps across entire WCA, every 2-3 years. Target understory, gradual canopy removal, Psicat monocultures annihilation.																					
	Sweep entire WCA for large Grerob one time. Follow up will be conducted during regular weed sweeps.			X																		
	Control weedy grasses across WCA annually.	X																				
	Target Psicat monocultures.		X																			
	Control Monhib every 6 months. Target known hotspots in gulch.																					
Kahanahaiki-13 Lower Ethans	Control weeds across entire WCA every 2 years. Focus on native forest patches. Target gradual canopy control and select understory control.			X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ungulate Control	Maintain snare groups, Hypalon	X	X	X																		
	Maintain snare groups, Buttslide	X	X	X																		
	Maintain snare groups, C-Ridge	X	X	X																		
	Construct Subunit II																					
	Assess need for additional snaring in the Fluggea Gulch area of Subunit II. Install if necessary																					
Rodent Control	Run trapping grid 2x/month; change to 1x/month if feasible	X	X	X	X																	
	Monitor tracking tunnels montly; 6x/year in Year 7; 4x/year in Year 8	X	X	X	X	See above																
	Monitor slugs and *Euglandina* 1x/quarter					See above																
	Monitor *C. superba* var. *superba* fruit production and predation					See above																
	Monitor seedling plots 2x/year					See above																
	Monitor seed rain buckets 2x/month					See above																
	Monitor arthropods 1x/year					See above																
	Monitor Achmus ground shell plots 1x/year	X				See above																
Slug Control	Deploy slug bait around *C. superba* subsp. *superba* population(s) frequency to be determined during research phase		X	X	X	Continuation depends on Special Local Needs permit for slug bait																
Predatory Snail Control	Determine if any *E. rosea* or *O. alliarus* snails are present at the *A. mustelina* sites																					
	Maintain physical barriers (exclosures) to protect *A. mustelina* form predatory snails	X																				
	Implement control as improved tools become available																					
Ant Control	Conduct surveys for ants across MU with bait cards	X		X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Analyze results of surveys, develop management plan			X		Completed April 2010																
	Implement control if deemed necessary																					
	Conduct arthropod survey along transects as part of rat trap out project.	X		X		Sampling planned through 2011 only																
Black Twig Borer	Put out BTB high-release ethanol traps if BTB damage to target plants exceeds acceptable levels					Trapping not proven to reduce BTB damage to trees																
	Implement control as improved tools become available																					

Hatched=Quarter Planned
X=Action Pau

1.2.5 Kaluakauila

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General Survey	Survey LZs (Punapohaku, Upper Catchment, Above lower, Makai Corner, Camp LZ) once per quarter (no use, no survey)	X				checked as they were used																
	Survey LZ Above Lower Euphae Patch whenever used, not to exceed once per quarter. If not used, do not need to survey.	X																				
	Survey Kaluakauila Lower Patch Camp LZ whenever used, not to exceed once per quarter. If not used, do not need to survey. NOT CURRENTLY IN USE - LZ NOT BIG ENOUGH. STILL A CAMPSITE, CONSIDER MOVING TO CAMPSITE SURVEY	X																				
	Survey Punapohaku LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.	X																				
	GPS Kaluakauila catchment LZ. Add to GIS layer and get ID #. Use ID# to correct temporary survey site code in weed and scheduling databases.																					
	Survey Kaluakauila catchment LZ whenever used, not to exceed once per quarter. If not used, do not need to survey. RENAME WITH CORRECT SURVEY SITE CODE WHEN GET ID #.	X																				

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Survey Kaluakauila upper campsite LZ survey (at Pinetree) whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Kaluakauila Makai Coner LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Kuaokala-Kaluakauila Trailhead LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey transect on Hill from Hell quarterly.					change to annual survey																
	Survey transect in upper gulch quarterly.					change to annual survey																
ICA	MMR-CirVul-02 Monitor/control CirVul at veg plots every 6 months. Pick and remove from field any potentially mature fruit.																					
ICA	MMR-SyzJam-01 Monitor/control SyzJam at upper gulch fence location annually. Monitor during fence check. Only 1 tree found at site.					None seen while doing fence checks																
General WCA	GPS boundaries of all WCAs not yet delineated																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Kaluakauila-01 Lower Patch	Control weedy grasses across entire WCA. Focus D and E lines, borders of WCA. Goal is to reduce fuel load throughout patch. Target Panmax, Melmin.		X	X		lower patch grass sprayed during wet season																
	Control understory weeds around Nerang/Hibbramok/Abusan reintros every 6 months/year.					not needed																
	Control understory weeds around Nothum every 6 months/annually.					will weed as needed																
	Control understory weeds around Euphae, particularly female trees, every 6 months/year.					will weed as needed. Changed scheduled dates.																
	Control Leuleu across WCA (along rat grids and in areas with mostly native plants).			X																		
	Control canopy weeds across entire WCA every 2 years. This may require several trips. Target Grerob. Remove more common species like Schter/Psicat gradually. Focus on mature trees first. Priority areas include: along rat grid trails, B line																					
	Sweep forested area above upper catchment, focusing on areas around rare taxa (Bonmen, Bobsan) and native forest patches, annually																					
	Monitor common reintroductions planted spring of 2008 annually. Species are: Dodvis, Sapoah, Raosan, Pluzey.					Conclude monitoring after 5 years, if survivorship poor.																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Conduct trial translocation with common native species, including RaoSan, SapOah, NesSan to determine efficacy of this technique. Tag and map translocated plants.					Postponed a year																
	Monitor trial translocation from spring 2011 every 6 months till determine whether useful.					Postponed a year																
	Take Photopoints 1x/yr at Lower Patch																					
Kaluakauila-02 Upper Patch	Control canopy weeds across entire WCA every 2 years. This may require several trips. Target Grerob. Remove more common species like Schter/Psicat gradually. Focus on mature trees first.					Quarter in which control is conducted is not important. Focus is to sweep through entire area, however long that takes.																
	Control weedy grasses across entire WCA. Focus on makai end, B-line ridge, reintro sites, borders of WCA. Goal is to reduce fuel load throughout patch. Target Panmax, Melmin.		X	X																		
	Control understory weeds around Delsub reintro every 6 months/year.																					
	Control understory weeds around Nerang/Hibbramok/Abusan reintros every 6 months/year. Target Passub.	X																				
	Control Leuleu across WCA (highest concentration along B line).			X	X																	
	Control understory weeds around Euphae, particularly female trees, every 6 months/year.																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control understory weeds around Nothum in gulch every 6 months/annually.																					
Kaluakauila-03 Fuelbreak/Trail Grass Control	Establish/maintain fuelbreak along ridge and fenceline on eastern side of exclosure, as needed/quarterly. Fuelbreak should be 5m wide (subject to change). Targets are weedy grasses (Panmax, Melmin) and shrubs (Leuleu). Ensure fuel breaks in good shape Q2 and Q3.	X		X	X																	
Ungulate Control	Monitor fence integrity					easily accessable upper sections of the fence were checked quarterly. No trips were made down the waterfalls to check entire fence.																
	Extend and monitor transect (MMR-12)					up for discussion?																
Rodent Control	EupHae.MMR-A: Lower patch re-bait every 6 weeks.	X	X	X	X																	
	EupHae.MMR-B: Upper patch re-bait every 6 weeks	X	X	X	X																	
	Run tracking tunnels once a quarter	X	X	X	X																	
Slug Control	N/A																					
Predatory Snail Control	N/A																					
Ant Control	N/A																					

hatched=planned Qtr
X=pau

1.2.6 Ohikilolo (Lower Makua)

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct vegetation monitoring across the accessible areas of Lower Makua.					Problematic due to UXO concerns. Currently unscheduled.																
	Conduct vegetation monitoring for the cliff community.					Discussed in Ohikilolo (Upper) update																
General Survey	Survey Lower Makua campsite LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Arch Camp LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Upper Lower Makua LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Lower Makua trailhead LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																					
	Survey Elepaio 15 LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.		X																			
	Survey transect in Koiahi gulch quarterly.																					

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Install/monitor weed transects in Lower Makua. Consider installing along access trail.																					
ICA	Review Appendix 3.1 from MIP to facilitate discussion of possible ICAs.																					
General WCA	Re-draw WCAs/MU to faciliate weed control. 1. GPS the Lower Makua trail. 2. GPS forest/nice forest line; use aerial data if possible. 3. Adjust MU boundary 4. Adjust WCA boundaries. Seek to eliminate MMRNoMU-02, 03, 04, 05, 06, 07.																					
Ohikilolo-01 Nerang South Fork	Conduct understory and canopy weed control across WCA annually. Focus around Nerang and native species patches. Target Spacam.																					
Ohikilolo-02 Nerang North Fork	Conduct understory and canopy weed control across WCA annually. Focus around Nerang and native species patches. Target Melmin.																					
Ohikilolo-05 Lower Makua	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Spacam, Monhib, Melaze, Trisem, etc. Sweep entire WCA once every 3-5 years.					Also planned in 2016																

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ohikilolo-07 Lower Makua	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Grerob,Spacam, Melaze, etc. Sweep entire WCA once every 3-5 years.					Also planned in 2017																
	Control all weeds within fenced Nerang zone every 6 months. Focus around Nerang/Nothum plants and potential reintro spots. Target Bleapp, Agerip, Chrsp		X																			
	Control weedy grasses within Nerang exclosure every 6 months, as needed. Exercise care when working around rare taxa.																					
Ohikilolo-12 Lower Makua	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Grerob, etc. Sweep entire WCA once every 3-5 years.					Also planned in 2017																
Ohikilolo-15 Lower Makua	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Grerob, etc. Sweep entire WCA once every 3-5 years.					Also planned in 2015																
Ohikilolo-16 Lower Makua	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Grerob, Toocil, Spacam, etc. Sweep entire WCA once every 3-5 years.	X	X																			

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ohikilolo-18; Lower Makua	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Grerob, Spacam, Toocil, etc. Sweep entire WCA once every 3-5 years.	X				Also planned in 2016																
MMR No-MU-02	Propose combining with Ohikilolo-05																					
MMR No-MU-03	Propose combining with Ohikilolo-07																					
MMR No-MU-04	Propose combining with Ohikilolo-12																					
MMR No-MU-05	Propose combining with Ohikilolo-15																					
MMR No-MU-06	Propose combining with Ohikilolo-16																					
MMR No-MU-07	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches. Target Grerob, Spacam, Toocil, etc. Sweep entire WCA once every 3-5 years.																					
MMR No-MU-09 Below East Rim	Clear and maintain LZ as needed		X																			
Ungulate Control						small fence checks																
Rodent Control						seasonal elepaio work																
Slug Control	No actions																					
Predatory Snail Control	No actions																					
Ant Control	No actions																					

hatched=planned Qtr
X=pau

1.2.7 Ohikilolo (Upper)

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct vegetation monitoring across the accessible areas of Upper Ohikilolo every 3 years.			X																		
	Conduct vegetation monitoring for the cliff community.					Protocol development underway																
General Survey	Survey Ohikilolo Camp/Pinetree LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.	X		X	X																	
	Survey Ohikilolo Mid LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Did not use																
	Survey Ohikilolo Pisonia LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Did not use																
	Survey Koiahi LZ (on Ohikilolo ridge) whenever used, not to exceed once per quarter. If not used, do not need to survey.		X	X	X																	
	Survey Red Dirt Puu LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Did not use																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Survey Makua Big Ridge LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.					Did not use																
	WT-MMR-09. Survey transect on upper portion of Ohikilolo ridge quarterly.					Only survey when chance of goat breach.																
	WT-MMR-08. Survey transect on lower section of Ohikilolo ridge quarterly.		X																			
	WT-MMR-13. Survey transect at Ohikilolo saddle quarterly		X																			
	Survey LZs (Koiahi, Camp) once per quarter (no use, no survey)	X	X	X	X	Checked as used																
ICA	MMR-Aracol-01: Monitor/control AraCol at Ohikilolo campsite every 6 months/year. Survey entire ICA on each visit.	X	X	X																		
	MMR-Cirvul-01: Monitor/control CirVul at camp/Lancam gulch every 6 months. Survey entire ICA on both visits. Pick and remove from field any potentially mature fruit.				X	Matures found in MIP YR 5, need to stick to revisitation schedule																
	MMR-Rubarg-02: Monitor/control Rubarg at Hedpar below red dirt puu every 6 months. Use spades to dig roots/runners out of ground. Treat with 40% G4.					Check annually as slow to grow and not finding matures within a year																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	MMR-Rubarg-03: Monitor/control Rubarg in lancam gulch annually. Only 1 plant found here. Use spades to dig roots/runners out of ground. Treat with 40% G4.	X				Research seed bank to determine when eradication can be declared for Rubarg.																
	MMR-Frauhd-01: Monitor/control FraUhd in Prikaa A exclosure annually. Only 1 tree known from this area.	X	X	X		Mature tree re-treated. No seedlings found. Check annually																
	MMR-Ehrsti-01: Monitor/control Ehrsti at Pinetree LZ site quarterly. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.	X	X	X	X	Oust (preemergent herbicide) will be used to assist in exhausting seed bank.																
General WCA	GPS boundaries of all WCAs not yet delineated					Ongoing as time allows																
Ohikilolo-03 Prikaa-I	Assess/control weedy grasses throughout reintroduction area. Control within WCA, but focus on perimeter to prevent ingress.					Grass not significantly impacting site. Will double check after monitor reintros 8/11																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Sweep reintro area annually. Conduct gradual removal of canopy weeds, focusing on Schter, Grerob. Minimize changes to light levels, but open canopy around reintros to give them more sun. Remove understory weeds, focusing on shrubs, herbs, Chrpar.				X																	
Ohikilolo-06 Sanmar MMR-A	Conduct weedy grass/shrub control around Sanmar A, as needed/annually. Conduct in spring, when Sanmar visible and can minimize trampling potential. Focus on grasses, Stadic, Ageade. Sweep through population, but also focus on edges, esp at bottom, to expand habitat, and along fence to prevent ingress.					Should make sure to at least evaluate in yr7. Difficult place to work (steep). Need to consider errosion too.																
	Control weedy trees gradually, focus on Schter, every 2 years as needed. Minimize light level changes, particularly around Sanmar.					See above																

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ohikilolo-08 Ridge Crest and Slope	Control Grerob, some Schter from Sanmar A up to Ohikilolo-09. Focus along fence, and down side ridges where feasible. Remove all Grerob. Remove some of Schter, maintaining some canopy. Sweep entire area 1x in 3 years. Resweep after another 3 years.					Planned for MIP Year 7																
Ohikilolo-09 Makai Gulch	Conduct weed sweeps across entire area 1x by end of 2010. Control both canopy and understory weeds; remove weedy trees gradually to minimize light changes. Focus on patches of native forest. Conduct follow up sweeps every 6 months/annually after 2010.	X			X																	
	Evaluate WCA shape and needs by conducting ground surveys.				X																	
	Conduct grass control across WCA, as needed. Check every 6 months. Focus on fencelines, and around native forest patches.																					
Ohikilolo-10 Forest Patch Exclosure	Control grass across entire forest exclosure fence, annually/ as needed. Focus along fence, in open areas, Stadic Flats.				X	Last controlled 9/09. Grass looking ok.																

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control weeds in open/weedy areas in forest exclosure, every 6 months, specifically: fenceline, Sanmar reintro, below LZ, and Prikaa reintros planted outside fence. Goal is to prevent weedy ingress, restoration. Below LZ, focus efforts around common reintros.					Area now highly native. Rescheduling to annual visits.																
	Conduct weed sweeps across entire forest patch exclosure every 2-3 years. Control all canopy/understory weeds found.																					
	Monitor common reintroductions planted quarter 1 2008 annually (*M . strigosa*)				X																	
	Monitor common reintros planted 2002 (*A. koa*) and 2003 (*M. lessertiana*) every 2 years.				X																	
Ohikilolo-11 Prikaa A Patch	Conduct canopy/understory weed control annually																					
	Evaluate potential for use of common natives; select species to use					Ongoing. Working out logistics for common natives.																
	Continue evaluation of use of Fusilade with surfactant; if not found harmful to *P. kaalae,* spray grasses annually, or as needed.					Greenhouse trial showed no harm; test spray an area in *P. kaalae* patch and monitor.																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ohikilolo-13 Mauka Patch/Lancam Gulch	GPS lower portion of WCA to ensure includes all suitable P. kaalae habitat for reintroduction and prior weed control.				X	Follow up to see if any additional surveys needed.																
	Conduct understory/canopy weed sweeps across WCA every 6 months. Remove canopy elements gradually, prevent drastic light changes. Focus on maintenance in Ptemac and Myrsine gulches.				X																	
	Target weedy zones (lancam gulch) twice per year, separate to full WCA sweeps.				X																	
	Control grass across WCA every 6 months/year. Focus on Lancam gulch, Ptemac gulch, Myrsine gulch, and around native patches on cabin slope.																					
	Monitor common reintros planted quarter 1 2008 annually (*M. strigosa*)				X																	
	Monitor common reintros planted 2004 and 2005 every 2 years (*A. koa*)					Done Q3 2009- don't need to do till MIP yr7																
	Install/monitor common native seed sow from quarter 3 2009. Species include: Acakoa.				X	No seeds germinated in plots. Discontinue informal trial																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Install/monitor Ptemac seed sow. Monitor until clear whether or not successful. Success is defined in two parts: germination, and survival. For germination success, monitor until past point when all germination should have occurred, and all seeds either germinated or dead. For survival, monitor until plants are at least .5m tall.					Do not conduct any additional seed sow. Only monitor.																
	Install/monitor transplanting Ptemac trial to determine efficacy at this location. Montior annually.					Do not conduct any additional transplantings. Only monitor.																
	Read Bleapp trails from 2006. Evaluate need for future *B. appendiculatum* removal trials as well as need to pursue control measure.			X		2006 trials need to be monitored 1x. All past Bleapp trial data needs to be analyzed. Identify whether additional trials needed, and where most appropriate to conduct them.																
Ohikilolo-14 Puu Tetramolopium	Conduct grass control across Puu Tetramolopium, as needed. Goal is to keep Tetfil habitat free from grasses.					Will treat as needed.																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ohikilolo-17 Ctenitis Ridge	Conduct understory/canopy weed control around reintroduction areas in fence, every 6 months/year. Bleapp a major weed at this site; control methods are very destructive, and should be implemented with much care. Control canopy gradually. Expand weeded area slowly to fence boundary.	X				Weeded understory thoroughly this year. Thinned overstory to acceptable levels. Reduce to annual weed sweep across area.																
	Plant common natives in fence area, focusing in weeded areas close to Prikaa. Tag and map. Species include: Micstr. Expand species list as needed. Conduct once, and if successful, conduct annually.				X	Planted and monitored. Plants look good.																
	Monitor common reintroductions planted fall/winter of 2008 annually. Species include: Micstr.				X	See above																

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ohikilolo-20 Big Ridge and below Forest Exclosure	Control canopy species across WCA, focusing on Psicat, Grerob, Toocil, and any other less common species. Sweep entire WCA 1x by end of 2012. Conduct follow up control as needed, every 3 years.			X		Minimal weeding done so far. Psicat found during veg monitoring was treated. WCA shape created for future weed expansion. Will scope and weed if time allows.																
Ungulate Control	Read Ungulate Transect MMR-13		X	X	X																	
	Read Ungulate Transect MMR-08		X	X	X																	
	Maintain and install snares for goat ingress from Keaau		X	X	X																	
	Monitor fence integrity from Tetfil Puu to Range Control		X	X	X																	
	Monitor fence integrity from 3-points to Tetfil Puu			X	X																	
	Monitor fence integrity of Forest Patch Exclosure		X	X																		
	Monitor fence integrity of Prikaa A fence	X	X	X	X																	
	Monitor fence integrity of Ctesqu fence annually	X																				

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Evaluate need to repair/replace lower southwest section of fence			X		Area scoped. Discussion ongoing about best means of addressing decay of fence.																
Localized Rodent Control	Restock baits for AchMus: Pteralyxia Gulch and Forest Patch Baits 2x/qtr	X	X	X	X																	
	Restock Baits for all Prikaa at Ohikilolo (MMR-A, MMR-B, MMR-C, MMR-D, Myrles Patch) 2x/qtr	X	X	X	X																	
	Monitoring tracking tunnels 1x a quarter	X		X																		
	Reconfigure MMR-A w/ stations and trap boxes	X				Action complete																
	Monitor ground shell plots 1x a quarter	X			X	Changed to annually by Rare Snail Specialist																
	Evaluate rodent control grids & modify if necessary	X				Grid updated. Action complete																
Predatory Snail Control	Determine if any *E. rosea* or *O. alliarus* snails are present in proximity to *A. mustelina* populations					Need to schedule searches with research specialist																
Ant Control	Conduct surveys for ants across MU with bait cards quarterly.																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Analyze results of surveys, develop management recommendations					Ongoing																

Hatched=Quarter Planned
X= Action Pau

1.2.7.1 Ohikilolo Vegetation Monitoring Update

Primary Objectives:

- Assess the cover of alien plant species within the MU to determine if it is less than 50% across the sampled unit or continuing to decrease to ultimately meet that threshold requirement (Makua Implementation Team et al. 2003).
- Re-read vegetation monitoring transects every three years. The next planned monitoring cycle for this area is in quarter 3 of 2013 (MIP year 10).

Secondary Objectives:

- Monitor the status of native plant species within the MU.
- Assess the status and changes in bare ground (not vegetated areas) within the MU.
- Determine if any ungulates (feral pigs or goats) are detected within the fenced portion of a MU.

MU Vegetation Monitoring

Vegetation monitoring will be conducted for both the Ohikilolo (Upper) and Lower Makua sections of this MU (refer to the Ohikilolo ERMUP in the 2009 Status Update for the MIP and OIP for discussion on reasons for the division of this MU). From April to June of 2010, vegetation monitoring was conducted for the Upper Ohikilolo portion of the MU. The total effort, including commute time, was 285 hours. Current vegetation monitoring does not include the inaccessible cliff section of the MU, for safety reasons. Until a safe method for this type of monitoring is developed, OANRP will continue to qualitatively monitor the cliff communities.

Statistical Threshholds

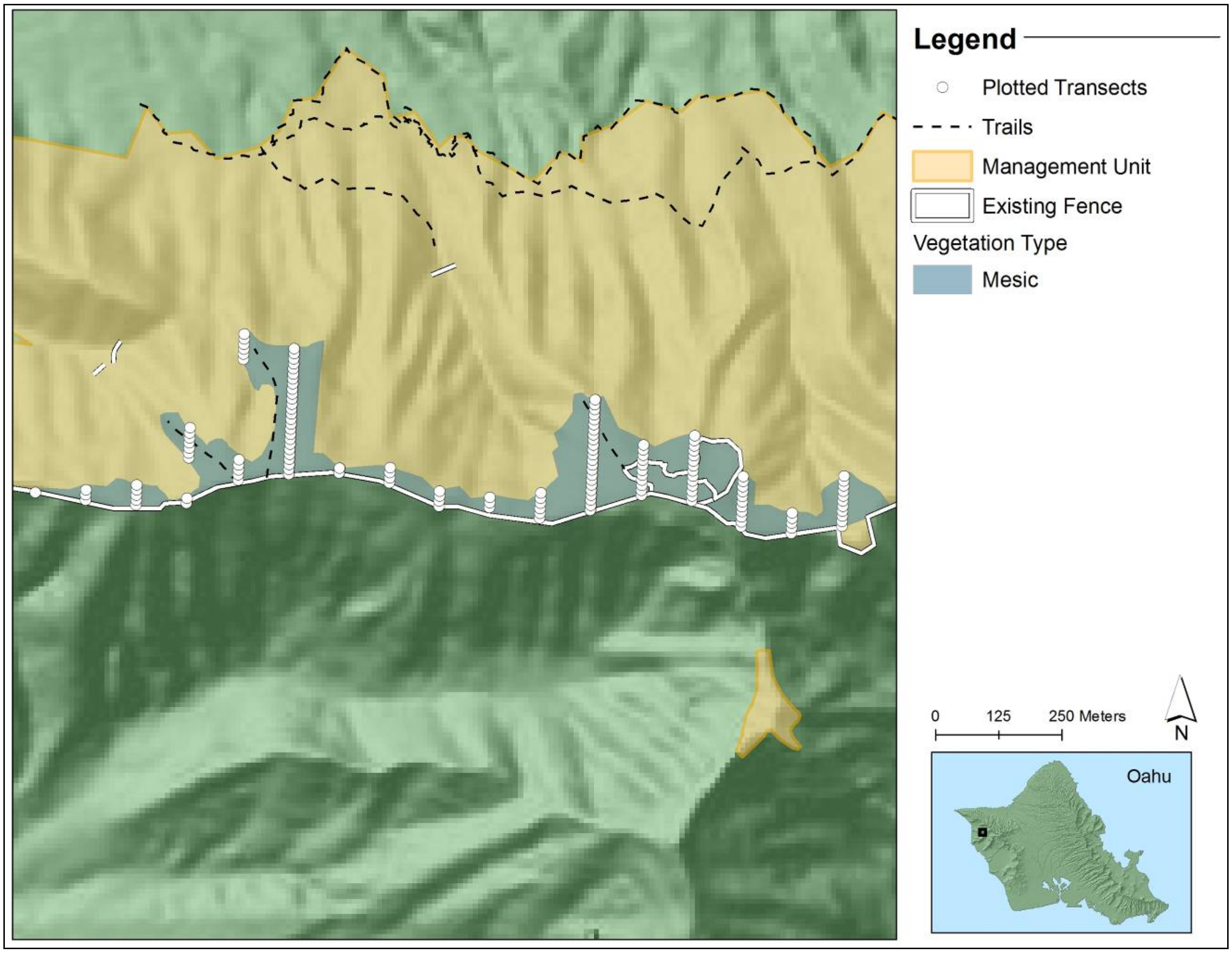
All of the sampling and analysis methods addressed in this protocol are based on the following assumptions:

- The probability of making a Type I error (detecting change or difference when none exists) is <10% (Alpha = 0.10)
- The probability of making a Type II error (missing a change or difference that does exist) is <20%.
- Minimum detected change or difference between two samples being compared is 10% over the sampling period.

Sample Size Coniderations

A post hoc sample size was calculated using the statistical thresholds mentioned above and a standard deviation of 33. The minimum sample size for this MU is be 136 stations, which is close to the 133 stations actually read.

MU Monitoring Transects



MU Vegetation Monitoring Baseline Analyses

The mean alien vegetation cover in the understory for this MU was 61% in the understory and 30% in the canopy. The percent cover was below the IP goal in the canopy but not in the understory (see the MU Percent Vegetation Cover Monitoring Analyses table below). The native canopy cover pre-disturbance is unknown but was likely lower than 50%. This assumption is based off of the composition of the remaining native patches in the Ohikilolo MU.

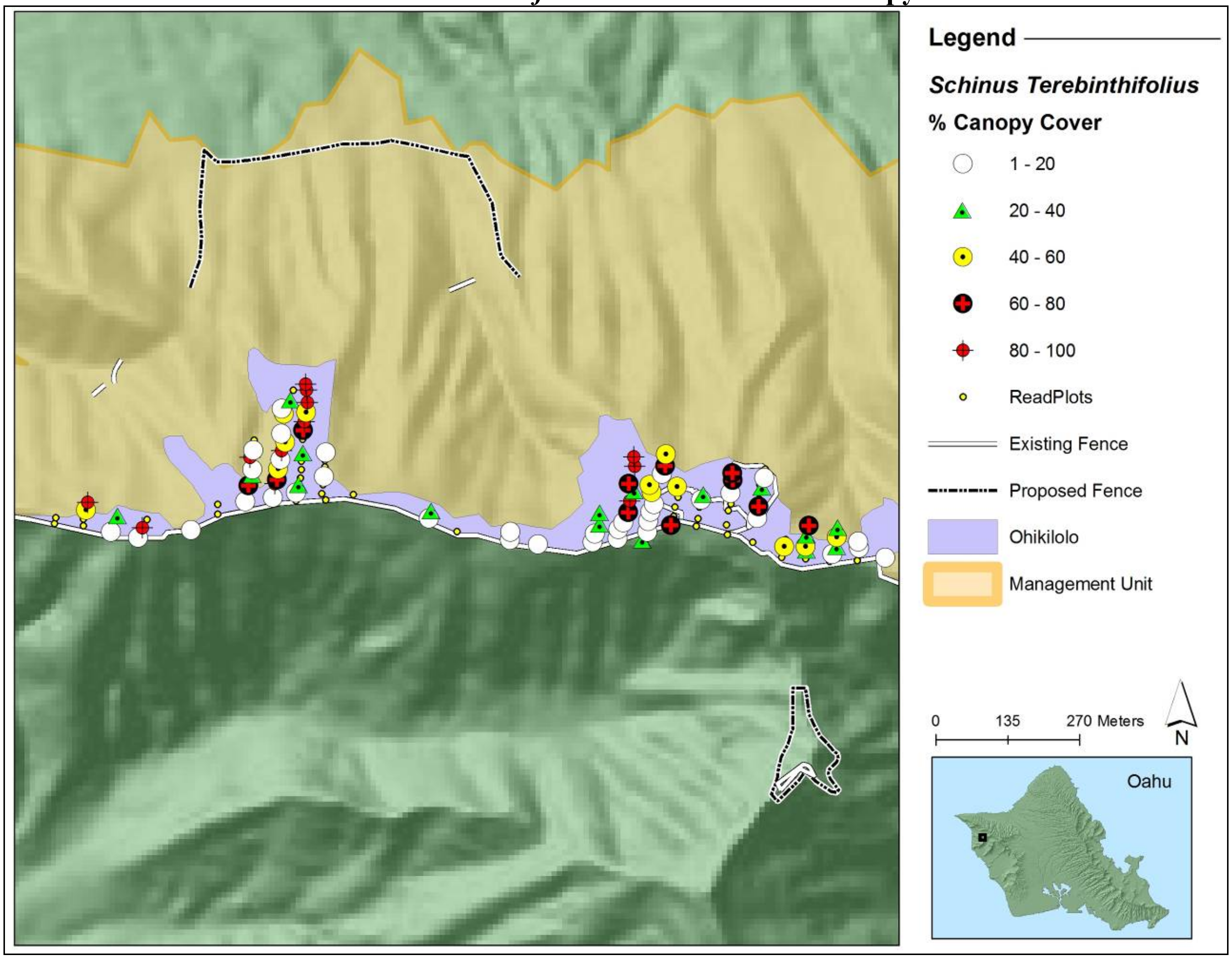
MU Percent Vegetation Cover Monitoring Analyses

Variable	Stations	Mean	Standard Error Of the Mean	Standard Deviation	Q1	Median	Q3
Native Shrub	133	16.77	1.69	19.46	2.5	7.5	25
Native Fern	133	18.17	2.18	25.12	0.5	7.5	30
Native Grass	133	24.28	2.28	26.27	2.5	15	35
Bryophytes	133	5.39	1.12	12.97	0.5	0.5	2.5
Total Native	133	46.38	2.57	29.59	25	45	75

Variable	Stations	Mean	Standard Error Of the Mean	Standard Deviation	Q1	Median	Q3
Understory							
Alien Shrub	133	26.27	1.96	22.62	7.5	25	35
Alien Fern	133	28.73	2.94	33.94	2.5	7.5	55
Alien Grass	133	25.04	2.43	28.07	0.5	15	40
Bare Ground	133	12.9	1.97	22.73	0.5	2.5	15
Total Alien Understory	133	60.94	2.94	33.86	30	65	95
Total Native Canopy	133	15.32	1.95	22.43	0	2.5	25
Total Alien Canopy	133	30.16	2.82	32.57	0.5	15	55
Total Canopy	133	42.59	2.92	33.7	7.5	45	75

The main alien tree found in Ohikilolo was *Schinus terebinthiflius* (see map below). The mean vegetation cover was 27% for this species in the canopy and 16% in the understory (see table below). Due to its invasive characteristics and ecosystem altering potential, *S. terebinthiflius* poses a major threat to this MU. The primary weed control strategy for *S. terebinthiflius* in the next five years is to focus efforts on removing it around rare species and native forest patches. Staff will also focus on preventing current monotypic patches of *S. terebinthiflius* from expanding.

***Schinus terebinthiflius* distribution in the canopy**



Percent Vegetation Cover for *Schinus terebinthifolius*

Variable	Stations	Mean	Standard Error of the Mean	Standard Deviation	Q1	Median	Q3
% Understory Cover	133	15.98	1.64	18.94	0.5	7.5	25
% Canopy Cover	133	27.03	2.75	31.74	0	15	45

Blechnum appendiculatum, Melinis minutiflora, and Grevillea robusta are several other invasive alien species found in the Ohikilolo MU. Though these species are too widespread to control as incipient they are of particular interest to OANRP due to their distribution, density, and invasive characteristics. *B. appendiculatum* is concerning due to its ability to create a thick ground cover which might reduce the amount of light available for germinating native seedlings. The mean percent cover of *B. appendiculatum* was 28%. *B. appendiculatum* weed control techniques are currently being researched and MU scale control options will be reconsidered once results have been analyzed and feasibility discussed. *M. minutiflora* is an alien grass that is controlled along fencelines and in rare plant patches. The mean percent cover for *M. minutiflora* in 2010 was 21%. If subsequent monitoring data shows an increase in the percent cover for this species, additional control will be considered. *G. robusta* is an alien tree that, with the exception of the cliff communities, is treated as zero tolerance for mature plants. The mean percent cover for *G. robusta* in 2010 was 25% in the canopy and 0.45% in the understory. The five year MU goal for *G. robusta* is to kill all mature, reachable plants found within the Ohikilolo (Upper) MU.

Species that are not treated as incipient but for which staff also has zero tolerance for in Ohikilolo include *Psidium cattleianum*, *Psidium guajava*, *Passiflora suberosa*, *Leucaena leucocephala*, *Casuarina* sp., *Toonia ciliata*, and *Syzygium cumini*. These species will not be analyzed using vegetation monitoring since all individuals are controlled as soon as they are found. During vegetation monitoring, 26 new locations of species from this list were found. These individuals will be controlled during scheduled WCA weed sweeps.

1.2.8 Palikea

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General Surveys	Survey Puu Palikea LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.			X																		
	Survey Halona Ridge LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.		X																			
	Survey Palikea Camp LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.		X	X																		
ICA	SetPal- Palikea-01, Monitor/control Setpal at site east of camp quarterly. Handpull and remove from field all plants/fruit.		X	X																		
	SetPal-Palikea-02, Monitor/control SetPal at steps site quarterly. Only 1 immature plant found here. Handpull and remove from field plant and potentially viable fruit.		X	X	X																	
	CroCro-Palikea-01, Monitor/control Crocro at Norfolk pine site minimum every 6 months. Sweep entire ICA each time. Dig out corms, remove from field. Pick and remove from field any potentially viable fruit.			X																		

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	CroCro-Palikea-02, Monitor/control Crocro at DZ/akolea gulch site minimum every 6 months. Once initial knockdown is complete, sweep entire ICA each time. Dig out corms, remove from field. Pick and remove from field any potentially viable fruit.			X																		
	CroCro-Palikea-03, Monitor/control Crocro at steps site minimum every 6 months. Sweep entire ICA each time. Dig out corms, remove from field. Pick and remove from field any potentially viable fruit.	X		X																		
	CroCro-Palikea-04, Monitor/control Crocro on fence N of lunch puu a minimum every 6 months. Sweep entire ICA each time. Dig out corms, remove from field. Pick and remove from field any potentially viable fruit.			X																		
	DicChi-Palikea-01, Monitor/control Dicchi inside old TNC exclosure quarterly. This weed is roundup resistant. Pick and remove from field any potentially viable fruit or roots.																					
	FraUhd, Establish ICA. Survey, GPS, enter into database, begin control.																					
	FicMic, Establish ICA. Survey, GPS, enter into database, begin control.																					
	Melqui, Establish ICA. Survey, GPS, enter into database, begin control.																					

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General WCA	Scope inside new Palikea exclosure to delineate WCAs. GPS WCAs, and create accurate GIS shapes for them. GPS other noteworthy landmarks as well.					No future actions scheduled																
Palikea-01 North Corner	Control weedy grasses along fence, crest quarterly/as needed. Target Ehrsti. Exercise care when working around native species.		X	X																		
	Control both understory and canopy weeds across entire WCA every other year. Use sweeps. Target Psicat, Morfay.			X																		
Palikea-02 Uluhe Flats	Control weeds across entire WCA annually. Focus first around nice forest patches and uluhe flats. Move into weedier areas. Target Schter, Psicat, select understory weeds. Target Sphcoo wherever found. GPS and flag locations of mature plants.		X	X																		
	Control Psicat monocultures using chipper technique. Scope possible work sites. Implement control.																					
	Scope/install/monitor common reintros in weedy zones of WCA. PUBLIC OUTREACH																					
Palikea-03 Crestline	Control weedy grasses along fence, crest quarterly/as needed. Target Ehrsti. Exercise care when working around native species.																					

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control canopy and understory weeds across all accessible portions of WCA annually. Much of WCA is steep/cliff. Target Morfay, Schter, Psicat. Control canopy weeds gradually; do not remove more than 10% cover in any year.																					
	Install/monitor experimental Diclin transplant. Plant into grassy areas. Monitor quarterly for survival/ establishment, success.				X																	
	Control weeds on steep, inaccessible portions of MU using alternative technologies: weeding on rappell, HBT, etc. Conduct control every other year. Target Morgay, Schter.																					
Palikea-04 Mid-Gulch	Control understory and canopy weeds along 2 ridges in WCA, focusing around native forest patches, every other year. Target gradual removal of Morfay.			X																		
	Control weedy grasses across WCA every 6 months, as needed. Target Ehrsti, Melmin, Pascon. Exercise care when working around native species.			X																		
	Scope/install/monitor common reintroductions in light gaps from Schter gulch weeding.																					
	Control understory and canopy weeds in gulch every other year. Target gradual removal of Schter; open 10-15% of canopy per year. Coordinate efforts wth common native reintroductions.																					

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Palikea-05 Subunit 1A (Cyagri)	Control understory and canopy weeds in gulch portion of WCA (around wild and reintro Cyagri, TNC reintros) every 6 months. Exercise care when working around rare taxa. Target understory. Do not control large Cryjap.			X																		
	Control understory and canopy weeds across non-gulch portion of WCA annually. Do not kill large Cryjap.			X																		
Palikea-06 Tsugi gulch	Control understory and canopy weeds across WCA annually. Focus first around native forest paches, move into weedier areas. Target understory species; use monitoring data to trigger control. Control canopy gradually, target Morfay, Schter, Bleapp; do not kill C	X		X																		
	Elepaio territory: control Psicat gradually, in conjunction with Vertebrate Specialist, two times a year, as needed.																					
	Control weedy grasses across WCA annually/as needed. Target Ehrsti. Exercise care when working around native species.			X																		
	Install/monitor Lobyuc seedsow using TNC seed. Sow along trail, in areas that aren't super wet, but are close to crest line.					Determine if seed still viable or if action should be cancelled.																
Palikea-07 South Corner	Control weedy grasses along fence, trail quarterly/as needed. Target Ehrsti. Exercise care when working around native species.																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control both understory and canopy weeds across entire WCA annually. Use sweeps. Target Psicat, Morfay, Schter, Aracol keiki's. Control canopy weeds gradually to minimize light changes. Consider options for removing (or not) Aracol. Use volunteers fo					Evaluate site for chipper and snail survey work day/night																
	Install/monitor seedsow in CroCro ICA site. Identify candidates species. Native species options: Diasan, Hedter. PUBLIC OUTREACH																					
Palikea-08 Mid-east Gulch	Control weedy grasses across WCA every 6 months, as needed. Target Ehrsti. Exercise care when working around native species.			X																		
	Control understory and canopy weeds along 2 ridges in WCA, focusing around native forest patches, every other year. Target gradual removal of Morfay.																					
	Scope/install/monitor common reintroductions in light gaps from Schter gulch weeding.																					
	Control understory and canopy weeds in gulch every other year. Target gradual removal of Schter; open 10-15% of canopy per year. Coordinate efforts wth common native reintroductions.																					

Action Type	Actions	MIP Year 6 Oct 2009- Sept 2010				Comments	MIP Year 7 Oct 2010- Sept2011				MIP Year 8 Oct 2011- Sept2012				MIP Year 9 Oct 2012- Sept2013				MIP Year 10 Oct 2013- Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Palikea-09 East Corner	Control understory and canopy weeds across WCA every 1-2 years. Focus first around native dominated areas, then move into weedier areas. Control canopy weeds gradually, to prevent major light changes. Target Schter, Morfay, scattered Psicat. Target Sp			X																		
	Control Psicat monocultures. Target 1-3 stands per year. Use chipper where possible. Focus first on far eastern side of WCA and work back towards camp; encourage natural koa recruitment. PUBLIC OUTREACH																					
Ungulate Control	Cyagri monitor fence integrity and transect		X																			
	Check snare group outside the fence.		X	X																		
	Site visit/scoping for Trap Out Grid																					
	North Palawai fence monitor for integrity																					
	Palikea fence monitor integrity	X	X	X	X																	
	Identify high probability ungulate usage areas																					
	Install transects			X																		
Rodent Control	AchMus.PAK, All sites with rat control grids, Bait every 6 weeks	X	X	X	X																	
	Tracking tunnel set up and running				X																	
	Set up Trap Out Grid				X																	
Slug Control	Monitor slug activity at *Cyanea grimesiana*																					

Action Type	Actions	MIP Year 6 Oct 2009-Sept 2010				Comments	MIP Year 7 Oct 2010-Sept2011				MIP Year 8 Oct 2011-Sept2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014			
		4	1	2	3		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Predatory Snail Control	Determine if any *E. rosea* or *O. alliarus* snails are present at *A. mustelina* sites / implement control																					
Ant Control	Conduct surveys at human entry points and *A. mustellina* sites annually																					
	Analyze survey results and develop management plan			X		Management plan completed April 2010																
	Inplement control if necessary																					
	Conduct anthropod survey to determine recovery following rat trap out project	X		X		Arthropod survey to continue through 2011.																
Jackson Chameleon	Survey for C. jacksonii along Palehua road/cabins																					
	Survey for C. jacksonii in MU fence																					
	Plan actions for next five years if needed																					
	Survey/control C. jacksonii as deemed necessary																					
Monitoring	Conduct vegetation monitoring across the accessible areas of Upper Ohikilolo.			X		Pau																
	Conduct vegetation monitoring for the cliff community.					Ongoing																

Hatched=Quarter Planned
X= Action Pau

1.3 ECOSYSTEM RESTORATION MANAGEMENT UNIT PLANS

The Ecosystem Management Unit Plans (ERMUPs) included here follow the same format as ERMUPs included in the 2009 Status Report for the MIP and OIP. Minor changes have been made to the format since last year, including listing all proposed actions in one table at the end of each plan, rather than in multiple tables spread throughout each plan. This change was made to facilitate yearly updates, as only the table will be reviewed and provided to the IT on an annual basis. Each plan includes a summary of rare resources as well as a discussion of all threats to the MU. The ERMUPs are designed to be stand-alone, technical documents which guide OARNP field crews. Some repetitive verbiage is intentional

1.3.1 Kaena

Ecosystem Restoration Management Plan

MIP Year 7-11, Oct. 2010 – Sept. 2015

MUs: Kaena and East of Alau

Overall MIP Management Goals:

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

Background Information

Location: Westernmost tip of Oahu, at Northern base of Waianae Mountains

Land Owner: State of Hawaii

Land Managers: Department of Land and Natural Resources (DLNR) - Natural Area Reserve System (NARS), DLNR – Land Division.

Acreage: 51.7 acres

Elevation Range: Sea level to 894 ft.

Description: Kaena Point includes two IP MUs: Kaena and East of Alau. Access is via a 4-wheel drive road along the Mokuleia coastline. The Kaena MU is within the Natural Area Reserve (NAR) boundary and is protected from off road vehicles by a large rock barrier. It is actively managed by DLNR, NARS, and OANRP, and contains areas of native dominant dry coastal strand and shrubland. The East of Alau MU is located on a parcel managed by DLNR Land Division and receives a minimal amount of management by OANRP staff. Vegetation within and surrounding the MU is alien dominant dry coastal shrubland. Fire serves as the greatest threat to these MUs due to heavy public use and high fuel loads in the surrounding area.

Native Vegetation Types

Waianae Vegetation Types
Dry Coastal
Canopy includes: *Myoporum sandwicense, Psydrax odoratum* Understory includes: *Eragrostis variabilis, Chenopodium oahuensis, Sida fallax, Chamaesyce degeneri, Jacquemontia ovalifolia, Melanthera integrifolia.*
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Units	Management Designation	Wild/ Reintroduction
Plant	*Chamaesyce celastroides* var. *kaenana*	KAE-A	East of Alau	MFS	Wild
Plant	*Chamaesyce celastroides* var. *kaenana*	KAE-B	Kaena	MFS	Wild

MFS= Manage for Stability

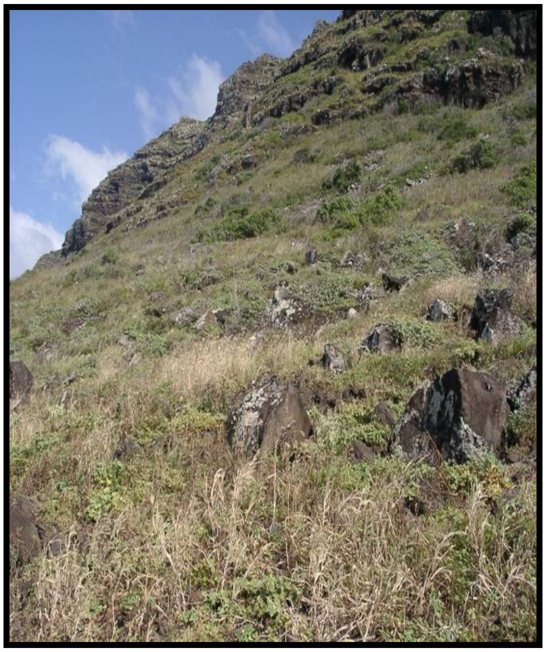
Other Rare Taxa at Kaena MU

Organism Type	Species	Status
Plant	*Sesbania tomentosa*	Endangered
Plant	*Scaevola coriacea*	Endangered
Plant	*Achyranthes splendens* var *rotundata*	Endangered

Locations of rare resources at Kaena

Map removed, available upon request

Dry Coastal Vegetation Type at Kaena



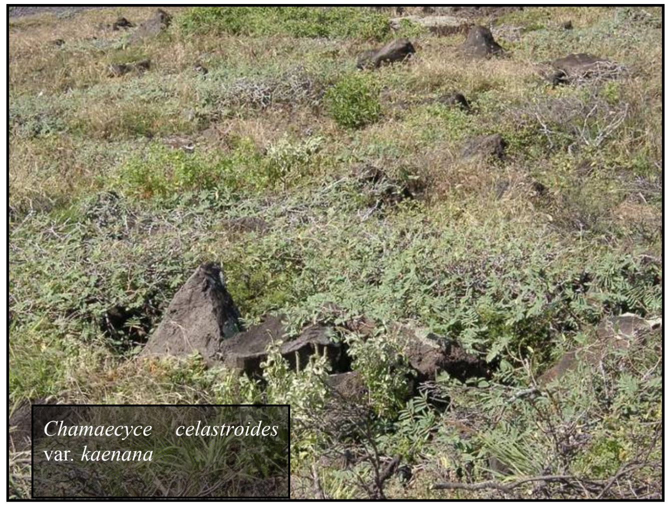
Kaena MU looking Mauka

Kaena MU looking East

Aerial view of Kaena Point

Rare Resources at Kaena

Achyranthes splendens var. *rotundata*



Chamaecyce celastroides var. *kaenana*

Sesbania tomentosa flower

Chamaecyce celastroides var. *kaenana* flower and fruit

MU Threats to MIP/OIP MFS Taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Rats	*Chamaesyce celastroides* var. *kaenana*	Yes	No	Yes
Ants	*Chamaesyce celastroides* var. *kaenana*	Yes	No	Yes, depends on species of ant
Weeds	*Chamaesyce celastroides* var. *kaenana*	Yes	No	Yes
Fire	*Chamaesyce celastroides* var. *kaenana*	No	Yes	No

Management History

- 2001: OANRP staff begins weed control efforts within NAR targeting *Leucana leucocephala* around known *Chamaecyce celastroides* var. *kaenana*.
- 2004: OANRP staff begins weed control efforts at East of Alau MU targeting *Leucana leucocephala* around *Chamaecyce celastroides* var. *kaenana*.
- Aug-2007: A wildland fire consumed approximately 74 acres near the East of Alau MU (approximately 35m from the Kaena-02 WCA).
- Nov-2007: Additional 140 plants found by OANRP and WCA area expanded.
- 2008: Ongoing restoration work including weed removal and re-vegetation with common native plants is performed by OANRP.
- July-2009: A wildland fire burned within 95 m of the East of Alau population.
- 2009: The genetic storage goals were met for Kaena PU (50 plants represented in seed storage).
- Nov-2009: Another group of approximately 30 *Chamaecyce celastroides* var. *kaenana* found.
- 2010: Predator proof fence around a portion of the NAR (which will include a subset of the *Chamaecyce celastroides* var. *kaenana* population) is slated for construction.

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)

Vegetation Monitoring

Currently there is no plan for vegetation monitoring in the Kaena and East of Alau MUs. Current OANRP methods of vegetation monitoring are designed for larger scale MUs. These methods would need to be modified, or a different methodology would need to be chosen, in order to accurately detect changes in vegetation composition. Once a complete census of the *Chamaecyce celastroides* var. *kaenana* population within the Kaena MU is conducted, OANRP will determine if a vegetation monitoring program at Kaena will aid in the management of *Chamaecyce celastroides* var. *kaenana* populations.

Surveys

Army Training?: No

Other Potential Sources of Introduction: OANRP and NARS staff, public hikers, 4-wheel drive vehicles, and birds.

Survey Locations: high traffic areas.

Management Objective:

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

Monitoring Objectives:

- Note unusual, significant, or incipient alien taxa during the course of regular field work and annual survey of main access road.

Management Responses:

- Novel alien taxa found will be researched and evaluated for distribution and life history. If taxa found to pose a major threat, control will begin and will be tracked via ICAs.

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. At Kaena, one road survey is conducted on a dirt road starting at the terminus of Farrington Highway and ending at the rock wall barricade. OANRP will consider installing additional surveys in other high traffic areas, however, due to Kaena's small size, incidental observations during regular field management should suffice.

Incipient Taxa Control (ICAs)

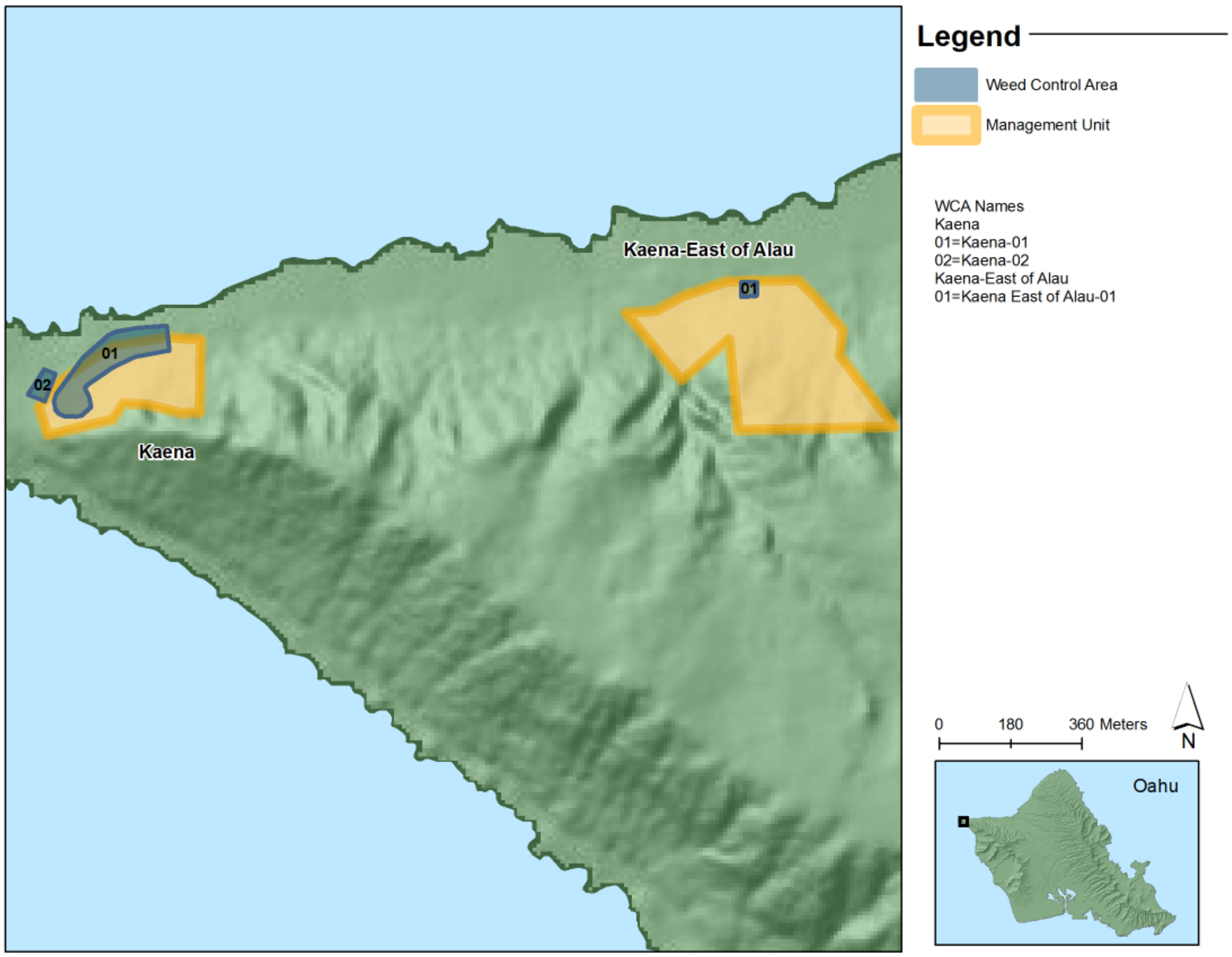
No incipient species have been identified by OANRP in the MU therefore there are currently no ICAs. OANRP will continue to monitor and consider control on possible incipients when appropriate. While there are no 'incipient' targets within this MU, *Atriplex semibaccata, Achyranthes aspera* var. *aspera, Cenchrus echinata*, and *Verbesina encelioides* are targeted within the WCAs. OANRP will continue to control *Acacia farnesiana* and *Leucaena leucocephala* in order to remove all matures within WCAs. Return visits will be scheduled in order to prevent immature individuals from reaching maturity.

The table below summarizes invasive taxa at Kaena. 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. If no code is listed in the 'original' column, the species was not evaluated by the IP, but was added later by OANRP. 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. OANRP supplemented and updated Appendix 3.1 with additional target species identified during field work. In many cases, the weed management code assigned by the MIP has been revised to reflect field observations. ICAs are not designated for species in the table below; however, occurrences of all species in the table should be noted by field staff.

Summary of Potential ICA Target Taxa

Taxa	MIP weed man. code		Notes	No. of ICAs
	Original	Revised		
Acacia farnesiana		2	The majority of weed efforts have focused on this taxa within the WCAs. Always targeted for removal during weed sweeps.	0
Agave sislana	1	2	A population is located along the mauka side of the access road prior to East of Alau, previously known from Kaena MU. Zero tolerance within WCAs.	0
Achyranthes aspera var. *aspera*		2	Common throughout MUs. NARS targets around laysan albatross areas. OANRP controls within WCAs.	0
Cenchrus echinatus		2	Common along access road. Will always target for control within WCAs.	0
Chloris barbata		2	Grass is widespread throughout Kaena-01 WCAs. Control has been performed in past via grass specific herbicide and outplanting of the native grass Kawelu. NRS will continue to monitor the extent and perform control as necessary.	0
Digitaria insularis		2	Most common grass in MU therefore posing greatest fire threat. Control performed within WCAs.	0
Leucaena leucocephala	2	2	The majority of OANRP weed efforts were used to control within WCAs. Always targeted for removal during weed sweeps.	0
Urochloa maxima (Panicum maximum)		2	Target for removal within WCAs. Priority for removal due to fire threat.	0
Passiflora edulis	2	2	Common along access road. Will monitor within WCAs and perform control as necessary.	0
Verbecina encelioides		2	Targeted for removal within WCAs during weed sweeps.	0

Incipient and Weed Control Areas



Ecosystem Management Weed Control (WCAs)

MIP 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:

- Focus weeding around *Chamaecyce celastroides* var. *kaenana* populations to enlarge and improve habitat.
- After complete census of *Chamaecyce celastroides* var. *kaenana* population is conducted at Kaena MU, determine what, if any, vegetation monitoring method will provide an accurate depiction of vegetation composition change over time.

Management Responses:

- Modify weeding efforts if *Chamaecyce celastroides* var. *kaenana* population monitoring indicates weed control efforts are not contributing to stable population growth.

OANRP weed control at Kaena is focused on reducing alien vegetation encroachment on populations of *Chamaecyce celastroides* var. *kaenana* and providing expanded habitat for population recruitment. These efforts have been effective at removing woody weeds. Currently there is no complete census of *Chamaecyce celastroides* var. *kaenana* at the Kaena MU, and the current vegetation monitoring method designed for larger MUs is not fit for monitoring vegetation changes at either MU. Completing a population census and modifying or developing different vegetation monitoring methods may allow OANRP to quantify weed control impacts on *Chamaecyce celastroides* var. *kaenana* at Kaena.

WCAs: Kaena-01

Veg Type: Dry Coastal

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

Targets: All woody species, particularly *A. farnesiana* and *L. leucocephala*, as well as herbaceous weeds *A. aspera* var *aspera, V. encelioides*, and *A. semibicatta.* Grasses such as *D. insularis* and *P. maximum* are also targeted as needed.

Notes: Weed control began at the Kaena MU in coordination with NARS in 2001. The focus of control efforts has been around the Kaena Point *C. celastroides* var. *kaenana* population in the western portion of the NAR. WCA control efforts were expanded in 2007, and again in 2010 upon discovery of new groups of plants. The WCA boundary was expanded to encompass these additional areas. Control of *A. farnesiana* and *L. leucocephela* within this WCA has succeeded in drastically diminishing their overall extent. Previously, loppers and hatchets were needed to clear these species. Visitation frequency has been dramatically reduced. Few plants are found throughout the WCA, most of which are small immature that can be cut with clippers or hand-pulled.

Although common along the access road, there is zero tolerance for *C. echinatus* and *Achyranthes aspera* var. *aspera* within the WCAs. *D. insularis* and *P. maximum* are targeted along the upper portion of WCA to aid fire suppression. OANRP is currently evaluating the need for control of *C. barbata* found throughout WCA. Previous efforts at control have not proved effective; however, it does not appear to be spreading beyond its initially observed extent. OANRP will continue to monitor *C. barbata* and will perform control as necessary.

OANRP also target *A. semibicatta*, a creeping shrub that densely occupies *C. celastroides* var. *kaenana* habitat. *A. semibicatta* is easily removed by handpulling during weed sweeps. OANRP will continue to monitor *A. semibicatta* and investigate further control methods if necessary.

Common native plant reintroductions of *Myoporum sandwicense* and *Eragrostis variabilis* began in 2008 to aid in weedy grass control, habitat restoration, and fire prevention. As of 2010 the survival rate for outplanted *M. sandwicense* was 88%, and 93% for outplanted *E. variabilis*. OANRP staff hopes to continue working with DOFAW staff to grow more common native plants and reintroduce them in order to aid in restoration and fire suppression efforts.

WCA: Kaena-02

Veg Type: Dry Coastal

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

Targets: All woody species, particularly *A. farnesiana* and *L. leucocephala*, as well as herbaceous weeds *A. aspera* var *aspera, V. encelioides*, and *A. semibicatta.* Grasses such as *D. insularis* and *P. maximum* are also targeted as needed.

Notes: The weed control goals and targets in this WCA are largely the same as those in Kaena-01. Weed control is conducted around a patch of *C. celastroides* var. *kaenana* that is fragmented from the larger patch below a road. Additionally, this WCA will be enclosed by the proposed predator proof fence at Kaena point. Weed control around this small patch has only taken place in the last year, and there is still more weed control needed to create a weed-free buffer zone around the rare plants. Once this is accomplished, annual sweeps for target weeds across the entire WCA will be conducted.

WCA: EastOfAlau-01

Veg Type: Rock/talus slope

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

Targets: All weeds, focusing on *A. farnesiana* and *L. leucocephala* and grasses.

Notes: OANRP control efforts began in 2004 at the East of Alau MU. Minimal weed control effort is needed because *C. celastroides* var. *kaenana* plants are found on rock talus with few weeds directly surrounding them. A small buffer of weed free area is maintained around this talus slope. OANRP is currently pursuing an agreement with DLNR Land Division to create a fire break east of the patch by clearing a large stand of Kiawe (*Prosopis pallida).* Removal of *A. farnesiana* and *L. leucocephala* around the WCA to create a wide fire buffer zone (approximately 50m) will also aid in fire suppression.

Rodent Control

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

Threat level: Unkown

Current control method: None

Seasonality: N/A

Number of control grids: None

Primary Objective:

- Implement rodent control if complete census of *C. celestroides* var. *kaenana* indicates rodents are a threat to a stable population.

Monitoring Objective:

- Monitor rare plant (*C. celestroides* var. *kaenana*) populations to determine impacts by rodents.

MU Rodent Control:

- OANRP have observed chewed branches of *C. celestroides* var. *kaenana* within other MUs, however no rat predation has been observed at either Kaena or East of Alau MU. Currently no rodent control is conducted by OANRP around the taxa due to the large number of individuals thriving without rodent control. DLNR will be building a predatory proof fence that will surround a portion of the *C. celestroides* var. *kaenana* in the Kaena PU. OANRP will monitor differences in population structure and vigor between the fenced and unfenced sites and will perform future control if deemed necessary.

Ant Control

Species: *Ochetellus glaber, Monomorium floricola, Paratrechina longicornis, Tetramorium simillimum* confirmed

Threat level: Unknown

Control level: Only for new incipient species

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

Number of sites: One site in the Kaena East of Alau Management Unit (MU) at the *C. celastroides* var. *kaenana* (KAE-A) wild site; three sites in the Kaena MU: gate, trail split and *C. celastroides* var. *kaenana* (KAE-B) wild site.

Acceptable Level of Ant Activity: Unknown

Primary Objectives:

- Determine the effect (if any) of ants on *C. celastroides* var. *kaenana*.
- Monitor for MUs for incipient ant species

Monitoring Objective:

- Continue to sample ants at human entry points (gate and trail split) as well as at *C. celastroides* var. *kaenana* wild sites a minimum of once a year. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.

Management Objective:

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

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. There are no published accounts of ants being a direct or indirect threat to *C. celastroides* var. *kaenana*. From preliminary floral observations, ants have been observed to be the dominant floral visitor of *C. celastroides* var. *kaenana*. In general, ants are regarded as poor pollinators, because pollen does not readily adhere to their bodies and antibiotics secreted by ants to combat fungal growth reduces the viability of pollen. Ants may also limit seed set and viability in plant populations by both diminishing the amount of available nectar, aggressively deterring pollinators at flowers and farming aphids and mealy bugs which damage the plants. [9]

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). In 2008, Ant

[9] Pollination biology of *Euphorbia celastroides* var. *kaenana* (Euphorbiaceae) 2010-2011. Melody Euaparadorn; Department of Botany; University of Hawaii at Manoa.

sampling took place in Kaena MU on 3/13, 6/19 and 10/2 using the following protocol described in Appendix 6-1 (this document).

A number of species were found: *Ochetellus glaber, M. floricola, P. longicornis,* and *T. simillimum*. *Ochetellus glaber* was the only species to occur in high numbers (>50 foragers per bait). All species are well established and not considered incipient. Observations of ants tending scales and mealy bugs on *C. celastroides* var. *kaenana* in August 2010 may indicate that ant control is warranted. More sampling is needed to determine which ant species is responsible. Graduate student Melody Euaparadorn will be studying the pollinators of *C. celastroides* var. *kaenana* throughout the next two years, and if her study indicates ants are disrupting pollination, ant control will commence.

Ochotellus glaber gathering nectar from *C. celastroides* var. *kaenana* flowers.

Scales on branch of *C. celastroides* var. *kaenana*

Fire Control

Threat Level: High

Available Tools: Fuelbreaks, Visual Markers, 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

Due to high fuel loads, low precipitation levels, and high arson activity, fire poses a great threat to both MUs. Rarely does a year go by without a wildfire starting somewhere within Kaena State Park or the surrounding DLNR Land Division lands. OANRP efforts have focused on preventative fire measures such as common reintroduction and weed control within the MUs. Removal of the most fire prone weeds (*A. farnesiana, L. leucocephela* and *P. maximum*) remains a high priority within the MUs. The East of Alau MU has a higher fire threat then the Kaena MU, due to higher fuel loads. OANRP will focus upcoming weed control efforts on creating a 50m fuel break in order to reduce fuel loads surrounding the *C. celastroides* var. *kaenana* PU. See the Weed Control section for further details.

OANRP will focus on maintaining good communication with the Wildland Fire Working Group to facilitate positive on-the-ground fire response in the event of another fire. NRS will maintain red-carded staff to assist with fire response.

August 2007 fire

Map removed to protect rare resources

August 2007 fire, Red circle indicates *C. celastroides* var. *kaenana* East of Alau PU

Map removed to protect rare resources

July 2009 fire, *C. celastroides* var. *kaenana* East of Alau PU circled in red, yellow arrow indicates furthest extent of burned area.

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
General Survey	Survey along Kaena dirt road from gate at the end of the paved road to the NAR barrier.																				
General WCA	Redraw MU boundaries. Create new Kaena MU WCA for lower (below road) *C. celastroides* var. *kaenana* plants recently discovered by OANRP staff (will be within predator fence). Use landmarks to mark in field.																				
WCA: Kaena-01	Control weeds across entire WCA. Focus on *L. leucocephala, A. farnesiana, A. semibicatta, A. aspera* var *aspera,* and *V. encelioides.* Work to remove all mature *L. leucocephala* from area and expand to boundaries of WCA.																				
	Control grass across WCA as needed, every 3-6 months. Focus on upper portion of patch targeting *D. insularis* and *P. maximum.* Zero tolerance for *C. echinatus* within WCA and evaluate control strategies for *C. barbata.*																				
	Monitor prior common reintroductions annually, any new plantings at six months, then annually. Species include: *M. sandwicense* and *E. variabilis.*																				
	Plant common natives through WCA, focusing on edges of patch and open areas. Tag and map. Species include: *M. sandwicense* and *E. variabilis*. Expand species list as needed.																				
	Take Photopoints 2x/year																				
WCA: Kaena-02	Control weeds across entire WCA every 6 months. Focus on Leuleu, Acafar, Atrsem, Achasp, Verenc. Work to remove all mature LeuLeu from area, expand boundaries of WCA.																				

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**
WCA: EastofAlau-01	Control weeds across WCA every 6 months. Target *A. farnesiana* and *L. leucocephala* but include other weeds as well. Expand boundaries of weeded area to improve habitat. Area severely fire threatened.																				
	Use chainsaws and possibly chipper to remove a large *Prosopis pallida* on the East side of the WCA, and a 50m swath of *A. farnesiana* and *L. leucocephela* surrounding the WCA in order to create a fire buffer zone.																				
	Control weedy grasses in area. Fire threat is high.																				
Rodent Control	Monitor *C. celastroides* var. *kaenana* for predation by rodents																				
	Implement localized rodent control if determined to be necessary for the protection of rare plants																				
Ant Control	Conduct surveys for ants across at 4 sites (see above) with bait cards																				
	Determine species of ant farming scale and mealy bugs																				
	Review study of *C. celastroides* var. *kaenana* pollinators to determine ant impacts on pollination.																				
	Implement control if deemed necessary																				

Hatching=Quarter Scheduled

1.3.2 Kahuku Training Area (KTA)

Ecosystem Restoration Management Plan

OIP Year 4-8, Oct. 2010 – Sept. 2015

Region: Kahuku Training Area

MU: Kaunala, Pahipahialua, Oio, KTA no MU

Overall OIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, rodent, arthropod, slug, fire, rust fungus, and weed threats to support stable populations of IP taxa. Implement control methods by 2013.

Background Information

Location: Kahuku Training Area (KTA)

Land Owner: US Army

Land Manager: Oahu Army Natural Resources Program (OANRP)

Acreage: 9,400 acres ~10 acres within fenced MUs

Elevation Range: 80 ft. - 2,100 ft

Description: KTA is located on the northern extent of Oahu, beginning in the lowlands across Kamehameha Highway from the shrimp farms and agricultural fields to the summit of the Koolau Mountains. The Army purchased KTA from The Estate of James Campbell. The Army uses KTA for pyrotechnic training, foot maneuver training, urban combat training and heli training. The terrain consists of rolling hills dissected by broad drainages in lower elevations, and relatively steep and windswept ridges in upper elevations. Habitat within KTA is highly disturbed with some small, predominantly native forest patches in the mid elevation mesic forest leading up to mostly native stretches of summit and wet forest. MU management is primarily focused within 3 small fenced MUs within the mid elevation mesic forest around the populations of endangered Eugenia koolauensis. Management is also implemented to control key incipient weeds throughout KTA. Road and LZ surveys are conducted to assist in detection of invasive taxa and monitoring spread within the training area. There are four IP species found at KTA.

Native Vegetation Types

Koolau Vegetation Types
Mesic mixed forest
Canopy includes: *Acacia koa, Metrosideros polymorpha, Psydrax odorata, Nestegis sandwicensis, Diospyros* spp., *Pouteria sandwicensis, Charpentiera* spp., *Pisonia* spp., *Psychotria* spp., *Antidesma platyphylum, Bobea* spp. and *Santalum freycinetianum, Pleomele halapepe* Understory includes: *Microlepia strigosa, Sphenomeris chinensis, Scaevola gaudichaudiana, Alyxia stellata*
Mesic-Wet forest

Canopy includes: *M. polymorpha, Cheirodendron trigynum, Cibotium* spp., *Melicope* spp., *A. platyphyllum*, and *Ilex anomala*.

Understory includes: *Cibotium chamissoi, Broussasia arguta, Dianella sandwicensis, Dubautia* spp. Less common subcanopy components of this zone include *Clermontia* and *Cyanea* spp.

Primary Vegetation Type in Kaunala, Pahipahialua, and Oio

Mesic Gulch

OIP Rare Resources:

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Cyanea koolauensis*	KTA-A	Kamananui-Kawainui Ridge	GSC	Wild
Plant	*Eugenia koolauensis*	KTA- A, B, C, D, E, F, H, I	Pahipahialua, Kaunala, Kaleleiki, Oio, East of Oio, Aimuu, Ohiaai	MFS and GSC	Wild
Plant	*Gardenia mannii*	KTA-A, B	Ihiihi-Kahawainui ridge, Kamananui-Malaekahana Summit Ridge	GSC	Wild
Plant	*Hesperomannia arborescens*	KTA-A	Ohiaai Ridge	GSC	Wild

MFS= Manage for Stability *= Population Dead
GSC= Genetic Storage Collection †=Reintroduction not yet done

Other Rare Taxa at KTA:

Organism Type	Species	Status
Plant	*Bobea timonioides*	SOC
Plant	*Nesoluma polynesicum*	SOC
Plant	*Pteralyxia macrocarpa*	C
Plant	*Tetraplasandra gymnocarpa*	E
Animal	*Lasiurus cinereus semotus*	E

SOC: Species of Concern, **C:** Candidate, **E**: Endangered

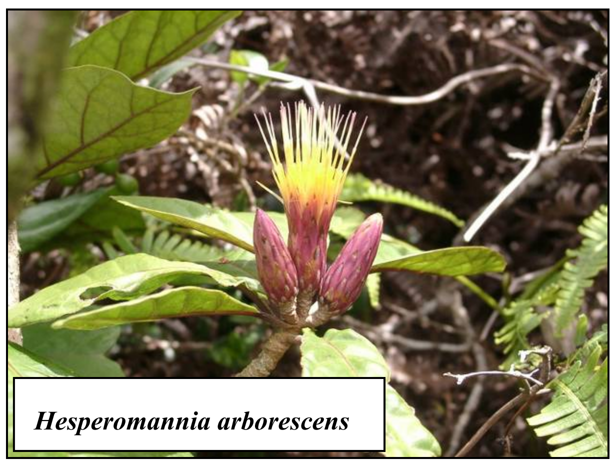
Rare Resources at KTA

Cyanea koolauensis

Eugenia koolauensis

Eugenia koolauensis

Gardenia mannii



Hesperomannia arborescens

MU Threats to OIP MFS taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required ?	Control Method Available?
Pigs	All	No	Yes	Yes
Rats	All	Yes	No	Yes
Rust fungus	*E. koolauensis*	No	Yes	No
Slugs	*C. koolauensis, G. mannii, H. arborescens*	Yes	No	Under development
Ants	Unknown, but may impact rare plants by tending pest insects	Unknown	Unknown	Some available, depends on species
Weeds	All	No	Yes	Yes
Fire	All	No	Yes	Yes

Management History

1996 - Robust *E. koolauensis* population found in Pahipahialua

1998 - *E. koolauensis* surveys conducted in KTA

1998 - Weed control initiated around *E. koolauensis* populations

1999 - ICA's established in KTA

2005 - *Casuarina equisetifolia* removal contracted for Oio and Pahipahialua

2006 - Kaunala, Pahipahialua and Oio MU fences constructed

2006 - *Puccinia psidii* rust noted on *E. koolauensis* at all sites

2010 - Thorough census conducted at all *E. koolauensis* MFS sites

Fall **2010** - *P. psidii* rust control research initiated by OANRP in KTA

Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Primary Objectives:

- Maintain all three MU fences (Kaunala, Pahipahialua, and Oio) as ungulate free.

Monitoring Objectives:

- Conduct fence checks and read transects quarterly. GPS and mark the fence at ten meter intervals so that the fence will be one large transect.
- Monitor for pig sign while conducting other management actions in the fence.
- Monitor fence integrity of all fences after extreme weather/wind events as soon as possible.

Management Responses:

- If any pig activity is detected within the fenced units, remove pigs through hunting and/or trapping methods.
- Check fence and repair breaches.

Maintenance Issues:

All three fences are prone to possible damage from tree fall and potentially after extreme weather/high wind events. Vandalism to the fences has not been an issue in the past but is always a concern, especially since the Kaunala and Pahipahialua fences are in close proximity to public access trails.

Weed Control

Weed Control actions are divided into 4 subcategories:

5) Vegetation Monitoring
6) Surveys
7) Incipient Taxa Control (Incipient Control Area - ICAs)
8) Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of OIP requirements.

Vegetation Monitoring

Currently there is no plan for MU-scale vegetation monitoring in the Kaunala, Pahipahialua, and Oio MUs. Current OANRP methods of vegetation monitoring are designed for larger scale MUs. These methods would need to be modified, or a different methodology would need to be chosen, in order to accurately detect changes in vegetation composition.

Instead we are considering a small-scale monitoring project to examine the effects and potential benefits of common reintroductions in: 1) increasing native plant cover, and 2) reducing weeding effort required to prevent alien vegetation cover levels from exceeding 25%. This trial will help direct future management efforts in Kaunala, Oio, and Pahipahialua.

Surveys

Army Training?: Yes

Other Potential Sources of Introduction: NRS, pigs, public hikers

Survey Locations: Landing Zones, Fencelines, High Potential Traffic Areas, Roads

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 (as applicable).

Monitoring Objectives:

- Survey transects for weeds; begin surveys of fenceline ungulate transect.
- Quarterly surveys of LZs (if used). Annual surveys of Army LZs (required by contract).

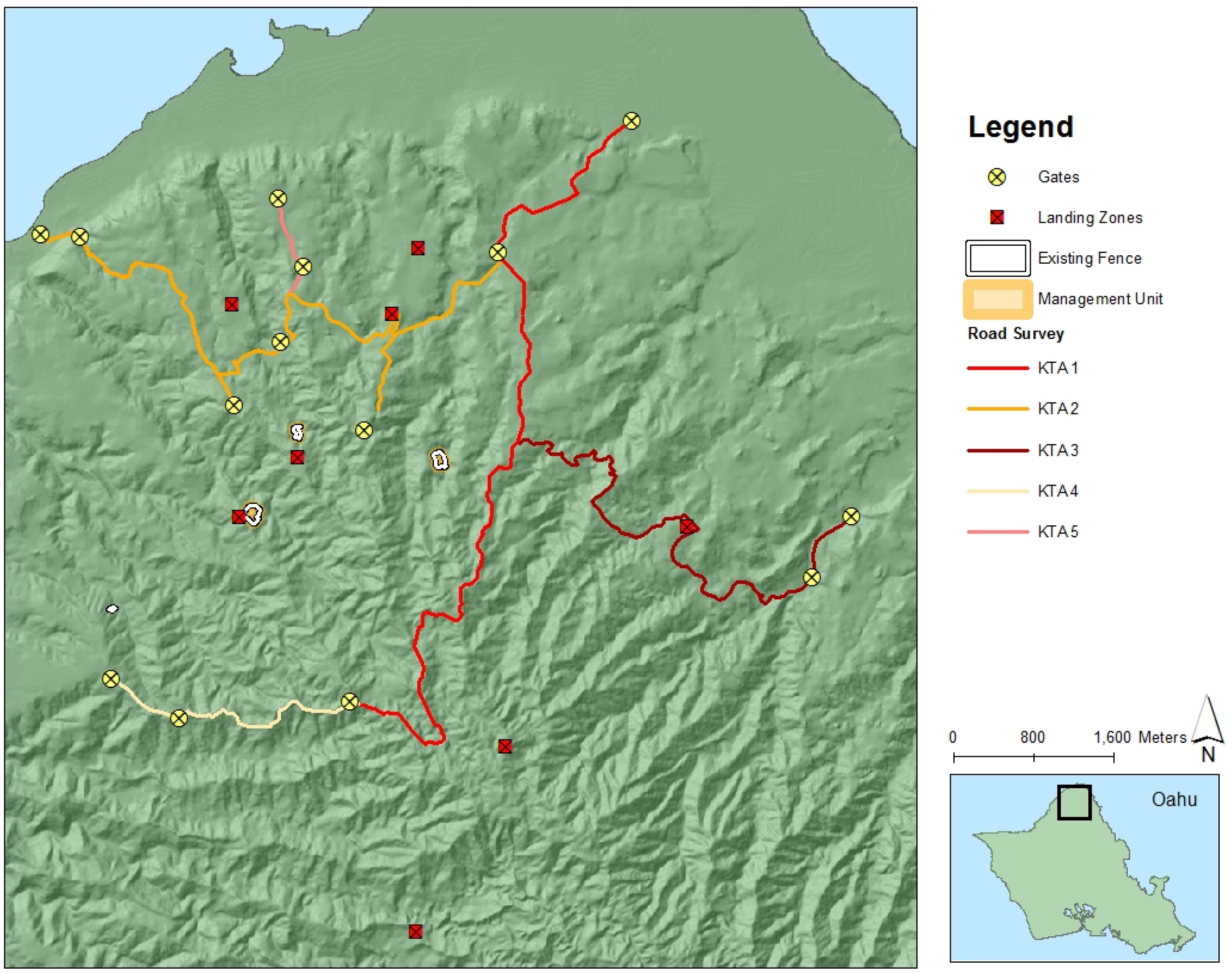
- Note unusual, significant or incipient alien taxa during the course of regular field work.
- Road surveys (required by contract).

Management Responses:

- Any significant alien taxa found will be researched and evaluated for distribution and life history. If found to pose a major threat, control will begin and will be tracked via Incipient Control Areas (ICAs)

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Roads, landing zones, fence lines, and other highly trafficked areas are inventoried regularly; 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.

Survey Locations at KTA



Incipient Taxa Control (ICAs)

Management Objectives:

- Target high priority species identified as incipient in the region by 2015.
- Conduct seed dormancy trials for all high priority incipients by 2015.

Monitoring Objectives:

- Visit ICAs at stated revisitation intervals. Control all mature plants in 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 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 bank, dormancy and life cycle information are important in making management decisions to facilitate eradication. NRS will compile information for each ICA species and conduct research to understand the biology of incipient species.

The table below summarizes incipient invasive taxa at Kahuku Traing Area. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in the training range. ICAs are not designated for every species in the table below; however, occurrences of all species in the table should be noted in Kahuku Traing Area. All current ICAs are mapped. Three management designations are possible: Incipient (small populations, eradicable), Control Locally (significant threat posed, may or may not be widespread, control feasible at WCA level), and Widespread (common weed, may or may not pose significant threat, control feasible at WCA level).

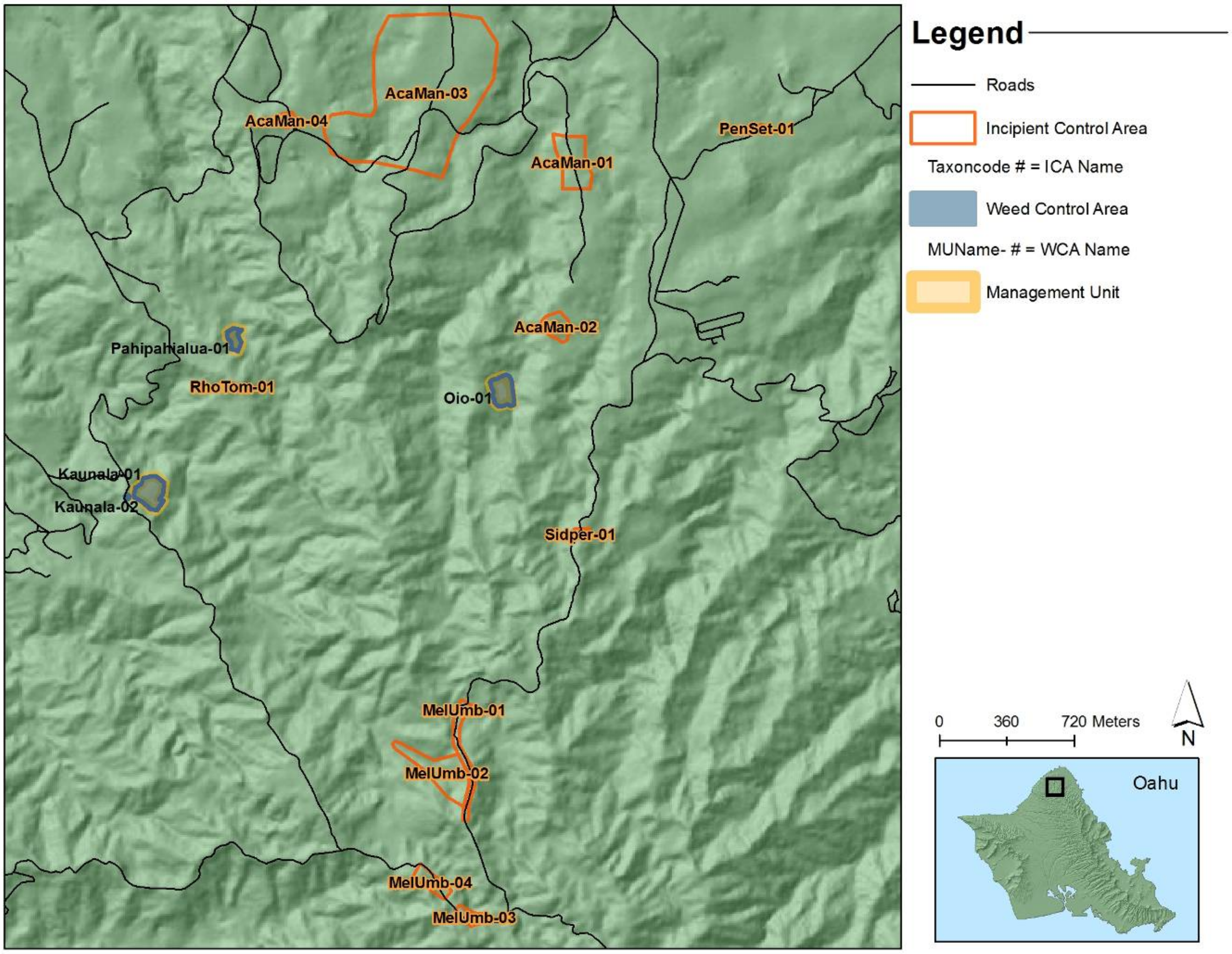
Summary of Potential ICA Target Taxa

Taxa	Management Designation	Notes	No. of ICAs
Acacia mangium	Incipient	Planted by ITAM in 2000. Four sites where OANRP is currently still finding individuals.	5
Angiopteris evecta	Widespread	Widespread in upper elevation areas in Kahuku. The leaves of this fern can form a canopy up to 5 m tall shading out most other plants in the area. High priority for control in MU fences, if found.	
Arthrostemma ciliatum	Widespread	Widespread across KTA. Of the KTA MU's only an issue at Oio. High priority for control in fenced areas. OANRP is currently using a foliar application due to the plants vegetative reproduction abilities. OANRP need to diligently decontaminate their gear to minimize seed dispersal.	0
Casuarina equisetifolia	Control locally	Widespread throughout Kahuku. High priority for control in areas near *E. kooluaensis;* do not significantly altering light levels around *E. koolauensis*.	0
Chrysophyllum oliviforme	Control locally	Widespread throughout Kahuku. *Chrysophyllum oliviforme* is a habitat modifier that creates monotypic stands. It is a high priority for OANRP to do thorough sweeps targeting *C. oliviforme* inside the MU fences as well as a 5m buffer around the fences.	0
Ficus spp.	Control locally	Widespread throughout Kahuku. Ficus *spp.* is a habitat modifier that can strangle and shade out native species. It is a high priority for OANRP to do thorough sweeps targeting *Ficus spp.* inside the MU fences as well as a 5m buffer around the fences.	0
Leucaena leucocephala	Control locally	Widespread throughout Kahuku. *Leucaena leucocephala* grows quickly and in dense thickets which crowd out any native vegetation. It is a high priority for OANRP to do thorough sweeps targeting *L. leucocephala* inside the MU fences as well as a 5m buffer around the fences.	0

Taxa	Management Designation	Notes	No. of ICAs
Leptospermum scoparium	Widespread	Widespread in upper elevation areas in Kauhuku. This small, scrubby tree forms thickets which crowd out other plants. It appears to have allelopathic activity like many other members of the Myrtaceae. Herbicide Ballistic Technology™ with James Leary has been tested on a handful of plants. If aerial control techniques become available, consider targeting this species across landscape.	
Macaranga mappa	Control locally	*Macaranga mappa* is naturalized in Kahuku. This large leaved tree forms dense thickets, crowding out other plants and forming deep shade areas. It is a high priority for OANRP to do thorough sweeps targeting *M. mappa* inside the MU fences as well as a 5m buffer around the fences.	0
Melaleuca quinquenervia	Control locally	*Melaleuca quinquinnervia* has been planted extensively in reforestation projects throughout Oahu. This is a high priority for OANRP due to the allelopathic activities of this species, as well as the ability to harbor *Puccinia psidii,*Ohia rust. OANRP staff thoroughly sweep inside MU fences as well as a 5m buffer around the MU fences.	0
Melochia umbellata	Incipient	First started control in 1999. Highly invasive, particularly on the Big Island. On Oahu, only known from KTA and Punaluu. Likely introduced via military training. There are two sites OANRP is still currently finding individuals. Other three site OANRP staff have not found since 2006. One new site found in 2010.	6
Pennisetum setaceum	Incipient	First discovered in 1998. Highly invasive grass with known tolerance of fire. Likely introduced to KTA via military training. Last plant found in 2004. Site is still monitored by OANRP annually and will continue to monitor until the seed dormancy is known. Preliminary research suggest seeds may only be viable for a year.	1
Pimenta dioica	Control locally	Widespread throughout Kahuku. High priority for control in all areas near *E. kooluaensis* without significantly altering light levels. Harbors *Puccinia* rust. Forms dense thickets. OANRP staff thoroughly sweep inside MU fences as well as a 5m buffer around the MU fences.	1
Pluchea carolinensis	Control locally	Widespread throughout Kahuku. Tends to colonize open sunny areas. High priority for control in MU fences without significantly altering light levels.	0
Psidium cattleianum	Widespread	Widespread throughout Kahuku. High priority for control in MU fences without significantly altering light levels. Forms dense monocultures. May harbor *Puccinia* rust, as it is in the Myrtaceae family.	0
Pterolepis glomerata	Widespread	This melastome is ubiquitous across the Koolaus. It thrives in disturbed areas, particularly pig wallows. OANRP do not currently target it for control. Strict sanitation measures should be followed to ensure staff do not accidentally track it to the Waianaes.	0
Rhodomyrtus tomentosa	Incipient	One immature was found in 2005. OANRP continues to monitor site. Plant possibly introduced by motocross users. Taxa widespread in the Kaneohe area, where it forms dense monocultures. Also highly invasive on Kauai.	1
Sideroxylon persimile	Incipient	One immature was Found in 2008. OANRP continues to monitor site. No information on how plant might have established in the area.	1

Taxa	**Management Designation**	**Notes**	**No. of ICAs**
Setaria palmifolia	Control locally	*Setaria palmifolia* is widespread across Kahuku. It high priority for OANRP staff to do thorough sweeps targeting *S.palmifolia* throughout the fence as well as a 5m buffer around the fences. OANRP need to diligently decontaminate their gear to minimize seed dispersal.	0
Sphaeropteris cooperi	Widespread	Widespread in the upper areas of Kahuku. High priority for control in MU fences. If aerial control techniques become available, consider controlling across the landscape.	0
Spathodea camapnulata	Control localy	Widespread throughout Kahuku. High priority for control in MU fences without significantly altering light levels.	0
Syzygium cumini	Widespread	Widespread throughout Kahuku. This large tree forms a dense cover, excluding all other species. The large black fruit are dispersed by birds and perhaps occassionally by feral pigs. OANRP staff thoroughly sweep inside MU fences as well as a 5m buffer around the MU fences.	0
Syzigium jambos	Widespread	Widespread throughout Kahuku. *S. jambos* is a major host for the *Puccinia* rust. Stands of *S. jambos* have been defoliated by the rust, although the rust does not necessarily appear to kill *S. jambos*. Dead-looking stands are highly visible from a distance. The proximity of rust reservoirs to *E. koolauensis* populations is very concerning. All *S. jambos* inside MU fences, and in a 5m buffer around the fences, are targeted for control. If aerial control options become available, consider controlling *S. jambos* stands within 1km of known *E. koolauensis*.	0

Incipient and Weed Control Areas at KTA



Ecosystem Management Weed control (WCAs)

OIP 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:

- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Reach 50% or less alien canopy cover across the MU in the next 5 years.
- 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 strategies around *E. kooluaensis* should be executed with extreme caution. When weeding the over story around *E. kooluaensis* light levels should be maintained. Weeding should be primarily focused on understory weeds around *E. kooluaensis*.

WCA: Oio-01 KTA-F

Veg Type: Mesic / Mid-Slope / Gulch

OIP Goal: 10% native cover

Targets: All weeds, focusing on *P. carolinensis, Ficus sp., C. oliviforme, P. dioica, C. equisetifolia, M. quinquenervia, M. mappa, S. campanulata, A. ciliatum, S. palmifola, L. leucocephala.*

Priority: High.

Notes: There is a wild *E. koolauensis* in this WCA. No other rare species found in the WCA. OANRP staff plan to weed around the *E. koolauensis* annually across the entire WCA once every year until OIP goals are achieved. Extreme care must be used when weeding around rare species.

WCA: East Oio-01 KTA-D

Veg Type: Mesic / Mid-Slope / Gulch

OIP Goal: 10% native cover

Targets: All weeds, focusing on *P. carolinensis, Ficus sp., C. oliviforme, P. dioica, C. equisetifolia, M. quinquenervia, M. mappa, S. campanulata, A. ciliatum, S. palmifola, L. leucocephala.*

Priority: High.

Notes: There are wild *E. kooluaensis* and reintroductions of common natives in this WCA. No other rare species found in this WCA. This WCA contains two separate areas, east and west of the dividing ridge. OANRP staff plan to work around the *E. koolauensis* twice a year and across the entire WCA once every year until OIP goals are achieved. Extreme care must be used when weeding around rare species.

WCA: Pahipahialua-01 KTA-A Pahipahialua

Veg Type: Mesic Ridges / Mesic Gulches

OIP Goal: 10% native cover

Targets: All weeds, focusing on *P. carolinesnsis, Ficus. spp., C. oliviforme, P. dioica, C. equisetifolia, M .quinquenervia, M. mappa, S. campanulata, A. ciliatum, S. palmifola, L. leucocephala* and *Grevillia robusta.*

Priority: High.

Notes: There are wild *E. kooluaensis* and reintroductions of common native species in this WCA. No other rare species found in this WCA. OANRP staff plan to work around the *E. koolauensis* twice a year and across the entire WCA once every year until OIP goals are achieved. Extreme care must be used when weeding around rare species.

WCA: Kaunala-01 KTA B/E Kaunala

Veg Type: Mesic/Mid Slope

OIP Goal: 15% native cover.

Targets: All weeds, focusing on *P. carolinesnsis, Ficus spp., C. oliviforme, P. dioica, C. equisetifolia, M. quinquenervia, M. mappa, S. campanulata, A. ciliatum, S. palmifola, L. leucocephala, G. robusta, Passiflora suberosa.*

Priority: High.

Notes: This WCA contain the highest concentration of wild *E. kooluaensis* compared to the other WCA's in the Kahuku area. No other rare species found in this WCA. OANRP staff plan to work around the *E. koolauensis* twice a year and across the entire WCA once every year until OIP goals are achieved. Extreme care must be used when weeding around rare species.

WCA: Kaleleiki-01

Veg Type: Mesic Forest

OIP Goal: 50% native cover

Targets: All weeds, focusing on*, P. cattleianum*, *C. hirta*, *C. equisetifolia, P. edulis, and P. suberosa.*

Priority: High.

Notes: There are wild *E. kooluaensis* in fence. No other rare species found in this WCA. Kaleleiki is owned by the State of Hawaii and is in a game management area. NRS needs to collaborate with the state to develop weed control strategies. The WCA is surrounded by *C. equisetifolia* requiring annual sweeps to control any immature individuals.

Rodent Control

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

Threat level: Unkown

Current control method: None

Seasonality: N/A

Number of control grids: None

Primary Objective:

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

Monitoring Objective:

- Monitor rare plant populations to determine impacts by rodents.

MU Rodent Control:

- OANRP have observed predated fruits of *Cyanea* sp. within other MUs, however no rat predation has been observed at KTA. Currently no rodent control is conducted by OANRP around the *C. koolauensis*, *E. koolau*ensis, *G. Mannii*, and *H. arboescens*. If rare plants are determined to be impacted adversely by rodents OANRP will evaluate the use of localized rodent control for the protection of rare species.

Slug Control

Species: *Unknown*

Threat level: Low

Control level: Localized

Seasonality: Wet season

Number of sites: *Cyanea koolauensis* site (1 site KTA-A)

Primary Objective:

- Determine whether slugs are present within the vicinity of *C. koolauensis*
- If present, reduce slug population to levels where germination and survivorship of *C. koolauensis* is unaffected by predation.

Management Objective:

- If slugs are present in numbers sufficient to negatively impact *C. koolauensis* seedling survival begin control program using Sluggo (if additional conservation use labeling is approved)
- By 2013, reduce slugs by at least 50% of estimated baseline densities around the *C. koolauensis* population through a pilot control program

Monitoring Objectives:

- Annual census monitoring of *C. koolauensis* seedling recruitment following fruiting events.
- Annual census monitoring of slug densities during wet season.

No slugs have been collected within this MU, however, they may be present as no focused surveys have taken place. It is unlikely that slugs are abundant given the dry habitat.

Rust Control

Species: *Puccinia psidii*

Threat level: High

Control level: Localized

Seasonality: Year round

Number of sites: Six to eight *E. koolauensis* populations

Acceptable Level o fActivity: Unknown

Primary Objective: Reduce the disease incidence (number of diseased leaves/total number of leaves) and prevent infection of new individuals.

Management Objective:

- Remove alien tree species which serve as hosts for *P. psidii (P. dioica, M. quinquenervia, Syzigium jambos, S. cumini*), particularly those upwind of *E. koolauensis*.

- Conduct research to develop fungicide treatments which are both safe and effective against rust in a field setting.

Monitoring Objectives:

- Annual monitoring of disease incidence within *E. koolauensis* population(s).
- Annual sweep of areas surrounding *E. koolauensis* to locate alien tree species which can serve as hosts to the rust.

Three methods are recommended for disease control: disease avoidance, planting resistant genotypes, and fungicide applications. A degree of disease avoidance may be achieved by removing alien trees which serve as rust hosts. OANRP plans to target host trees within 100 m of *E. koolauensis* within the boundaries of the fence line. Aerial application of herbicide is a possibility for monotypic alien tree stands such as the patch of *S. jambos* situated near the Oio population. When taking cuttings for propagation of *E. koolauensis,* it is desirable to take material from individuals with the lowest disease incidence. In practice, however, *E. koolauensis* must be propagated from whichever cuttings successfully root. A few fungicides have been effective in preventing rust infection in *M. polymorpha* but none are labeled for use on *E. koolauensis* in the wild. With permission from the Hawaii Department Agriculture, OANRP hopes to begin field testing a subset of these fungicides. If proven effective and not phytotoxic to *E. koolauensis*, an expansion of the fungicide label may be pursued.

E. koolauensis showing clusters of rust pustules (groups of urediniospores are yellow-orange in color).

Rust is most common on new leaf flush. *E. koolauensis* with rust lesions on the young leaves.

Ant Control

Species: *Leptogenys falcigera, Pheidole megacephala* confirmed

Threat level: Unknown

Control level: Only for new incipient species

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

Number of sites: Three, trailhead to Oio, Pahipahialua and Kaunala *E. koolauensis* sites
Acceptable Level of Ant Activity: Unknown

Primary Objective: Eradicate incipient ant invasions and control established populations when densities are high enough to threaten rare resources.

Management Objective:

- If incipient species are found and deemed to be a high threat and/or easily eradicated locally (<0.5 acre infestation) begin control.
- Ant populations will be kept to a determined acceptable level across the MU to facilitate ecosystem health.

Monitoring Objective:

- Sample ants at human entry points (trailhead to Oio, Pahipahialua and Kaunala). Use samples to track changes in existing ant densities and to alert NRS to any new introductions.
- Look for evidence of ant tending of aphids or scales on rare plants.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. It is therefore important to know their distribution and density in areas with conservation value. This can be accomplished using a survey methodology developed by S. Plentovich (UH Manoa). The protocol for sampling ants follows:

Place index cards (3 X 5 inches) containing SPAM, peanut butter and honey throughout the sampling area. Place card so that it is halfway out of a ziplock "sandwich" bag. Deploy a minimum of 10 cards separated by at least 15 meters and label them with the date, location, card # and collector name. Deploy cards no earlier than 8:00 am in the morning and leave them in places where ants were likely to forage (under vegetation) for 1 hour. Collect baits rapidly by slipping the card into its accompanying ziplock and immediately closing the ziplock. Bring samples in for identification.

Standardized surveys have not yet taken place. Opportunistic collection confirms that the following two species are present: *L. falcigera* and *P. megacephala*. The first species occurs in low numbers and is not considered a threat to native resources. The second is present in high numbers at Pahipahialua but does not appear to be damaging *E. koolauensis.* Both species are well established and widespread throughout Oahu, therefore any attempt at control would be temporary. While control is not recommended at this time, future surveys are needed to ensure new species are not becoming established.

Fire Control

Threat Level: Low

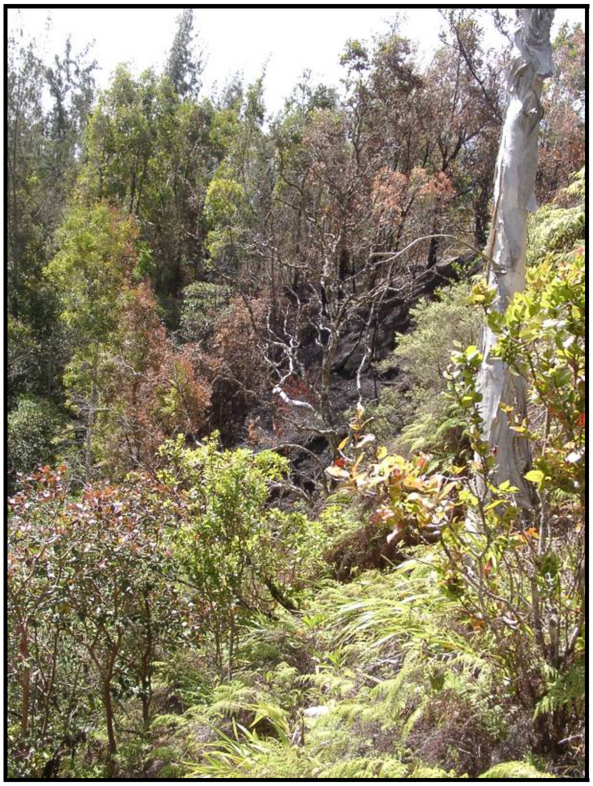
Available Tools: Fuelbreaks, Visual Markers, Helicopter Drops, Wildland Fire Crew, Red-Carded Staff.

Management Objective:

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

Preventative Actions:

There is little infrastructure to reduce the threat of fire. NRS will focus on maintaining good communication with the Army Wildland Fire Working Group to facilitate positive on-the-ground fire response. NRS will maintain red-carded staff to assist with fire response.




Burned area at Pahipahialua, stretching from ridge (point of ignition) to *E. koolauensis* location.


E. koolauensis seedling, with burned *C. equisitifolia*. Edge of fire behind *E. koolauensis* trunk.

Action Type	Actions	OIP Year 3 Oct 2010-Sept 2011				OIP Year 4 Oct 2011-Sept 2012				OIP Year 5 Oct 2012-Sept 2013				OIP Year 6 Oct 2013-Sept 2014				OIP Year 7 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct common reintro trial/monitoring																				
General Survey	Survey LZ's actively used by the army once a year																				
	Conduct road surveys of frequently used army access roads.																				
ICA	KTA-AcaMan-01:Monitor/control AcaMan at lower oio road site every 6 months. Pick and remove from field any potentially viable fruit.																				
	KTA-AcaMan-02: Monitor/control Acaman at upper oio road site every 6 months. Pick and remove from field any potentially viable fruit.																				
	KTA-AcaMan-03: Survey aerially greater Canes area every 2-3 years to facilitate control efforts.																				
	KTA-AcaMan-03: Monitor/control AcaMan at Canes complex. Sweep entire ICA every 6 months. Pick and remove from field any potentially viable fruit. Track weeding effort with GIS; large ICA																				
	KTA-AcaMan-04: Monitor/control AcaMan at Puu 804 every 6 months. Pick and remove from field any potentially viable fruit.																				
	KTA-Melumb-01: Monitor/control Melumb at roadside core quarterly. Pick and remove from field any potentially viable fruit.																				
	KTA-Melumb-01: Spray roadside with Garlon/Roundup mix to faciliatate survey/detection. Every 6 months or as needed.																				

Action Type	Actions	OIP Year 3 Oct 2010- Sept 2011				OIP Year 4 Oct 2011- Sept 2012				OIP Year 5 Oct 2012- Sept 2013				OIP Year 6 Oct 2013- Sept 2014				OIP Year 7 Oct 2014- Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	KTA-MelUmb-02: Monitor/control MelUmb at Kaunala/off-road site. Pick and remove from field any potentially viable fruit. Flag locations of any plants found to facilitate later follow-up. Visit all hot spots and sweep upper portion of ICA quarterly. Track weeded																				
	KTA-MelUmb-02: Survey aerially every 2-3 years to facilitate control efforts.																				
	KTA-MelUmb-02: Monitor lowest know plant site (in gulch) annually.																				
	KTA-MelUmb-03: Monitor/control MelUmb at west outlier site annually. Pick and remove from field any potentially viable fruit.																				
	KTA-MelUmb-04: Monitor/control MelUmb at east outlier site annually. Pick and remove from field any potentially viable fruit.																				
	KTA-MelUmb-05: Monitor/control MelUmb at delta farmer's gate site annually. Pick and remove from field any potentially viable fruit.																				
	KTA-PenSet-01: Monitor/control Penset at watertank hill road site annually.																				
	KTA-RhoTom-01: Monitor/control RhoTom on road below Puu 1010 annually.																				
	KTA-Sidper-01: Survey around known ICA to distance of 200m. Verify that SidPer not present elsewhere. Update ICA shape. GPS.																				
	KTA-Sidper-01: Monitor/control SidPer at charlie road site annually.																				

Action Type	Actions	OIP Year 3 Oct 2010- Sept 2011				OIP Year 4 Oct 2011- Sept 2012				OIP Year 5 Oct 2012- Sept 2013				OIP Year 6 Oct 2013- Sept 2014				OIP Year 7 Oct 2014- Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General WCA	GPS boundaries of all existing WCAs. Use geographical and vegetation data. Use landmarks to mark in field																				
	GPS trails																				
	Determine whether Oio will remain a MFS population, or if Kaleleiki will replace it as an MFS population. Revise plan accordingly																				
	Evaluate *E. koolauensis* Aimuu site to determine need for weed control. Obtain permission from land owner for access.																				
Aimuu No MU	Conduct weed control across (proposed) exclosure annually. This is a genetic storage population. Focus around Eugkoo; exercise extreme care around Eugkoo seedlings. Target understory weeds. Control canopy weeds gradually to prevent major light changes.																				
EastOio-01	Conduct weed control across (proposed) exclosure annually. This is a genetic storage population. Focus around Eugkoo; exercise extreme care around Eugkoo seedlings. Target understory weeds. Control canopy weeds gradually to prevent major light changes.																				
Kaunala -01	Control weedy grasses across exclosure as needed. Focus around native plants, Eugkoo, but exercise care around Eugkoo seedlings. Target Oplhir, Pascon.																				
	Target Casgla/equ, Melqui, Eucrob, Grerob and other very large potentially allelopathic trees for removal.																				

Action Type	Actions	OIP Year 3 Oct 2010-Sept 2011				OIP Year 4 Oct 2011-Sept 2012				OIP Year 5 Oct 2012-Sept 2013				OIP Year 6 Oct 2013-Sept 2014				OIP Year 7 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Conduct weed control across exclosure, focusing on areas around Eugkoo first, then around other native species, then on connecting these areas. Target understory, gradually control canopy (minimize light change). Use volunteers whenever possible.																				
	Maintain clear LZ as needed. May not need, as road now runs through LZ.																				
Kaleleiki -01	Conduct weed control across the exclosure every 6 months/year. This is a genetic storage population. All management actions to be cleared with the State. Exercise extreme care around Eugkoo seedlings. Focus on understory weed control.																				
	Control grass (Pascon) across the exclosure every 6 months/year. This is a genetic storage population. All management actions to be cleared with the State. Exercise extreme caution around Eugkoo seedlings.																				
Oio -01	Control weedy grasses across exclosure as needed. Focus around native plants, Eugkoo, but exercise care around Eugkoo seedlings. Target Oplhir, Pascon.																				
	Conduct weed control across exclosure, focusing on areas around Eugkoo first, then around other native species and common reintroductions, then on connecting these areas. Target understory, gradually control canopy (minimize light change). Use volunteers whenever possible.																				

Action Type	Actions	OIP Year 3 Oct 2010-Sept 2011				OIP Year 4 Oct 2011-Sept 2012				OIP Year 5 Oct 2012-Sept 2013				OIP Year 6 Oct 2013-Sept 2014				OIP Year 7 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Pahipahialua - 01	Control weedy grasses across exclosure as needed. Focus around native plants, Eugkoo, but exercise care around Eugkoo seedlings. Target Oplhir, Pascon.																				
	Conduct weed control across exclosure, focusing on areas around Eugkoo first (3 subgulches), then around other native species and common reintroductions, then on connecting these areas. Target understory, gradually control canopy (minimize light change).																				
Ungulate Control	Kaleleiki- Monitor and maintain fence integrity																				
	Kaunala- Monitor and maintain fence integrity																				
	Oio- Monitor and maintain fence integrity																				
	Pahipahialua- Monitor and maintain fence integrity																				
Rodent Control	Monitor rare plants for predation by rodents																				
	Implement localized rodent control if determined to be necessary for the protection of rare plants.																				
Slug Control	Monitor slug activity at *C. koolauensis* site																				
	Monitor *C. koolauensis* seedling recruitment following fruiting events																				
	If slugs found to exceed acceptable levels during monitoring, maintain slug bait at sensitive plant population(s)																				
Rust Control	Remove alien host trees																				
	Survey E. koolauensis for rust																				
	Test fungicides, pursue label expansion if feasible																				
Ant Control	Conduct surveys for ants at human entry points annually																				
	Implement control if deemed necessary																				

hatched=planned Qtr

1.3.3 Lower Ohikilolo

Ecosystem Restoration Management Plan

MIP Year 7-11, Oct. 2010 – Sept. 2015

MU: Lower Ohikilolo

Overall MIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, rodent, fire, and weed threats to support stable populations of IP taxa. Implement control methods by 2013.

Background Information

Location: Northern Waianae Mountains

Land Owner: US Army Garrison Hawaii

Land Manager: Oahu Army Natural Resources Program (OANRP)

Acreage: 10.5

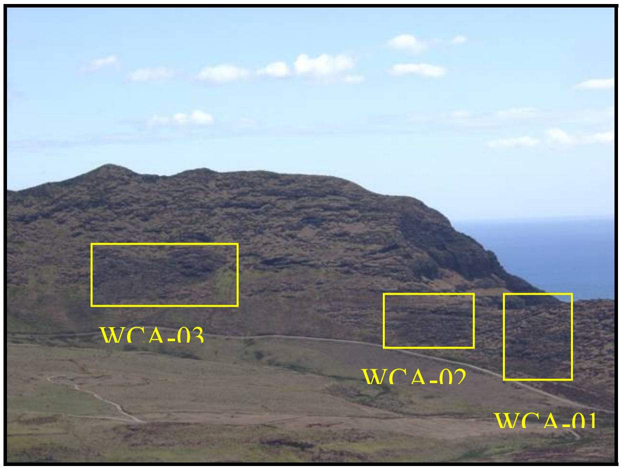
Elevation Range: 100 – 400ft.

Description: Lower Ohikilolo MU is located in the Makua Military Reservation (MMR). It lies in the southwestern corner of Makua valley, on the bottom section of Ohikilolo ridge that curves to parallel the ocean. This MU is accessed via the Makua firebreak road and consists of rocky cliffs. While the MU is home to large populations of endangered plants, the overall landscape is highly degraded and weedy, and very fire-prone. The majority of rare taxa management is focused on reducing fuel loads to minimize the risk of fire. Overall, Lower Ohikilolo is dominated by *Panicum maximum* which requires substantial labor to manage. Thus NRS will not manage the entire MU to the same level. Weed control will be focused only around the rare plant populations which consist mostly of weedy grasses and shrubs. However, as a consequence of recent OANRP weeding actions, the WCA's are increasingly being dominated by native shrubs and plants including the endangered *Chamaesyce celastroides* var. *kaenana* and *Hibiscus brackenridgei* subsp. *mokuleianus* populations.

Native Vegetation Types

Waianae Vegetation Types
Lowland Dry Shrubland/ Grassland
Canopy includes: *Erythrina sandwicensis*, *Myoporum sandwicense, Dodonaea viscosa, Santalum ellipticum, Melanthera tenuifolia, Hibiscus brackenridgei* subsp. *mokuleianus.* Understory includes: *Heteropogon contortus, Sida fallax, Eragrostis variabilis, Abutilon incanum, Leptecophylla tameiameiae, Chamaesyce celestroides, Waltheria indica, Bidens* sp.
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

Vegetation Types at Lower Ohikilolo



Map removed to protect rare resources

Lower Ohikilolo MU.

C. celastroides var. *kaenana* patch

Map removed to protect rare resources

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

MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Chamaesyce celastroides* var. *kaenana*	MMR-D	Makua	Manage for Stability	Wild
Plant	*Hibiscus brackenridgei* subsp. *mokuleianus*	MMR-A MMR-F	Makua	Manage for Stability Manage for Stability	Wild Augmentation
Plant	*Melanthera tenuifolia*	MMR-D	Ohikilolo	Genetic Storage Collection	Wild

MFS= Manage for Stability GSC= Genetic Storage Collection

Locations of Rare Resources at Lower Ohikilolo

Map removed, available upon request

MU Threats to MIP Taxa

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

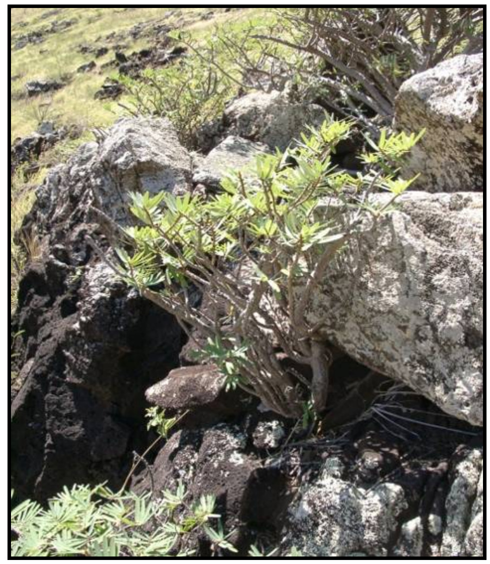
*Note: Localized control is distinct unit within the MU separated by geographic or fence barrier

Other Rare Taxa at Lower Ohikilolo MU

Organism Type	Species	Status
Plant	*Capparis sandwicensis*	Species of concern
Plant	*Spermolepis hawaiiensis*	Endangered

Rare Resources at Lower Ohikilolo

Hibiscus brackenridgei subsp. *mokuleianus*



Chamaesyce celastroides var. *kaenana*

Spermolepis hawaiiensis

Melanthera tenuifolia

Management History

- 1970: Fire from military training burns Makua Valley
- 1984: Fire from military training burns Makua Valley
- 1995: Escaped prescribed fire in Makua burns part of the valley
- 1998: Fire burns part of Lower Ohikilolo MU.
- 1998: Live fire training ceased as a result of a law suit by Malama Makua.
- 2000: Perimeter fence was completed that separates Makua Valley from the adjoining Ohikilolo Ranch.
- 2001: *H. brackenridgei* subsp. *mokuleianus* and *Chamaesyce celastroides* var. *kaenana* found at MU.
- 2001: Grass control begins.
- 2003: Escaped prescribed fire in Makua burns half of the valley.
- 2003: A breach in the fence allows goats to cross over into Makua Valley. Goats are removed and fence is repaired.
- 2005: Augmentation of *H. brackenridgei* subsp. *mokuleianus* begins with outplantings.
- 2006: Breach in the fence is repaired and goats are caught.
- 2007-2008: Needed repairs are made in the Ohikilolo ridge fence, goats continue to breach some areas of the fence.

Ungulate Control

Identified Ungulate Threats: Pigs and Goats

Threat Level: High

Primary Objective:

- Maintain all of Makua valley as goat free.

Secondary Objective:

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

Strategy:

- Ohikilolo ridge fence creates a barrier for goat access from Ohikilolo Ranch and Makaha Valley, while pig activity in the area has historically been minimal.

Monitoring Objectives:

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

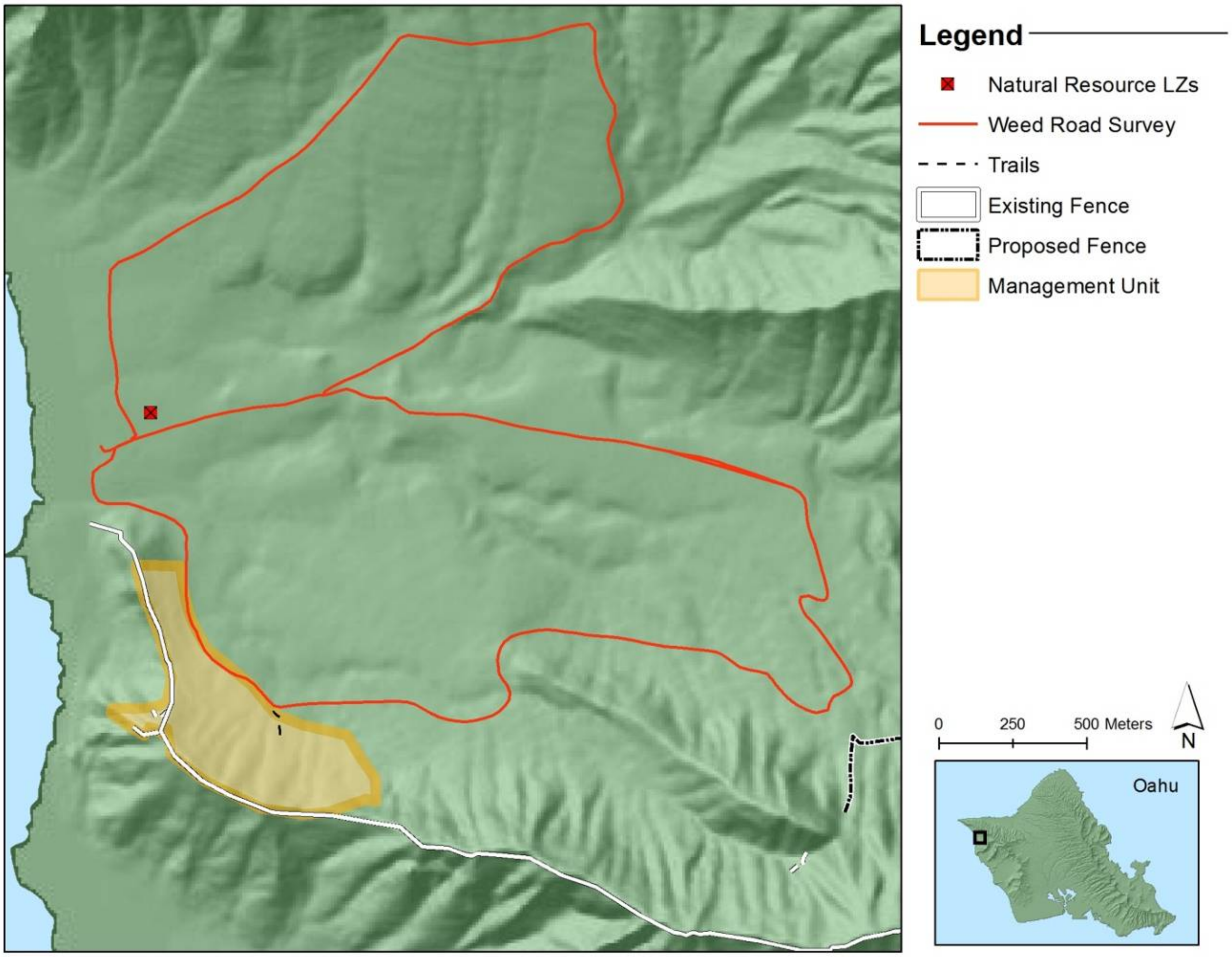
Management Responses:

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

Maintenance Issues

- The major threats to the Ohikilolo Ridge fence include fire, vandalism, and erosion.

Ungulate Management and Survey Locations at Lower Ohikilolo



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:

- Due to small size and highly degraded nature of MU, transect protocols implemented at other MUs are not appropriate here. Instead, we assume current alien vegetation management practices are sufficient to decrease fuels and increase the rare plant populations. Recruitment of new rare taxa seedlings and increase of native plant vegetation will be monitored to determine if time intervals between scheduled weeding are sufficient.

Surveys

Army Training: Yes

Other Potential Sources of Introduction: Public visitors, Natural Resource Management staff, Makua access events, close proximity to road.

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

Management Objective:

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

Monitoring Objectives:

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

Management Responses:

- New weeds found during surveys and will be added as ICA's if they are deemed a serious threat to the MU. MMR-NoMU firebreak road surveys and LZ's are managed, as weed control of these areas is necessary to prevent fire from reaching endangered taxa.

Incipient Taxa Control (ICAs)

Management Objective:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2015.
- Seed dormancy trials for *P. setaceum*.

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. NRS will compile this information for each ICA species. ICA species include *Pennisetum setaceum* and *Caesalpinia decapetala*. During regular actions, the occurrence of *P. setaceum* ICA is monitored, and *C. decapetala* is checked during the firebreak road survey.

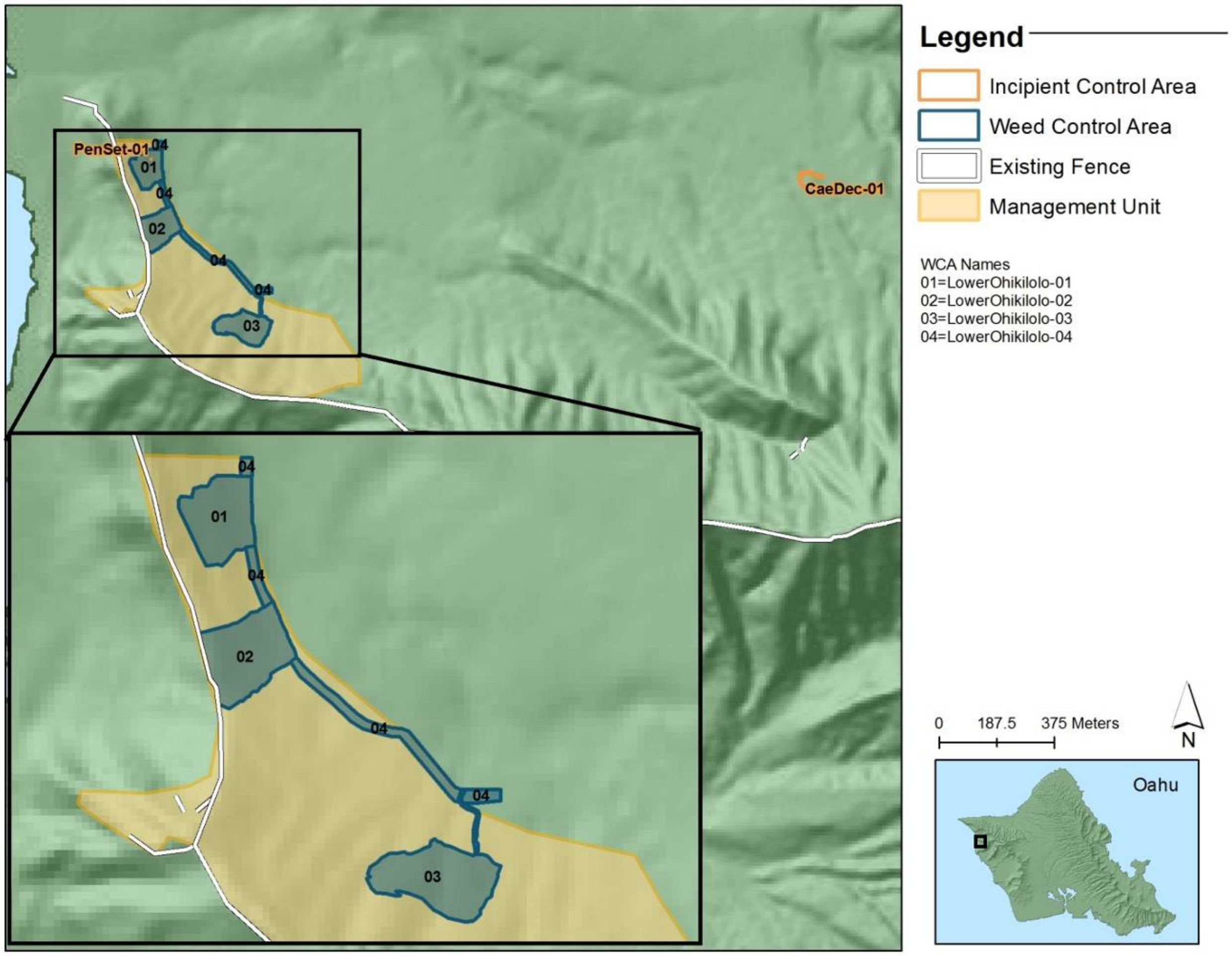
The table below summarizes incipient invasive taxa at Lower Ohikilolo. Appendix 3.1 of the MIP lists significant alien species and ranks their potential invasiveness and distribution. Each species is given a weed management code: 0 = not reported from MU, 1 = incipient (goal: eradicate), 2 = control 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. NRS 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. ICAs are not designated for every species in the table below; however, occurrences of all species in the table should be noted at Lower Ohikilolo.

Summary of Potential ICA Target Taxa

Taxa	MIP Weed Code		Discussion/Notes	No. of ICAs
	Original	Revised		
C. decapetala	1	1	Old point found on road survey. Monitor for future spread on survey.	1
P. setaceum	1	1	Monitor/control PenSet in Lower Chamaesyce patch annually. Only 1 plant ever found here in 2006.	1

Staff working around *C. celastroides*

Incipient and Weed Control Areas at Lower Ohikilolo



Ecosystem Management Weed Control (WCAs)

MIP Goals:

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

Management Objectives:

- Throughout remainder of MU (Priority 2) to reach 50% or less alien vegetation cover. This is the tan shaded area on the WCA map (see above)

Management Responses:

- Increase/expand weeding efforts if current management is insufficient to stop weed spread or shorter intervals are needed between weeding efforts

Weed control in Lower Ohikilolo by OANRP has mostly been conducted around populations of wild and reintroduced rare plants. The overall weed management strategy for the MU is focused on fuel reduction of large patches of *Panicum maximum* and *Rhynchelytrum repens*. A 20m buffer around the outside of each WCA will be cleared as an additional weed control strategy, where removal of *Leucaena leucocephala* will be a priority. Herbicide control of weeds is varied, with Fusilade, a grass-specific herbicide, used around rare taxa, along with hand-pulling weeds. Roundup is applied to the remainder of the WCA; while Oust, a pre-emergent herbicide, is applied downslope of rare taxa to suppress the seed bank after initial knockdown of weeds using Roundup. To prevent re-sprouts of *L. leucocephala* in the extended buffer area around the WCA's, Garlon is applied. Much of the native cover in Lower Ohikilolo is dominated by *Dodonaea viscosa, Waltheria indica*, *Abutilon incanum*, *Sida fallax,* and *Santalum ellipticum. D. viscosa* are numerous throughout the MU and provide shade for a break in monotypic areas of *P. maximum*. The MU is very weedy except for patches around *D. viscosa*, and these weeds include *P. maximum*, *L. leucocephala, Leonotis nepetifolia*, *R. repens*, and *Acacia farnesiana*.

Lower Ohikilolo WCA-01 (Lower Chacel)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 25% non-native cover

Targets: *P. maximum*, *L. leucocephala, L. nepetifolia*

Notes: *C. celastroides* var. *kaenana* is centered in this WCA. This area is very steep with exposed rock faces, with the bottom of the WCA tapering off to a flat area. Weedy grasses are prevalent throughout the WCA, especially near the top and bottom. The WCA is very dry with limited overstory and is dominated by non-native *P. maximum*, *L. leucocephala, L. nepetifolia*, *R. repens*, and *A. farnesiana*, and the natives *W. indica*, *A. incanum*, *S. fallax*. Overstory taxa are limited to the native *D. viscosa*. Treatment of weeds is done by backpack sprayer and handpulling around managed taxa. A change in weed composition from *P. maximum* and *R. repens* to monotypic *L. nepetifolia* has recently occurred following the application of Oust near the bottom of the patch.

Lower Ohikilolo WCA-02 (Upper Chacel)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 25% non-native cover

Targets: *P. maximum*

Notes: *C. celastroides* var. *kaenana* is centered in this WCA. This area is very steep with exposed rock faces leading up to the ridgeline. Large *D. viscosa* are filling in the WCA following control of monotypic *P. maximum*. The WCA is dominated by non-native *P. maximum*, *L. leucocephala, L. nepetifolia*, *R. repens*, *A. farnesiana* and the natives *W. indica*, *S. ellipticum*, *A. incanum*. Overstory taxa are limited to the native *D. viscosa*. Treatment of weeds is done by backpack sprayer and handpulling around managed taxa.

Lower Ohikilolo WCA-03 (Hibbra Patch)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 25% non-native cover

Targets: *P. maximum*

Notes: *H. brackenridgei* is centered in this WCA, which is the largest in the MU. The topography is a combination of rocky cliff faces and rocky slopes, with a mix of rocky and deep soils. Hand weeding is done around emerging seedlings, as well as backpack spraying for large grass areas. This WCA is dominated by grasses *P. maximum* and *R. repens*. The overstory contains more mature *D. viscosa* than the other WCA's, most of which have newly emerged since weed control began. As with the other WCA's in this MU, the area is very dry, steep, and rocky. Additional weeds include *L. leucocephala, L. nepetifolia*, *R. repens*, *B. pilosa*, *A. farnesiana* and *A. adenophora*.

Lower Ohikilolo WCA-04 (Roadway)

Veg Type: Dry Shrubland/Grassland

MIP Goal: Less than 50% non-native cover

Targets: *P. maximum*

Notes: The roadside stretches beneath WCA's 1, 2, and 3. These areas are dominated by *P. maximum* and *L. nepetifolia*. The goal of this MU is to expand the road fuel break and protect the entire MU from fire. Additional weeds include *L. leucocephala, L. nepetifolia*, *R. repens*, *B. pilosa*, *A. farnesiana* and *A. adenophora*. Trials of herbicide mixtures have also been conducted along this WCA. Control of weeds in this WCA is generally done using a powersprayer. Annual road surveys are conducted to monitor the spread of target weeds across WCA's.

Rodent Control

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

Threat level: Unkown

Current control method: None

Seasonality: N/A

Number of control grids: None

Primary Objective:

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

Monitoring Objective:

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

MU Rodent Control:

- Currently no rodent control is conducted by OANRP around these taxa since rodents are not deemed a threat at this time. If rare plants are determined to be impacted adversely by rodents OANRP will evaluate the use of localized rodent control for the protection of these species.

Ant Control

Species: Unknown

Threat level: Unknown

Control level: Unknown

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

Number of sites: One; *Chamaesyce celastroides* var. *kaenana* population

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

Primary Objective: Collect data on species present and control if ant densities are high enough to threaten rare resources.

Management Objective:

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

Monitoring Objective:

- Sample ants at *Chamaesyce celastroides* var. *kaenana* population. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- Look for evidence of ant tending of aphids or scales on rare plants.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and 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). The protocol for sampling ants appears in Appendix 6-1 (this document.)

Standardized surveys have not yet taken place.

Fire Control

Threat Level: High

Available Tools: Fuelbreaks, Visual Markers, Helicopter Drops, Wildland Fire Crew, Red-Carded Staff.

Management Objective:

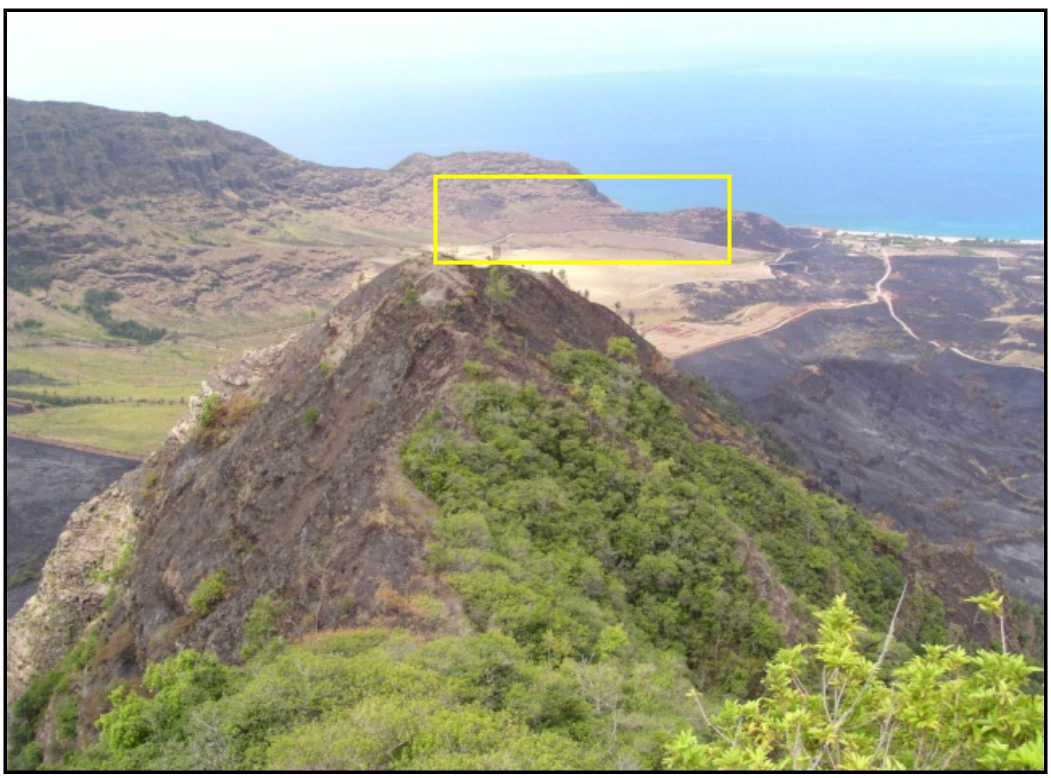
- To prevent fire from burning any portion of the MU at any time.

Preventative Actions

Fire control in the Lower Ohikilolo MU is focused on fuel-break construction and management. Backpack spraying of herbicide is used to control grasses and weeds while reducing the fuel load of the area. The threat of fire is high due to the large fuel load and hot, dry climate, and many fires are intentionally set by vandals along the Farrington Highway, near the MU. These fires are set regularly and create a high risk of burning over Ohikilolo Ridge and into the MU area. Future weed control along the ridge on the outside of the MU fence will be implemented during scheduled WCA spraying to limit the risk of fire burning over the ridge and into the MU. Removal of the most fire prone weeds (*A. farnesiana, L. leucocephela* and *P. maximum)* remains a high priority within the MU. Sprayed areas with large patches of dead grass are also weedwacked to reduce standing dead vegetation and create a buffer around endangered taxa. Plans are in place to cut an additional 20m buffer, extending the entire weed control area around each managed plant population. OANRP will focus on maintaining good communication with the Wildland Fire Working Group to facilitate positive on-the-ground fire response in the event of another fire. OANRP will maintain red-carded staff to assist with fire response.

C. celastroides area burned by 2003 Makua fire.

Lower Ohikilolo fire view from the North.



View of Lower Ohikilolo fire from C-Ridge

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-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General Survey	Survey both north and south firebreak roads.																				
	Range control LZ survey																				
	Water catchments: repair/maintain as needed. 3 catchements in MU.																				
ICA	PenSet-01: Monitor/control PenSet in Lower Chamaesyce patch annually. Only 1 plant found here. Pick and remove from field any potential mature fruit.																				
	CaeDec-01: Monitor for future spread, old point/ road survey																				
Lower Ohikilolo-01: Lower Chacelkae	Control grasses and herbaceous weeds across entire WCA (excluding marked rare plant zones) quarterly, as needed. Goals: maintain low fuel levels, encourage native recruitment. Primary control methods: spraying, weedwhacking. Only use Oust downslope of endangered plants.																				
	Control weeds in marked rare plant zones quarterly/as needed. Exercise extreme care when working/spraying around rare taxa and seedlings; use Fusilade, handpulling, NO Oust.																				
	Control woody weeds (LeuLeu, Acafar) across the entire WCA annually. Goal: reduce/maintain coverage at 0%.																				
Lower Ohikilolo-02: Upper Chacelkae	Control grasses and herbaceous weeds across entire WCA (excluding marked rare plant zones) quarterly, as needed. Goals: maintain low fuel levels, encourage native recruitment. Primary control methods: spraying, weedwhacking. Only use Oust downslope of endangered plants.																				

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-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control weeds in marked rare plant zones quarterly/as needed. Exercise extreme care when working/spraying around rare taxa and seedlings; use Fusilade, handpulling, NO Oust.																				
	Control woody weeds (LeuLeu, Acafar) across the entire WCA annually. Goal: reduce/maintain coverage at 0%.																				
Lower Ohikilolo-03: Hibbra patch	Control grasses and herbaceous weeds across entire WCA (excluding marked rare plant zones) quarterly, as needed. Goals: maintain low fuel levels, encourage native recruitment. Primary control methods: spraying, weedwhacking. Only use Oust downslope of endangered plants.																				
	Create/maintain buffer fuel break around entire LowerOhikilolo-03. ADD NEW WCA IF THIS ACTION COMPLETED																				
	Control weeds in marked rare plant zones quarterly/as needed. Exercise extreme care when working/spraying around rare taxa and seedlings; use Fusilade, handpulling, NO Oust.																				
	Control woody weeds (LeuLeu, Acafar) across the entire WCA annually. Goal: reduce/maintain coverage at 0%.																				
Lower Ohikilolo-04: Roadway	Control grasses, broadleaves along road corridor quarterly, as needed. Goal: maintain fuel break along road. Use powersprayer.																				
Rodent Control	Monitor rare plants for predation by rodents																				
	Implement localized rodent control if determined to be necessary for the protection of rare plants																				

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-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Ant Control	Sample ants at *Chamaesyce celastroides* var. *kaenana* population																				
	If ants exceed acceptable level begin control																				
Ungulate Control	Melten MMR-D fence: Fence maintanence																				
	Melten MMR-D fence: Fence monitor																				

Hatching=Quarter Schedule

1.3.4 Makaha

Ecosystem Restoration Management Plan

MIP Year 7-11, Oct. 2010 – Sept. 2015

OIP Year 4-8, Oct. 2010 – Sept. 2015

MU: Makaha Subunits I and II

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 in Subunits II and III by 2015.

Background Information

Location: Northern Waianae Mountains

Land Owner: Honolulu Board of Water Supply

Land Manager: Oahu Army Natural Resources Program (OANRP)

Acreage: Subunit I (MIP): 85 acres

Subunit II (MIP-proposed): ~30 acres

Kamaili (OIP-proposed): ~25 acres

Total fenced: 175 acres

Elevation Range: 1,600 – 2,740 ft.

Description: Makaha Valley is located on the leeward side of the northern Waianae Mountains. Precipitation from Mt. Kaala provides the headwater for an intermittent stream in the back of the valley that often flows during the winter months. The Subunit I (85-acre) fence is located on the southern side of the valley, facing north. The lowest line of Subunit I is approximately 200ft. in elevation above the Makaha Stream. The bottom fence line crosses four gulches leading towards the eastern fence line. The fence then travels up a moderately sloped ridge to the crest line west of the Kumaipo saddle. The top line continues west on Kamaileunu Ridge and crosses the to the north side of the "no name" or Cable Puu. The fence line then continues down the steep narrow ridge of the makai line. There are several portions of the fence that use cliffs and steep gulch slopes strategically. The lower habitat is dominated by strawberry guava and coffee, but becomes more diverse at higher elevations, with a mix of native and non-native components. Near the top of the exclosure, the terrain gets very steep with some vertical cliff areas which host a variety of rare native plants.

The proposed Subunit II fence (~30 acres) has not been completed yet but a line has been scoped and is slated to be completed in 2011. This fence was originally proposed to be 65 acres but was scaled down to about 30 acres. Ground surveys revealed that most of the lower half of the proposed fence was monotypic strawberry guava and coffee stands with little native components for restoration work. Beginning at the top easternmost corner of Subunit I, this fence line goes toward Kaala along Kumaipo Saddle to a point below Three Poles. The fence then will head down, toward the Makaha Valley stream, for about 100 meters and then turn back toward the Subunit I fence. The fence line will maintain a line

100 meters below Kumaipo Saddle back to the Subunit I fence. The vegetation is predominantly non-native except for a small native band that this new fence line encompasses.

The Kamaili fence (~25 acre) has not been completed yet but a line has been scoped and is slated to be completed in 2011. This fence will be built around wild populations of *Abutilon sandwicensis* and *Flueggea neowawraea*.

Native Vegetation Types

Waianae Vegetation Types
Mesic mixed forest
Canopy includes: *Acacia koa*, *Metrosideros polymorpha, Nestigis sandwicensis, Diospyros* spp., *Pouteria sandwicensis, Charpentiera* spp., *Pisonia* spp., *Psychotria* spp., *Antidesma platyphyllum*, *Bobea* spp. and *Santalum freycinetianum*. Understory includes: *Alyxia stellata, Bidens torta, Coprosma* spp., and *Microlepia strigosa*
NOTE: For MU monitoring purposes vegetation type is assigned based on theoretical pre-disturbance vegetation. Alien species are not noted.
NOTE: For MU monitoring purposes, vegetation types were subdivided using topography (gulch, mid-slope, ridge). Topography influences vegetation composition to a degree. Combining vegetation type and topography is useful for guiding management in certain instances.

Primary Vegetation Types at Makaha

Mesic Gulch

Mesic Mid-Slope

Mesic Ridge

MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction/ Future Reintro
Plant	*Abutilon sandwicense*	MAK-B MAK-D MAK-E	Makaha Makai Makaha Makai Makaha Mauka	MFS MFS GSC	Wild
Plant	*Alectryon macrococcus* var. *macrococcus*	MAK-A MAK-B MAK-D MAK-E	Makaha	MFS	Wild
Plant	*Cenchrus agrimonioides* var. *agrimonioides*	MAK-A MAK-B†	Makaha	MFS	Reintroduction
Plant	*Chamaesyce herbstii*	MAK-A	Makaha	MFS	Reintroduction
Plant	*Cyanea grimesiana* subsp. *obatae*	MAK-A MAK-B†	Makaha	MFS	Wild Future Reintro
Plant	*Cyanea longiflora*	MAK-A MAK-B†	Makaha	MFS	Wild Future Reintro
Plant	*Cyanea superba* subsp. *superba*	MAK-A	Makaha	MFS	Reintroduction
Plant	*Dubautia herbstobatae*	MAK-A MAK-B MAK-C MAK-D	Kamaileunu Makaha Makaha/Ohikilolo Makaha/Ohikilolo	GSC MFS GSC GSC	Wild

Organism Type	**Species**	**Pop. Ref. Code**	**Population Unit**	**Management Designation**	**Wild/ Reintroduction/ Future Reintro**
Plant	*Flueggea neowawraea*	MAK-A MAK-B MAK-C MAK-D MAK-E MAK-G MAK-G MAK-I	Makaha	MFS	Wild Wild Wild Wild Wild Reintroduction Reintroduction Reintroduction
Plant	*Hesperomannia arbuscula*	MAK-A MAK-B†	Makaha Makaha	MFS	Wild
Plant	*Melanthera tenuifolia*	MAK-A MAK-B MAK-C MAK-D MAK-E MAK-F MAK-G MAK-H	Kamaileunu and Waianae Kai	MFS	Wild
Plant	*Neraudia angulata*	MAK-A MAK-B MAK-C	Makaha	GSC	Wild
Plant	*Nototrichium humile*	MAK-A MAK-B MAK-D MAK-E	Makaha	GSC	Wild
Plant	*Phyllostegia kaalaensis*	MAK-A	Makaha	MFS	Reintroduction
Plant	*Schiedea nuttallii*	MAK-A MAK-B†	Makaha	MFS	Reintroduction Future Reintro
Plant	*Schiedea obovata*	MAK-A† MAK-B†	Makaha	MFS	Future Reintro
Plant	*Viola chamissoniana* subsp. *chamissoniana*	MAK-A MAK-B MAK-C MAK-D MAK-F MAK-G	Kamaileunu Makaha Kamaileunu Makaha/Ohikilolo Makaha Makaha	GSC MFS GSC GSC MFS MFS	Wild
Snail	*Achatinella mustelina*	MAK-A, MAK-B, MAK-C, MAK-D, MAK-E	Makaha	MFS	Wild
Bird	*Chasiempis ibidis*		Makaha	GSC	Wild

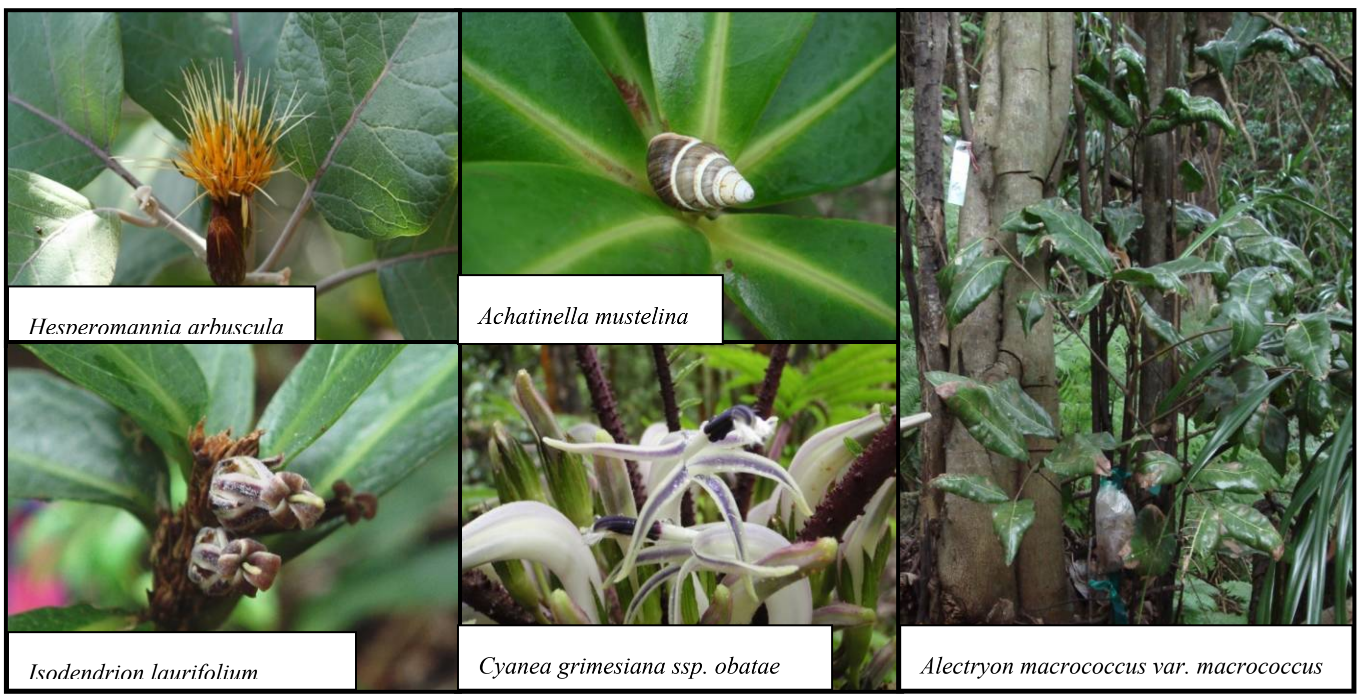
MFS= Manage for Stability *= Population Dead

GSC= Genetic Storage Collection †=Reintroduction not yet done

Other Rare Taxa at Makaha MU

Organism Type	Species	Status
Plant	*Cyanea membranacea*	Rare
Plant	*Diellia falcata*	Endangered
Plant	*Gouania meyenii*	Endangered
Plant	*Isodendrion laurifolium*	Endangered
Plant	*Joinvillea ascendens var. ascendens*	Candidate
Plant	*Labordia kaalae*	Rare
Plant	*Lobelia niihauensis*	Endangered
Plant	*Melicope makahae*	Candidate
Plant	*Platydesma cornuta* var. *decurrens*	Endangered
Plant	*Pteralyxia macrocarpa*	Candidate
Plant	*Schiedea hookeri*	Endangered
Plant	*Strongylodon ruber*	Rare
Plant	*Sicyos lanceoloidea*	Endangered
Plant	*Tetraplasandra kavaiensis*	Rare
Snail	*Amastra spirozona*	Rare

Rare Resources of Makaha



Hesperomannia arbuscula

Achatinella mustelina

Isodendrion laurifolium

Cyanea grimesiana ssp. obatae

Alectryon macrococcus var. macrococcus

Locations of Rare Resources at Makaha Subunit I

Map removed, available upon request

Locations of Rare Resources at Makaha Subunit II

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	Yes.
Goats	All	No	Yes	Yes
Rats	All	Yes	Unknown	Yes
Predatory snails	*A. mustelina*	Yes	No	Limited to hand-removal and physical barriers. No control currently conducted.
Slugs	*C. grimesiana* subsp. *obatae, C. longiflora, C. superba* subsp. *superba, S. nuttallii, S.obovata, P. kaalaensis*	Yes	No	Label expansion being sought for Sluggo. No control currently
Ants	Unknown, possibly a threat to native snails, arthropods, plants and birds	Yes	No	No control programs currently
Black Twig Borer (BTB)	*F. neowawraea, A. macrococcus* var. *macrococcus*	Yes	No	No proven methods currently available
Weeds	All	Yes	Yes	Yes
Fire	All	No	Yes	Yes

Management History

Makaha has a diverse history of management dating back to the early Polynesian era. Over the years the landscape has gone through drastic changes in vegetation due to various land uses and practices.

- Early 1800's Makaha ahupuaa ruled by a Hawaiian chief named Kanepaiki
- 1850 High Chief Paki was awarded title to the ahupuaa of Makaha through the Mahele
- 1855 the Robinson firm purchased Makaha Valley for $5000 in gold
- Late 1800's sugar plantation attempted and failed in Makaha Valley
- 1886 Landowner August Ahrens plants the first coffee trees in Makaha Valley as a 45-acre coffee plantation
- 1893 James Lowe also attempts to farm coffee in Makaha Valley
- 1987 Board of Water Supply gains control of water resources and management of Makaha Valley
- 1999: OANRP begins management in Makaha
- August 2005, Guava plots installed on camp ridge by NRS with UH Botany
- 2005 Subunit I fenceline scoped and EA approved
- September 2006 Subunit I fence construction begins
- September 2006, work trips initiated with Waianae high school students
- August 2007 Subunit I fence construction finished
- 2005-2009 Rat baiting for *Chasiempis ibidis* conducted
- August 2009 Subunit I declared pig free

- August-October 2009 Vegetation monitoring
- January 2010 Subunit II fenceline scoped
- March 2010 Kamaili fenceline scoped

Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Primary Objectives:

- Maintain Subunit I fence as ungulate-free.
- Construct Subunit II fence and remove any pigs within fence.
- Construct Kamaili fence and remove any pigs within fence.

Strategy:

- Maintain Subunit I as pig-free by maintaining fence.
- Construct a fence in Subunit II and remove pigs from fence.
- Construct a fence in Kamaili and remove pigs from fence.
- Conduct outreach with community hunting groups for hunting actions in Makaha. Prioritize actions as (1) pig removal in fences and (2) hunting activities in priority areas to reduce pressure on fences.

Monitoring Objectives:

- Conduct fence checks and read transect quarterly. GPS and mark new fences at ten meter intervals so that the fence will be one large transect.
- Monitor for pig sign while conducting other management actions in the fence.
- Monitor integrity of all fences after extreme weather/wind events as soon as possible.

Management Responses:

- If any pig activity is detected within the fenced unit, implement hunting and/or trapping program.
- If more than ten percent activity is detected along transects outside fence, increase volunteer hunting effort.

Maintenance Issues:

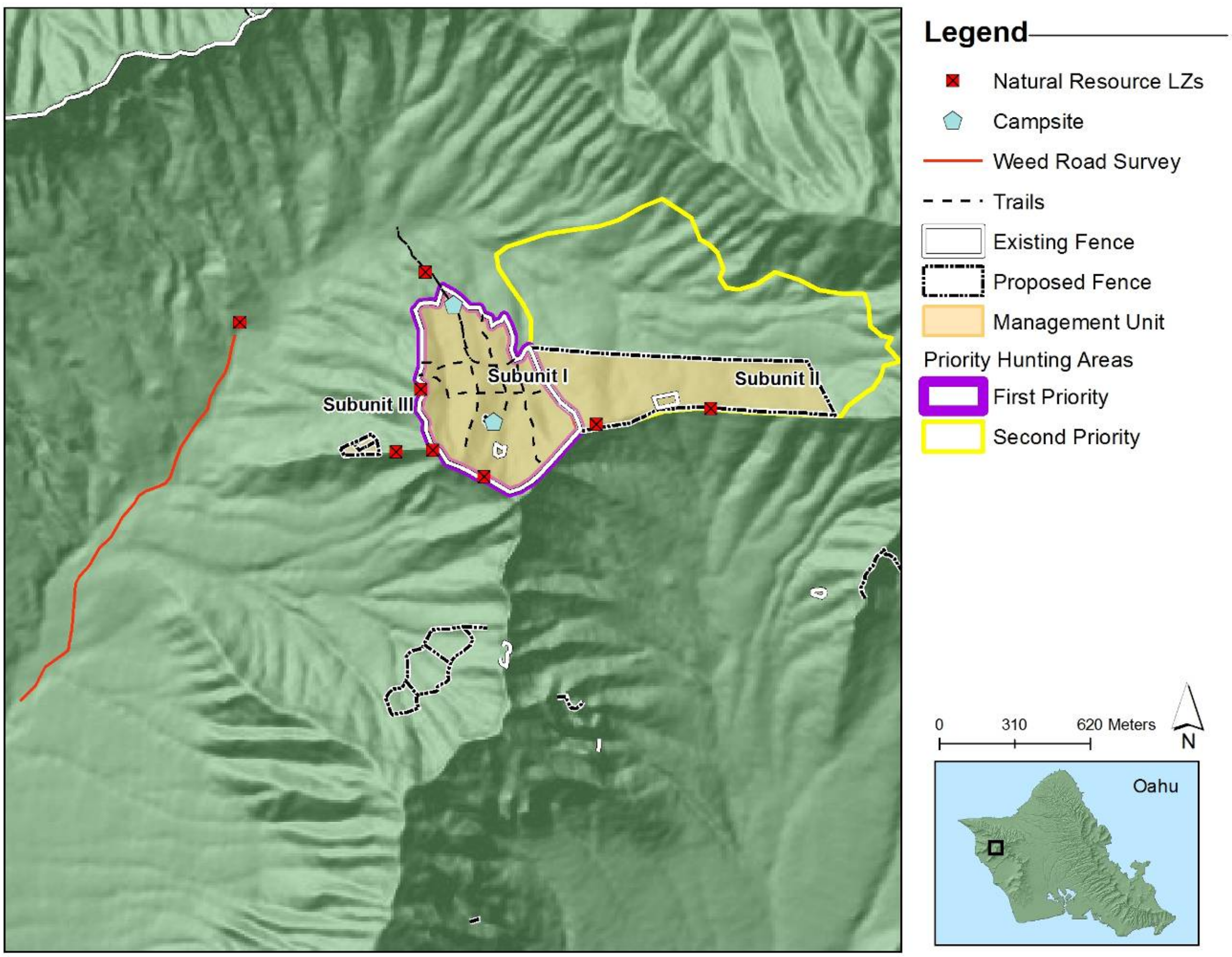
There is a perimeter fence around Subunit I. In the past year, fence checks have been done quarterly and additionally in conjunction with other Management Unit (MU) actions, thus, increasing the monitoring frequency of fence integrity. A few minor repairs were made to the fence due to canopy downfall, however, these did not result in any ungulate breach into the exclosure. Fences are prone to damage from tree fall, particularly after extreme weather/high wind events. Vandalism has been one issue in the past. Building relationships with local hunters and educating them about the need for fences to protect native resources has been successful in building community awareness and reducing incidences of vandalism.

Community Hunter Program

The community hunting program in Makaha is a collaborative effort between the Board of Water Supply, Oahu Army Natural Resources Program and community hunters. The goal is to protect rare species in the region. Hunters are educated about the area's resources, gain access and remove pigs. The partners plan to continue beneficial collaborative efforts and will hopefully minimize misunderstandings between hunters and natural resource workers as well as vandalism to the fence.

In the past year, efforts have been increased in establishing and maintaining the Volunteer Community Hunter Program. The community hunting areas are shown in order of ungulate control priority: 1) Purple Zone- Subunit I fence perimeter which was declared ungulate free in early 2009; this is the default priority hunting area if fence should be breached by pigs. 2) Yellow Zone- Currently being hunted by community teams to take pressure off the Subunit I fence.

Ungulate and Survey Locations at Makaha



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

Vegetation Monitoring Objectives

Primary Objectives

- Assess the cover of alien plant species within a specific MU to determine if it is less than 50% across the sampled unit or continuing to decrease to ultimately meet that threshold requirement (Makua Implementation Team et al. 2003).
- Re-read vegetation monitoring transects every three years. The next planned monitoring cycle for this area is in quarter 1 of 2012 (MIP year 10).

Secondary Objectives

- Monitor the status of native plant species within the MU.
- Assess the status and changes in bare ground (not vegetated areas) within the MU.
- Determine if any ungulates (feral pigs or goats) are detected within the fenced portion of a MU.

Statistical Thresholds

All of the sampling and analysis methods addressed in this protocol are based on the following assumptions:

- The probability of making a Type I error (detecting change or difference when none exists) is <10% (Alpha = .10)
- The probability of making a Type II error (missing change or difference that does exist) is <20%.
- Minimum detected change or difference between two samples being compared is 10% over the sampling period.

Sample Size Considerations

A post hoc sample size was calculated using the statistical thresholds mentioned above and the standard deviation of 28. The minimum sample size for this MU would be 105 stations which is less than what the sample size of 121 taken.

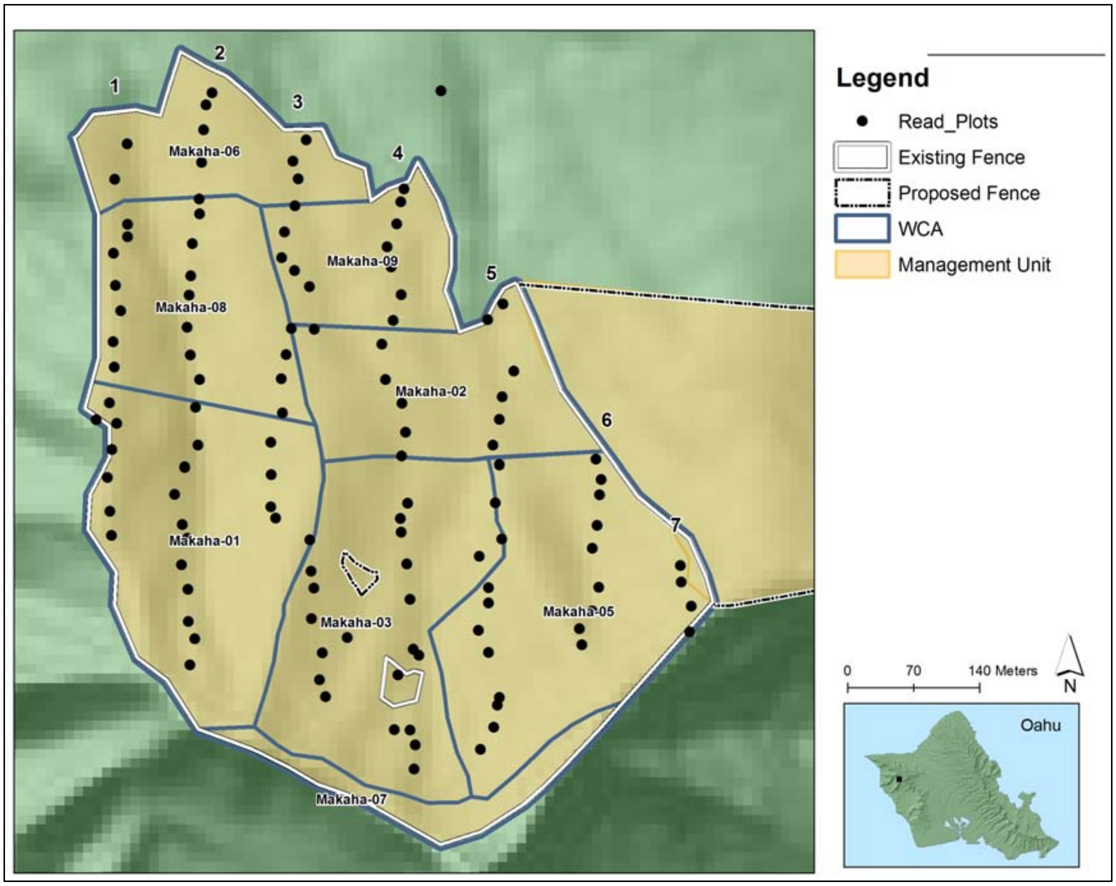
Vegetation Monitoring Methods

Refer to the monitoring section in the 2008 yearend report.

MU Vegetation Monitoring

From August – October of 2009 baseline vegetation monitoring was conducted for the Makaha subunit 1 management unit. The total effort including commute time was 557 hours. A total of 121 plots were read and 84 acres covered. MU monitoring will be conducted every three years and will provide OANRP with trend analyses on vegetation cover and species diversity.

MU Monitoring Transects



Vegetation Monitoring Analyses

Baseline data collect in 2009 showed that the mean percent alien vegetation cover in the understory was 38% and in the canopy it was 66% (refer to MU % vegetation cover table below). The mean alien percent cover met the management goal of 50% or less non-native cover in the understory but didn't in the canopy (Refer to the map above).

As more datasets are collected for this area over time, trends in canopy change can be used by OANRP to determine how effective current weed management strategy is at reaching IT goals. Several variables of particular interest are how bare ground area will change relative to the removal of ungulates and the spread and percent cover change of invasive species in both the canopy and understory.

Ungulates were removed from the management unit in 2009. This initial baseline monitoring showed that the mean percent cover of bare ground was 74%.

The most common invasive trees in the Makaha MU were *Psidium cattleianum, Toona ciliata,* and *Coffea arabica*. On a WCA scale, these species are the main targets for weed control due to their ecosystems altering ability. In the next five years a majority of the weed management will focus on WCA's 1, 3, and 5 (priority 1 WCAs). Priority 1 WCAs will be the main focus since the majority of rare species are located within them. The weed control strategy will be to target *P. cattleianum, T. ciliata,* and *C. arabica* in native patches and prevent monotypic stands from expanding. Percent vegetation cover for *Psidium cattleianum, Toona ciliata,* and *Coffea arabica* that fall within the priority 1 area were taken out from the baseline dataset and summarized (refer to target species table below). Weed sweeps will be conducted once annually in WCA 1, WCA 3 once every two years in WCA 3, and once every three years for WCA 5. Canopy weed control effort will be gradual around rare plant taxa in order to minimize drastic light level changes. OANRP will continue to track these species; monitoring both the movement and percent cover change over time. The percent cover trend will indicate if current management strategy is an effective method for containing these species. Species distribution maps for *P. cattleianum, T. ciliata,* and *C. arabica* will also be compared to future maps in order to track the decline/spread of these species (Refer to the maps below). Other significant weeds that will be targeted during sweeps will be *Grevillea robusta* and *Spathodea campanulata*. In the priority 1 area the five year goal is a zero tolerance for *S. campanulata* and a reduction of mature *G. robusta* from a mean percent occurrence from 8% to 5%.

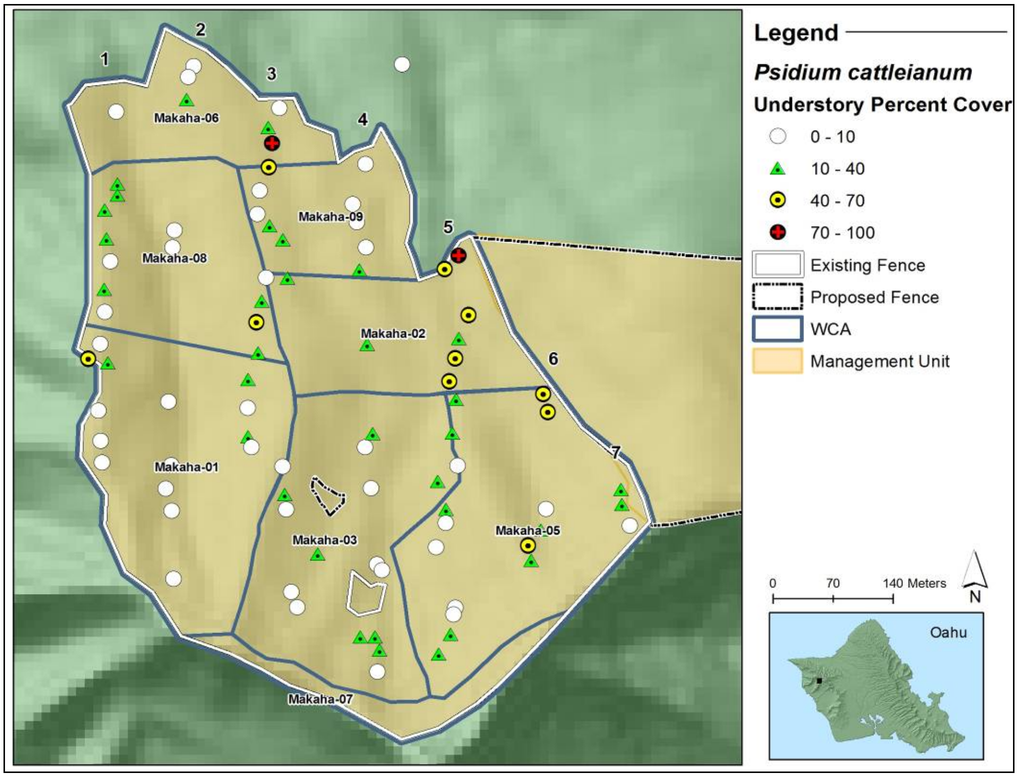
MU Percent Vegetation Cover Analysis

MU % Vegetation Cover Analysis							
Variable	*N	Mean	Standard Error of Mean	Standard Deviation	Q1	Median	Q3
Native Shrubs Understory	121	12.6	1.5	16.4	0.5	7.5	15
Native Ferns Understory	121	1.2	0.2	2.7	0	0.5	0.5
Native Grass Understory	121	0.7	0.3	3.3	0	0	0
Bryophytes	121	2.4	0.4	4.8	0.5	0.5	2.5
Total Native Understory	121	14.2	1.5	16.7	2.5	7.5	25
Alien Shrubs Understory	121	33.7	2.3	25.4	15	25	55
Alien Ferns Understory	121	5.2	0.9	10.2	0	0.5	2.5
Alien Grass Understory	121	1.7	0.8	9.3	0	0	0.5
Bare Ground	121	73.9	2.2	24.3	55	85	95
Total Alien Understory	121	38.2	2.3	25.5	15	35	55
Total Native Canopy	121	28.1	2.4	26.5	5	25	45
Total Alien Canopy	121	65.9	2.6	28.5	55	75	95
Total Canopy	121	80.8	1.5	16.8	75	85	95
*N = # of Plots Read							

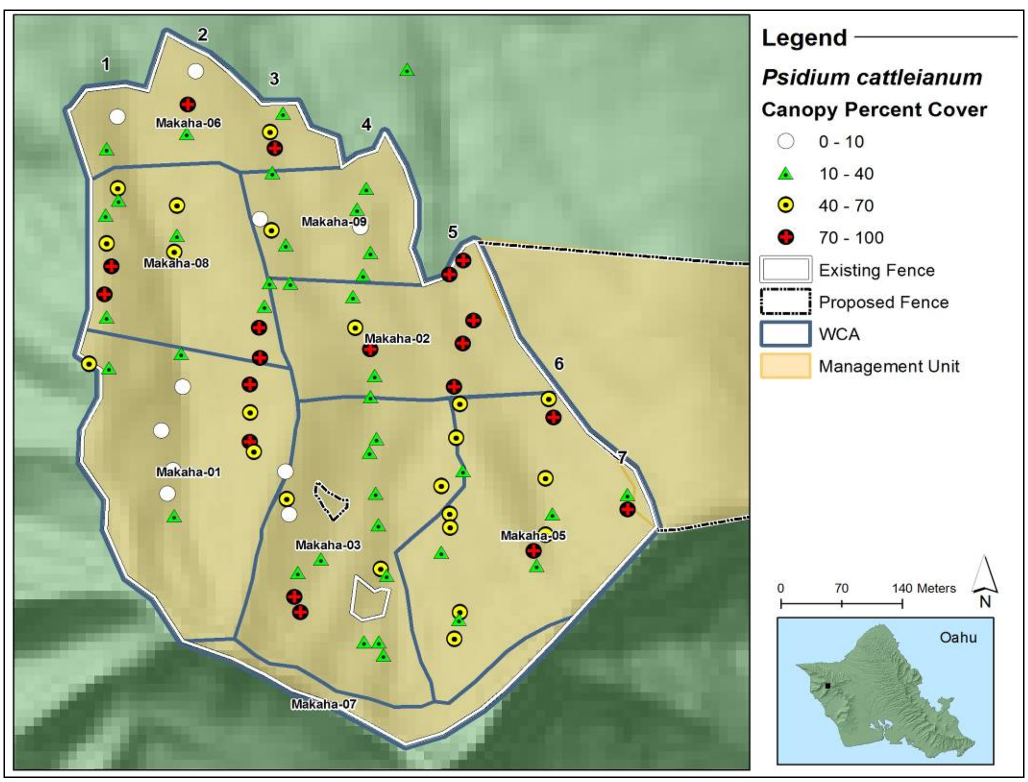
Target Species Percent Cover in WCAs 1, 3, and 5

Target Species % Cover in WCA 1, 3, and 5							
Variable	*N	Mean	Standard Error of Mean	Standard Deviation	Q1	Median	Q3
Toona ciliate canopy	65	5.7	1.4	11.6	0.0	0.0	8.0
Toona ciliate understory	65	3.2	0.9	6.9	0.0	1.0	3.0
Psidium cattleianum canopy	65	24.2	3.1	25.0	0.0	15.0	45.0
Psidium cattleianum understory	65	9.0	1.6	12.6	0.3	2.5	15.0
Coffea arabica canopy	65	7.3	2.6	21.0	0.0	0.0	0.3
Coffea arabica understory	65	6.4	2.0	15.8	0.0	0.0	2.5
*N = # of plots							

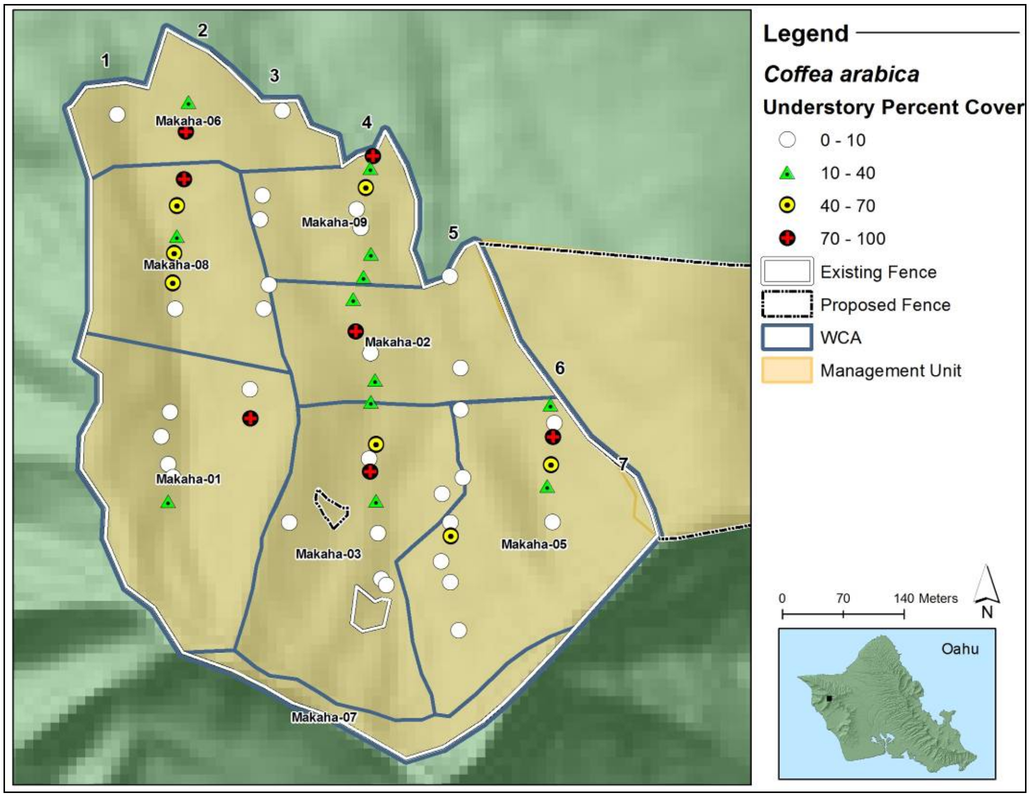
Psidium cattleianum **distribution in the understory**



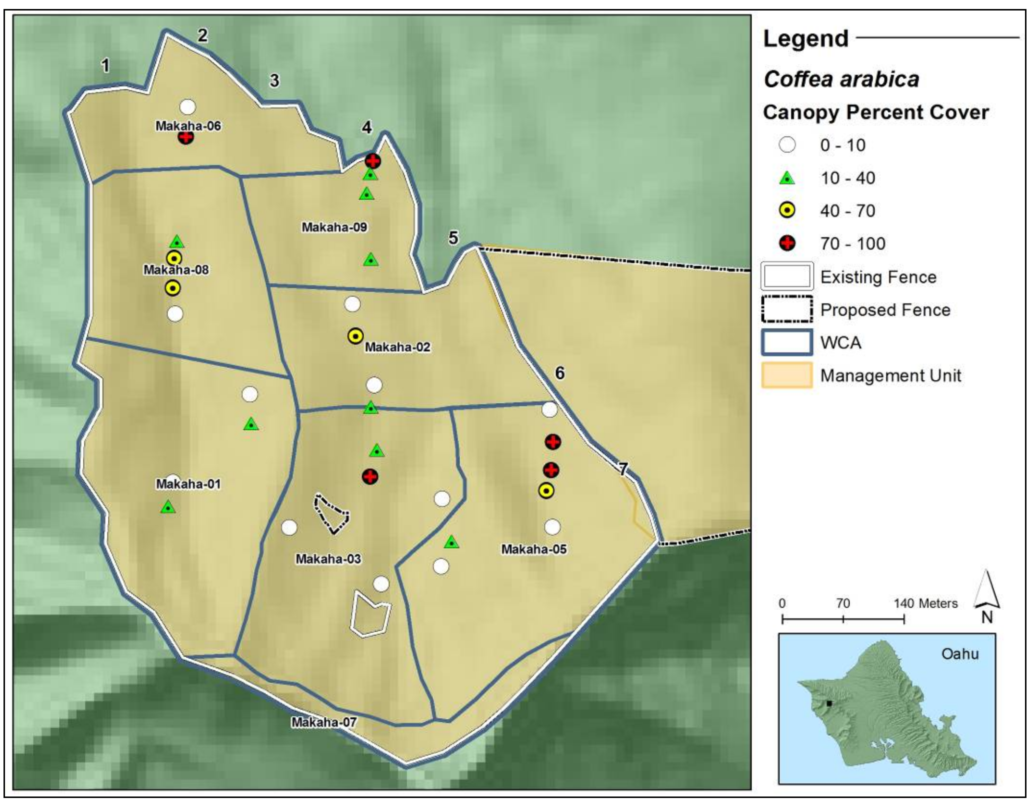
Psidium cattleianum **distribution in the canopy**



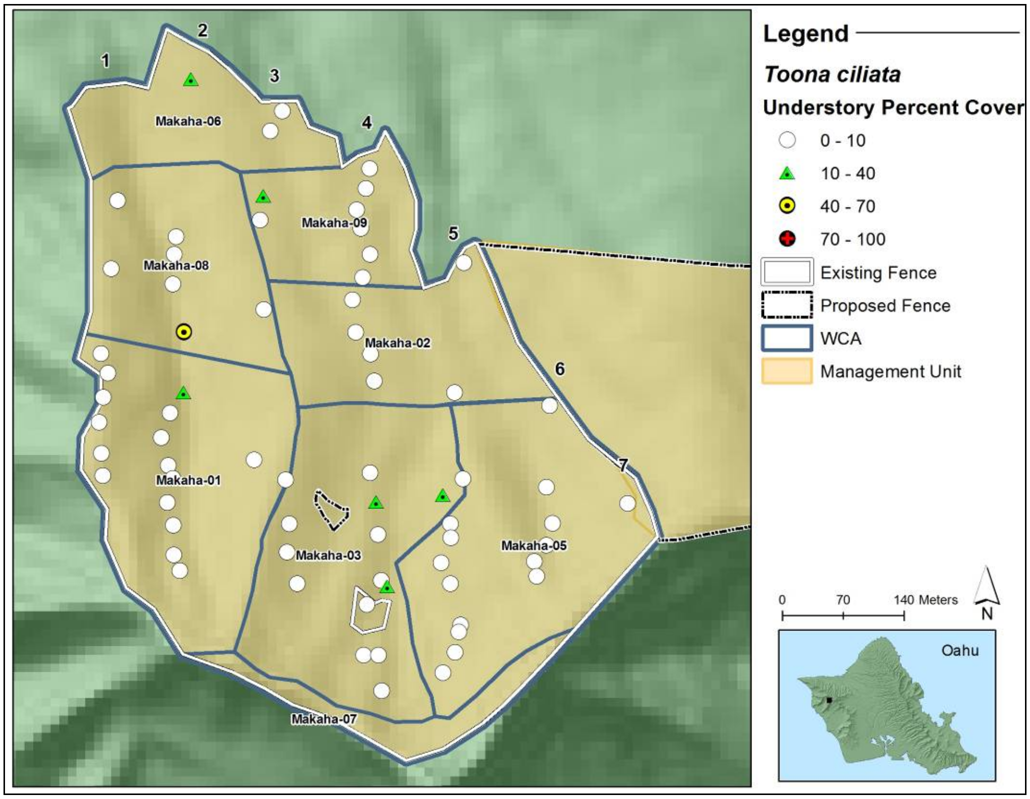
Coffea arabica distribution in the understory



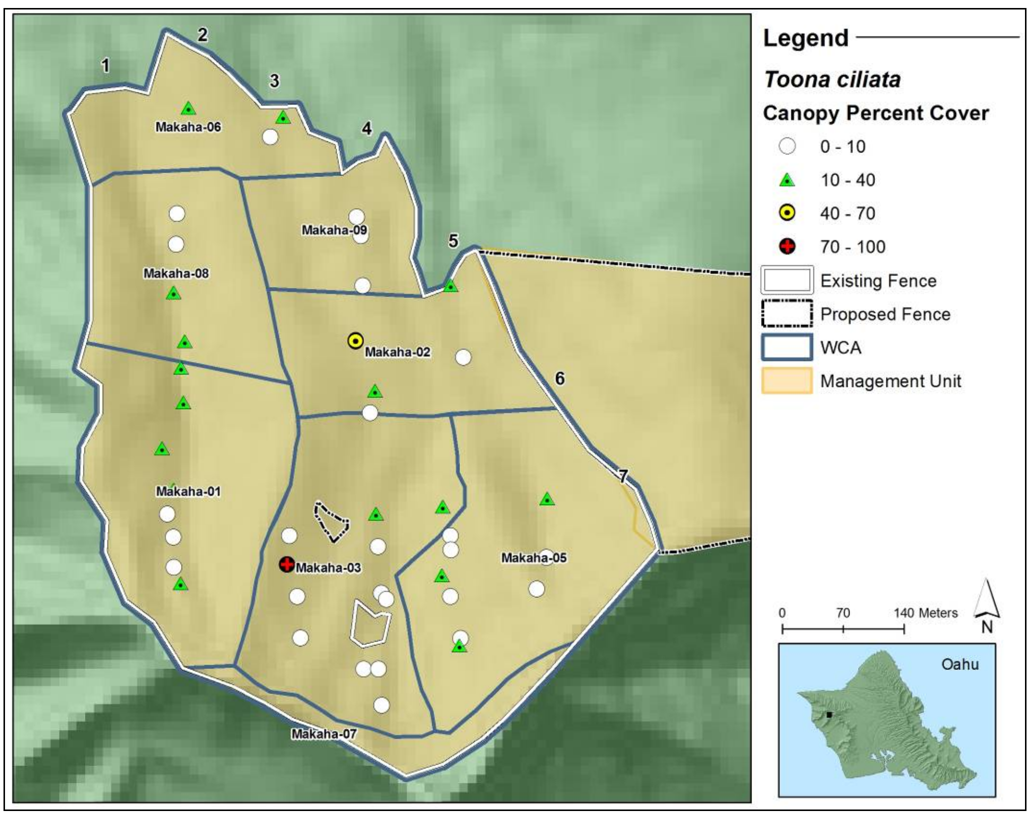
Coffea arabica distribution in the canopy



Toona ciliata **distribution in the understory**



Toona ciliata **distribution in the canopy**



Vegetation Monitoring Response:

- Increase weeding efforts if the alien vegetation goals are not being met in the MU.

Surveys

Army Training: No

Other Potential Sources of Introduction: NRS, pigs, public hikers

Survey Locations: Landing Zones, Fencelines, High Potential Traffic Areas, Roads

Management Objective:

- Detect the establishment of any new invasive alien plant or animal species through regular surveys along roads, landing zones, camp sites, fencelines, trails, and other high traffic areas (as applicable).
- Survey roads annually.
- Develop protocol for monitoring weeds along the fenceline transects.

Monitoring Objectives:

- Quarterly surveys of LZs (if used).
- Quarterly surveys of campsites for weeds (if used).
- Note unusual, significant or incipient alien taxa during the course of regular field work.

Management Responses:

- Any significant alien taxa found will be researched and evaluated for distribution and life history. If found to pose a major threat, control will begin and will be tracked via Incipient Control Areas (ICAs).

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Roads, landing zones, fencelines, and other highly trafficked areas are inventoried regularly; 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. At Makaha, only roads and LZs are currently surveyed. See the *Survey Locations and Hunting Areas in Makaha* map. NRS will consider installing additional surveys in other high traffic areas as needed.

Incipient Taxa Control (ICAs)

Management Objectives:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2015.
- Conduct seed dormancy trials for all high priority incipients by 2015.

Monitoring Objectives:

- Visit ICAs at stated revisitation 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 bank, dormancy and life cycle information is important in determining when eradication may be reached. NRS will compile information for each ICA species and conduct research to understand the biology of incipient species.

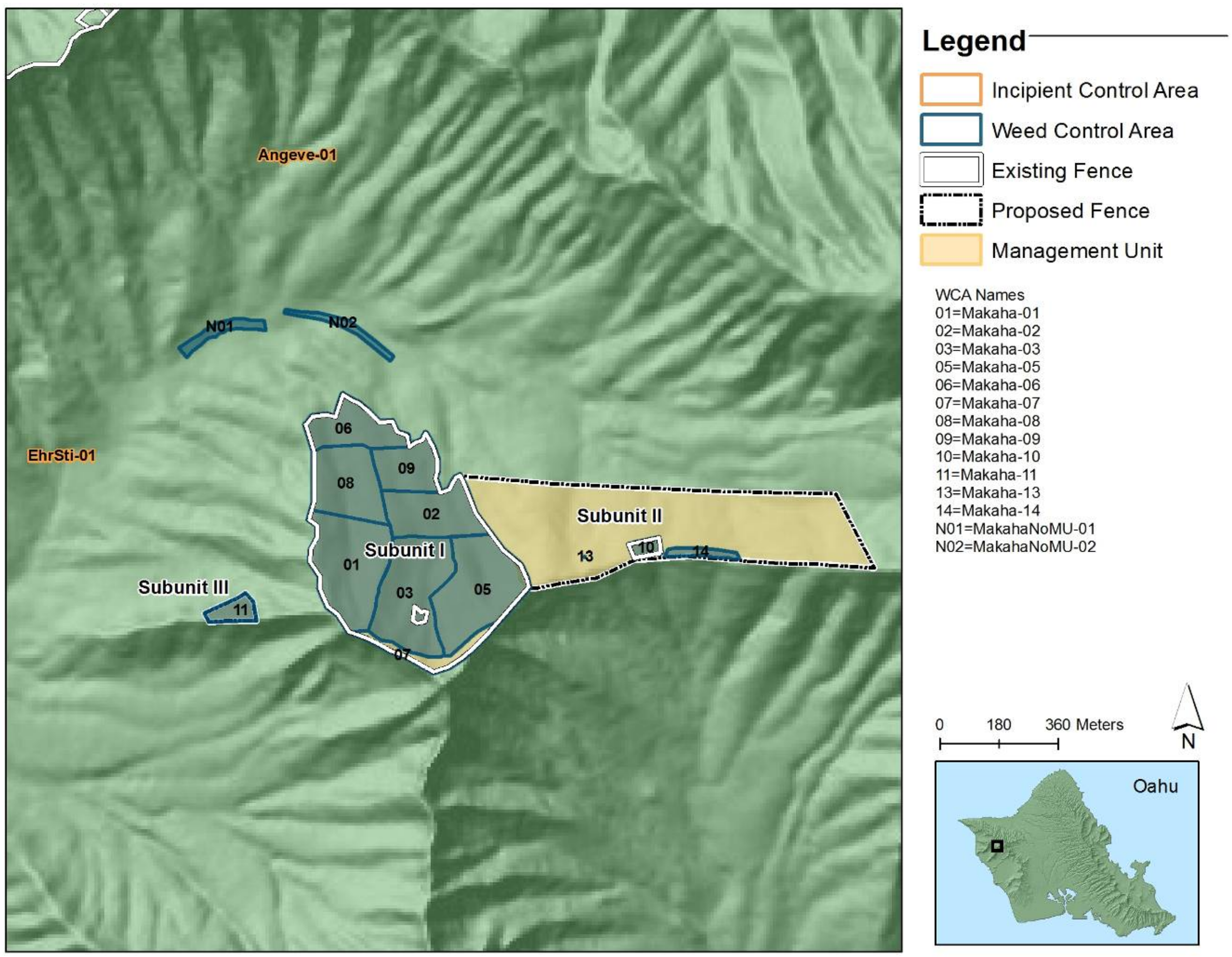
The Makaha MU was not evaluated in Appendix 3.1 of the MIP. This Appendix lists significant alien species and ranks their potential invasiveness and distribution. The table below summarizes incipient invasive taxa at Makaha, and is a substitute for Appendix 3.1. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in an MU. ICAs are not designated for every species in the table below; however, occurrences of all species in the table should be noted whenever staff is in Makaha. All current ICAs are mapped. Three management designations are used here: Incipient (small populations, eradicable), Control Locally (significant threat posed, may or may not be widespread, control feasible at WCA level), and Widespread (common weed, may or may not pose significant threat, control feasible at WCA level).

Summary of Target Taxa

Taxa	Management Designation	Notes	No. of ICAs
Angiopteris evecta	Incipient	One mature was found in 2009 on the north side of the valley, outside of the MU. NRS will monitor in Nov. 2010 and remove any plants found.	1
Cissus repens	Control locally	Only location found on Oahu. Localized just off of road in between pumping station and the heiau combo-lock gate. OISC is controlling this population.	0
Coffea arabica	Widespread	Forms a band across MU. NRS will aggressively remove. (See WCA actions)	0
Cordia alliodora	Control locally	One of two locations found on Oahu (Waimea Valley is other site). Localized at Kaneaki Heiau, appears to be naturalizing. NRS will assist other organizations (i.e. BWS, OISC, Waianae MountainsWatershed Partnership) with control	0
Dicliptera chinensis	Control locally	Spreads rapidly. Localized in *C. superba* fence. NRS will aggressively remove. (See WCA actions)	0
Ehrharta stipoides	Incipient	Two mature were found in 2007 in parking lot. Monitored annually as part of road survey. Not seen since 2007.	1
Mahogany spp.	Control locally	Found on Keaau side of valley. Needs to be identified and area surveyed.	0
Melia azederach	Control locally	Uncommon in MU. NRS will target wherever seen.	0
Pimenta dioica	Control locally	Uncommon in MU. NRS will target wherever seen.	0
Psidium cattleianum	Widespread	Forms monotypic stands. NRS will evaluate the potential to be controlled with chipper.	0
Rubus argutus	Control locally	Control technique needs to be developed. Current control methods not 100% effective. NRS are careful to not transport seeds.	0
Sideroxylon persimile	Control locally	Found along access road and in Kamaili. Need to confirm species and survey for extent.	0
Spathodea campanulata	Control locally	NRS are currently controlling within the fence.	0

Taxa	Management Designation	Notes	No. of ICAs
Toona ciliata	Widespread	Spreads rapidly. NRS are currently targeting mature individuals. (See WCA actions)	0
Trema orientalis	Control locally	Uncommon in MU. NRS will target wherever seen.	0
Triumfetta semitrilobata	Widespread	NRS are removing from trails and targeting in WCAs.	0

Incipient and Weed Control Areas in Makaha



Ecosystem Management Weed Control (WCAs)

MIP Goals:

- Within 2m of rare taxa: 0% alien vegetation cover where removal does not harm rare taxa
- 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:

- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Reach 50% or less alien canopy cover across the Priority 1 areas in MU within the next 15 years.
- 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.

Vegetation monitoring in subunit I of Makaha indicates that the area meets the MU 50% or less alien cover goal in the understory, but does not meet the goal in the canopy. Many of the WCAs are drawn around rare taxa sites; based on vegetation/topography type. Currently, none of the WCAs meet the 25% or less weed cover goal for areas near rare taxa. Areas near rare taxa will be continued to be prioritized. The WCAs with top priority are 1, 3 and 5 due to rare taxa; therefore, weeding efforts are focused in these areas. The lower priority WCAs are 2, 6, 8 and 9 due to the lack of rare taxa. However, prolific seeding species such as *T. ciliata*, *S. campanulata* and *C. arabica* are targeted and volunteer efforts will continue in these areas. Within the areas of *A. mustelina* presence, NRS will seek to avoid unintentional negative impact by being cognizant of snail presence and avoiding control of preferred trees.

WCA: Makaha-01 (Upper Makai Gulch)

Veg Type: Mesic Ridge / Mid-Slope / Gulch

MIP Goal: 25% or less alien cover around *F. neowawraea* and other rare taxa in the central part of the WCA. 50% or less alien cover elsewhere.

Targets: All weeds, focusing on *C. arabica, P. cattleianum, S. terebinthifolius*, and *T. ciliata*.

Priority: High

Notes: There is a wild *F. neowawraea* and reintroductions of *F. neowawraea* in this WCA. This area has some predominantly native areas. Other rare species found in this WCA include *M. tenuifolia*, *Tetraplasandra kavaiensis, S. ruber* and *A. mustelina*. OANRP staff plan to work around the reintroductions twice a year and across the entire WCA once every year. This WCA contains the core of *T. ciliata* and is the primary target of WCA-wide sweeps.

WCA: Makaha-02 (Upper Flag City)

Veg Type: Mesic Ridges / Mesic Gulches

MIP Goal: 25% or less alien cover

Targets: All weeds, focusing on *T. ciliata*.

Priority: High priority around *F. neowawraea*, low priority for the rest of the WCA.

Notes: There is *P. macrocarpa* located near the north eastern corner. Much of this WCA is very weedy with large *P. cattleianum* and *C. arabica* stands. OANRP staff plan to work across the entire WCA once every two years.

WCA: Makaha-03 (Chaher /Fluneo Gulch)

Veg Type: Mesic Mid-Slope

MIP Goal: 25% or less alien cover

Targets: All weeds, focusing on*, T. ciliata, P. cattleianum*, *S. terebinthifolius*, and *C. arabica.*

Priority: High

Notes: This WCA contains the greatest number of rare taxa in Subunit I both in terms of total number of plants and diversity of species. This area hosts wild populations of *A. macrococcus* var. *macrococcus, F. neowawraea, I. laurifolium, M. makahae, M. tenuifolia, V. chamissoniana* subsp. *chamissoniana, G. meyenii, T. kavaiensis, S. lanceoloidea*, *S. ruber, D. falcata* and *A. mustelina.* Reintroductions of *C. superba* subsp. *superba, F.neowawraea, C. herbstii, and P. kaalaensis* have been implemented. OANRP staff must be extremely careful when weeding around all rare taxa, especially *C. herbstii* which have been observed to be recruiting heavily. Due to the density of managed taxa, the future actions in this WCA are high priority. OANRP plan to work around the reintroductions and rare taxa twice a year.

WCA: Makaha-05 (Hesarb Ridge)

Veg Type: Mesic Forest

MIP Goal: 25% or less alien cover

Targets: All weeds, focusing on*, T. ciliata, P. cattleianum*, *S. terebinthifolius*, and *C. arabica.*

Priority: High.

Notes: *S. nuttalii* have been reintroduced into this area. *H. arbuscula*, *G. meyenii, A. macrococcus var. macrococcus, S. lanceoloidea, L. Kaalae, S. hookeri, P. macrocarpa, M. makahae*, and *A. mustelina* occur naturally. OANRP staff must be extremely careful when weeding around all *A. mustelina*. A buffer of about 1.5m around all *H. arbuscula* should not be weeded to prevent trampling. One of the OANRP staff goals for this WCA is to promote recruitment around mature *H. arbuscula*. Due to the density of managed taxa the future actions in this WCA are high priority. OANRP plan to work around the reintroduction and rare taxa twice a year.

WCA: Makaha-06 (Camp Ridge)

Veg Type: Mesic Ridge

MIP Goal: 50% or less alien cover

Targets: All weeds, focusing on *T. ciliata*.

Priority: Low.

Notes: Waianae High School volunteers are the major weeding resource for this WCA. The main focus of volunteer groups is currently weed control in the lower section surrounding the *A. koa* transplants and archaeological site to mitigate weed threats from high foot traffic entering the fence through the gate. The OANRP staff focus in this WCA is to sweep for mature *T. ciliata* and other tree weeds.

WCA: Makaha-07 (Sub Unit I Fenceline)

Veg Type: Mesic Ridge

MIP Goal: 50% or less alien cover

Targets: All weeds, focusing on, *P. cattleianum, C. hirta, S. terebinthifolius, T. ciliata, T. semitrilobata,* and grasses

Priority: Medium.

Notes: Mostly cliff face, this WCA does include *V. chamissoniana* subsp. *chamissoniana.* The moderate priority is due to the importance of fence maintenance. Creating a weed buffer reduces seed transfer from weeds outside the management unit. High foot traffic is a concern for introducing weeds along the fenceline through predominantly native areas.

WCA: Makaha-08 (Lower Makai Gulch)

Veg Type: Mesic Ridges / Mesic Gulches

MIP Goal: 50% or less alien cover

Targets: All weeds, focusing on *T. ciliata.*

Priority: Low.

Notes: There are no managed taxa in this WCA. This weedy area is dominated by *T. ciliata, C. Arabica, G. robusta*, *S. terebinthifolius* and *S. campanulata*. OANRP staff plan to work across the entire WCA once a year to sweep for mature *T.ciliata* and other prolific seeders.

WCA: Makaha-09 (Lower Flag City)

Veg Type: Mesic Forest

MIP Goal: 50% or less alien cover

Targets: All weeds, focusing on, *T. ciliata, S. terebinthifolius*, *G. robusta, C. arabica, S. campanulata* and grasses.

Priority: Low

Notes: There are no managed taxa in this WCA. OANRP staff plan to work across the entire WCA once a year to sweep for mature *T.ciliata* and other prolific seeders.

WCA: Makaha-10 (Cyalon Fence)

Veg Type: Mesic Forest

MIP Goal: 25% or less alien cover

Targets: All weeds, focusing on, *P. cattleianum*, *G. robusta, C. hirta*, and *R. argutus*

Priority: High.

Notes: This WCA is located in subunit II. There is a wild population of *C. longiflora* within this WCA. This area is predominantly native forest. Other rare species found in this WCA are *P. cornuta* var. *decurrens,* and *B. elatior.* OANRP plan to work across the entire WCA every six months until MIP goals are achieved.

WCA: Makaha-11 (Makaha Nerang Ridge)

Veg Type: Mesic Forest

MIP Goal: 25% or less alien cover

Targets: All weeds, focusing on*, P. cattleianum*, *G. robusta, S. terebinthifolius, Melia azederach* and *R. argutus*

Priority: Low

Notes: This WCA not within any MU. There is a wild population of *N. angulata* within this WCA, but it is not a Manage For Stability population. Minimal weed control will be conducted, to facilitate the collection of propagules from this rare plant site.

WCA: Makaha-13 (Cyagri)

Veg Type: Mesic Forest

MIP Goal: 25% or less alien cover

Targets: All weeds, focusing on*, P. cattleianum*, *S. terebinthifolius,* and *C. hirta*.

Priority: High

Notes: There is a wild population of *C. grimesiana* subsp. *obatae* in this WCA. OANRP plan to work around the wild population annually to create a buffer from weeds.

WCA: Makaha-14 (Makaha-Waianae Kai Burn site)

Veg Type: Mesic Ridge

MIP Goal: 50% or less alien cover

Targets: All weeds, focusing on*, R. argutus*, *B. asiatica*

Priority: High.

Notes: This area used to be predominantly native. It burned in 2003. Rehab led by BWS was done to outplant common natives. Due to the burn, the area is mostly open canopy and is used as a landing zone. The surrounding area is comparatively native canopy with *A. koa* and *M. polymorpha.*

WCA: MakahaNoMU-01,02 (Access Trail)

Veg Type: Mesic Forest

MIP Goal: 50% or less alien cover

Targets: All weeds, focusing on*, T. semitriloba.*

Priority: High.

Notes: These WCAs are located along the access trail and is highly susceptible to weed spread due to heavy foot traffic from NRS, hunters and pigs. They will be combined into one continuous WCA.

Rodent Control

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

Threat level: High

Control method: Localized control (small scale bait station and rat trap grids)

Seasonality: Year-round at tree snail locations

Number of control grids: 2 (8 bait stations, 16 rat traps)

Primary Objectives:

- To maintain rodent populations at a level that facilitates stabilized or increasing tree snail populations and to implement rodent control if determined necessary for the protection of rare plants.

Management Objective:

- Establish and maintain localized small scale bait station and rat trap grids around two *A. mustelina* populations.
- Implement rodent control on a small scale if determined necessary for the stability of rare plant populations.

Monitoring Objective:

- Monitor *Alectryon macrococcus* var. *macrococcus, Cyanea superba* subsp. *superba*, *Cyanea grimesiana* subsp. *obatae*, *Cyanea longiflora*, *Dubautia herbstobatae, Fleuggea neowawraea,,* and *Hesperomannia arbuscula* to determine the occurrence of fruit/plant predation by rats. Monitor tree snails to determine if rats are impacting the tree snail populations within the rat control areas.

Localized Rodent Control Actions:

- Localized control consists of bait stations and rat traps deployed around trees containing tree snails. Bait stations and rat traps are maintained every 4 to 6 weeks.

Slug Control

Species: *Deroceras leave, Limax maximus, Veronicella cubensis* confirmed

Threat level: High

Control level: Localized

Seasonality: Wet season

Number of sites: No control currently taking place, however, surveys to occur at *Cyanea grimesiana* subsp. *obatae, C. longiflora,* and *C. superba* subsp. *superbsa* wild and reintroduction sites

Primary Objective: Eliminate slugs to facilitate germination and survivorship of rare plant taxa.

Management Objective:

- If additional Special Local Needs labeling is approved by USFWS and HDOA control slugs at sensitive plant populations via Sluggo application.

Monitoring Objectives:

- Annual census monitoring of *Cyanea grimesiana* subsp. *obatae, C. longiflora,* and *C. superba* subsp. *superba* seedling recruitment following fruiting events.
- Annual census monitoring of slug densities during wet season.

Predatory Snail Control

Species: *Euglandina rosea* (rosy wolf snail)

Threat level: High

Control level: Localized

Seasonality: Year-Round

Number of sites: 2 sites *A. mustelina*

Acceptable Level of Activity: Not tolerated within a 20 m radius of known *A. mustelina* populations

Primary Objective: Eliminate predatory snails to promote *A. mustelina* survival.

Management Objective:

- Continued to develop better methods to control predatory snails.
- Keep sensitive snail populations safe from predatory snails via currently accepted methods (such as hand removal of alien snails within 20 m radius of known *A. mustelina*).

Monitoring Objectives:

- Annual searches for predatory snails to confirm their absence or presence in proximity to *A. mustelina.*

No baits have been developed for the control of predatory snails. Little is known regarding their distribution and prey preference. Control is limited to hand removal. Opportunistic collection of *E. rosea* in this MU suggests they are common in gulches but are not as abundant on ridges where *A. mustelina* occur. Preliminary research by M. Meyer (2007)[10] indicates that *E. rosea* does not disperse long distances (on average they move <0.25 m per day). This data suggest that keeping a 20 m *Euglandina* free buffer around *A. mustelina* populations would be adequate to protect native snails.

Ant Control

Species: *Anoplolepis gracilipes* confirmed

Threat level: Unknown

Control level: Only for new incipient species

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

Number of sites: Three; Makaha parking lot LZ, and the two *A. mustelina* snail locations

[10] Meyer, M. 2007. 2007 Status Reports for the Mākua Implementation Plan and the Draft O‘ahu Implementation Plan. Appendix 3-4: Year 2: Microhabitat utilization, population size estimates, and possible control of the introduced predatory snail *Euglandina rosea* on O‘ahu, Hawai‘i. http://manoa.hawaii.edu/hpicesu/DPW/2007_YER/Appendicies/Appendix_3-4_Eugros_research.pdf Accessed October 14, 2010

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

Primary Objective: Collect data on species present and control if ant densities are high enough to threaten rare resources.

Management Objective:

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

Monitoring Objective:

- Sample ants at Makaha parking lot LZ, and the two *A. mustelina* snail locations. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- Look for evidence of ant tending of aphids or scales on rare plants.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and 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). The protocol for sampling ants appears in Appendix 6-1 (this document).

Standardized surveys have not yet taken place. Opportunistic collection confirms that the Yellow Crazy Ant *Anoplolepis gracilipes* is present at the Makaha LZ (1,100 ft elevation). This species is widespread at elevations below 1,500 feet and any attempt at control would be temporary. While control is not recommended at this time, future surveys are needed to ensure new species are not introduced.

Black Twig Borer (BTB) Control

Species: *Xylosandrus compactus*

Threat level: High

Control level: Localized

Seasonality: Year-Round

Number of sites: Variable, depends on when air layers are taken from *F. neowawraea* or *A. macrococcus* var. *macrococcus*

Acceptable Level of Activity: Unknown

Primary Objective: Enhance success of air layering rare plant species

Management Objective: Reduce air layer failure due to BTB

OANRP has conducted extensive testing on the efficacy of trap deployment to reduce BTB damage. Results have been mixed. There is no significant evidence that trapping reduces damage, however, no other methods exist. As air layers appear to be heavily attacked but are only exposed to BTB for a finate amount of time, trap deployment and maintenance will take place until the air-layers either clearly succeed or fail. For more information on trap catch and efficacy please refer to Chapter 6.1 (this document).

Fire Control

Threat Level: Medium

Available Tools: Fuel breaks, Visual Markers, Helicopter Drops, Wildland Fire Crew, Red-Carded Staff.

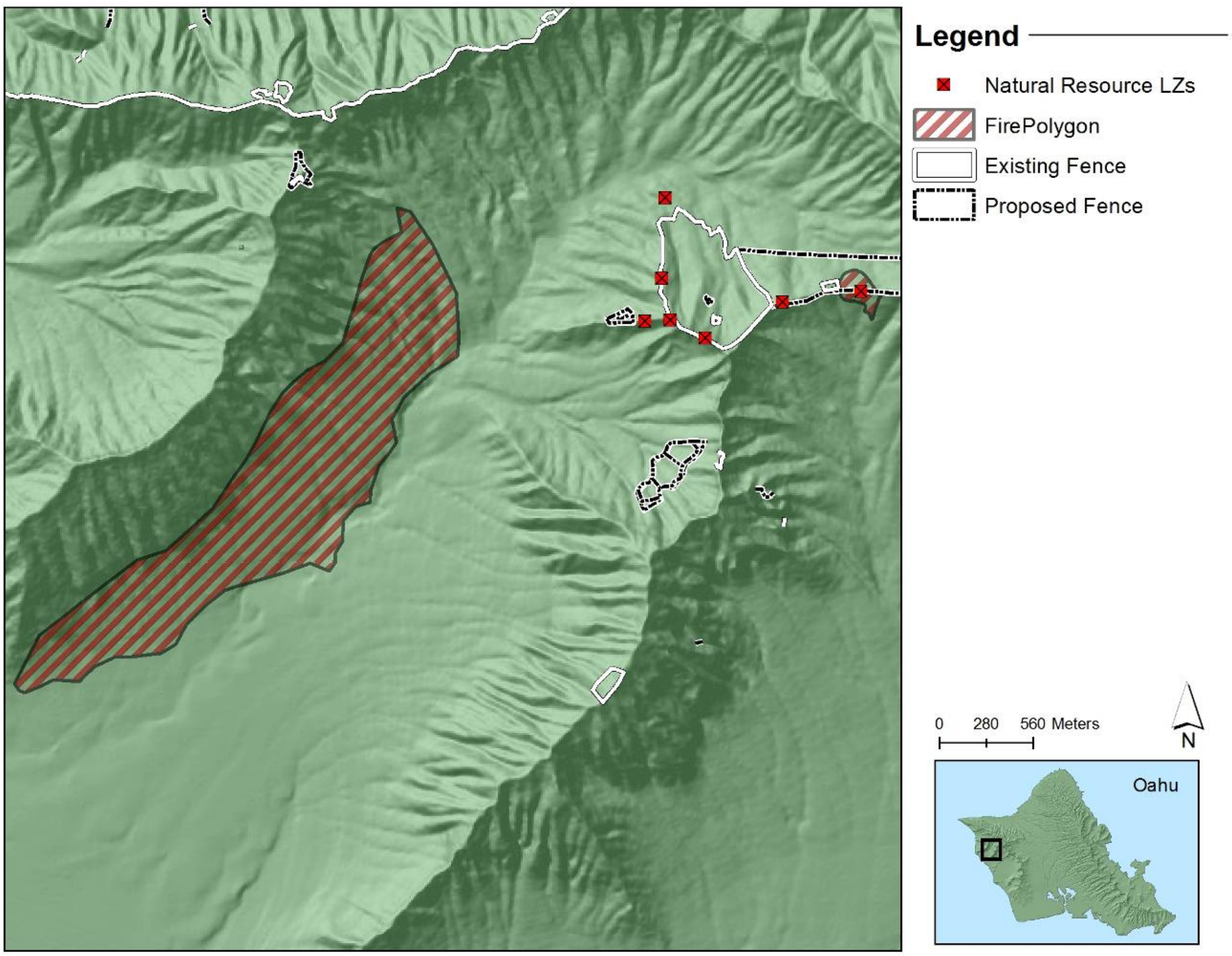
Management Objective:

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

Preventative Actions

There is little infrastructure/construction which would be helpful to reduce fire threat. OANRP will focus on maintaining good communication with the Wildland Fire Working Group to facilitate positive on-the-ground fire response. OANRP will maintain red-carded staff to assist with fire response.

Burned Areas in Makaha



Action Type	Actions	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct vegetation monitoring across the accessible areas of Makaha.																				
General Survey	Survey Lyon-Makaha LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Makaha Parking Area LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Upper Makai Makaha LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Middle Makai - Makaha LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Lower Makai Makaha LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Makaha Camp Ridge LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Kumaipo Ridge LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Burn Site LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey road from first gate to parking area at the end of the road.																				
	Survey Kumaipo burn site for germination from erosion control breaks																				
	Develop and install fenceline weed monitoring protocol																				

Action Type	Actions	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Collect sample of unknown Mahogany sp. on NW side of valley. Depending on what species is, evaluate whether a survey is justified to determine extent of species spread. Use data to evaluate infestation, discuss with OISC/OED, and determine possibl																				
	Collect sample of Sideroxylon persimile from NW side of valley and confirm identification with Bishop Museum. Depending on what species is, evaluate whether a survey is justified to determine extent of species spread. Use data to evaluate infestation.																				
ICA	MakahaNOMU-EhrSti-01. Monitor/control EhrSti in parking lot every year. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.																				
	MakahaNOMU-AngEve-01. Monitor/control AngEve in north Makaha every 6 months to a year. Foliar spray of G4 works well; to reduce non-target drift, cut off large fronds of mature plants and treat when new croziers appear.																				
	Conduct trials to determine best means of controlling CorAll. Need to locate trial site, either at Makaha (check with BWS) or at Waimea Botanic Garden (check with David Orr).																				
	MakahaNOMU-CorAll-01. Monitor/control CorAll infestation near heiau. Joint effort with OISC, BWS, heiau kupuna, Waianae Mts. Watershed Partnership. OANRP not the lead on this project, but an active participant. Timeline to be determined by OISC.																				

Action Type	Actions	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Monitor/control LepSco infestation along Kumaipo, towards Kaala. Joint effort with OISC, BWS, Waianae Mts. Watershed Partnership. OANRP to coordinate effort.																				
	Makaha-MorFay-01. Monitor/control Morfay every 6 months																				
General WCA	GPS boundaries of all existing WCAs. Use geographical and vegetation data. Use landmarks to mark in field																				
	GPS trails																				
	After completion of Subunit II, survey unit to scope potential weed control actions																				
	Scope creation of new WCAs in Subunit II to facilitate canopy weed and grass control.																				
	Define and GPS boundaries of new WCAs and begin control.																				
	Modify ERMUP to reflect these new WCAs																				
Makaha-01	Control Toocil across WCA annually. Target mature trees as top priority, then immature trees. If no native species present, spray seedling beds; otherwise, let seedling beds seld-thin. Treat other significant weeds during sweeps also: Grerob, Spac																				
	Control weeds across Phykaa and Fluneo Mak-I reintro zone/2 acre core every 3-6 months. Target understory weeds and gradual control of canopy weeds to prevent major light changes. Targets include: Schter, Budasi, Psigua, Psicat, Toocil.																				
Makaha-02	Control weeds around Fluneo reintro quarterly, as needed. Target understory, canopy, and grasses. Maintain high light levels at this site.																				

Action Type	Actions	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Control canopy weeds and select understory across WCA every 2 years. Focus around native forest patches. Target Toocil, Schter, Psicat, Riccom, Rubarg, Trisem.																				
Makaha-03	Control weeds around Chaher and Phykaa reintros every 6 months. Target understory weeds, some canopy control (TooCil). Spray Dicchi as needed.																				
	Control weeds around Fluneo reintros (1) quarterly. Target both canopy and understory, grasses especially; area to be maintained for high light levels.																				
	Control weeds around Cyasup reintro fence every 6 months. Target both understory and canopy species.																				
	Control Cofara, targeting thick stands. Possible Chipper site. Potential volunteer site. Goal: reduce Cofara by 25% every year. PUBLIC OUTREACH.																				
	Control canopy weeds and select understory across WCA every 2 years. Target Toocil, Schter, Psicat, Riccom, Rubarg, Trisem, TreOri, Schter, Psicat, Cofara. Focus around Flueno, Alemac but reduce cover gradually to prevent shocking light changes.																				
	Control weeds around Cenagr reintro zone annually. Target understory.																				
Makaha-05	Control weeds around Schnut reintro zone annually (both in donut fence and outside). Target understory (Clihir, Rubarg) and gradual canopy control (Schter, Psicat).																				
	Control understory weeds across Hesarb zone annually. Hesarb extremely sensitive to trampling; minimize effort directly around them.																				

Action Type	Actions	MIP Year 7 Oct 2010- Sept 2011				MIP Year 8 Oct 2011- Sept 2012				MIP Year 9 Oct 2012- Sept 2013				MIP Year 10 Oct 2013- Sept 2014				MIP Year 11 Oct 2014- Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Conduct canopy weed control across WCA; cover entire WCA once every 2 years. Gradually remove canopy so as to not drastically change light regime at any one time. Target Toocil.																				
Makaha-06	Facilitate Waianae Highschool field trips to this WCA. Includes: outreach about conservation and OANRP, weed control, planting.																				
	Control Psicat, Cofarb, other weeds surrounding mature Acakoa/common native forest patches every 6 months. Goal: treat 2 acres per year. Time control to avoid peak Psicat germination window; Dec -June ideal. Complement Waianae Highschool plots. Use volunteers.																				
	Conduct weed control across WCA every 2 years. Focus on significant weeds, particularly TooCil, GreRob, TriSem. Target understory in previously treated Psicat stands. Target canopy weeds other than Psicat across MU (Grerob, Toocil).																				
Makaha-07	Clear/maintain fence, as needed. Remove downed trees, spray grass, treat thick understory, as needed.																				
Makaha-08	Control mature Toocil across WCA annually. Goal: reduce potential spread of Toocil across MU. Treat other significant weeds during sweeps also: Grerob, Spacam, Trisem, isolated-small Cofarb.																				
Makaha-09	Conduct canopy and select understory weed control across WCA; cover entire WCA once every 3 years. Focus on TooCil, GreRob, SpaCam, TriSem, grasses.																				

Action Type	Actions	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Makaha-10	Control weeds across exclosure every 6 months. Focus around Cyalon and native forest patches. Target understory weeds (Clihir, Rubarg). Target canopy weeds for gradual control; reduce Psicat canopy by no more than 40% annually.																				
Makaha-11	MAY NOT MANAGE, MFS STATUS UNDER CONSIDERATION. Control weeds across (proposed) exclosure annually. Focus efforts around rare taxa (Abusan, Nerang, Nothum). Target understory (Rivhum) and canopy (Schter, Melaze). Increasing light levels in 10m radius will aid rare taxa.																				
	MAY NOT MANAGE, MFS STATUS UNDER CONSIDERATION. Experiment with cliffside weeding. Focus on ledges below mature Nerag, to facilitate recruitment.																				
Makaha-13	Control weeds in 2m buffer around Cyagrioba annually.																				
Makaha-14	Work at this site only in conjunction with BWS/DOFAW; these agencies should prompt trip scheduling. Conduct weed control across burn site at Kumaipo. Target Rubarg, Budasi, weedy trees.																				
MakahaNoMU-01, 02	Maintain trail to facilitate MU access. Conduct control as needed. In particular, target Trisem to reduce likelihood of it spreading via NRS.																				
Ungulate Control	Monitor and maintain fence integrity - Subunit I fence.																				
	Fence construction - Subunit II fence																				
	Monitor and maintain fence integrity - Subunit II fence.																				
	Fence construction - Kamaili fence																				
	Monitor and maintain fence integrity - Kamaili fence.																				
	Monitor and maintain fence integrity - Cyalon fence.																				

Action Type	Actions	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Monitor and maintain fence integrity - Chaher fence																				
	Maintain fence integrity - Cyasup fence																				
	Scope for ungulate sign throughout all fences.																				
	Trap building / maintenance, as appropriate.																				
Rodent Control	Install two small scale control grids for tree snail protection																				
	Maintain bait stations and rat traps every 4-6 weeks in snail areas																				
	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																				
Predatory Snail Control	If E. rosea discovered in the vicinity of A. mustellina sites, conduct sweeps and remove predatory snails																				
Slug Control	Monitor slug activity at Cyanea grimesiana subsp. obatae, C. longiflora,and C. superba subsp. superba population(s)																				
BTB Control	Set traps with high release enthanol baits and replenish insectical strips once every three weeks at air layers established on F. neowawraea and A. macrococcus var. macrococcus																				
Ant Control	Conduct surveys for ants at A. mustelina sites and at Makaha LZ																				
	Implement control if deemed necessary																				

hatched=planned Qtr

1.3.5 Pahole

Ecosystem Restoration Management Plan

MIP Year 7-11, Oct. 2010 – Sept. 2015

MU: Pahole

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 all control methods by 2015.

Background Information

Location: Northern Waianae Mountains

Land Owner: State of Hawaii

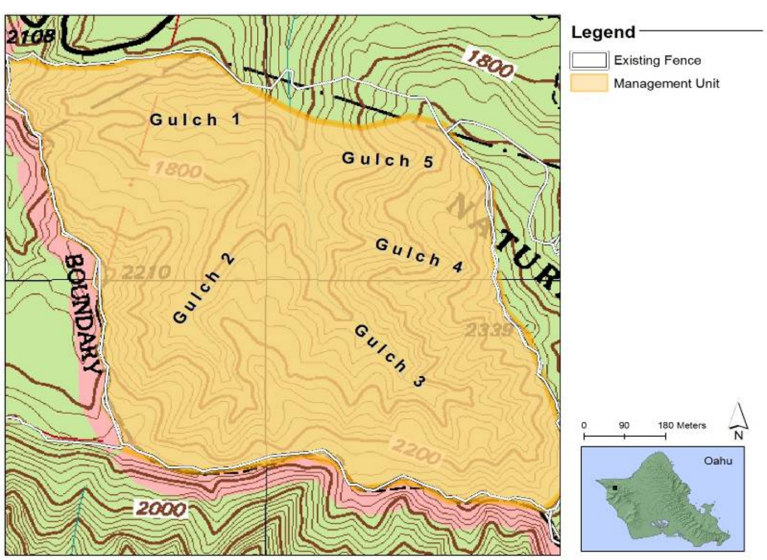
Land Manager: State of Hawaii, NARS

Acreage: 215

Elevation Range: 1500-2400 ft.

Description: Pahole MU is one of three major gulches within the Pahole NAR. The other two gulches that make up the NAR are Kapuna and Keawapilau and are covered in the upper Kapuna Ecosysystem Restoration Management Plan. The Pahole MU itself is further divided into five gulches. When facing South, these five gulches are shaped like a left handprint, with Gulch 1 representing the thumb (see picture below). Gulch 1 ends in the main Waianae Summit ridge separating Pahole from Kahanahaiki, Gulch 2 and 3 reaches back to the Makua rim, and gulchs 4 and 5 ends at the ridge that separates Pahole from Kapuna. The Pahole MU as a whole is diverse, mesic, and contains numerous rare taxa. The east rim of Pahole contains many wild and reintroduced endangered MIP plant sites as well as the ridges dividing each gulch. The most intact native habitat is found above Gulches 2, 3, while the weediest areas are in gulches 4 and 5.

Pahole NAR Gulch Numbers



Native Vegetation Types

<table>
<tr><td>Waianae Vegetation Types</td></tr>
<tr><td>Mesic Ridge/crest</td></tr>
<tr><td>Canopy includes: The canopy is dominated by Acacia koa and/or Metrosideros polymorpha. Other canopy associates include Psychotria spp., Antidesma platyphylum, Bobea spp. and Santalum frecinetianum.

Understory includes: Microlepia strigosa, Sphenomeris chinensis, Alyxia stellate, and Coprosma spp.</td></tr>
<tr><td>Mesic Slope</td></tr>
<tr><td>Canopy includes: Diospyros sandwicensis, Sapindus oahuensis, Nestigis sandwichensis, Pouteria sandwicensis, Antidesma platyphylum, and Pisonia spp.

Understory includes: A. stellate, Psydrax odorata, and Bidens spp.</td></tr>
<tr><td>Mesic Gulch</td></tr>
<tr><td>Canopy includes: Pisonia spp., Charpentiera tomentosa, Psychotria spp, and D. hillebrandii

Understory includes: Diplazium sandwicensis, Microlepia strigosa and Tectaria gaudichaudii as well as Freycinetia arborea, Urera glabra, Pipturus albidus and Coprosma spp.</td></tr>
<tr><td>NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.</td></tr>
<tr><td>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.</td></tr>
</table>

MIP/OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Alectryon macrococcus* var. *macrococcus*	PAH-A,B,F,G	Kahanahaiki to W. Makaleha	MFS	Wild
Plant	*Chamaesyce herbstii*	PAH-E,F,G,H,I,R	Kapuna to Pahole	MFS	Both
Plant	*Cenchrus agrimonioides* var. *agrimonioides*	PAH-A,B,C,D,E,F	Kahanahaiki and Pahole	MFS	Both
Plant	*Cyanea grimesiana* subsp. *obatae*	PAH-A,B,C,D	Pahole to W. Makaleha	MFS	Both
Plant	*Cyanea longiflora*	PAH-A,B,C,G,H,I	Pahole	MFS	Wild Reintroduction
Plant	*Cyanea superba* subsp. *superba*	PAH-A,B	Pahole to Kapuna	MFS	Reintroduction
Plant	*Cyrtandra dentata*	PAH-A,B,C,D,E,F,G	Pahole to Kapuna to West Makaleha	MFS	Wild
Plant	*Delissea waianaeensis*	PAH-B,C,E	Kahanahaiki to Keawapilau	MFS	Both
Plant	*Flueggea neowawraea*	PAH-A,C	Kahanahaiki to Kapuna	MFS	Wild
Plant	*Hedyotis degeneri*	PAH-A,B	Kahanahaiki to	MFS	Wild

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
	var. *degeneri*		Pahole		
Plant	*Nototrichium humile*	PAH-A	Kahanahaiki	GSC	Wild
Plant	*Phyllostegia kaalaensis*	PAH-B	Pahole	MFS	Reintroduction Wild*
Plant	*Plantago princeps* var. *princeps*	PAH-A	Pahole	GSC	Wild
Plant	*Schiedea kaalae*	PAH-A,B,C,E	Pahole	MFS	Both
Plant	*Schiedea nuttallii*	PAH-A,B,D,E	Kahanahaiki to Pahole	MFS	Both
Plant	*Schiedea obovata*	PAH-A,C,D,E	Kahanahaiki to Pahole	MFS	Reintroduction Wild*
Snail	*Achatinella mustelina*	ESU-A	Kahanahaiki to Pahole	MFS	Wild

MFS= Manage for Stability *= Populaiton Dead GSC= Genetic Storage Collection †=Reintroduction not yet done

Other Rare Taxa at Pahole MU:

Organism Type	Species	Status	Comments
Plant	*Diellia falcata*	Endangered	
Plant	*Neraudia melastomifolia*	Species of Concern	
Plant	*Tetraplasandra kavaiensis*	Species of Concern	
Plant	*Lobelia yuccoides*	Species of Concern	
Plant	*Pteralyxia macrocarpa*	Candidate	
Plant	*Exocarpos gaudichaudii*	Species of Concern	
Plant	*Bonamia menziesii*	State endangered	
Plant	*Nothocestrum longifolium*	Species of Concern	

Rare Resources at Pahole

Chamaesyce herbstii

Hedyotis degenerii var *degenerii*

Cyanea longiflora

Schiedea obovata

Locations of Rare Resources at Pahole

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
Rats	*A. mustelina,C. grimesiana,C. herbstii,C. longiflora,C. superba, C. dentata, D. waianaeensis, P. princeps, P. kaalaensis, S. nuttallii, S. obovata,*	On-going at snail areas	No	Localized control
Black twig borer (BTB) *Xylosandrus compactus*	*F. neowawraea, A. macrococcus* var. *macrococcus*	Unknown	No	No effective methods known. No control taking place
Predatory snails, *Euglandina rosea, Oxychilus alliarius*	*Achatinella mustelina*	Yes	No	Physical exclosure to protect native snails from alien snails in place
Slugs	*C. grimesiana,C. herbstii C. longiflora,C. superba C. dentata ,D. waianaeensis, P. princeps P. kaalaensis, S. nuttallii S. obovata*	Yes	No	Revised label for Sluggo under review by Hawaii Department of Agriculture. Currently no control is taking place
Ants	Unknown, possibly a threat to native snails, arthropods, plants and birds	Yes	No	Hydramethylnon (Amdro, Maxforce, Siege) available. Currently no control is taking place
Weeds	All	Yes	Yes	Yes
Fire	All	No	Yes	Yes

Management History

- 1981: Listed as a NAR.
- 1996: First recorded rare plant monitoring by OANRP.
- 1998: Pahole MU fence completed.
- 1998: Snail exclosure built.
- 1999: All pigs were removed by NARS.
- 2000: First outplanting in Pahole.
- 2002: Although started weeding prior, OANRP began extensive weed control in 2002.
- 2006: Several small pigs breached the fence and were able to breed before detection.
- 2008: All pigs removed after breach in 2006. A total of 23 pigs were removed via snares.
- 2009: Rat, snail, and slug monitoring began as a part of the Kahanahaiki trap out study.

Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Strategy:

- Eradication in the MU. NARS staff is the primary manager for this MU therefore all management actions must be cleared through the NARS Specialist.

Primary Objective:

- Maintain the fenced area as ungulate-free.

Secondary Objective:

- It would be advantageous to reduce current pig activity just outside of the fence by using snares on the upper slopes of Makua to reduce pressure on fence.

Monitoring Objectives:

- Conduct monthly fence checks during the public hunting season, and quarterly fence checks when not hunting season.
- Work with NARS crew to install 1-2 transects. The transect locations have not yet been decided.
- Monitor for pig sign when conducting other management actions in the fence.

Management Responses:

- If any pig activity detected in the fence area, implement a NARS directed snaring program.

Maintenance Issues:

- There is a perimeter fence around this 215 acre MU. The major threats to the perimeter fence include fallen trees and vandalism; there is one major gulch crossings. The fence is constructed in such a way at the crossing that allows the water to pass under without opening access to pigs. There have been relatively few incidences of vandalism in the past. Special emphasis will be placed on checking the fence after extreme weather events.

Weed Control

Weed Control actions are divided into 4 subcategories:

5) Vegetation Monitoring
6) Surveys
7) Incipient Taxa Control (Incipient Control Area - ICAs)
8) Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

Primary Objectives

1) Assess the cover of alien plant species within a specific MU to determine if it is less than 50% across the sampled unit or continuing to decrease to ultimately meet that threshold requirement (Makua Implementation Team et al. 2003).
2) If alien species cover is not below the 50% threshold, determine if this value is decreasing significantly toward that goal based on repeat monitoring of the MU.

Secondary Objectives

1) Monitor the status of native plant species within the MU.
2) Determine if any ungulates (feral pigs or goats) are detected within the fenced portion of a MU.

MU Vegetation Monitoring

- Conduct MU vegetation monitoring every three years (2012 and 2015) to measure the effectiveness of current weeding effort within the MU.

Surveys

Army Training: None

Other Potential Sources of Introduction: OANRP, NARS, pigs that breach the fence, birds, mongoose, public visitors, construction and landscaping at Dillingham Ranch.

Survey Locations: Roads, Landing Zones, Fencelines, Trails, and High Potential Traffic Areas.

Management Objective:

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

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Roads, fencelines, and other highly trafficked areas are inventoried regularly; Army roads are surveyed annually, non-Army roads are surveyed annually or biannually, while all other sites are surveyed quarterly or based on frequency of use. OANRP will continue to do annual road surveys. No weed transects have been established along fence lines or other possible high traffic areas, such as trails and staging areas. OANRP will consider whether such transects are a valuable tool at Pahole in the coming year. Due to its small size, incidental observations during regular field management may suffice.

Monitoring Objectives:

- Survey roads annually.
- Quarterly survey of LZs.
- Note unusual, significant, or incipient alien taxa during the course of regular field work.
- Install monitoring transects in conjunction with ungulate transects.

Incipient Taxa Control (ICAs)

Management Objectives:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2015.
- Conduct seed dormancy trials for all high priority incipients by 2015.

Monitoring Objectives:

- Visit ICAs at stated revisitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.
- Detect 100% of known mature incipient invasives at all ICAs and at least 75% of known immature incipient invasives through quarterly ICA sweeps.

Management Responses:

- If unsuccessful in preventing immature plants from maturing, revisit ICA's more frequently.

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

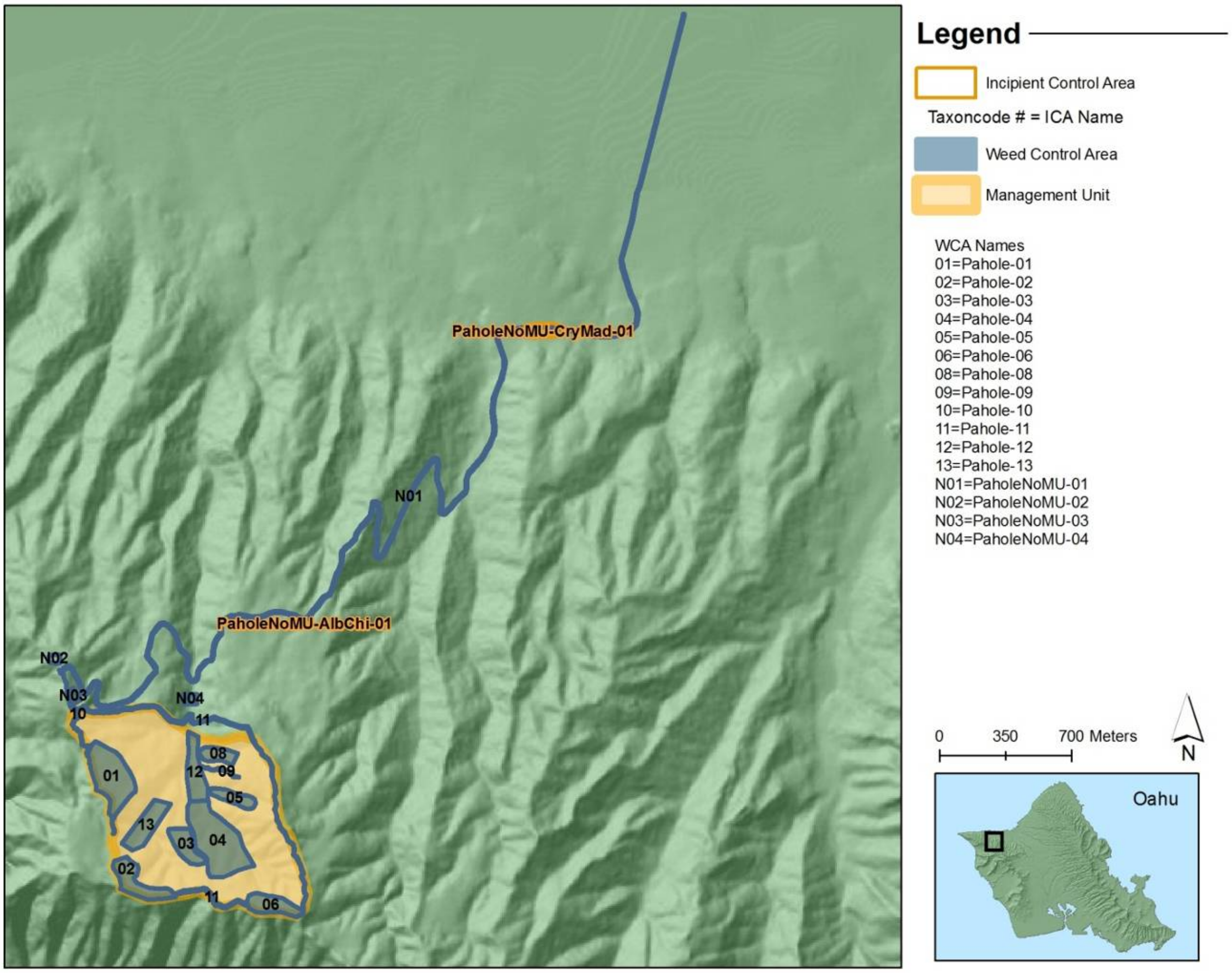
The table below summarizes incipient invasive taxa at Pahole MU. Appendix 3.1 of the MIP lists significant alien species and ranks their potential invasiveness and distribution. Each species is given a weed management code: 0 = not reported from MU, 1 = incipient (goal: eradicate), 2 = control locally. 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 Pahole MU. ICAs have been designated for taxa in shaded cells and text in red.

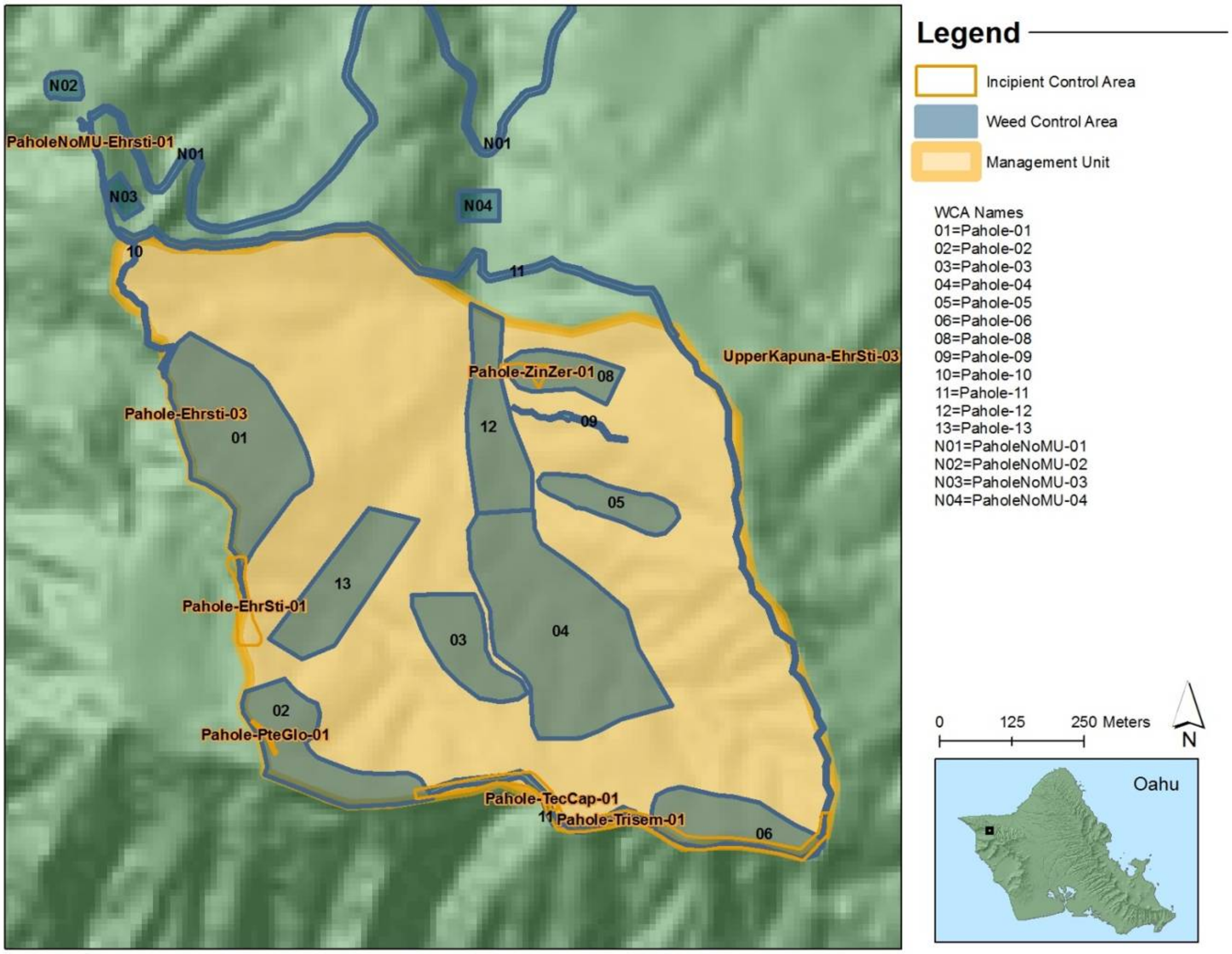
OARNP have been very diligent about regular re-visitation of ICAs throughout the MU. While most are visited quarterly and are treated before more individuals become mature, some species persist and may need more frequent visitation or new control methods in order to reach complete eradication. OARNP would also like to discuss with NARS staff the use of Oust, a pre-emergent herbicide, at *Ehrharta stipoides, Pterolepis glomerata* 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 man. code: Original	MIP weed man. code: Revised	Notes	No. of ICAs
Acacia mearnsii	N/A	1	Located on the border of Kahanahaiki and Pahole at the top of the Schwepps trail. The population is recorded under the Kahanahaiki MU as an ICA. On both sides of the trail there is only a minute amount.	0
Achyranthes aspera	1	1	Small population located in the lower section of the Pahole NAR. The objective is to keep it out of the Pahole MU by targeting this species when observed in WCAs.	0
Albizia chinesis	**1**	**1**	**Only a few plants found near the Peacock Flats gate. Monitor location.**	**1**
Angiopteris evecta	**1**	**1**	**In gulch 5, systematic control and surveys needed.**	**0**
Axonopus compressus	1	1	Medium size population located at the top of the Switchbacks near the water catchment. Sprayed previously and continue to monitor. The population is recorded under the Kahanahaiki MU as an ICA.	0
Cryptostegia grandiflora	**N/A**	**1**	**Only known from along Pahole road near Dillingham Ranch. Treatment on May 2010 was effective in killing the known plant. Continue to monitor and treat with State assistance.**	**1**
Ehrharta stipoides	**1**	**1**	**Species present both in and outside of MU. Control needed to prevent greater spread of this species.**	**4**
Grevillea robusta	2	2	Not targeted by OARNP. NARS staff are currently treating large trees. Will continue communication with NARS staff to assess help needed.	0
Montanoa hibiscifolia	1	2	Known from multiple locations across MU, and appears to be widespread. It will be a target weed species at all weed control areas and all occurrences will be GPSed.	0
Passiflora suberosa	1	1	Found only on fenceline border of Kahanahaiki and Pahole. Appears to be more widespread in Kahanahaiki MU than originally thought. Controlled as part of Kahanahaiki MU. Vegetation monitoring in Pahole will help determine distribution. This species will be controlled in WCAs.	0
Pennisetum clandestinum	0	1	None from one location on state land near the NIKE site. Population is not spreading, no seed produced. OANRP will monitor to detect potential changes in behavior and work with State to determine level of control.	0
Pterolepis glomerata	**1**	**1**	**Small infestation along trail was found May 2007 and was probably carried in on accident on a shoe of a hiker. A pre-emergent such as Oust may need to be used to help eradicate this species.**	**1**
Sphaeropteris cooperi	1	1	Small infestation along trail. One mature found on 3-4-10.	0
Tecomaria capensis	**N/A**	**1**	**Potential for invasiveness has been observed elsewhere. This site is located at the top of the ridge dividing gulch 2 and 3. The last 3 visits yielded no plants. Control was effective.**	**1**
Triumpheta semitriloba	**1**	**1**	**Most of the plants are known from the Makua rim along the Makua/Pahole fenceline including where the Upper Kapuna fence meets the Pahole fence. This is where the control has been focused. Emphasis is placed on preventing movement off the ridge and into Pahole.**	**1**
Zingiber zerumbet	**N/A**	**1**	**Known from one location in Gulch 5. Ica formed, and control is ongoing. This plant is a Polynesian introduction, and is only controlled in MU.**	**1**

Incipient and Weed Control Areas at Pahole





Ecosystem Management Weed Control (WCAs)

MIP Goals:

- Within 2m of rare taxa: 0% alien vegetation cover (with exceptions where this will cause harm to rare taxa).
- 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:

- Conduct baseline vegetation monitoring transects by 2011 in MU. Management objectives will then be defined based upon these monitoring outcomes.
- In WCAs within 50m of rare taxa, work towards achieving 25% or less alien vegetation cover in understory and canopy. Although monitoring not yet done, OANRP already know that most rare plant taxa sites do not meet this goal.

Management Responses:

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

Pahole as a whole consist mostly of invasive plants, however in a certain areas such as the back of gulches 2 and 3 just below the edge of the Makua ridge, intact plant communities exist hosting the largest wild, naturally occurring populations of *C. dentata, C. hebstii, C. longiflora, H. degeneri* var. *degeneri, and S. nutalii* in the world. Large populations of wild and reintroduced *C. agrimonioides* var. *agrimonioides*, *C. superba, C. grimesiana,* and *S. obovata* also exist in Pahole MU. OANRP began small scale weed control around some of these rare plant populations in Pahole prior to 2002, but it was in that year when extensive weed control began around all known wild sites, reintroduction sites that were planted in subsequent years, and incipient taxa.

There are 12 WCAs inside the Pahole MU, and 4 WCAs outside the MU. A few of these WCAs have *R. rosifolius* and *B. appendiculata* as its main understory weeds. OANRP should consider developing a strategy to reduce the amount of time needed for weeding especially in these highly repetitive areas, perhaps by utilizing common reintroductions. Rat grids and slug control in the immediate areas surrounding rare taxa may help seedlings get established and make weeding more effective, as well as protecting the parent plant from predation and destruction.

Future vegetation monitoring at Pahole will commence in 2012 and will likely indicate that it will take a long time to meet the MU 50% alien cover goal in the understory and canopy. Most of the WCAs are drawn around rare taxa sites, where the alien goal is 25% or less, and OANRP effort is focusing in these areas. A few WCAs are drawn where there are no rare taxa; this is done to facilitate control of target species throughout the MU like *M. hibiscifolia*. Areas around rare taxa will continue to be priority. Where *A. mustelina* are present, OANRP will seek to avoid unintentional negative impact by being cognizant of snail presence and avoiding control of preferred snail trees.

WCA Pahole-01 (Switchbacks Schnut Reintro)

Veg Type: Mesic slope

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *Schinus terebinthifolius*, *Psidium cattleianum*, *Montanoa hibiscifolia,* and shrubs.

Notes: This WCA is located at the top of Gulch 1 which includes part of the Pahole/Kahanahaiki trail and stretches from Puu 2210 to the Kahanahaiki Schwepes trail. This is a large WCA, priority being understory and gradual control around rare plant taxa, then grass control and canopy control. There is a large patch of *Microlepia strigosa* in the area encompassing the *D. waianaensis* outplanting and controlling the understory weeds may help this native understory expand. Many areas along the rim just need periodic grass spray and minimal weeding of alien understory. OANRP should start *B. appendiculatum* control in this area. It is better to attack before clumps get too large. If the population extends past an easy control threshold it is still possible to kill *B. appendiculatum* in 5 X 5 meter sections over time (a few years), reducing alien understory gradually.

WCA Pahole-02 (Cenagragr PAH-A)

Veg Type: Mesic slope/ridge

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, *M. hibiscifolia*, and shrubs.

Notes: This large WCA spans a north facing gulch slope and includes the area from the Pahole Snail exclosure to the *H. degeneri* var. *degeneri* population. The area surrounding the large *C. agrimonioides* outplanting site is native dominated and will be maintained. However, the surrounding area will require further weeding, including periodic grass spray, *B. appendiculatum,* and *P. cattleianum* control. *H. degeneri*, *C. longiflora*, and *P. princeps* are located on the eastern side of this WCA. Although portions of the WCA are dominated by native understory, there is a concern of removing too much canopy, allowing non-native and invasive canopy to move in. Common reintroductions may help, with *Acacia koa* being a good candidate.

WCA Pahole-03 (Cenagragr PAH-B)

Veg Type: Mesic slope

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, *M. hibiscifolia*, and shrubs.

Notes: This fairly steep sloped WCA is located on top of the ridge dividing Gulches 2 and 3 which includes the in-situ population of *C. agrimonioides*. Sprinkled throughout this population are pockets of the native panicum grass. The top portion of the ridge is mostly covered by natives, canopy as well as understory. Unfortunately the parts not covered by natives have been overgrown with *M. minutiflora*. Periodic grass spray/ hand pull is needed. Directly downslope of the *C. agrimonioides* population there is a large stand of *P. cattleianum*. This should be replaced slowly with *Acacia koa* as weeds are removed, so as not to let *P. cattleianum* continually encroach upon the wild population. Continuing down this ridge in a southern direction is the *D. falcata* - A population.

WCA Pahole-04 (Gulch 3 Cyasup reintro/Chaher)

Veg Type: Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, and shrubs.

Notes: This WCA is located in gulch 3 and includes the area from the bottom *C. superb* outplanting site to the top of the Gulch 3 *C. herbstii* sites G, I, and R. The majority of this WCAs overstory consists of large *P. cattleianum* stands. In most areas of the gulch, little light is able to penetrate through the overstory. The groundcover in the gulch is partially comprised of native taxa such as *M. strigosa*, *Asplenium macrei,* and *A. kaulfussii*. Continue periodic control of *R. rosifolius, P. cattleianum* and grasses, as well as sweeps to continually control *M. hibiscifolius*. Weeding of ground cover around the *C. superba* and *C. herbstii* populations to help recruitment seedlings is the primary objective. The area requires lots of repetitive weed control of *R. rosifolius* in the understory. OANRP should start *B. appendiculata* control around these sites and future reintroduction sites as it is much easier to control before the establishment of endangered taxa into the area.

WCA Pahole-05 (Gulch 4)

Veg Type: Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, and shrubs.

Notes: WCA is in gulch 4 around the failed *P. kaalaensis* reintroduction. The rare taxa, *C. dentata* are located on the eastern slope of the WCA. Weeding to help native recruitment of rare taxa such as *Pisonia sp.* is important as there are a lot of light gaps. Sweeps should be continually conducted for *M. hibiscifolia*. This WCA is cool, moist, and shady due to the large overstory created mostly by *P.*

cattleianum. If *P. kaalaensis* is reintroduced to this site again, continual weeding of *R. rosifolius* and *B. appendiculatum* will be necessary, especially in the vicinity the planted plants. It would be prudent to target the non-native understory and then gradually aim towards non-native canopy removal.

WCA Pahole-06 (East Pahole Rim Schnut/Cyalon)

Veg Type: Mesic slope

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *P. cattleianum* and shrubs.

Notes: Stretching from the eastern side of Gulch 3 up to the Pahole rim, lies WCA-06. This WCA is extremely sensitive due to steep, wet banks with possible *C. longiflora* recruitments in the soil. Due to the sensitivity of the habitat, it is recommended that activities in the area, such as weeding (*P. cattleianum*) and plant monitoring, be coupled with plant collection trips to minimizethe number of visits to the site. There are several pockets of native forest patches. Rare taxa in the WCA include populations of *C. longiflora*, *C. dentata*, and one population of *S. nuttalii*. All these populations are evenly dispersed among the WCA. The canopy consist of *A. koa*, *C. glaucum*, *A. platyphylum*, and the understory consist of *A. oliviformis*, *A. nidus,* and *B. occidentale*.

WCA Pahole-08 (Gulch 5)

Veg Type: Mesic gulch

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, and shrubs.

Notes: WCA is located in gulch 5 around the *C. grimesiana* and *S. kaalae.* Overstory cover is fairly dense, with *S. terebinthifolius* and *P. cattleianum* as dominant species. Also intermixed is *A. moluccana* and *D. sandwicensis*. Understory is patchy and includes *B. asiatica*, *M. strigosa*, and *A. oliviformis*. The gulch is steep and narrow, and the closed canopy encourages a wet environment. The goal in this WCA is to improve habitat, by gradually controlling weedy understory and canopy without shocking area with major changes in light levels. This will provide a more suitable habitat for the reintroduced *C. grimesiana* subsp. *obatae* and wild and reintroduced *S. kaalae.*

WCA Pahole-09 (Cenagragr outplanting site)

Veg Type: Mesic slope

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, and shrubs.

Notes: This WCA is located on the ridge dividing Gulches 4 and 5, and is maintained mostly for the C. *agrimonioides* reintroduction population F. This is the only rare taxa in the immediate area, therefore the main focus of weeding is specific to this one population. Alien grasses are hand pulled near C. *agrimonioides* and grasses that are a safe distance away are sprayed. Continual weeding of *R. rosifolius* and *B. appendiculatum* is recommended. It would be prudent to target the non-native understory and then gradually work towards non-native canopy removal. Some of the canopy cover consists of non-natives, such as *P. cattleianum*, as well as native canopy, such as *A. koa*.

WCA Pahole-10 (Pahole Trail Spraying)

Veg Type: Mesic Ridge

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, and shrubs.

Notes: This WCA spans from the Pahole trailhead to the Schweps trail, the most northern point of WCA 1. WCA 10 is comprised primarily of the main Pahole trail and the areas adjacent to the trail. This WCA was created primarily to facilitate grass sprays along the trail, however since there are now reintroduced *C. agrimonioides* var. *agrimonioides*, *S. nuttallii*, and *S. obovata* in the area, the WCA was expanded to include weed control around these new taxa. Dominant target weeds are *P. cattleianum, P. guajava, S. terebinthifolius*. There have also been rare sightings along the trail of the weed *A. mearnsii*. Unfortunately, there are few large patches of *P. cattleianum* in the first half of the WCA. There is no native canopy in the immediate vicinity that would be able to fill the void if the the P. cattleianum were to be removed. Many native species line the trail as well, *M. polymorpha, A. koa, A. oliviformis, B. torta*. The majority of the area has minimal canopy cover, and thus there is an abundance of light reaching down to the understory.

WCA Pahole-11 (Pahole Fenceline)

Veg Type: Mesic Gulch

MIP Goal: Less than 50% non-native cover

Targets: All weeds, focusing on *S. terebinthifolius*, *P. cattleianum*, *M. hibiscifolia* and shrubs.

Notes: WCA 11 encompases the Pahole fence particularly the North and East portions of the fence including the Hypalon. It is important to maintain and clear the fenceline in this area that spans from gulch to ridge top. Occasionally remove large fallen trees off of the fence to maintain the integrity of the fence. Spraying grass and treating the thick invasive understory will be done as needed in order to keep weeds at a manageable size. Periodic sweeps for *M. hibiscifolius* will be conducted annually, as well as general sweeps for other target weeds. The majority of this WCA's canopy consists of *P. cattleianum*, yet there is a significant portion of native taxa in the understory. Weed control will be conducted as needed to keep the fence line clear and facilitate fence line checks.

WCA Pahole-12 (Main Gulch)

Veg Type: Mesic Gulch

MIP Goal: Less than 50% non-native cover

Targets: All weeds, focusing on *P. cattleianum*, *M. hibiscifolia* and shrubs.

Notes: The Pahole main gulch entrance has no rare taxa in the immediate area of this WCA. The moisture of this gulch environment allows for a lush, generally native filled understory consisting of native ferns. This large drainage is the most commonly used corridor that leads to the five gulches in Pahole, each of which contains rare managed taxa. One the most vital goals here is to focus our attention on *M. hibiscifolius* sweeps, as well as searching for other target weeds including *T. ciliata*, *T. semitriloba* and *P. edulis*, which became a potential threat a year ago. Due to the fact that this gulch is the main pathway used to access the other gulches, it is pertinent to halt any further transport of the previously mentioned weeds.

WCA Pahole-13 (Back of Gulch 2)

Veg Type: Mesic Gulch

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *P. cattleianum*, *M. hibiscifolia* and shrubs.

Notes: *C. herbsteii* F-population and *F. neowawraea* is the managed taxa within this WCA. Weed control efforts, around the rare taxa, are targeted on understory and gradual canopy weed control, while at the same time preventing major light changes to the micro-environment. Understory species of concern are *C. hirta, B. appendiculatum*, and *R. rosifolius*. It is critical to control the minimal amount of weedy groundcover because there is abundance of native seedling recruitment. The overstory consisting of native and non-native species is not dense and allows for significant light to penetrate down below. The gulch should be swept for *M. hibiscifolius*, *T. ciliata*, and *T. semitriloba* at least once a year.

WCA Pahole No MU-01 (Pahole Road)

Veg Type: Mesic Forest

MIP Goal: N/A

Targets: Roadside weeds, focusing on P. maximum.

Notes: The goal of this WCA is to maintain the Pahole road and control/reduce of target weeds as a safety issue. OANRP staff sprays grass and herbaceous weeds along road from Peacock Flats gate to the ranch gate as needed. Often, a power sprayer and weedwackers are used. These actions are shared between teams. Maintenance and weed control on other parts of the road occurs occasionally. It is important to prevent spread of weeds on road that it is utilized by several organizations: OANRP, State, HECO (Hawaiian Electric Company), Verizon Wireless, and HPD (Hawaii Police Department), as well as public hunters and hikers.

WCA Pahole No MU-02 (Nike Site)

Veg Type: Mesic Flat

MIP Goal: N/A

Targets: All weeds.

Notes: The goal of this WCA is to control weeds around the Nike site facility. Weed control is focused around the LZ, OANRP greenhouses, the upper building at Nike including the octagon where we fly loads off of, and anywhere else needed. Some common weeds found on these WCA sites include: *P. cattleianum, P. guajava, S. terebinthifolius, R. rosifolius, C. hirta, L. leucocephala, M. minutiflora, P. maximum.*

WCA Pahole No MU-03 (Cenagragr Reintro Outside Fence)

Veg Type: Mesic Slope

MIP Goal: Less than 25% non-native cover

Targets: All weeds, focusing on *P. cattleianum*, and shrubs.

Notes: This WCA is located on the east facing slope just below the Pahole trail, just after the Re-veg road cut-off and before the water catchment. The managed rare taxa here are reintroduced *C.*

agrimonioides and *S. obovata* in a steep terrain habitat. The canopy is predominately *S. terebinthifolius*, and very open. The area is an exposed ridge top, and therefore, not much ground cover is present. Target understory and gradual canopy removal.

WCA Pahole No MU-04 (Fig Gulch)

Veg Type: Mesic Gulch

MIP Goal: Less than 50% non-native cover

Targets: All weeds, focusing on *P. cattleianum*, and shrubs.

Notes: This WCA is located between the Pahole fence and the Pahole road. Any target species in this WCA should be killed including *M. hibiscifolius* and *T. ciliate*. No rare taxa are in this WCA and the goal is to prevent these target species from getting established and spreading into the MU. This area is fairly weedy with *M. hibiscifolia* and some *P. suberosa* intermixed along the slopes. The understory is comprised of mostly native taxa, *A. oliviformis* and *M. strigosa* and there are no rare taxa in the immediate area. Weed sweeps for *M. hibiscifolia* are on-going while conducting other MU actions and weed sweeps.

Rodent Control

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

Threat level: High

Control method: Localized control (bait station and snap trap grids)

Seasonality: Year-round: Snail exclosure: Fruiting season: *C. superba* subsp. *superba*

Number of control grids: 2 (Snail exclosure: 3 bait stations, 6 rat traps & *C. superba* subsp. *superba*: to be determined)

Primary Objectives:

- To maintain rodent populations at a level that facilitates stabilized or increasing plant and tree snail populations by the most effective means possible.

Management Objective:

- Continue to maintain localized bait station and rat trap grid around *Achatinella mustelina* exclosure.
- Establish and maintain a small scale bait station grid around *C. superba* subsp. *superba* populations during the flowering and fruiting season.
- Institute rodent control on a small scale if determined necessary for other rare plant populations (*D. waianaeensis, C. longiflora*)

Monitoring Objective:

- Monitor *Cyanea superba* subsp. *superba*, *Cyanea grimesiana* subsp. *obatae*, *Cyanea longiflora*, *Delissea waianaensis,* and *Plantago princeps* var. *princeps* to determine the occurrence of fruit/plant predation by rats. Monitor tree snails to determine if rats are impacting the tree snail population within the exclosure.

Localized Rodent Control Actions:

- Localized control consists of bait stations and rat traps deployed around the Pahole NAR tree snail exclosure. Bait stations are maintained every 4 to 6 weeks and rat traps maintained every two weeks. The exclosure is designed to keep out the predator snail *Euglandina rosea*, but not rodents. The localized control is designed to reduce rat predation on tree snails within the exclosure. Additional rat control is ongoing at the Kahanahaiki MU which is directly adjacent to the snail exclosure. The large scale trapping grid at the Kahanahaiki MU, maybe affording additional protection for snails within the exclosure (See Research Chapter: Kahanahaik Large Scale Trapping Grid).
- Monitoring fruit fate of *C. superba* subsp. *superba* during the 2009-2010 fruiting season revealed a high rate of rat predation on fruits within the Pahole MU (See Research Chapter: Kahanahaiki Large Scale Trapping Grid). Rat control will consist of bait stations deployed around plants to reduced fruit predation pressure by rats. Bait stations will be maintained every four weeks during the fruiting season (November-January).

Slug Control

Species: *Deroceras leave, Limax maximus, Limacus flavus, Meghimatium striatum, Veronicella cubensis*

Threat level: High

Control level: Localized

Seasonality: Wet season

Number of sites: Currently, no sites within this MU

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 specialist to identify areas where application would benefit native plants without harming nontarget snails.

Monitoring Objectives:

- Annual census monitoring of *C. superba* seedling recruitment following fruiting events (as this species is vulnerable to slug predation).
- Annual census monitoring of slug densities during wet season.

Effective molluscicides have been identified (Sluggo) and initial control programs are ongoing in Kahanahaiki under an Experimental Use Permit (EUP). Whether slug control is possible in this MU depends upon registration of Sluggo under a Special Local Needs permit. It is not legal to apply under the current label. Should slug control take place, a priority species for eradication would be *Veronicella cubensis*. First found in this area in April 2007, this species has not yet spread outside of this MU. The

Plots to monitor the effect of predator removal (rats) on slug populations were installed in the Pahole MU in June 2009.

Predatory Snail Control

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

Threat level: High

Control level: Locally at *Achatinella mustelina* site

Seasonality: Year-Round

Number of sites: One, PAH-A (*A. mustelina*)

Acceptable Level of Activity: Not tolerated within PAH-A *A. mustelina* snail enclosure

Primary Objective: Eliminate predatory snails to promote *A. mustelina* survival.

Management Objective:

- Continue to develop better methods to control predatory snails.
- Keep sensitive snail populations safe from predatory snails via currently accepted methods (such as hand removal of alien snails, construction of barriers which prevent incursion from alien snails).
- Work with NAR staff to maintain predator proof exclosure around the PAH-A *A. mustelina* population.

Monitoring Objectives:

- Annual or every other year census monitoring of *A. mustelina* population(s) to determine population trend.
- Annual search and removal of predatory snails in proximity to *A. mustelina.*

Ant Control

Species: *Solenopsis papuana, Leptogenys falcigera* 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, human entry point where Gulch 2 intersects Hypalon fence and at the *Achatinella mustellina* snail exclosure

Acceptable Level of Ant Activity: Probably acceptable at current levels

Primary Objective: Eradicate incipient ant invasions and control established populations when densities are high enough to threaten rare resources.

Management Objective:

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

Monitoring Objective:

- Sample ants at human entry point (Hypalon fence intersection with trial) and at *Achatinella mustellina* site. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- Look for evidence of ant tending of aphids or scales on rare plants.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and 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). The protocol for sampling ants appears in Appendix 6-1 (this document).

Standardized surveys have not yet taken place. Opportunistic collection confirms that the following two species are present: *Leptogenys falcigera* and *Solenopsis papuana*. The first species occurs in low numbers and is not considered a threat to native resources. The second is one of the most common ants encountered at higher elevations on Oahu (see Appendix 6-2, this document). Both species are widespread throughout Oahu, therefore any attempt at control would be temporary. While control is not recommended at this time, future surveys are needed to ensure new species are not introduced.

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**:**

Pahole 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 Pahole 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
General Survey	Install and maintain transects																				
	Discuss AngEve with NARS staff. Determine whether we should help with control. Survey for AngEve in gulch 5. Define ICA and develop control schedule.																				
ICA	PaholeNoMU-AlbChi-01: Monitor/control AlbChi at Peacock Flats site every 6 months. Pick and remove from field any potentially viable fruit.																				
	PaholeNoMU-CryGran-01: Control infestation along the Pahole road. Work in conjuction with State. DOFAW to assist with monitoring, OANRP to assist with initial knockdown. Monitor to ensure that control method effective. Pick and remove from field any potentially viable fruit.																				
	PaholeNoMU-EhrSti-01: Monitor/control Ehrsti at Kahanahiki/Pahole trailhead quarterly. Spray. Flag location to facilitate revisitation. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.																				
	Pahole-EhrSti- 01: Survey and correctly GPS ICA. What is currently drawn on GIS is not accurate: ICA should extend from puu 2210 to pink flag trail (unless any other Ehrsti is found). There should be Target Species points at each of the 2 blue flagged locations. On GIS now																				
	Pahole-EhrSti-01: Monitor/control EhrSti at site near pink cross crossover quarterly. There are two flagged locations between pink trail crossover and puu 2210. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.																				

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
	Pahole-EhrSti-02: Monitor/control EhrSti at state snail jail quarterly. Sweep entire ICA each time. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.																				
	Pahole-EhrSti- 03: Monitor/control Ehrsti at site on Kahanahaiki fence north of switchbacks quarterly. Possibly could have been Vulpia not Ehrsti at site. Pick and remove from field any potentially mature fruit. This species is cryptic and can be difficult to id.																				
	Pahole-PteGlo- 01: Monitor/control PteGlo at site south of state snail jail quarterly. Area was treated with Oust, a preemergent herbicide. Pick and remove from field any potentially mature fruit.																				
	Pahole-TecCap- 01: Monitor/control TecCap at East rim fence site every 6 months. Treat all roots with Garlon; majority of plants finding now appear to be resprouts from previous handpulling control efforts.																				
	Pahole-TriSem- 01: Survey outside of drawn ICA, off fence, on Pahole side; determine if any outliers present and if ICA shape needs to be updated. GPS.																				
	Pahole-TriSem- 01: Monitor/control TriSem along East Rim fenceline quarterly. Pick and remove from field any potentially viable fruit.																				
	Pahole-ZinZer- 01: Monitor/control ZinZer in gulch 5 annually. Treat rhizomes with Escort.																				
Pahole-01: Switchbacks/Schnut reintro	Control weeds around DelSub/CyaSup reintro zone every 6 months. Target understory weeds, gradual canopy weed control.																				
	Control weeds across CenAgr, SchObo reintro zone every 6 months. Target understory, gradual canopy weed control.																				

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
	Control weedy grasses across WCA every 6 months/year, as needed. Exercise care when spraying around rare taxa.																				
	Control weeds across SchNut switchbacks reintro zone every 6 months. Target understory, gradual canopy weed control.																				
	Spray grasses along Kahanahaiki/Pahole fenceline quarterly, or as needed.																				
	Control weeds across WCA annually. Focus around native forest patches. Target understory, SchTer, MonHib, gradual canopy control. Do not kill large GreRob; part of NARS trial.																				
	Control weeds around CenAgr reintro every 6 months/year. Target understory and gradual control of canopy weeds.																				
Pahole-02: Cenagragr PAH-A	Control weeds around SchObo, CyaGri reinto zone every 6 months. Target understory weeds and gradual control of canopy weeds to prevent major light changes.																				
	Control weeds around native forest patches, across WCA, annually. Target MonHib, select understory weeds and gradual removal of canopy weeds. Do not kill large GreRob; part of NARS trial.																				
	Spray grasses along Kahanahaiki/Pahole fenceline quarterly, or as needed.																				
	Control weedy grasses across WCA every 6 months/year, as needed. Target MelMin, PasCon, OplHir.																				
	Control weeds around CenAgr and nice forest patches every 6 months. Target MonHib, understory and gradual control of canopy weeds (PsiCat). Do not kill large GreRob; part of NARS trial.																				

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
Pahole-03: Cenagragr PAH-B	Control weedy grasses across MU every 6 months/as needed. Target MelMin. Exercise care when working around CenAgr.																				
Pahole-04: Gulch 3 Cyasup reintro/ Chaher	Control weeds around CyaSup reintro every 6 months. Target understory and gradual canopy weed control (prevent major light change). Understory very weedy; selectively work around CyaSup plants controlling understory to help seedling germination.																				
	Control weeds around ChaHer reintro every 6 months. Target understory and gradual canopy weed control (prevent major light change).																				
	Control weeds around native forest patches and wild ChaHer every 6 months. Target canopy and select understory weeds including *Ageratina spp. Rubus rosifolius, Christella spp*., etc. Target MonHib wherever found in gulch 3. GPS and flag locations of mature MonHib plants. Track number/reproductive status of MonHib trea																				
Pahole-05: Gulch 4	Control MonHib wherever found in gulch 4. GPS and flag locations of mature plants. Track number/reproductive status of plants treated.																				
Pahole-06: East Pahole rim Schnut/Cyalon	Control weeds across WCA once every 1-2 years. Focus around native forest patches and CyaLon. Exercise extreme care when working around CyaLon, rare taxa; sensitive habitat. Pair with rare plant collection trips. Target understory and gradual canopy removal.																				
Pahole-08: Gulch 5	Control weeds across Schkaa/Cyagri reintro zone every 6 months. Target understory weeds, especially weedy ferns. Conduct minimal canopy weeding to prevent light regime changes.																				

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
Pahole-09: Cenagragr outplanting site	Control understory and canopy weeds around CenAgr reintro every 6 months.																				
Pahole-10: Pahole Trail Spraying	Control understory and canopy weeds around CenAgr, SchNut, and SchObo reintro every 6 months.																				
Pahole-11: Pahole Fenceline	Spray grasses along Kahanahaiki/Pahole fenceline every 6 months, or as needed.																				
	Clear and Maintain fence. Remove downed trees,spray grass, treat thick understory, as needed. Target all MonHib seen along frence at one time a year.																				
Pahole-12: Main Gulch	Sweep gulch at least once a year, focusing on significant weeds, particularly MonHib, TooCil, TriSem.																				
Pahole-13: Back of Gulch 2	Control weeds around ChaHer every 6 months. Target understory and gradual canopy weed control (prevent major light change). Always target MonHib, TooCil, and TriSem in Pahole.																				
	Sweep gulch at least once a year, focusing on significant weeds, particularly MonHib, TooCil, TriSem.																				
Pahole No MU-01: Pahole Road	Control grass/herbaceous weeds along the Pahole road, from Peacock Flats gate to the Ranch gate quarterly/as needed. Use the power sprayer, weedwack. Alternate this action between teams. Goal: maintain road, public safety, reduce weed spread.																				
Pahole No MU-02: Nike site	Control weeds aound Nike site facility as needed. Focus on LZ, around greenhouse, and anywhere else needed. Coordinate with Horticultural Staff.																				

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
Pahole No MU-03: Cenagragr Reintro Outsides Fence	Control weeds around SchObo and CenAgr reintros every 6 months/year. Targe understory weeds and limited canpoy weed control																				
Pahole No Mu-04: Fig Gulch	Control taget weed species, particularly MonHib, TooCil, and TriSem. Sweep area at least once per year.																				
Ungulate Control	Assist State with elimination of any pig ingress into the fence																				
	Maintain fence integrity																				
	Scoping out portion of fence that needs skirting																				
	Survey areas for ungulate sign.																				
Rodent Control	Establish and maintain small scale bait station grid around *C. superba* subsp. *superba* during the fruiting season																				
	Maintain bait stations and rat traps at the Pahole snail exclosure																				
	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																				
Slug Control	Annual census monitoring of *C. superba* seedling recruitment following fruiting events (as this species is vulnerable to slug predation).																				
	Annual census monitoring of slug densities during wet season.																				
Predatory Snail Control	Determine if any *E. rosea* or *O. alliarus* snails are present at the *A. mustelina* snail exclosure and remove																				
	Maintain physical barriers (exclosures) to protect *A. mustelina* form predatory snails																				
Ant Control	Conduct surveys for ants annually																				
	Implement control if deemed necessary																				

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
Canopy includes: *Acacia koa*, *Metrosideros polymorpha, Nestegis sandwicensis, Diospyros* spp.*, Pouteria sandwicensis, Charpentiera* spp.*, Pisonia* spp. ,*Psychotria* spp., *Antidesma platyphyllum*, *Bobea* spp. and *Santalum freycinetianum*. Understory includes: *Alyxia stellata, Bidens torta, Coprosma* spp., and *Microlepia strigosa*
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	*Alectryon macrococcus* var. *macrococcus*	KAP-A	Kahanahaiki to West Makaleha	MFS	Wild
Plant	*Chamaesyce herbstii*	KAP-A, B, C, E	Kapuna to Pahole	MFS	Both
Plant	*Cyanea longiflora*	KAP-B PIL- B, C, D, E	Kapuna to West Makaleha	MFS	Both
Plant	*Cyrtandra dentata*	KAP-A, B, C, PIL-A, B,C,D	Pahole to Kapuna to West Makaleha	MFS	Wild
Plant	*Cyanea superba* subsp. *superba*	KAP-A, B	Pahole to Kapuna	MFS	Reintroduction
Plant	*Delissea waianaeensis*	KAP-A*, B*, C, D	Kahanahaiki to Keawapilau	MFS	Both
Plant	*Flueggea neowawraea*	KAP-A, B† PIL-A	Kahanahaiki to Kapuna	MFS	Both
Plant	*Hesperomannia arbuscula*	KAP-A* PIL-A	Pahole NAR	MFS	Reintroduction
Plant	*Phyllostegia kaalaensis*	KAP-A*, B* PIL-A*, B*	Keawapilau to Kapuna	MFS	Both
Plant	*Schiedea kaalae*	KAP-A	Pahole	MFS	Reintroduction
Plant	*Schiedea nuttallii*	PIL-A*, B†	Kapuna-Keawapilau Ridge	MFS	Both
Plant	*Schiedea obovata*	PIL-A*, B, C	Keawapilau to West Makaleha	MFS	Both
Snail	*Achatinella mustelina*	KAP-A, B, C	ESU-A	KAP-C is MFS	Wild

MFS= Manage for Stability *= Population Dead

GSC= Genetic Storage Collection †=Reintroductionnot yet done

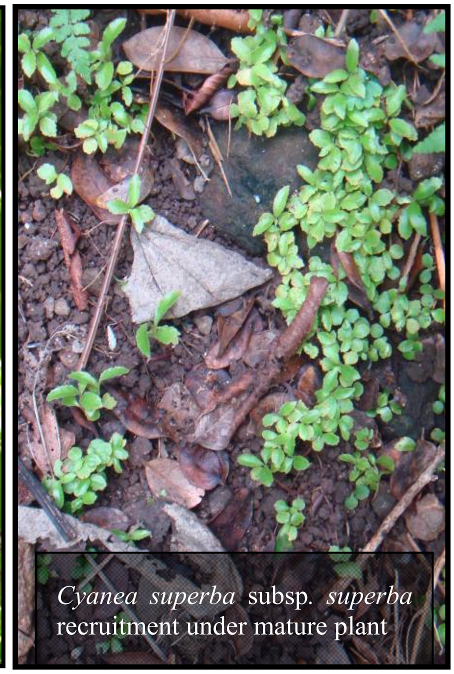
Other Rare Taxa at Upper Kapuna MU

Organism Type	Species	Status
Plant	*Pteralyxia macrocarpa*	Candidate
Plant	*Cyanea calycina*	Candidate
Plant	*Colubrina oppositifolia* (State reintroduction)	Endangered
Plant	*Caesalpinia kavaiensis* (State reintroduction)	Endangered

Rare Resources at Upper Kapuna MU

Cyanea longiflora

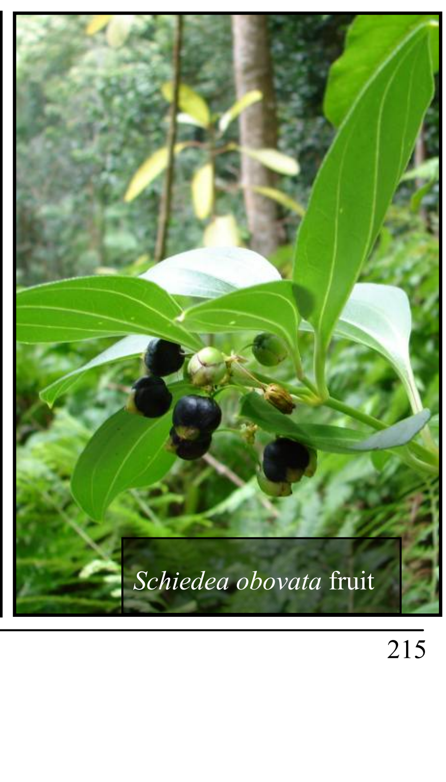
Cyanea superba subsp. *superba*



Cyanea superba subsp. *superba* recruitment under mature plant

Tree Snail, *Achatinella mustelina*

Chamaesyce herbstii



Schiedea obovata fruit

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	*A.macrococcus* var. *macrococcus, Achatinella mustelina C. longiflora, C. superba* var. *superba, D. waianaeensis*	Yes	No	Localized bait and snap grids used when damage seen. MU wide snap trap grid being tested in other MUs.
Predatory snails: *Euglandina rosea, Oxychilus alliarius*	*Achatinella mustelina*	Yes	No	Hand-removal of snails possible, however *Achatinella mustelina* managed in another MU for this ESU of snails.
Ants: *Solenopsis papuana* and *Tetramorium simillimum*	Unknown, possibly a threat to native snails, arthropods, plants and birds	Yes	No	Hydramethylnon (Amdro, Maxforce, Siege) available, but most effective on *Solenopsis*
Slugs	*C. longiflora, C. dentata, C. superba* subsp. *superba, D. waianaeensis, H. arbuscula, P. kaalaensis, S. nuttallii, S. obovata, S. kaalae*	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?
	waianaeensis, H. arbuscula, P. kaalaensis, S. nuttallii, S. obovata, S. kaalae			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 OARNP 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:

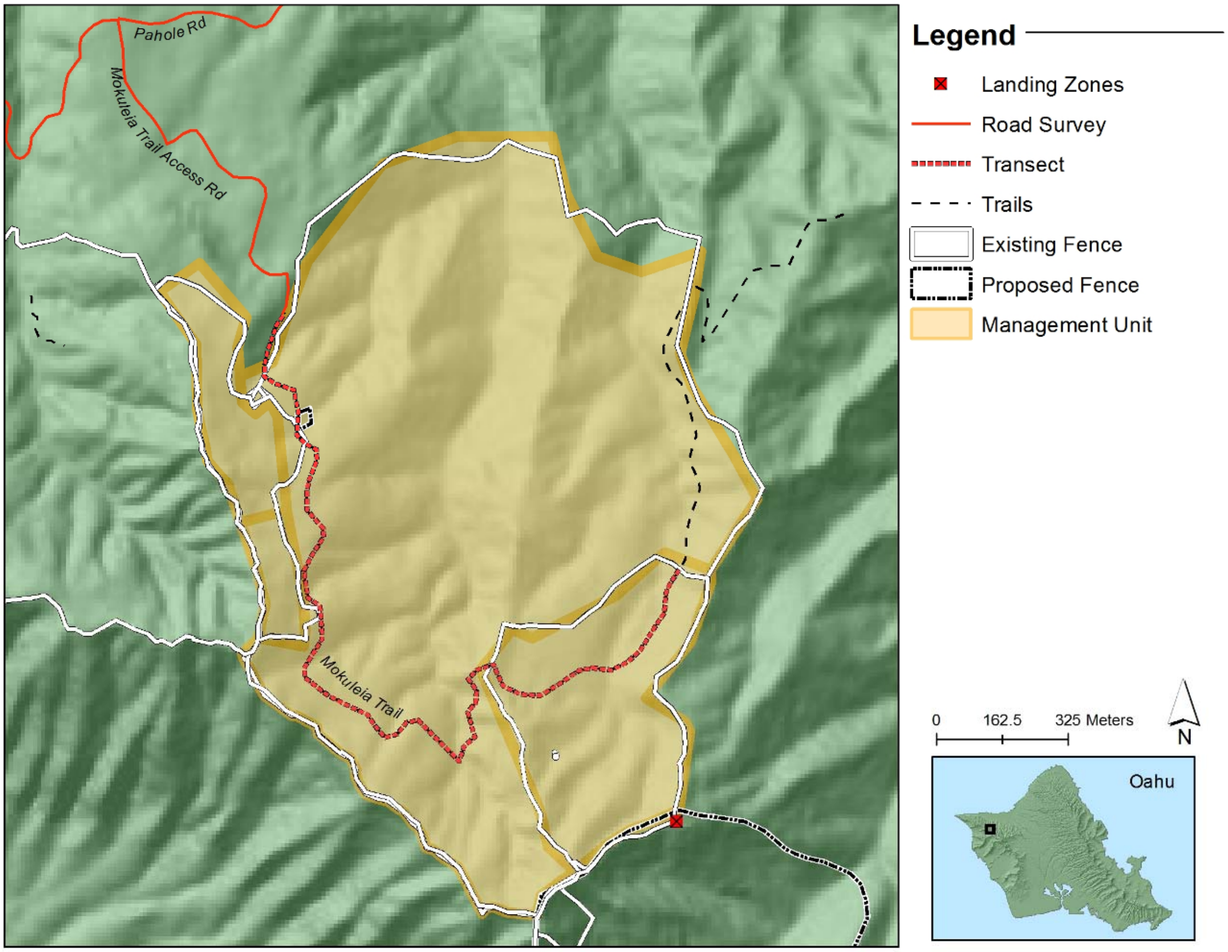
- Prevent the establishment of any new invasive alien plant or animal species through regular surveys along roads, landing zones, fencelines, trails, and other high traffic areas (as applicable).

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. OARNP 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.

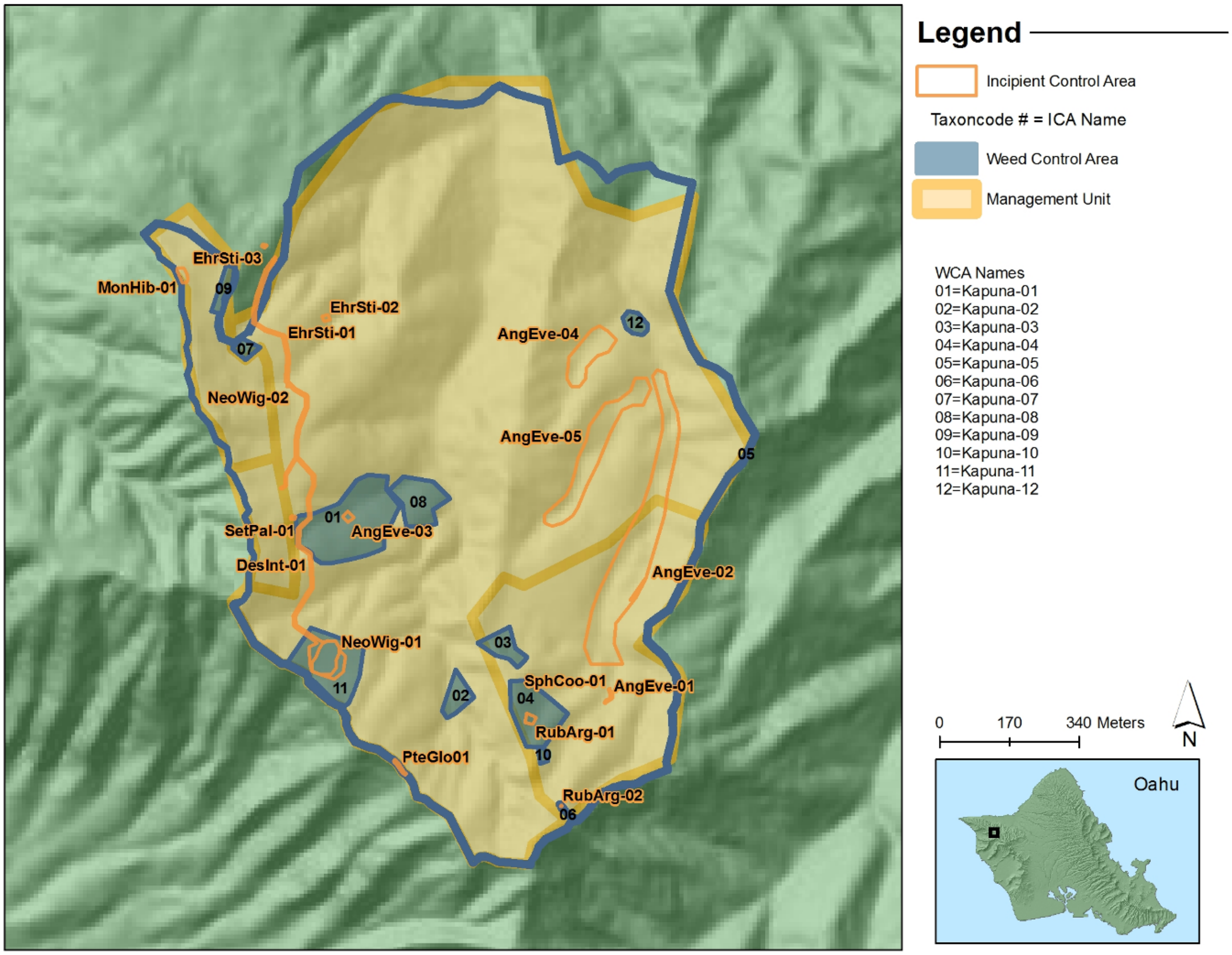
OARNP have been very diligent about regular re-visitation of ICAs throughout the MU. While most are visited quarterly and are treated before more individuals become mature, some species persist and may need more frequent visitation or new control methods in order to reach complete eradication. OARNP 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		
Angiopteris evecta	**0**	**1**	**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.**	**5**
Blechnum appendiculatum	2	2	Widespread. Local control may be conducted, but further investigation of control methods is needed.	
Coffea arabica	2	0	Not frequently seen. Will target in weed sweeps if seen.	
Desmodium incanum	2	2	Treat at Hunter Cabin in conjunction with other ICA control, but otherwise widespread on trail and not specifically targeted	
Desmodium intortum	**0**	**1**	**Plants treated quarterly. Along Mokuleia Trail, from trailhead to Hunter Cabin. Low numbers found consistently**	**1**
Ehrharta stipoides	**1**	**1**	**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).**	**3**
Ficus macrophylla	0	1	OARNP will target this weed during weed sweeps or as seen incidentally within the MU.	
Fraxinus uhdei	2	2	Widespread at Mokuleia trailhead, but not across the MU. Will target in WCAs.	
Grevillea robusta	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.	
Montanoa hibiscifolia	**0**	**1**	**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.**	**1**
Neontonia wightii	**0**	**1**	**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.**	**2**
Pterolepis glomerata	**0**	**1**	**New site found 2010.**	
Rubus argutus	**1**	**1**	**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.**	**2**
Ricinus communis	2	1	Not widespread and rarely seen. Will target in if seen during weed sweeps in WCAs, or incidentally.	
Schefflera actinophylla	0	1	1 plant found and treated, and will gps/remove any others.	
Setaria palmifolia	**1**	**1**	**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.**	**1**
Sphaeropteris cooperi	**1**	**1**	**Few individuals found. There will be a zero tolerance for this fern in the MU.**	**1**
Triumphetta semitriloba	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.	
Toona ciliata	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, OANRP 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 trials. 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 *Chamaecyce herbstii* in a small fence in Kapuna stream. Understory weed control is mostly conducted here. Weed control will be conducted annually across the exclosure, 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. OANRP 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 waianaeensis.* 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. waianaeensis* and *C. superba* subsp. s*uperba.* 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. waianaeensis.* 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. *Microlepia 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 (Fluneo 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. rosifolious, 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 OANRP 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 waianaeensis* (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/Delwai 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) *Schiedea nuttallii*, *S. obovata*, *Cyanea longiflora*, *C. superba* subsp. *superba*, *Cyrtandra dentata*, *Delissea waianaeensis*																				
	If slugs found to exceed acceptable levels during monitoring, maintain slug bait at sensitive plant population(s)																				

Hatched=Quarter Schedule

CHAPTER 2: FIVE YEAR RARE PLANT PLANS

2.1 INTRODUCTION

OANRP has begun to update and develop more detailed plans for each IP taxa. These plans are intended to include all pertinent species information for stabilization, serve as a planning document and an updated educational reference for new staff. In many cases, data or information is still being gathered and these plans and will continue to be updated. A brief description of each slide is given here:

Species Description: These first slides provide an overview of each taxon. The IP stability requirements are given along with a taxon description, biology, distribution, population trends, habitat and taxonomic history. Much of this information was transcribed from the original MIP and OIP documents and has been updated by OANRP.

Reproductive Biology Table: OANRP has begun to document basic information to inform management strategies. This information was summarized by OANRP based on best available data from the MIP, OIP, USFWS 5-year Status Updates, OANRP field observations and other published research. Phenology is primarily based on observations in the OANRP rare plant database. The suspected pollinator is based on and casual observations and pollinator syndromes as reported in the MIP and OIP. The information on seeds is from data collected at the Army seed lab and from collaborative research with the Harold L. Lyon Arboretum.

Pictures: These are intended to document habitat, habit, floral morphology and variation, all stage/age classes and many stages of maturing fruit and seed. This should serve as a reference for field staff making collections and searching for seedlings.

Species Occurrence Maps: Detailed maps will be provided for OANRP and the IT. These will display historic and current locations, MUs, landmarks and any other useful geographic data for each taxon. Other features may be used on public documents to obscure locations of rare elements.

Population Units: A summary of the PUs for each taxon is provided with current management designations, action areas and management units.

Population Structure: A discussion of the observed structure for each PU and a plan to establish or maintain population structure at levels that will sustain stability goals. A history of observed structure is given to provide a background for developing strategies. In many cases, establishing or documenting a healthy stable population structure may require developing new techniques (sub-sampling) or overcoming legal obstacles (slug control).

Monitoring Plan: Current techniques and plans are discussed in this section. Monitoring of the *in situ* and reintroduction populations will be conducted to determine progress toward attaining taxon stability. Data to be collected may include number, vigor, and phenological phase of all plants or samples of the individuals by size class. This information may be evaluated using an appropriate statistical analysis to assess current and projected status of the monitored PUs. Adaptive modifications to the *in situ* management, augmentation, or reintroduction strategies for the PUs for each taxon and each MU will be made based on the results of the monitoring program. As research results bring in new information on reintroduction methods and threat control methods techniques will be modified. While the stabilization of the PU is the end goal, changes in management of the PU, threats to the PU, and the quality of the surrounding habitat must be monitored to determine which factors are affecting the taxon's ability to reach stability.

Genetic Storage Section: This section provides an overview of propagation and genetic storage issues. A standardized table is used to display information recorded for each taxon or PUs where applicable. The plan for genetic storage is displayed and discussed. In most cases, seed storage is the preferred genetic storage technique; it is the most cost-effective method, requires the least amount of maintenance once established, and captures the largest amount of genetic variability. For taxa that do not produce enough mature seed for collection and testing storage conditions, micropropagation is considered the next best genetic storage technique. The maintenance of this storage method is continual, but requires much less resources and personnel than establishing a living collection. For those taxa that do not produce storable seed and cannot be established in micropropagation, a living collection of plants in the greenhouse or an *inter situ* site is the last preferred genetic storage option. In most cases, current research is ongoing to determine the most applicable method. For species with substantial seed storage data, a schedule may be proposed for how frequently seed bank collections will need to be refreshed to maintain genetic storage goals. This schedule is solely based on storage potential for the species; other factors such as threats and plant health must be factored into this schedule to create a revised collection plan. Therefore, the frequency of refresher collections will constantly be adjusted to reflect the most current storage data. The re-collection interval is set to prevent the viability of the collection from dropping below 30%. For example, *Delissea waianaeensis* shows no decrease in viability after ten years. OANRP would not have to re-collect every ten years as the number of viable seeds in storage would not have yet begun to drop. It is likely that the re-collection interval will be at least every 15 years (≥15 yrs). If its viability decreases by more than 30% at 15 years, the interval may be moved to between 10-15 years. Please read Appendix ES-4 of the 2010 report for details on re-collection intervals. The status of seed storage research is also displayed and discussed. Collaborative research with the USDA National Center for Genetic Resources Preservation (NCGRP) and Lyon Arboretum Seedlab is ongoing.

Reintroduction Plan: A standardized table is used to display the reintroduction plans for each PU. Each outplanting site in each PU is displayed showing the number of plants to be established, the PU stock and number of founders to be used and type and size of propagule (immature plants, seeds, etc.). Comments focus on details of propagation and planting strategies and propose a schedule for completing the reintroductions.

2009-2010 Stabilization Goals Update: For each PU, the status of compliance with all stability goals is displayed in this table. All required MFS PUs are listed for each taxon. 'YES, NO or PARTIAL' are used to represent compliance with each stability goal. For population targets, whether or not each PU has enough mature plants is displayed, followed by an estimate on whether a stable population structure is present. Threats are listed separately for each PU. The boxes are shaded to display whether each threat is present at each PU. A dark shade identifies PUs where the threat is present and the lighter boxes where the threat is not applicable. The corresponding status of threat control is listed for each PU. See the species update example for more discussion of the threat definitions. A summary of the status of genetic storage collections is displayed in the last column.

5-Year Action Plan: This slide displays a table to be used by OANRP staff to schedule actions for each PU. All management is planned by 'MIP or OIP Year' and the corresponding calendar dates are listed. This table can be used to schedule the actions proposed for each species into the OANRP scheduling database. Comments in this section focus on details of certain actions or explain the phasing or timeline in some PUs.

2.2 FIVE YEAR PLANS

Chamaesyce celastroides var. *kaenana*

- **Scientific name:** *Chamaesyce celastroides* (Boiss.) Croizat & Degener var. *kaenana* (Sherff) Degener & I. Degener
- **Hawaiian name:** akoko
- **Family:** Euphorbiaceae (Spurge family)
- **Federal status:** Listed endangered
- **Requirements for Stability**
    - 4 population units (PU)
    - 25 reproducing individuals in each population (long-lived perennial)
    - Threats controlled
    - Complete genetic storage of all PUs

- **Description and biology:** *Chamaesyce celastroides* var. *kaenana* is a milky-sapped, prostrate to erect shrub usually 1-2 m (3.3-6.6 ft) tall. The stems are thick and knobby. The leaves measure 20-65 mm (0.8-2.6 in) long, and are oppositely arranged in a horizontal plane. The flowers are borne on compact side branches, each of which bears 5-10 cyathia (specialized flower-like inflorescences with a single central female flower surrounded by much-reduced male flowers). The capsules measure 2-2.5 mm (ca. 0.1 in) long and contain a maximum of three seeds.
- *Chamaesyce celastroides* var. *lorifolia* on the south slope of Haleakala, Maui has been observed reproducing vegetatively by root suckers (Medeiros *et al.* 1986). With *C. celastroides* var. *kaenana*, however, vegetative reproduction has not yet been reported.

Chamaesyce celastroides var. *kaenana*

- **Description and biology continued:** Most plants grow in the low elevation dry zone and are summer-deciduous, losing their leaves before the height of the dry season. Plants at higher elevation mesic sites can be leafed out year-round (Lau pers. comm. 2000). Flowering and fruiting are year-round but peak during the summer, when the plants are leafless. Little is known about the breeding system of *C. celastroides* var. *kaenana*. However, the genus as a whole is usually monoecious (male and female flowers on different parts of the cyathium), or rarely dioecious (male and female flowers on separate plants). It is not known if the taxon is capable of self-fertilization. Bees and flies visit the flowers of *C. celastroides* var. *kaenana* (Lau pers. comm. 2000), and presumably act as pollination agents for the taxon. *Chamaesyce* capsules dry and split open explosively upon maturity, flinging the seeds for a short distance. The seed or seeds of the colonizing ancestor of *C. celastroides* var. *kaenana* probably arrived in Hawaii attached to a bird (Carlquist 1970), as most *Chamaesyce*s have a sticky coating on their seeds when wet. Some Hawaiian species, especially certain lowland ones, still retain this feature, while most upland forest species have lost it, exemplifying the frequent loss of dispersability in upland oceanic island plants whose ancestors were weedy lowland plants (Carlquist 1970). *Chamaesyce celastroides* var. *kaenana* retains this feature. Dispersal of its seeds in pre-human times is thus theorized to have been carried out by birds, including many now-extinct flightless Hawaiian birds. The taxon occurs in scattered or isolated groups, usually with no additional plants in the intervening stretches. Based on long-term observations of the growth rates of particular individuals in the wild, the plants appear to live at least two or three decades, and perhaps considerably longer (Lau pers. comm. 2000).

Chamaesyce celastroides var. *kaenana*

- **Known distribution:** *Chamaesyce celastroides* var. *kaenana* has been recorded only from the Waianae Mountains, with the exception of a single specimen collected by W. Hillebrand in the 1800's at Niu Valley in the southeastern Koolau Mountains. In the Waianae Mountains it has been recorded primarily from the Kaena Point area. It has been recorded at several spots further east in Mokuleia, as far east as the Kawaihapai area (inland of the Dillingham Airfield) but it not known from there today. The taxon has long been known in the Keawaula land section on the leeward side of Kaena Point. In 1991 it was discovered further south in the Waianae Mountains in Waianae Kai. In 2000 and 2001 it was discovered in the Makua Action Area at Kaluakauila and Punapohaku Gulches, on the ridge separating Kahanahaiki Valley from Makua Valley, and on the seaward end of Ohikilolo Ridge. The recorded elevations for this taxon range from near sea level, such as at the Kaena and Keawaula sites, to about 790 m (2,600 ft) at the Waianae Kai site.

- **Population trends:** *Chamaesyce celastroides* var. *kaenana* is a fairly hardy plant, able to persist in the much altered lowland and coastal areas in the face of serious threats. Its cliff populations have also been protected against the effects of cattle and feral goats.

Chamaesyce celastroides var. *kaenana*

- **Habitat:** *Chamaesyce celastroides* var. *kaenana* occurs mainly in very dry coastal areas though the Waianae Kai population unit is located within the drier end of the mesic zone. Most plants, including the plants in the large colony at Kaena Point, grow on gentle to moderately steep slopes consisting of soil and rock. Others, including many of the plants on the leeward side of the Waianae Mountains, grow on nearly vertical cliff faces. Most sites are now dominated by alien plants, particularly alien grasses and the shrub koa haole (*Leucaena leucocephala*). Many still have a fair percentage of native shrubs and grasses remaining; some sites on the nearly vertical cliffs are still native dominated. The vegetation on these cliffs is usually sparse, consisting mostly of native shrubs, grasses, and sedges.

- **Taxonomic background:** There are 16 native species of *Chamaesyce* in Hawaii; all are endemic. Several alien species of this genus are also found in Hawaii. The genus *Chamaesyce* is considered by some to be a subgenus of the large genus *Euphorbia* (Koutnik 1987). The elevation of *Chamaesyce* to the genus level leaves only a single native Hawaiian *Euphorbia*, *E. haeleeleana*, which occurs only on Kauai and in the Waianae Mountains of Oahu. *Chamaesyce celastroides* is endemic to the Hawaiian Islands, occurring on all the main islands as well as on Nihoa in the Northwestern Hawaiian Islands. *Chamaesyce celastroides* var. *kaenana* is one of its eight currently recognized varieties (Koutnik 1987). W. Hillebrand's Koolau Range specimen, which was destroyed in Berlin in World War II, had leaves measuring about 2.5 cm (1 in) long, much shorter than leaves of the Waianae Range plants, which measure 3-6.5 cm (1.2-2.5 in) long (Sherff 1938).

Chamaesyce celastroides var. *kaenana*

- Hawaiian *Chamaesyce*s have successfully been experimentally crossed in many combinations (Koutnik 1987). There are also several known cases of natural hybridization between co-occurring Hawaiian *Chamaesyce*s. In some cases hybridization has resulted in hybrid populations such as ones involving *C. rockii* and *C. clusiifolia* in the Koolau Mountains (Lau pers. comm. 2000). Another situation involving hybrids in Hawaiian *Chamaesyce*s is observed in the transition zone between two habitats, where hybrids form a zone of intergradation between the *Chamaesyce* of one habitat and the *Chamaesyce* of the other habitat. Such intergradation zones involving *C. multiformis* var. *multiformis* of the forest understory and *C. celastroides* var. *amplectans* of the exposed rocky ridgetops are common in the Waianae Mountains (Lau pers. comm. 2000).

- Aside from *C. celastroides* var. *kaenana*, there are seven *Chamaesyce* taxa native to the northern Waianae Mountains or adjacent coastal areas. They are *C. herbstii*, *C. kuwaleana*, *C. multiformis* var. *multiformis*, *C. multiformis* var. *microphylla*, *C. degeneri*, *C. celastroides* var. *amplectens*, and the possibly extinct *C. celastroides* var. *tomentella.* The *Chamaesyce* relative *Euphorbia haeleeleana* is also native to the northern Waianae Mountains.

- *Chamaesyce celastroides* var. *amplectens*, *C. degeneri*, and *E. haeleeleana* are known to grow naturally with or near *C. celastroides* var. *kaenana*. It appears that under natural conditions, reproductive barriers and/or ecological differentiation between *C. celastroides* var. *kaenana* and relatives with which it occurs are at levels high enough for the persistence of the taxa as separate entities. A possible exception to this is an area in the North Kahanahaiki PU where hybrids are observed (Lau pers. comm. 2005).

Chamaesyce celastroides var. *kaenana*

- **Threats:** Feral goats and pigs, competition from alien plants, and fire threaten *C. celastroides* var. *kaenana*. Fire has burned into several population units in the last two decades, namely the units of Kaena (East of Alau), Kaena and Keawaula, Lower Ohikilolo, Punapohaku, Kaluakauila and Kahanahaiki. With the increasing amount of alien grass in the lowlands of the Waianae Range, the fire threat to the taxon is increasing accordingly. Cattle grazing used to be a major threat to the taxon, but cattle are no longer grazed in *C. celastroides* var. *kaenana* areas. It is not known if the weedy alien *Chamaesyce*s could possibly hybridize with the native taxa.

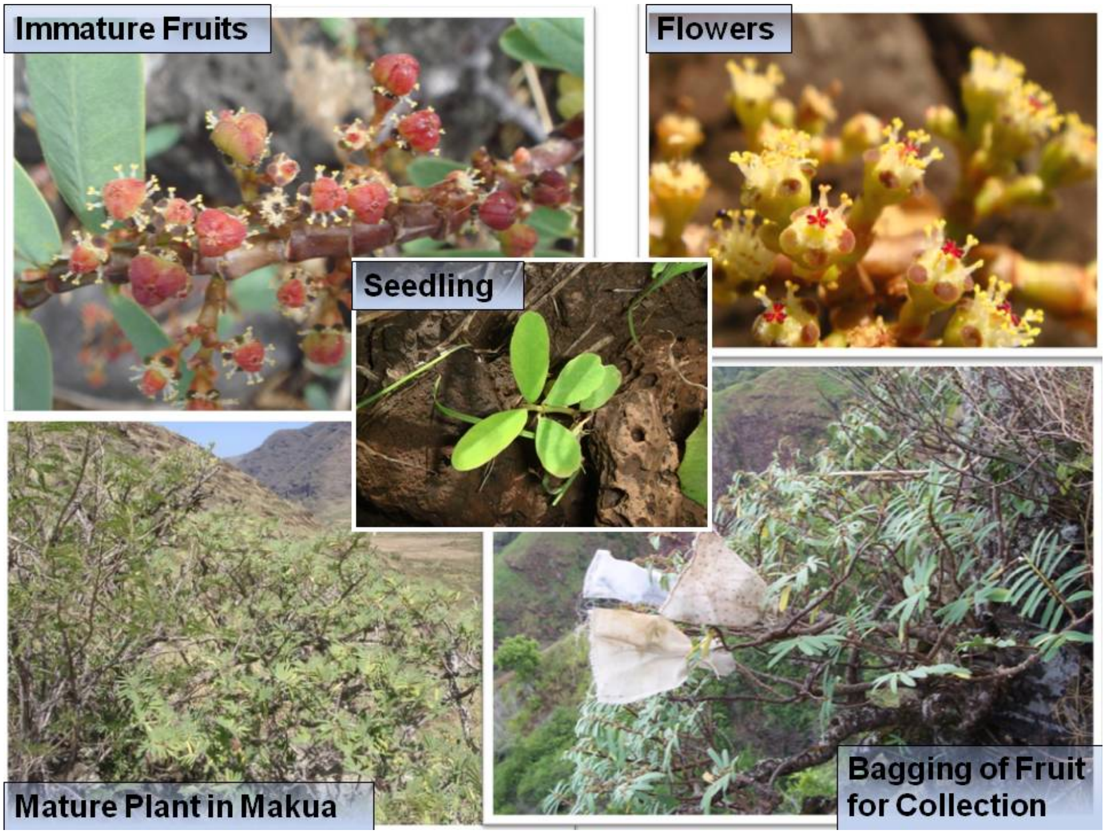
Reproductive Biology Table

	Observed Phenology				Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Peak Collecting	Breeding System	Suspected Pollinator*	Average # Per Fruit	Dormancy
Makua	Apr-Oct	Apr-Dec	Apr-Dec	Aug-Oct	Monoecious	Bees, Flies	1-3	ND
East of Alau	Jul-Oct	Jul-Oct	Jul-Oct	Aug-Oct	Monoecious	Bees, Flies	1-3	ND
Kaena	April-Oct	April-Oct	Apr-Dec	Aug	Monoecious	Bees, Flies	1-3	ND
Puaakanoa	Oct-Nov	Oct-Dec	Oct-Dec	Nov	Monoecious	Bees, Flies	1-3	ND
East Kahanahaiki	Jul-Oct	Jul-Oct	Jul-Oct	TBD	Monoecious	Bees, Flies	1-3	ND
North Kahanahaiki	Apr-Oct	Apr-Oct	Apr-Oct	Aug	Monoecious	Bees, Flies	1-3	ND
Kaluakauila	Jul-Oct	Jul-Nov	Jul-Nov	TBD	Monoecious	Bees, Flies	1-3	ND
Keawaula	Jul-Nov	Jul-Nov	Jul-Nov	Aug-Sep	Monoecious	Bees, Flies	1-3	ND
Waianae Kai	TBD	TBD	TBD	TBD	Monoecious	Bees, Flies	1-3	tbd

*"From preliminary floral observations, ants have been observed to be the dominant floral visitor of *C. celastroides* var. *kaenana*. In general, ants are regarded as poor pollinators, because pollen does not readily adhere to their bodies and antibiotics secreted by ants to combat fungal growth reduces the viability of pollen. Ants may also limit seed set and viability in plant populations by both diminishing the amount of available nectar, aggressively deterring pollinators at flowers and farming aphids and mealy bugs which damage the plants."

**excerpt from:* Pollination biology of *Euphorbia celastroides* var. *kaenana* (Euphorbiaceae) 2010-2011. Melody Euaparadorn; Department of Botany; University of Hawaii at Manoa.

Chamaesyce celastroides var. *kaenana*



Map removed to protect rare resources


Puaakanoa habitat


Intact Kaena Habitat

Map removed to protect rare resources

Map removed to protect rare resources

Species Occurrence

Map removed, available upon request

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Makua	in situ	MIP	Lower Ohikilolo
East of Alau	in situ	None	East of Alau
Kaena	in situ	None	Kaena NAR
Puaakanoa	in situ	MIP	Puaakanoa
Genetic Storage Population Units			
East Kahanahaiki	in situ	MIP	None
North Kahanahaiki	in situ	MIP	None
Kaluakauila	in situ	MIP	None
Keawaula	in situ	None	None
Waianae Kai	in situ	None	None

Population Structure

• Immature plants and seedlings are observed at Puaakanoa, East of Alau, Kaena, Makua, Keawaula and North Kahanahaiki but not at Waianae Kai, East Kahanahaiki or Kaluakauila. We haven't yet defined what adequate population structure is for this taxon, or how to measure it.

• It is also not known if the populations are stable or what is an adequate structure to maintain the number of mature plants at each MFS PU. Monitoring the survivorship of all size classes at these sites will help to assess whether enough immature plants are present to maintain stability goals.

• Complete census monitoring has been conducted at East of Alau, Makua and Puaakanoa. This monitoring will continue in order to document population structure for these sites.

• Previous estimates for the Kaena PU have not counted the number of smaller plants. A complete census of this site is necessary to determine the population structure there. Once this is done, a smaller sub-set may be selected to monitor survivorship of smaller plants for this site.

• Ongoing management will continue to control weeds at the sites for fuel control and to promote recruitment and maintain population structure.

Population Estimate History

Population Monitoring History					
Manage for Stability Population Units	**2000 Mat/Imm/Seedling**	**2001 Mat/Imm/Seedling**	**2006 Mat/Imm/Seedling**	**2008 Mat/Imm/Seedling**	**2010 Mat/Imm/Seedling**
Makua			89/45/20	118/16/0	125/2/0
East of Alau		21/4/20	21/0/1		
Kaena		300*			
Puaakanoa			115/8/0		
Genetic Storage Population Units					
East Kahanahaiki	2/0/0	2/0/0	2/0/0	2/0/0	2/0/0
North Kahanahaiki		177**			
Kaluakauila	17/1/0		12/7/0		11/2/0
Keawaula		26/0/0	49/4/2	51/4/2	53/2/2
Waianae Kai		33/0/0			

*= The Kaena PU was given this estimate in 2000 and it has not been revised since. This site likely has many more mature plants than this estimate and lots of immature plants are regularly observed.
**= The North Kahanahaiki PU estimate is based on a combination of helicopter and ground surveys conducted over several years around 2001. This estimate has not been completely revised since, but surveys following fires have documented dead plants. There are plants that may be hybrids between *C. celastroides* var. *kaenana* and *C. celastroides* var. *amplectens* at several sites within this PU. This has further complicated estimates over the years since the taxonomy is not well known and sometimes hybrid plants are included in the estimates and other times, not.

Monitoring Plan

- All MFS PU will be monitored every two years for population structure, trends, threats, reproductive status and vigor.
- MFS PU with reproductive plants will be monitored in order to time the application of mesh bags on developing fruit for the purpose of fruit collection intended for storage.
- MFS PU with reproductive plants will also be monitored for new seedlings. Monitoring will focus on areas under fruiting plants. Seedlings will be counted and areas with seedlings will be delineated on sketch maps. A subset of new immature plants will be tagged and monitored for vigor and growth.
- Sites with seedlings will be examined and a profile of micro-site requirements will begin to be developed.
- A complete census of the Kaena PU will be done to revise the population estimate and count immature plants and seedlings. Once this is done, a smaller sub-set may be selected to monitor survivorship of smaller plants for this site. This will help to define the structure needed to maintain the number of mature plants at each site.
- A UH Botany Graduate Student, Melody Euaparadorn, is researching the pollination biology of this taxon. Her project focuses on recording floral visitors, determining their effectiveness, describing the breeding system (ex: facultative out-crosser), an investigating differences in fitness measurements (ex: seed set) between small and large populations. Results may alter current management practices and will be reviewed upon the completion of this thesis.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goals?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Mature Seed	In situ	Seeds (-18C / 20% RH)	5+ years	Yes	Collect mature seeds from in situ sites

Genetic Storage Plan Comments: Genetic storage goals will be met by storing seeds collected from the wild plants at each PU. Seed collection requires the use of mesh bags that are placed around branches with maturing fruit. Bags are deployed after the peak flowering time for each PU and are checked two weeks later to collect seeds and re-install new bags as needed. Many PU require the use of ropes to access the plants.

Reintroduction Plan

Comments: No reintroductions are planned for this species as all MFS PU are at or above the stabilization goal of having at least 25 mature reproducing plants. If the number of plants begins to decline at the PUs, OANRP will develop plans for reintroduction. The number of mature plants at the East of Alau PU is currently just over the target number of 25. This site may be the first to need augmentation to meet the stability goal of having adequate structure to maintain at least 25 mature plants.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slugs	BTB	Are there enough propagules in Genetic Storage?
East of Alau	YES	NO	NO	PARTIAL	NO	NO	NO	N/A	NO
Makua	YES	NO	YES	PARTIAL	NO	PARTIAL	NO	N/A	NO
Kaena	YES	NO	NO	PARTIAL	NO	NO	NO	N/A	YES
Puaakanoa	YES	NO	NO	PARTIAL	NO	PARTIAL	NO	N/A	NO
Genetic Storage PU									
East Kahanahaiki	n/a	NO	NO	NO	NO	NO	NO	N/A	NO
North Kahanahaiki	n/a	NO	NO	NO	NO	NO	NO	N/A	NO
Keawaula	n/a	NO	NO	NO	NO	NO	NO	N/A	NO
Waianae Kai	n/a	NO	NO	NO	NO	NO	NO	N/A	NO
Kaluakauila	n/a	NO	NO	NO	NO	NO	NO	N/A	NO

5 Year Action Plan

	Proposed Actions for the following years:				
Population Unit	MIP YEAR 7 Oct.2010-Sept. 2011	MIP YEAR 8 Oct.2011-Sept. 2012	MIP YEAR 9 Oct.2012-Sept. 2013	MIP YEAR 10 Oct.2013-Sept. 2014	MIP YEAR 11 Oct.2014-Sept. 2015
Makua	•Collect	•Monitor		•Monitor	
East of Alau	•Monitor & Collect	•Collect	•Monitor	•Collect	•Monitor
Kaena	•Monitor		•Monitor		•Monitor
Puaakanoa	•Monitor & Collect	•Collect	•Monitor & Collect	•Collect	•Monitor
East Kahanahaiki		•Monitor & Collect		•Monitor	
North Kahanahaiki	•Monitor & Collect	•Collect	•Monitor & Collect		•Collect
Kaluakauila		•Monitor & Collect		•Monitor & Collect	
Keawaula	•Monitor	•Collect	•Monitor & Collect	•Collect	•Monitor
Waianae Kai	•Monitor & Collect	•Collect	•Monitor & Collect	•Collect	•Monitor & Collect

Eugenia koolauensis

- **Scientific name:** *Eugenia koolauensis* (Degener)
- **Hawaiian name:** nioi
- **Family:** Myrtaceae (Myrtle family)
- **Federal status:** Listed endangered March 28, 1994
- **Requirements for Stability:**
  - 3 Population Units (PU)
  - 50 reproducing individuals (long-lived perennial; doubled target number due to threat from rust (*Puccinia psidii*)
  - Stable population structure
  - Threats controlled
  - Genetic storage collections from all PU
  - Tier 1 stabilization priority
- **Description and biology:** *Eugenia koolauensis* is a small tree or shrub 2-7 m tall. The oppositely arranged leaves are concave, are 2-5 cm long and 1-3.3 cm wide. The leaf margins are strongly revolute. The upper leaf surfaces are glossy and hairless, or bear short hairs near the veins. The lower leaf surfaces are densely covered by short brown hairs. The flowers are white, borne 1-2 in the leaf axils, with four petals and about 150 stamens. The berries are yellow to red, ovoid in shape, measure 0.8-2.0 cm in length, and usually contain a single globose seed.

  The species flowers and fruits year round. The flowers of *E. koolauensis* are presumably insect pollinated. The species red and yellow fleshy berries suggest that fruit eating birds are the main dispersal agents for the species. Since the seeds are large and without a durable seed coat, the seeds would not be expected to remain viable long after the fruit ripens. Immature cultivated plants are slow growing (Lau pers. comm. 2005), and it seems likely that immature plants in the wild would also be slow growing. *Eugenia koolauensis* is a long-lived species. A tree in Papali Gulch has been observed for 25 years, but it has not increased very much in size during that time (Lau pers. comm. 2005).

Eugenia koolauensis

- **Known distribution:** *Eugenia koolauensis* has been found on the islands of Oahu and Molokai. On Oahu, the species has been recorded primarily from the northern Koolau Mountains, on both the windward and leeward sides of the mountain range, from 100-300 m (328-1,000 ft) in elevation. The species has also been recorded from Waianae Mountains in the area inland of Waialua. It was collected in this area by O. Degener in 1932 in the "gully having prominent dyke, north-northeast of Puu Kamaohanui" (Wilson 1958). In 2000, a few plants were discovered in the same general area in Palikea and Kaimuhole Gulches. Recorded elevations for the species in the Waianae Mountains are from 232-293 m (760-960 ft). Since the species grows in dry forests in the Waianae Range, it is possible that it formerly also occurred in the region between the two mountain ranges. If the species did indeed occur in that region, the now separated Koolau and Waianae plants would likely have been in genetic communication.

  On Molokai, the species is known from only two specimens collected by Joseph F. Rock. One of the specimens was collected in 1918, and the other in 1920 (Wilson 1958). These specimens were collected from the upper elevations of Maunaloa, the extinct volcano that formed West Molokai. Although elevations were not recorded for the West Molokai specimens, the plant or plants were likely located near the summit of Maunaloa, which is 421 m high in elevation. Little native vegetation remains on Maunaloa, and it seems unlikely that any *E. koolauensis* plants survive there. Although the species has not been recorded from East Molokai to date, that part of the island could have been part of the range of *E. koolauensis* since there probably once was unbroken suitable habitat extending from West Molokai to East Molokai over the plain of Hoolehua that connects the two mountain masses.

Eugenia koolauensis

- **Population trends:** The largest number of individuals occurs within the Kahuku Training Area (KTA) in the Northern end of the Koolau Mountains. Most of the populations of *E. koolauensis* in the Kahuku area contain seedlings and saplings. While it seemed that the numbers of individuals were increasing just a few years ago due to the high level of recruitment at the Kahuku populations, the species is now severely declining (see population status table for numbers of individuals). This species has been severely affected by an introduced myrtaceous rust, *Puccinia psidii*. The first sign of rust on *E. koolauensis* was reported in March of 2006 from Kahuku. Stands of *Syzigium jambos,* an alien species which hosts *Puccinia* rust, are abundant in the KTA. Other hosts present in the area are the native *Metrosideros polymorpha,* and three alien species *Pimenta dioica, Eucalyptus robusta* and *Melaleuca quinquenervia.* The rust primarily affects the new growth of plants of all sizes and ages. Some small, immature plants exhibited partial or total defoliation. This suggests the rust may limit the growth rate of this already slow-growing species, and perhaps even limit recruitment as flowers and fruit are also affected.

- **Current status:** *E. koolauensis* is still extant in both the northern Koolau Mountains and in the northern Waianae Mountains. Only three trees have been found recently in the Waianae Mountains, two in Palikea Gulch and one in Kaimuhole Gulch. The center of abundance for the species is in the KTA action area and the northern end of the Kawailoa Training Area action area. The plants in these action areas represent more than 80% of the extant individuals of the species. The only additional plants known to be extant in the Koolau Mountains are four mature plants in the Hauula area on the windward side of the mountain range. All plants observed have been heavily impacted by rust (*Puccinia psidii).* The Papali site has not been visited by OANRP yet so the status is unknown.

Eugenia koolauensis

- **Habitat:** *Eugenia koolauensis* occurs in dry to mesic forests, usually on gulch slopes. In the Koolau Mountains the plants occur in dry mesic forests dominated by ohia lehua *(Metrosideros polymorpha)* and/or lama *(Diospyros sandwicensis),* hoawa *(Pittosporum glabrum*), hao *(Rauvolfia sandiwicensis*), alaa *(Pouteria sandwicensis*). These sites also have non-native areas with stands of strawberry guava (*Psidium cattleianum*) and shoebutton ardesia (*Ardeia eliptica*). Other weeds in these areas include *Pluchia carolinensis, Ficus sp., Chrysophyllum oliviforme, Pimenta dioica, Casuarina equisetifolia, Melaleuca quinquenervia, Macaranga mappa, Spathodea camapnulata, Arthrostemma ciliatum, Seteria palmifola, Leucaena leucocephala, Grevillea robusta* and *Passiflora suberosa.* The known plants in the Waianae Mountains are located in dry forests dominated by lama, wiliwili *(Erythrina sandwicensis),* lonomea (*Sapindus oahuensis).* The trees are located along the margin where the remaining forest borders a highly degraded area with *Panicum maximum* and susceptible to fires. On Maunaloa, Molokai, the original dry forest vegetation has been largely destroyed, and there are no detailed descriptions of its original composition. However, this dry forest was possibly dominated by wiliwili, which is today perhaps the most common tree species amongst the remnant native trees in the area.

- **Taxonomic background:** *Eugenia koolauensis* is one of only two native Hawaiian species of *Eugenia*. The other species is the closely related *E. reinwardtiana,* whose range extends beyond Hawaii through much of the tropical Pacific Ocean. *Eugenia reinwardtiana* is a rare plant in Hawaii except for the northern Waianae Mountains, where it can be fairly common. There are certain populations of *Eugenia* in the Koolau Mountains with plants whose morphology is intermediate between the two *Eugenia* species. These intermediate population units have not been included among the population units included in this taxon summary. In the Waianae Mountains, *E. reinwardtiana* occurs in the same gulches containing known *E. koolauensis* trees, but in different parts of the gulches. There appears to be a zone of intergradation in these gulches between the typical plants of each of the two *Eugenia* species (Lau pers. comm. 2005).

Eugenia koolauensis

- **Threats:** Feral pigs are a major threats to *E. koolauensis* in both the Koolau and Waianae Range. Feral goats also threaten the Waianae sites. The animals degrade the plants' habitat by hastening the spread of invasive weeds . Alien plants threaten *E. koolauensis* by altering the species' habitat, competing with it for moisture, light, nutrients, and growing space. Also, the spread of highly flammable alien grasses increases the incidence and destructiveness of wildfires. The trees in the Palikea site were scorched by the Waialua fire in August 2007, but were not killed. The single tree in Kaimuhole Gulch was killed by this fire.

  In April 2005, the rust fungus *Puccinia psidii* Winter (ohia rust) was documented on cultivated ohia plants on Oahu. By August 2005, it was reported to be widespread across the state and considered to be a major threat to native ohia forests (Loope 2008) . It was not observed during monitoring of *E. koolauensis* at Kahuku in February of 2005, but was reported to be present at all sites in May 2006. Damage to some trees has been severe and lethal as shown by the picture below. All trees appear to have been at least partially defoliated after the rust was observed and many smaller immature trees have since died. The rust fungus has been observed to infect flowers and fruits and may affect overall health and fecundity reducing seed production and recruitment.

  Research on control methods conducted by Dr. Janice Uchida (University of Hawaii, Department of Plant and Environmental Protection Sciences, Tropical Plant Pathology Program) has been supported with a grant by OANRP. Further research on control methods will be conducted by OANRP using plants kept in the nursery living collection and those planted at Waimea Botanical Garden. A Bayer product containing tebuconizale is used to successfully control the rust fungus in the nursery.

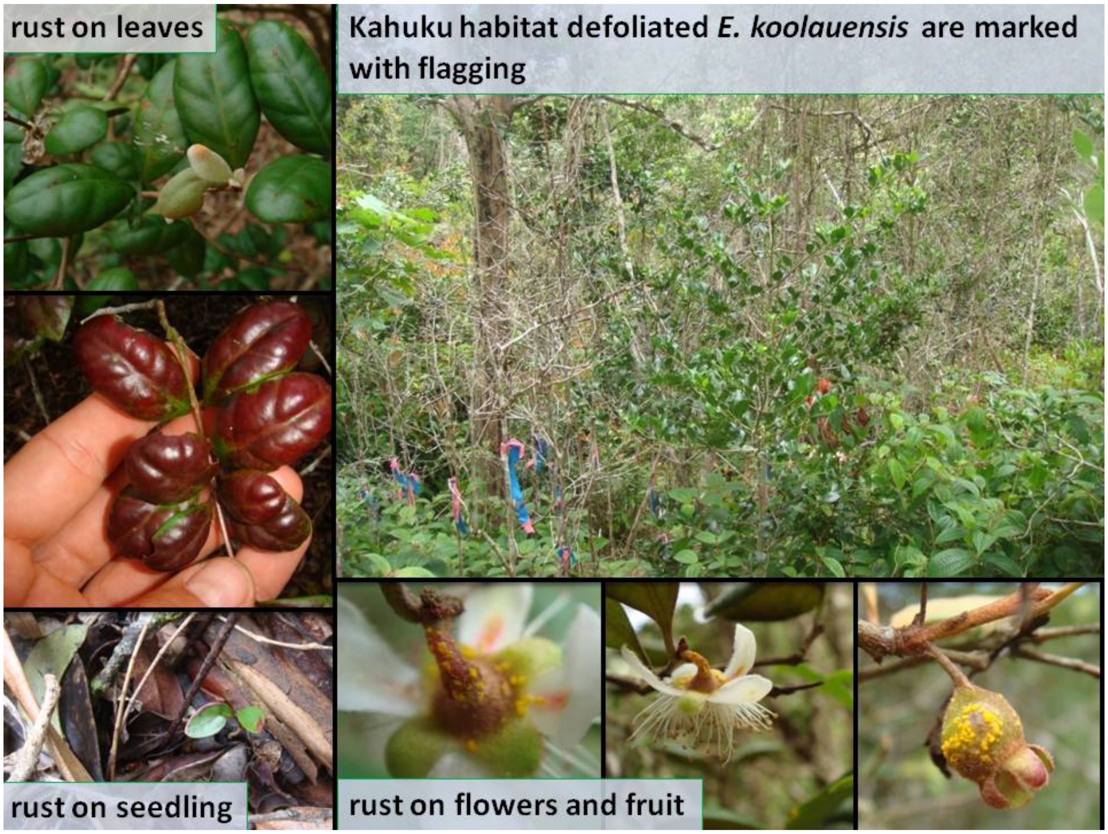
- **Outplanting Considerations:** Future reintroductions are at risk of being genetically swamped by *E. reinwardtiana* if outplanted close to *E. reinwardtiana*. Outplantings of this species in the Koolau Mountains should be limited to the portion of the mountain range where only *E. koolauensis has* been found. For the Waianae Mountains, an line to designate appropriate planting areas has been drawn that approximates the upper edge of the area occupied exclusively by *E. koolauensis* (see map below).

Loope, Lloyd and Anne Marie La Rosa. 2008. An Analysis of the Risk of Introduction of Additional Strains of the Rust *Puccinia psidii Winter (`Ohi`a Rust) to Hawai`i. U.S. Geological Survey Open File Report 2008-1008, Reston, Virginia.*

Reproductive Biology Table

	Observed Phenology				Reproductive Biology		Seeds	
Population Unit	Vegetative	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit	Dormancy
ALL	Dec-Aug	Mar-Sep	May-Oct	May-Nov	Hermaphroditic	insect	1	Non-dormant (ND)

Puccinia psidii rust on *E. koolauensis*


rust on leaves
Kahuku habitat defoliated E. koolauensis are marked with flagging
rust on seedling
rust on flowers and fruit

Species Occurence

Map removed, available upon request

Current Distribution of *Eugenia koolauensis* Waianae Range, Oahu

Map removed, available upon request

Population Units

Manage for Stability Population Units	PU Type	Which Army Action Area is the PU inside?	Management Unit(s) designated for threat control
Kaunala	in situ	OIP (KTA)	Kaunala
Oio	in situ	OIP (KTA)	Oio
Pahipahialua	in situ	OIP (KTA)	Pahipahialua
Genetic Storage Population Units			
Aimuu	in situ	OIP (KTA)	None
Kaiwikoele and Kamananui	in situ	OIP (KTA)	None
Ohiaai and East of Oio	in situ	OIP (KTA)	None
Hanaimoa	in situ	None	None
Kaleleiki	in situ	OIP (KTA)	None
Palikea and Kaimuhole	in situ	None	None
Papali	in situ	None	None

Population Structure

- The Pahipahialua and Kaunala MFS PU have more than the number of mature plants required to meet stability goals. The Oio PU does not meet this target.
- Many immature plants and seedlings have been observed at most PU. The Kaunala and Pahipahialua PU are theoretically more stable than most other populations of IP species since these sites have many times more immature plants and seedlings than matures. This structure (of younger to older plants) is not present in many other populations of IP species.
- *Puccinia psidii* is present at all sites and is likely impacting population structure. Evidence of this is seen in the 2010 estimates for younger plants where the numbers are greatly reduced from previous years' estimates.
- The Kaunala, Pahipahialua and Oio PUs were fenced in 2006. Prior to this, ungulates were not controlled and may have negatively affected population structure.
- It is also not known if the populations at each MFS PU are now stable (adequate structure to maintain the number of mature plants). Monitoring the survivorship of all size classes at these sites will help to assess whether enough immature plants are present to reach and maintain stability goals. See the Monitoring Plan for details.
- The 2010 population estimates given on the Population Estimate Table are the best yet for each PU. In most cases, the data from before 2010 were not complete and trends cannot be detected from these results.
- Weed control at the sites will continue to in an attempt to promote recruitment and maintain population structure.

Population Estimate History (Mature/Immature/Seedling)

	Population Monitoring History						
Population Unit	1998	2002	2003	2006	2007	2008	2010
Oio	27/38/65		36/19/62				22/17/15
Kaunala		21/41/200			36/45/89		59/111/137
Pahipahialua					81/73/1240		50/33/377
Kaleleiki				25/30/200			122/159/0
Aimuu				5/3/0			5/19/6
Kaiwikoele and Kamananui						16/16/15	6/62/19
Ohiaai and East of Oio			5/7/57			6/8/10	5/1/9
Hanaimoa	1/0/0	1/0/0					2/1/1
Palikea and Kaimuhole		3/0/0			2/0/0		3/0/0
Papali			1/0/0				?

Comments: The estimates above are from 2010 are the most thorough surveys of these PU. The ohia rust was first observed in 2006. A single tree was reported from Papali in the OIP but this PU has not yet been visited by OANRP. A single tree in the Palikea and Kaimuhole PU was killed in the 2007 Waialua fire. Most increases in population estimates are from plants being found during new surveys, not from new individuals being observed at the known sites. Monitoring of all sites has been too infrequent and conducted using differing stage class definitions to be able to detect a trend. The census surveys conducted in 2010 should provide a baseline from which trends can now be detected after future monitoring.

Monitoring Plan

Puccinia psidii: Phenology of trees at each PU will be documented and individual trees will be monitored for rust infection during times when the plants are flushing and producing new growth. This will begin to determine the time of year when the trees are most susceptible to damaging infections of the rust. If a season where the trees are most susceptible is determined, this would help to guide potential control methods. For example, if new infections of the rust were found to be reliant on rainfall and season this would help shape a strategy for spraying the trees with an approved fungicide.

Oio PU

- Estimates will be made during a census every two years. This will document a trend for each site.
- Determine if stability goals are likely to be met at this site or if switching to manage the Kaleleiki PU for stability is recommended.

Kaunala PU

- Estimates will be made during a census every two years. This will document a trend for each site.
- A subset of 50 plants <2m will be monitored once a year. Data collected will be used to quantitatively inform management on current survivorship and growth rate trends for this stage class for *E. koolauensis* at this PU.

Pahipahialua PU

- Estimates will be made during a census every two years. This will document a trend for each site.
- A subset of 50 plants <2m will be monitored once a year. Data collected will be used to quantitatively inform management on current survivorship and growth rate trends for this stage class for *E. koolauensis* at this PU.

Palikea and Kaimuhole PU

- Population estimates will be made during a census every year since there are only two trees remaining.

Aimuu, Kaleleiki, Hanaimoa, Papali, Kaiwikoele and Kamananui, and the Ohiaai and East of Oio PU

- Population estimates will be made during a census every two years.

Genetic Storage Plan

What propagule type is used to meet genetic storage goals?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Nursery living collection	in situ	Collecting seeds and cuttings	N/A	Yes	Collect seeds and propagate for living collection in the nursery and an inter-situ collection

Genetic Storage Plan Comments:
Seed storage would be the preferred genetic storage method, however, seeds are desiccation sensitive. The only seed storage that may work is -80C through -160C (lN2) (liquid nitrogen). These conditions have not yet been tested due to lack of seeds and facilities (lN2). Since seed storage is not a viable option at this time, living collections of plants are kept at the nursery to represent each of the PU. Once plants are too large to keep in the nursery, they will be added to the inter-situ site at Waimea Botanical Garden where they can continue to be treated with fungicides. The living collection at the nursery will be expanded to include new founders as they become available. These plants are also being used to produce seed for storage testing. Since nursery plants are susceptible to the same threats as the wild plants, another storage method must be developed. This may include research into cryo-preservation of meristematic tissue, seeds and other material at the National Center for Genetic Resources Preservation.

Reintroduction Plan

- On site threat management is highest priority for this species. Reintroductions will be considered for the Oio PU in the future, but not within the scope of this plan.

- The *Puccinia* rust is a serious concern for this species at this time. Once control methods are developed or the threat is significantly decreased, plantings into remote areas will be considered.

- The inter-situ sites at Waimea Botanical Garden will be used to develop propagation and planting techniques, test rust control methods and collect fruit for storage trials. Garden staff maintain the existing collections and are eager to expand the collection since this species is found on the property as well as in the Kaiwikoele and Kamananui PU.

- The potential of grafting *E. koolauensis* onto congeners will be investigated.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control					Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slugs	Are there enough propagules in Genetic Storage?
Oio	NO	TBD	YES	YES	NO	PARTIAL	NO	NO
Kaunala	YES	TBD	YES	YES	NO	PARTIAL	NO	NO
Pahipahialua	YES	TBD	YES	YES	NO	PARTIAL	NO	NO
Kaleleiki	N/A	N/A	PARIAL	YES	NO	NO	NO	NO
Aimuu	N/A	N/A	NO	NO	NO	NO	NO	NO
Kaiwikoele and Kamananui	N/A	N/A	NO	NO	NO	NO	NO	NO
Ohiaai and East of Oio	N/A	N/A	NO	PARTIAL	NO	NO	NO	NO
Hanaimoa	N/A	N/A	NO	NO	NO	NO	NO	NO
Palikea and Kaimuhole	N/A	N/A	NO	NO	NO	PARTIAL	NO	NO
Papail	N/A	N/A	NO	NO	NO	NO	NO	NO

5 Year Action Plan

Proposed Actions					
Population Unit	MIP YEAR 7 Oct.2010-Sept. 2011	MIP YEAR 8 Oct.2011- Sept. 2012	MIP YEAR 9 Oct.2012-Sept.2013	MIP YEAR 10 Oct.2013- Sept.2014	MIP YEAR 11 Oct.2014-Sept.2015
Oio	•Collection	•Census monitoring •Collection	•Collection	•Census monitoring •Collection	•Collection
Kaunala	•Collection	•Census monitoring •Collection	•Collection	•Census monitoring •Collection	•Collection
Pahipahialua	•*P. psidii* monitoring/ fungicide testing •Collection	•Census monitoring •Collection •*P. psidii* monitoring	•*P. psidii* monitoring •Collection	•Census monitoring •Collection •*P. psidii* monitoring	•*P. psidii* monitoring •Collection
Kaleleiki	•Collection	•Census monitoring •Collection	•Collection	•Census monitoring •Collection	•Collection
Aimuu		•Census monitoring •Collection		•Census monitoring •Collection	
Kaiwikoele and Kamananui	•Census monitoring •Collection		•Census monitoring •Collection		•Census monitoring •Collection
Ohiaai and East of Oio		•Census monitoring •Collection		•Census monitoring •Collection	
Hanaimoa	•Census monitoring •Collection		•Census monitoring •Collection		•Census monitoring •Collection
Palikea and Kaimuhole	•Census monitoring •Collection	•Census monitoring •Collection	•Census monitoring •Collection	•Census monitoring •Collection	•Census monitoring •Collection

Flueggea neowawraea

- **Scientific name:** *Flueggea neowawraea* W. Hayden
- **Hawaiian name:** *Mehamehame*
- **Family:** Euphorbiaceae (Spurge family)
- **Federal status:** Listed endangered 10 November 1994
- **Requirements for Stability**
  - 4 Population Units (PU)
  - 50 reproducing individuals in each PU (long-lived perennial, dioecious, low to no reproduction, all senescent, major pest problems)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology:** *Flueggea neowawraea* is a tree growing up to 30 m (98 ft) tall, with a trunk up to 2 m (6.6 ft) in diameter. The trees are often multi-trunked. The species' bark is rough and reddish-brown, and its wood is brown and often has a wavy grain. The leaves are 4-14 cm (1.6-5.5 in) long, and are arranged alternately along the stems. The flowers of an individual plant are usually all female or all male. They are borne in axillary clusters of 2-6. The fruits are globose, measure 3-6 mm (0.12-0.24 in) in diameter, are juicy, usually contain 6 seeds, and are reddish brown to black when ripe.

Makua Implementation Team (MIT). 2003. Final Makua Implementation Plan. Prepared for the U.S. Army Garrison, Schofield Barracks, HI.

Flueggea neowawraea

F. neowawraea is dioecious, bearing either all male flowers or all female flowers. However, the species apparently is not completely dioecious, as a cultivated plant isolated from others has been observed to produce viable seeds (Chung pers. comm. 2000). Flowering occurs over a brief period sometime in the late summer through the fall. The timing of the flowering in a given area is likely dependent on the area's weather patterns and the distribution of rainfall in that particular year. The flowering of the different trees in a given area is normally well synchronized (Lau pers. comm. 2000). The pollination biology of *F. neowawraea* has not been studied. The species' juicy fruits are suggestive of seed dispersal by fruit-eating birds.

Flueggea neowawraea are often the most massive trees in the forests in which they are found. Many of the remaining live trees are partially dead, with a strip or strips of bark extending up the trunks to crowns that have died back. The remaining living branches are often relatively healthy (Lau pers. comm. 2000). For this species, dying back may be a means of coping with environmental stresses. *Flueggea neowawraea*'s wood is very hard and lasts a long time after the death of the tree. It rots in a very distinctive fashion, and as a result, the decayed trunks and limbs of the species are readily identified. Old logs on the ground and pieces of wood in gulch bottoms and in streambeds document the former occurrence of the species throughout the Waianae Mountains.

- **Known distribution:** *Flueggea neowawraea* has been documented from Kauai, the Waianae Mountain Range of Oahu, Molokai, East Maui, and the leeward side of the island of Hawaii. In the Waianae Mountains it has been found throughout the mountain range. The species has been recorded from 305-732 m (1,000-2,400 ft) in elevation.

Flueggea neowawraea

- **Population trends:** The remaining living trees and the dead remains of *F. neowawraea* indicate that the species was formerly not uncommon in at least some parts of the Hawaiian Islands (Lau pers. comm. 2000). The recorded history of *F. neowawraea* is relatively short for a native Hawaiian tree, as it was not discovered until 1912. Reports of the species in the first half of the 1900's indicate that it had already been declining in numbers and health for a considerable time prior to its discovery. There were many reports of large mature trees, portions of which were already long dead; there were no reports of younger trees and immature plants. There are few records of immature plants to date. A pair of plants in Pahole Gulch was reported in the 1970's (Nagata 1980). One plant was reportedly a tree 6.1 m (20 ft) tall, with a main trunk measuring 5.1 cm (2 in) in diameter the other plant a sapling about 1.5 m (5 ft) tall with a trunk measuring 2.5 cm (1 in) in diameter.

  The decline of *F. neowawraea* has undoubtedly been greatly accelerated by the introduction of the black twig borer (BTB) *Xylosandrus compactus* in 1961. Of the individuals observed alive in the 1980's, more than half are now dead (Lau pers. comm. 2000).

- **Current status:** *Flueggea neowawraea* is extant throughout its recorded range except on Molokai, where only a single tree has ever been found. That individual was documented with a voucher specimen in 1931 and it died sometime prior to 1939. Only two trees are known to persist on the southern flank of Haleakala, East Maui. Five to nine trees are known on the island of Hawaii. The species is most common on Kauai where an estimated 60-80 trees are known. Currently on Oahu, a total of 35 trees are known alive, thirteen of which are in the Makua action area.

Flueggea neowawraea

- **Habitat:** *Flueggea neowawraea*'s center of abundance is in the drier parts of the mesic forests, which are often dominated by lama (*Diospyros sandwicensis*) or dominated by lama and ohia (*Metrosideros polymorpha*). Only a few live trees remain in the dry forests. The species was formerly more common in the dry forest than today, as evidenced by numerous old logs and standing dead trunks. Most trees occur either in gulch bottoms or on north facing lower to mid-gulch slopes.

- **Taxonomic background:** *Flueggea neowawraea* is the only member of the genus occurring in Hawaii. There are no obvious morphological differences between plants on the different islands (Lau pers. comm. 2000).

Reproductive Biology Table

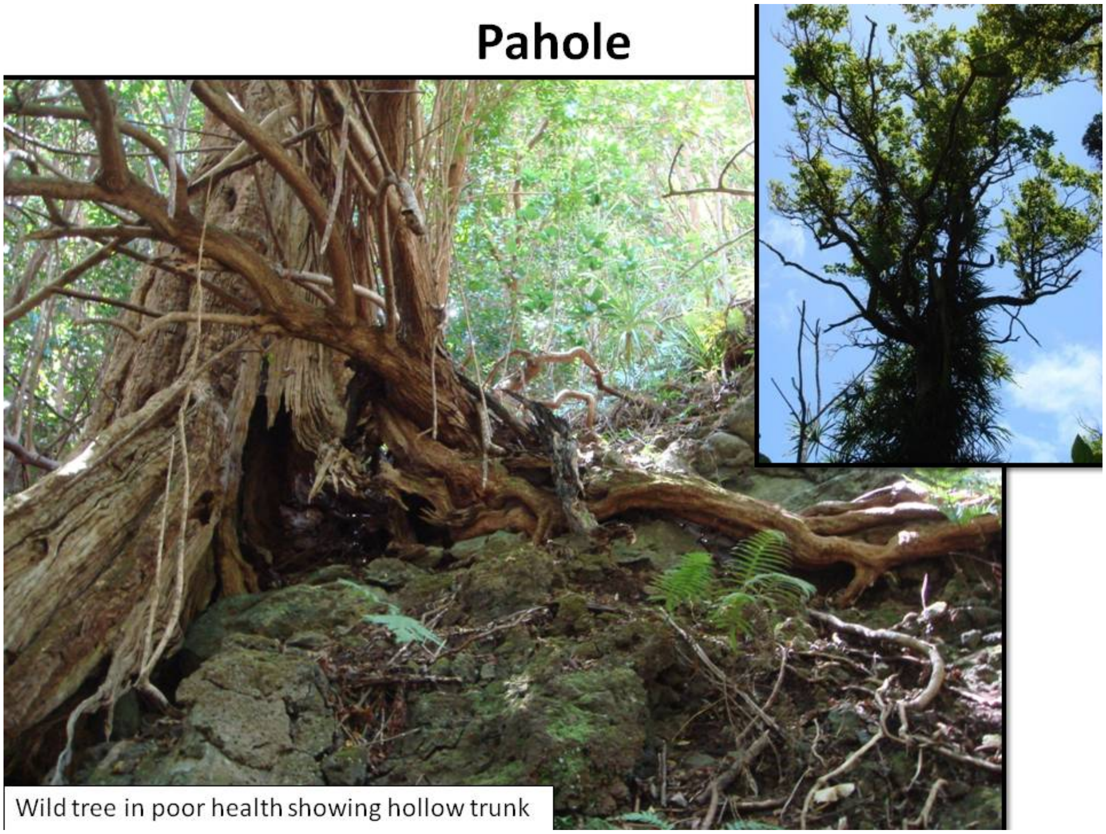
	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit	Dormancy
ALL	OCT-DEC	NOV-FEB	NOV-APR	Dioecious	Wind *	6	Non-dormant (ND)

*Presumed wind pollinated based on floral morphology, breeding system, and pollen dispersal at anthesis

Comments: The trees in the wild appear to flower once a year. Large clones in the living collection often flower more than once a year, typically in Oct-Nov and then again in Jan-Feb. Some plants will produce a small number of flowers at any time throughout the year.

Old Trees: Large trees are often mostly dead with strips of live material. Live sections of the tree can extend up into the canopy, but the trunks can be completely hollow.

Pahole

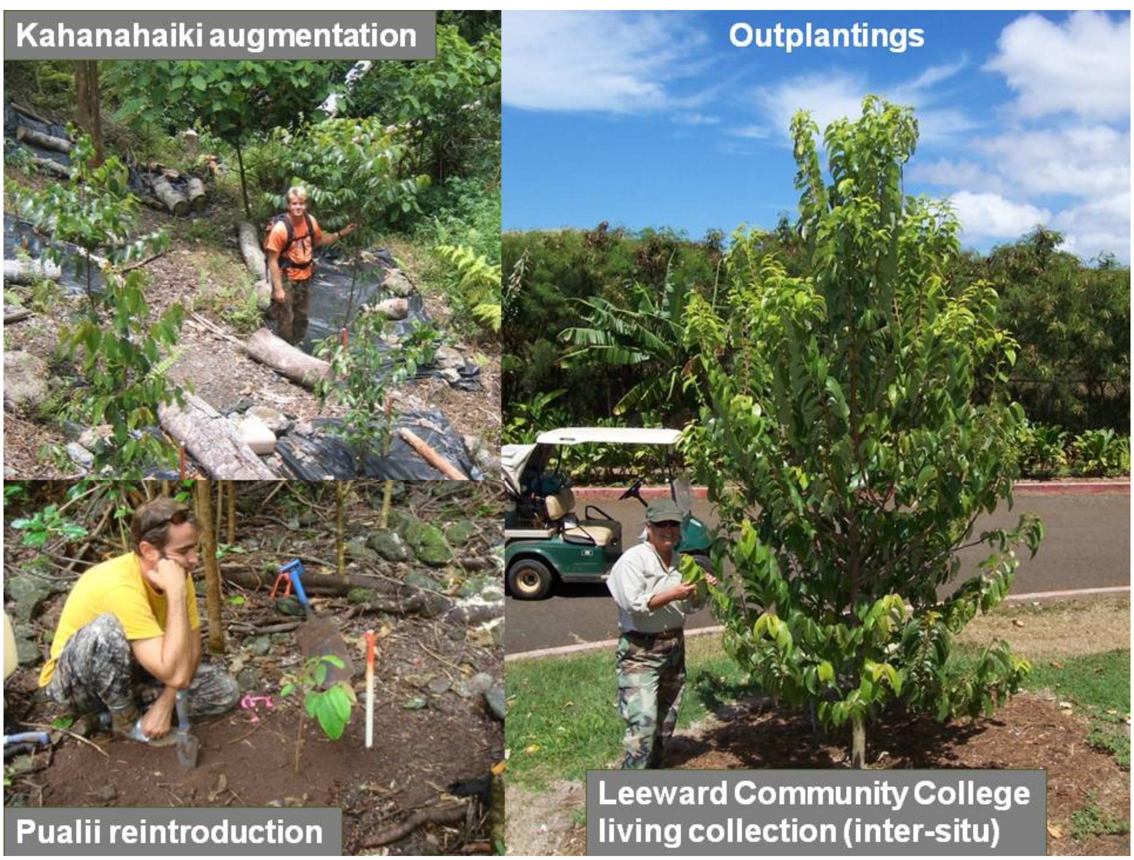


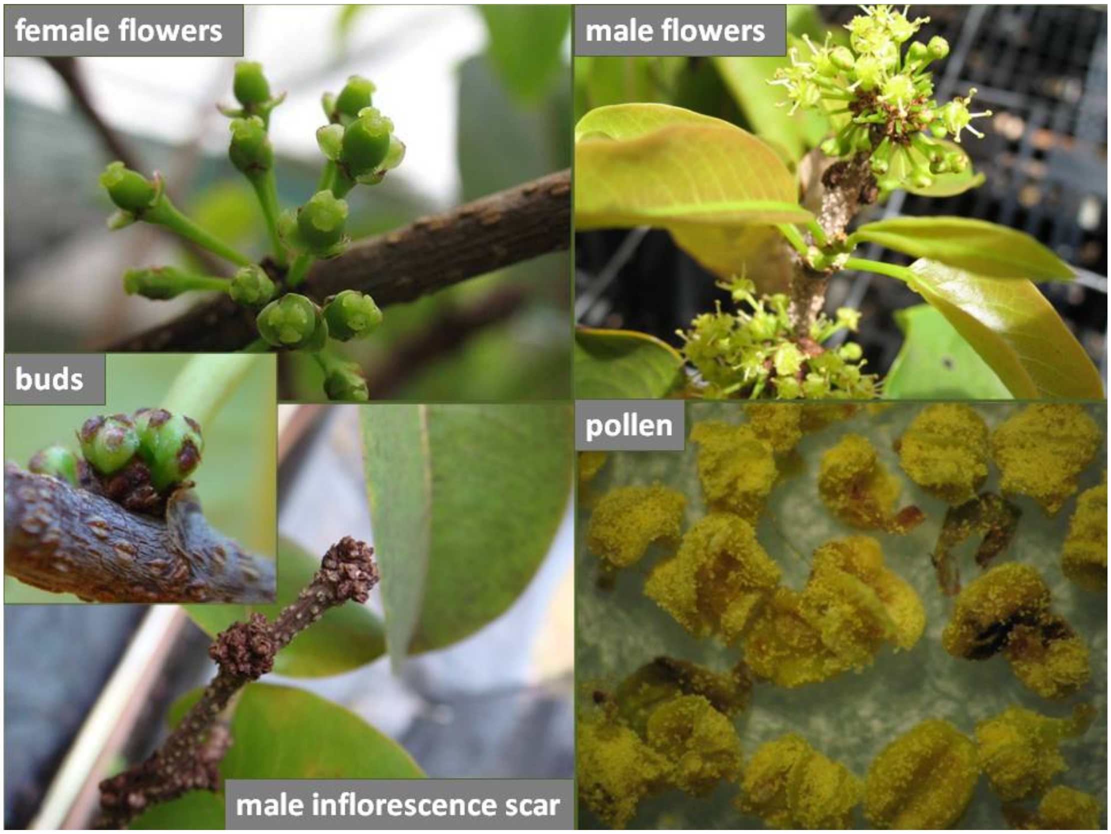
Wild tree in poor health showing hollow trunk

Propagation: Air-layer collected off wild tree (above) & Seedlings (below)

Black Twig Borer

The biggest invertebrate threat to *F. neowawraea* is the black twig borer (BTB). These beetles kill young branches by boring holes into living plant tissue, where they farm an *Ambrosia* fungus for food. In the upper left, a fresh entry hole on a *F. neowawraea* is shown. In the upper right, a BTB gallery with adults and larvae. In the lower left, an a *F. neowawraea* branch with BTB entry holes marked with white paint.




female flowers
male flowers
buds
pollen
male inflorescence scar


FRUIT AND SEEDS
immature fruit
mature fruit

Species Occurence

Map removed, available upon request

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Central and East Makaleha	Both in situ and augmentation	None	East Makaleha
Kahanahaiki to Kapuna	Both in situ and augmentation	MIP	Kahanahaiki Pahole Upper Kapuna
Makaha	Both in situ and augmentation	None	Makaha Kamaili
Manuwai	Reintroduction	None	Manuwai
Genetic Storage Population Units			
Halona	in situ	None	
Kauhiuhi	in situ	None	
Mikilua	in situ	None	PU fence
Mt. Kaala NAR	in situ	None	
Nanakuli, South Branch	in situ	None	
Ohikilolo	in situ	MIP	Ohikilolo
West Makaleha	in situ	MIP	West Makaleha
No Management Designation (Extirpated wild sites and outplantings that are not in PU)			
Mohiakea	in situ	OIP (SBW)	
Pualii	Reintroduction	None	
Waianae Kai	in situ	None	

Black Twig Borer (BTB) Trap-out Study

- **Introduction:** *Xylosandrus compactus* (black twig borer or BTB) is a major threat to a number of rare and endangered plants, notably *Flueggea neowawraea* (Euphorbiaceae). Published documentation is lacking, however OANRP and the DLNR have observed these species to suffer under BTB attack. Sequestered within the plant pith, BTB cannot be removed manually or with pesticides applied on the plant surface. Greenhouse collections of *F. neowawraea* are treated with the systemic insecticides Merit (Bayer Crop Research, Triangle Park, NC) applied as a root drench and Marathon (Olympic Horticultural Products, Mainland, PA) applied to the base of the plant in granular form. Neither is legal to use in a forest setting, but a Special Local Needs (SLN) Label (Nagamine and Kobashigawa 2003) could be pursued with permission from the manufacturer, HDOA and USFWS. OANRP is currently engaged in the process of SLN approval for a molluscicide, Sluggo and has found the process to be lengthy. Rather than embark on this long process for BTB management, OANRP looked for solutions which could be put into use immediately if found to be effective.

- **Methods:** OANRP tested the efficacy of modified Japanese Beetle Traps equipped with high-release ethanol bait (AlphaScents, NJ) and Vaportape insecticidal strips (Hercon Environmental, PA) to reduce BTB gallery formation in a target tree species (*F. neowawraea*). Prior tests demonstrated this lure to effectively capture BTB (Dudley *et al.* 2007) but it was unknown whether traps could be used to control BTB populations locally. We conducted field experiments to determine whether a ring of 6 traps placed around *F. neowawraea* could reduce attack rates relative to a control group (YER 2007, Figure 5.1.1). Work took place at two *F. neowawraea* stands, 250 m apart, located within the Kahanahaiki Mangement Unit at an elevation of 2000 ft (YER 2007, Fig. 5.2.1). The two sites, referred to here as Up Gulch (UG) and Down Gulch (DG), provide habitat for 37 and 24 trees respectively. Trees were reared in the greenhouse and planted by OANRP on February 17 2005, February 22 2006 (UG) and January 27 2007 (DG). DG contains 24 trees, seven of which were transplanted from a nearby site, Pteralyxia Gulch (PG), where they had been doing poorly. These seven, plus an additional 19 plants were originally planted at PG on December 10 2003.

  A total of 10 trees at the DG site and 20 trees at the UG site were included in this study. All trees were 1 meter or more in height. Half of the trees at each site were randomly assigned to a treatment (traps) or control (no traps) group for a total of 15 replicates per group. The rate of attack was determined using counts of new entry holes divided by the height of the tree accumulated over time (continues next page).

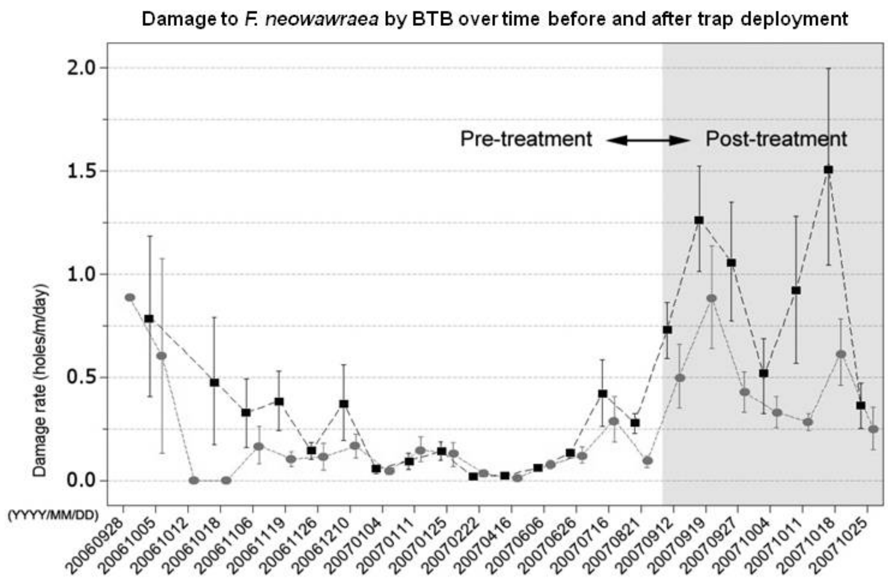
Black Twig Borer (BTB) Trap-out Study

- (con't.) This method has been used elsewhere (Gillette *et al.* 2006) to evaluate the success of experimental repellents. Using white latex paint, we marked existing holes on 30 *F. neowawraea* and recorded new holes on a weekly basis for six weeks. Prior to trap deployment attack rates had been monitored at irregular intervals for one year.

- **Results and discussion:** Post-treatment results were mixed (see data on the next page). Trees receiving traps had a consistently lower rate of attack compared to the controls. However, these differences were not significant when adjusted for pre-existing differences between the two groups. Some factors that confounded the results were: not enough replicates, varied levels of pre-treatment damage and despite using random sampling to select the treatment and control groups, the resulting control group was already sustaining a higher level of attack before treatment began.

  Despite the failure of trapping to significantly reduce damage to *F. neowawraea*, some useful information was obtained. First, it was discovered that baseline levels of attack were extremely high. At the peak of twig-borer season, trees in the control group accumulated three new entry holes per 1 meter of bole length every two days. This probably over-estimates twig borer damage however, because not all newly drilled holes result in the successful formation of a gallery. Second, the traps consistently yielded a steady number of beetles, at times as high as 100 or more each week. Each insect trapped was a gravid female, due to the insects' somewhat unique reproductive behavior. Males are incapable of flight, and upon hatching, they mate with related females and remain within the gallery, never to emerge (Hara and Beardsley 1979). Third, the traps did not exhibit a hypothesized potential counter-productive effect of increasing attack rates on *F. neowawraea*. This might have occurred if the traps attracted more beetles to the area than would naturally occur.

- Future research with more replicates may find that traps can serve as a sink for BTB on a small scale, slowing damage to *F. neowawraea*. Nonetheless, the data presented here suggest that trapping alone does not prevent appreciable numbers of BTB's from forming galleries within the host plant. As a result, we plan future tests with a combination of repellents and attractants. Also possible is the use of injection systems to more safely deliver systemic insecticides to the plant.



Damage to *F. neowawraea* by BTB over time before (white shaded area) and after (grey shaded area) trap deployment. The control group of trees (N=15) are shown in black squares with a dotted black mean connect line while the treatment group is shown in grey circles (N-15). Attack rate on the X- axis is displayed in units of new holes (twig borer galleries) per meter of tree height per day. Bars are ± one SEM.

Population Structure

• Statewide, no immature trees have been observed in any of the sites. There is no evidence that any seedlings or immature plants have been present at any of the PU for several decades.

• There are only four PUs where male and female trees are located within 100 meters of each other: Mt. Kaala NAR (Kaawa), Makaha, Central and East Makaleha (East Makaleha) and West Makaleha. Fruit with viable seed has been collected from female trees at these sites. Fruit collected from all other female trees has not had any viable seed.

• As the outplanted trees within the augmented PU (Makaha) begin to flower, the wild trees will also be monitored to determine if they are being pollinated by the younger reintroductions.

• The first reintroductions were started in 2003. Since then, a total of 128 immature trees have been planted into eight sites (three in Kahanahaiki, three in Makaha, one in Keawapilau and one in Pualii). There are currently 93 alive (survivorship = 73%). Fifty-three of the 93 remaining plants have been in the ground for more than three years. None of these surviving plants have been observed flowering and all are counted as immature plants. Trees in cultivation at Waimea Botanical Garden, Leeward Community College and others have been observed to flower just three years after germination.

• Since the reintroduced plants have not yet matured, recruitment of new seedlings is not expected within any of the sites within the next five years.

Population Estimate History (Mature/Immature/Seedling)

Manage for Stability Population Units	2003 (IP)	2004	2008	2009	2010
Central and East Makaleha	6/0/0		5/0/0		5/0/0
Kahanahaiki to Kapuna (in situ only)	6/0/0		7/0/0* *new plants found		7/0/0
Kahanahaiki to Kapuna (augmentations)			0/67/0	0/61/0	0/64/0
Makaha (in situ only)	4/0/0		10/0/0* *new plants found		10/0/0
Makaha (augmentations)	n/a			0/15/0	0/25/0
Manuwai (reintroductions)	n/a				0/0/0
Genetic Storage Population Units					
Halona	2/0/0				2/0/0
Kauhiuhi	1/0/0				1/0/0
Mikilua	1/0/0			0/0/0	0/0/0
Mt. Kaala NAR	4/0/0	3/0/0			3/0/0
Nanakuli, South Branch	1/0/0				1/0/0
Ohikilolo	3/0/0	1/0/0			1/0/0
West Makaleha	2/0/0	5/0/0* *new plants found			5/0/0
No Management Designation					
Mohiakea	1/0/0	0/0/0			0/0/0
Waianae Kai	1/0/0	0/0/0			0/0/0
Pualii (reintroductions)	n/a				0/4/0

Population Estimate History Comments

- The estimates given in the MIP in 2003 are displayed in the first column. Most sites have been observed every year since and many of the trees are still alive. When no change in the estimate was observed, the table is left blank. When trees are observed to have died or new trees are found, the new estimates are listed. All newly found individuals have been older large mature trees.
- The reintroductions are listed separately from the in situ sites to show where changes in the estimates occurred. When new trees are found the new estimates are marked (*). Ten new trees were found between 2003 and 2008 and none since then. Seven wild mature trees have died since 2003.
- The Manuwai PU was created for future reintroductions. The wild plant that used to be alive in that gulch was included in the Mt Kaala NAR PU, but was observed to be dead in 2004.
- The Waianae Kai and Mohiakea PUs with No Management designation have no more live trees. The Pualii PU is used for genetic storage back-up and to test planting sites in the southern Waianae.

Monitoring Plan

- All MFS PUs will be monitored annually for population structure, trends and threats.
- Reintroduced plants will be monitored twice annually for reproductive status, vigor and growth.
- All Genetic Storage PUs will be monitored every other year to determine status.
- No proven control methods have yet been developed for BTB. Research will be conducted to develop a BTB-specific pheromone. Until new control methods are ready for field testing, no more sampling using insect traps or monitoring *F. neowawraea* trees for BTB damage is needed at this time.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Seeds + Living Collection + Pollen	Ex situ living collection	Seed banking (-18C / 20% RH) & pollen storage (-18C / 20% RH) & clones of in situ stock	10 yrs. (seeds) and 2+ yrs. (pollen)	Yes	Collections will be made from ex situ hand-pollinations and reintroductions

Genetic Storage Plan Comments: Pollen stored for over 2 years was used to produce viable seed. Males are or will be represented as clones in an ex situ living collection. Pollen will be collected from these males and in situ males. It will be used in the breeding program to produce stock for reintroductions and as additional genetic storage backup. As pollen ages or it is used up, it will be continually replaced from the ex situ and/or in situ collection.

Ex situ Representation of in situ Founders

FOUNDER	SEX	CLONED	IN SITU SEED	FOUNDER	SEX	CLONED	IN SITU SEED
HAL-A-1	FEMALE	YES		MAK-A-1	MALE	YES	
HAL-B-1	MALE	YES		MAK-A-2	?	NO	
KAP-A-1	FEMALE	NO		MAK-B-1	FEMALE	NO	
KAU-A-1	FEMALE	YES		MAK-C-1	MALE	YES	
LEH-A-1	MALE	NO		MAK-D-1	FEMALE	YES	
LEH-A-2	FEMALE	NO	YES	MAK-D-2	MALE	YES	
LEH-A-3	MALE	NO		MAK-D-3	FEMALE	YES	
LEH-B-1	FEMALE	NO	YES	MAK-E-1	FEMALE	YES	
LEH-C-2	FEMALE	YES	YES	MAK-F-1	MALE	YES	
LEH-C-3	MALE	YES		MAK-F-2	?	NO	
LEH-D-1	MALE	NO		MMR-A-1	FEMALE	YES	
LEH-E-1	MALE	YES		MMR-B-1	FEMALE	YES	
LEH-E-2	MALE	NO		MMR-C-1	FEMALE	YES	
LEH-G-1	?	NO		MMR-E-1	?	YES	
LEH-I-10	MALE	NO		NAN-A-1	MALE	YES	
AAW-C-1	MALE	NO		PAH-A-1	MALE	NO	
AAW-C-2	FEMALE	YES	YES	PAH-C-1	?	NO	
AAW-C-3	MALE	NO		PAH-C-2	MALE	NO	

Reintroduction Plan for MFS PU

Manage for Stability Population Unit	Reintroduction Site(s)	Number of Plants to be planted	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population.	Plant Size	Pot Size
Central and East Makaleha	East Makaleha (TBD)*	100	Hand-pollinations of all stock in nursery	Immature Plant		~35cm	1 gal. tall tree
Kahanahaiki to Kapuna	Kahanahaiki (MMR-F)** (MMR-G)** (MMR-H)** Flueggea Gulch (MMR-I)* Kapuna (KAP-B)* (KAP-C)* Keawapilau (PIL-A) Pahole (PAH-D)*	 0 30 0 15 15 15 15 10	Hand-pollinations of all stock in nursery	Immature Plant		~35cm	1 gal. tall tree
Manuwai	Manuwai (TBD)*	100	Hand-pollinations of all stock in nursery	Immature Plant		~35cm	1 gal. tall tree
Makaha	Lower Elepaio (MAK-G) Upper Elepaio (MAK-H) Makai Gulch (MAK-I) Makaha (TBD)* Makaha (TBD)*	10 10 15 35 30	Hand-pollinations of all stock in nursery	Immature Plant		~35cm	1 gal. tall tree

Comments: * = reintroduction not started yet
**= reintroduction complete at this site

Reintroduction Plan Comments

- Outplantings into the Kahanahaiki to Kapuna, Makaha and Central and East Makaleha PU will be augmenting existing wild trees. The Manuwai PU has no known extant wild trees. All of these PU occur in the northern Waianae Mountains, where most of the trees are known and the habitat is not as denuded as sites in the south such as Lualualei and Honouliuli.
- The reintroduction goal for this taxon is to balance the 36 known founders in each of four sites. With such a small number of plants and a continuing decline, reintroductions must be initiated. Since the stabilization plan considers all wild plants to be one population, every female-male combination possible will be made. A balance of all possible combinations would be ideal at each outplanting but pollinating only for this goal is not realistic for the following reasons:
  - 1) 15 founders are still unrepresented *ex situ*.
  - 2) Since we test the effectiveness of the storage conditions by seed set, older pollen collections are prioritized regardless of the combination of crosses that are underrepresented.
  - 3) Some plants in the living collection produce flowers more frequently and in larger numbers than others, so they are often overrepresented. Without the luxury of time to wait for all founders to be cloned, protocols and the following priorities were established for crossing and outplanting as the sources of males and females slowly increase
- Prioritization of Fruit Production in ex situ Managed-Breeding-for-Reintroduction Program
  - 1st – Pollen donor within a female from within that *in situ* population site (founders are geographically close)*
  - 2nd – Pollen donor from an old collection (to test storage longevity and not lose any collection)
  - 3rd – Pollen donor not yet utilized (in storage but has yet to produce seed for storage)
  - 4th – Pollen donor that is novel for a particular female (a new combination)

  * While we can hypothesize that historically there were very few limitations of gene flow between all extant individuals, we are uncertain as to the extent of present gene flow except where individuals are found growing next to or near each other.

Reintroduction Plan Comments (con't.)

- For this species, we decided an approach of many small outplantings was more appropriate than a few large outplantings, given it's habit and gulch bottom requirements (to outgrow BTB damage rates).
- OANRP has shown trees can grow in outplantings at gulch bottoms where large kukui (*Aleurites moluccana*) trees have been removed to provide outplants with ample sun and water.
- Lots of mature, older plants are too large to occupy a single gulch bottom habitat.
- Standard weed control efforts for outplantings will not be applied. OANRP hopes that since the trees can outpace the BTB damage rates, that it will hopefully outgrow most weeds and form a canopy to reduce the light gap caused by large tree removal prior to outplanting.
- Gulch flooding after heavy rains can kill saplings, and it is uncertain which gulches are prone to heavy flooding. Therefore, we must experimentally try out different gulches to find the most appropriate locations and not plant directly into the center of the gulch bottom if possible or necessary.
- Since founders are still unrepresented, we will stagger new outplantings and new founders as available, and not represent all founders at all outplantings.
- Since seeds may only store for ten years and trees may take longer than that to mature, it is necessary to stagger founders using this many-small-sites approach so as not to risk losing representation of a founder in genetic storage and reintroduction (if plants die) before an outplant reaches maturity.

2010-2011 Stabilization Goals Update

Manage for Stability Population Units	PU Stability Target		MU Threat Control					Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Black Twig Borer (BTB)	Are there enough propagules in Genetic Storage?
Central and East Makaleha	NO	NO	NO	NO	NO	NO	NO	NO
Kahanahaiki to Kapuna	NO	NO	PARTIAL	PARTIAL	PARTIAL	NO	NO	NO
Makaha	NO	NO	PARTIAL	PARTIAL	NO	NO	NO	NO
Manuwai	NO	NO	NO	NO	NO	NO	NO	NO
Genetic Storage Population Units								
Halona	N/A	N/A	NO	NO	NO	NO	NO	NO
Kauhiuhi	N/A	N/A	NO	NO	NO	NO	NO	NO
Mikilua	N/A	N/A	YES	NO	NO	NO	NO	NO
Mt. Kaala NAR	N/A	N/A	NO	NO	NO	NO	NO	NO
Nanakuli, South Branch	N/A	N/A	NO	NO	NO	NO	NO	NO
Ohikilolo	N/A	N/A	YES	NO	NO	NO	NO	NO
West Makaleha	N/A	N/A	NO	NO	NO	NO	NO	NO

5 Year Action Plan

	Proposed Actions for the following years:				
Manage for Stability Population Unit	MIP YEAR 7 October 1, 2010 – September 31, 2011	MIP YEAR 8 October 1, 2011 – September 31, 2012	MIP YEAR 9 October 1, 2012 – September 31, 2013	MIP YEAR 10 October 1, 2013 – September 31, 2014	MIP YEAR 11 October 1, 2014 – September 31, 2015
Central and East Makaleha	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect •Reintroduce
Kahanahaiki to Kapuna	•Monitor & Collect •Reintroduce (MMR-G, PIL-A)	•Monitor & Collect •Reintroduce (MMR-G, PAH-D, PIL-A, KAP-B, KAP-C)	•Monitor & Collect •Reintroduce (MMR-G, MMR-I, PAH-D, PIL-A, KAP-B, KAP-C)	•Monitor & Collect •Reintroduce (MMR-I, PAH-D, KAP-B, KAP-C)	•Monitor & Collect •Reintroduce (MMR-I)
Makaha	•Reintroduce (MAK-G,MAK-H, MAK-I) •Monitor & Collect	•Reintroduce (MAK-G,MAK-H, MAK-I, new sites) •Monitor & Collect	•Reintroduce (MAK-I, new sites) •Monitor & Collect	•Reintroduce (new sites) •Monitor & Collect	•Reintroduce (TBD) •Monitor & Collect
Manuwai	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect •Reintroduce ANU-B	• Monitor & Collect •Reintroduce ANU-B	•Monitor &Collect •Reintroduce ANU-B
Genetic Storage Population Units					
Halona	•Monitor		•Monitor		•Monitor
Kauhiuhi	•Monitor		•Monitor		•Monitor
Mikilua		•Monitor		•Monitor	
Mt. Kaala NAR	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect
Nanakuli, South Branch	•Monitor		•Monitor		•Monitor
Ohikilolo	•Monitor	•Monitor	•Monitor	•Monitor	•Monitor
West Makaleha	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect •Reintroduce	•Monitor & Collect •Reintroduce	•Monitor & Collect •Reintroduce
No Management Population Units					
Pualii	•Monitor	•Monitor	•Monitor	•Monitor	•Monitor

Hesperomannia arbuscula

- **Scientific name:** *Hesperomannia arbuscula* Hillebrand
- **Hawaiian name:** None known
- **Family:** Asteraceae (Sunflower family)
- **Federal status:** Listed Endangered October 29, 1991
- **Requirements for Stability**
  - 3 Population Units (PU)
  - 75 reproducing individuals in each PU (long-lived perennial but with low seed set, tendency for large declines or fluctuations in population size, and recent severe population declines)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage

***Description and biology:** *Hesperomannia arbuscula* is a shrub or small tree 2-3.3 m tall, and reportedly reaching up to 7.6 m tall (Degener 1946). The leaves measure 10-18 cm long, 5.5-11.5 cm wide, and are covered with minute hairs. The flower heads, which resemble those of thistles, are borne at the stem tips, usually in clusters of 4-5. The florets are yellow in color, and are perfect (possessing both male and female reproductive parts) and project beyond the bracts of the flower head. The plant's achenes (a type of dry, seed-like fruit) are 0.8-1 cm long and are tipped by hair-like bristles about twice as long as the achene.

**excerpt from:* Makua Implementation Team (MIT). 2003. Final Makua Implementation Plan. Prepared for the U.S. Army Garrison, Schofield Barracks, HI.

Hesperomannia arbuscula

The flowers are visited by birds, and are presumably pollinated by them (Carlquist 1974). Bristle-bearing achenes are characteristic of the wind-dispersed members of the sunflower family. However, the achenes of *H. arbuscula* are very large and heavy in comparison to continental wind-dispersed members of the family, and seemingly would not be capable of being carried on the wind over long distances. Furthermore, this species usually grows in tight colonies (Lau pers. comm. 2000), supporting the supposition that the seeds are not widely dispersed. Judging from observed growth rates and the size of the largest plants, the plants may live 10 to 20 years, or more (Lau pers. comm. 2000).

- **Taxonomic background:** The genus *Hesperomannia* is endemic to Hawaii and currently consists of 3 species; *H. lydgatei* (Kauai); *H. arborescens* (Oahu, Molokai, Lanai, West Maui); and *H. arbuscula* (Oahu (Waianae Mts.), West Maui). The type specimen of *H. arbuscula* was collected near Lahaina. There are proposed changes to the taxonomic status of this genus, as a result of the M.S. Thesis by Susan Ching-Harbin (2003) on the fitness and genetic variation within the genus. Proposed changes include distinguishing *H. arbuscula* from West Maui and Oahu (*H. oahuensis*), as well as distinguishing the Oahu *H. arborescens* from all other islands. Taxonomic name changes will be recognized upon publication of this data.

- **Known distribution:** Under the new proposed taxonomic changes, *H. arbuscula* found in the Waianae Mts. will become their own species, *H. oahuensis.* In 1977, there were 96 plants known from 3 locations, with all stage classes represented. In 2010, there are only 12 plants known from 4 locations, 2 of which had only been discovered in the last couple years (Fig. 1). An additional 3 populations were both discovered and extirpated between 1977-2010.

S. Ching-Harbin. 2003. Measures of fitness and genetic variation in the endangered Hawaiian genus *Hesperomannia*. M.S. Thesis, University of Hawaii.

Hesperomannia arbuscula

•[†] **Habitat:** *Hesperomannia arbuscula* (*H. oahuensis)* in the Waianae Mts. typically grows in mesic forests on upper gulch slopes, or on ridge tops. The dominant trees at these sites are usually *ohia* (*Metrosideros polymorpha*), *lama* (*Diospyros sandwicensis*), and/or *koa* (*Acacia koa*). The *H. arbuscula* on West Maui occurs in wetter mesic forests to very wet rainforests, which are often dominated by *ohia*.

•[†] **Outplanting considerations:** The cause of the decline of this species is uncertain, thus it is difficult to select outplanting sites (see threats). Global climate change (GCC) should be a consideration when discussing elevation ranges for reintroductions. The stock to outplant is from in situ hand-pollinations of every possible parent combination. Reintroductions sites are limited to the Waianae Mts. and habitat similar to extant or extirpated locations. Proximity to extant populations should not be a concern, considering the need for cross-pollination to produce sufficient amounts of viable seed.

•[†] **Threats:** The major threats to *H. arbuscula* in the Waianae Mountains include feral pigs and goats, which degrade the species' habitat, and harm the plants by feeding on them, trampling them, or uprooting them while rooting for food. Invasive alien plants threaten *H. arbuscula* by altering the species' habitat and competing with it for sunlight, moisture, nutrients, and growing space. Also, the spread of highly flammable alien grasses increases the incidence and destructiveness of wildfires. The Waianae Kai plants are vulnerable to human disturbance. A major hiking and hunting trail runs right through the population unit. GCC may also be a threat as hotter, drier summers persist and/or increase in length. Many plants have been observed to drop leaves during this time. GCC may not allow for plants to recover in the winter, either by exacerbating summer drought and/or preventing winter flushing.

[†] *modified from:* Makua Implementation Team (MIT). 2003. Final Makua Implementation Plan. Prepared for the U.S. Army Garrison, Schofield Barracks, HI.

Population Structure

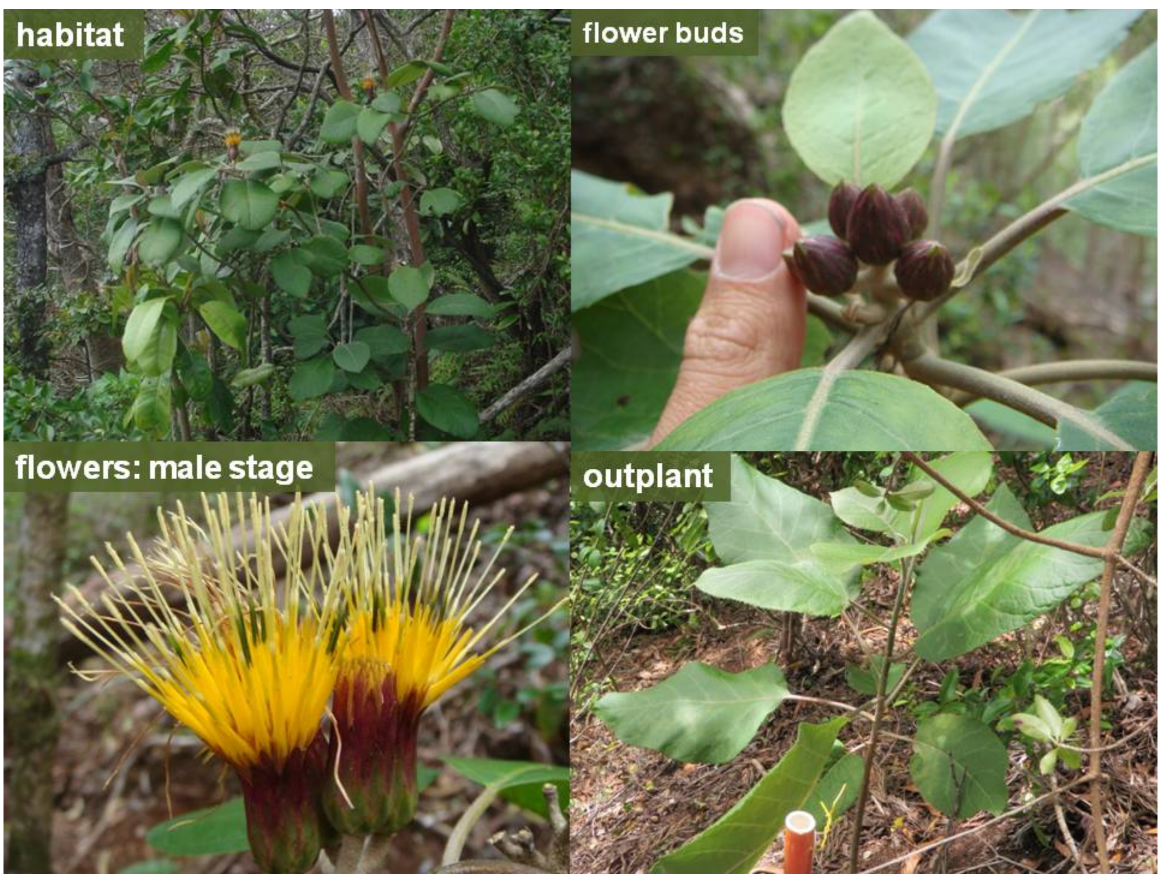
- There has been an 88% decline in number of in situ wild plants since 1977, despite the fact that 5 new populations were discovered after 1977. The areas where new populations have been located where likely under-surveyed or remnant of possible larger populations that once occupied more continuous habitat. These new populations have a similar population structure as known populations when they were found, suggesting that they too may have been larger in size in the past several decades.
- In the last decade, seedlings have only been observed in the Palawai PU, and all of these seedlings have died or were removed and now exist in an *ex situ* living collection. Small immature plants have been observed at Makaha, Palawai and Waianae Kai PU.
- Currently, all available mature fruit has been collected from all sites. Since 2004, no viable seeds have been observed that did not result from hand-pollination.
- As the plants mature and begin to produce flowers, hand-pollinations will continue at the outplantings for fruit production. Fruit will be collected for propagation at existing or new outplantings, and to create genetic storage collections. Eventually, a strategy to allow some fruit to remain onsite to germinate may be developed.
- Establishment of seedlings within the reintroduction sites may be dependent on hand-pollination to produce enough viable seed (in absence of natural pollinator). However, it is possible that a larger number of plants flowering synchronously at one site may lure pollinators .
- We do not know what population structure is necessary to reach stability targets. The current population structure at all the PUs is not expected to change over the next five years. They are not likely to recover to stable status without augmentation.

Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	% Viable Seed/Head (hand-poll.)	Dormancy
Makaha	Mar- May	Mar-Aug	July-Sept	Hermaphroditic	Bird *	9.2% (3 seeds/head)	Non-dormant (ND)
Palawai	May-June	May- July	June- Aug	Hermaphroditic	Bird *	23.6% (5 seeds/head)	ND
Waianae Kai	April- June	April- July	June- Aug	Hermaphroditic	Bird *	26.0% (7 seeds/head)	ND
Napepeiauolelo	N/A	N/A	N/A	N/A	Bird *	TBD	TBD
Haleauau	April-May	May	TBD	Hermaphroditic	Bird *	TBD	TBD

* Carlquist, S. 1974. Island biology. Columbia Univ. Press. New York, 660 pp.

- The plants at Napepeiauolelo have not been observed to be reproductive. The single plant at Haelauau became reproductive this year, producing 6 flowers. All flowers were pollinated and aborted prior to fruit maturation. In general, plants appear to take several years of producing flowers after they reach maturity to yield mature fruit.
- Average seeds per fruit is from hand-pollinations only, from 2007-2010. Prior to 2007, seed production was sporadic and lower than hand-pollinations. The average total number of achenes per head = 37.
- It is uncertain the degree of self-incompatibility these plants may possess. Casual selfing both *in situ* and *ex situ* have yielded no viable seeds, though more formal selfing experiments would be necessary to determine degree of incompatibility. It is unclear whether healthy populations would have needed genetic communication among them. However, with so few individuals remaining, the only option is to cross-pollinate among every individual for outplanting.



Hesperomannia arbuscula Occurence

Map removed, available upon request

Population Units

Manage for Stability Population Units	PU Type	Which Army Action Area is the PU inside?	Management Unit(s) designated for threat control
Haleauau	Both in situ and Augmentation	OIP (SBW)	PU fence/Lihue MU
Makaha	Both in situ and Augmentation	None	Makaha
Pahole NAR	Reintroduction	MMR	Upper Kapuna
Pualii	Reintroduction	None	North Pualii
Genetic Storage Population Units			
North Palawai	In situ	None	PU fence
Waianae Kai	In situ	None	PU fence
Napepeiauolelo	In situ	None	PU fence
No Management Designation			
Kaaikukai	Extirpated	None	
Kaluaa	Extirpated	None	

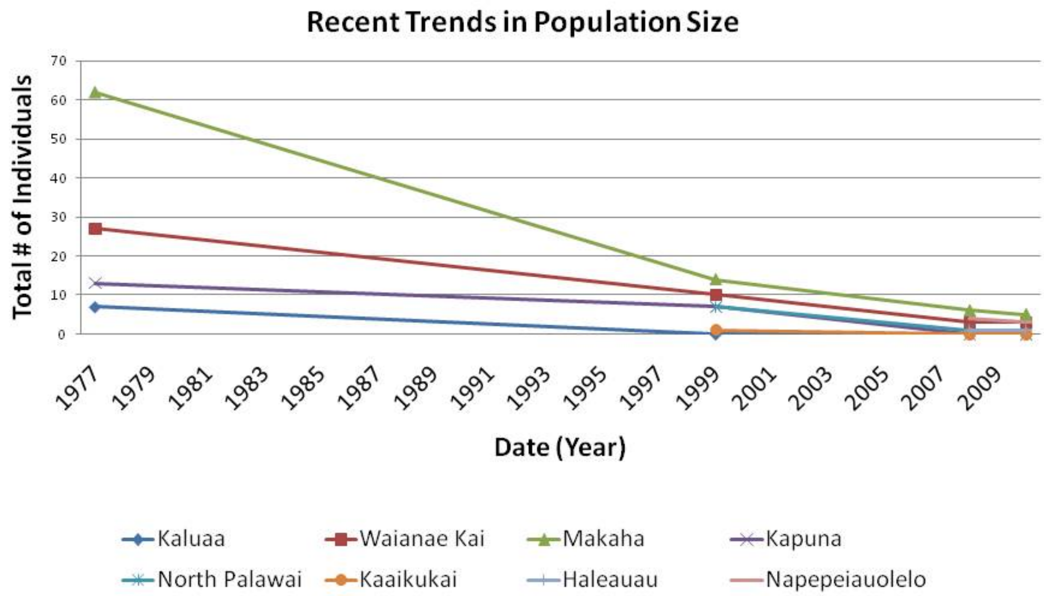
Population Estimate History (Mature/Immature/Seedling)

Population Unit Name	1977 - 1984	1985	1991	1999-2002	2003 (IP)	2004	2005	2006	2007	2008 - 2009	2010
Manage for Stability Population Units											
Makaha	12/25/25			13/1/0	8/0/0	5/4/0			3/3/0	3/3/0	*3/3/0
Pualii (reintro)											0/24/0
Pahole NAR (reintro & extirpated)			13/0/0	7/0/0	1/0/0	1/0/0	1/0/0	1/0/0	0	0	0/15/0
Waianae Kai	7/8/12			9/2/0	9/1/0	3/2/0	4/1/0	2/1/0	2/1/0	2/1/0	2/1/0
Haleauau									0/1/0	0/1/0	1/0/0
Genetic Storage and No Management Population Units											
Kaaikukai				1/1/0			0	0	0	0	0
Napepeiauolelo										0/4/0	0/3/0
Kaluaa	6/1/0	0/0/0	0	0	0	0	0	0	0	0	0
North Palawai					5/2/0	8/7/0	4/5/2†	3/1/0	2/1/0	1/0/0	*1/0/0

* 1 mature plant almost dead (no leaves; only bottom portion of stem alive)

† These immature plants were dug up and now exist in the *ex situ* nursery collection

outplant



Monitoring Plan

- All monitoring and management of this species is a joint effort between OANRP and OPEP (Oahu Plant Extinction Prevention Program).
- A complete census of all *in situ* plants will be conducted annually during hand-pollinations in March - August. No additional visits are necessary.
- Observations made during the flowering and fruiting season need to include a detailed sketch map and photos of the inflorescences to track hand-pollinations of the plants.
- Additional threats to any of the sites will be noted and management will be adapted.
- The first cohorts of seedlings from hand-pollinations were monitored and many measurements were taken to best determine how to quantify growth. After completing these measurements for one year after planting, it was decided that volume (height, length of longest leaf) would be sufficient. These measurements will be taken once a year. Vigor will be measured to determine if there are any crosses not fit enough to justify the time spent conducting them.
- Reintroduction sites will be monitored twice a year, with additional visits if needed for watering.
- Preliminary results suggest no differences in offspring fitness among different mother-father crosses in the first-year's growth of the saplings. However, maternal source alone may have more of an impact on offspring fitness. Progeny from one plant in Waianae Kai were smaller and grew slower than other plants. Venation color will also be noted as some plants still have no red coloration in the midrib.
- Lastly, once outplants become reproductive, fecundity will be measured by counting the number of flowers and calculating seed set. Ultimately, at this point, seed set will be the primary fitness measurement.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Mature Seed	In situ (via managed breeding)	Seed banking	To be determined	Not initiated	In situ and reintroductions

Genetic Storage Plan Comments: Genetic storage for this species has been difficult. Mature seed will be collected from the *in situ* sites via managed breeding for propagation for outplantings. After outplantings have been established, hand-pollinations will continue to collect seed for storage testing. Once preferred storage conditions have been determined, seeds will be collected from outplantings to create genetic storage collections to be stored at the Army Seed Lab.

Small immatures that were removed from the field are in the *ex situ* nursery collection. They will be used as a pollen source for hand-pollinations. Though it has been difficult to propagate this species via cuttings and air-layers, both *in situ* and *ex situ,* we will continue to try to clone this living collection.

Pollination & Collection Methods

- **Hand-Pollinations**: Due to several consecutive years of minimal to no fruit production at the *in situ* sites for this taxon, a joint effort between OANRP and OPEP was initiated in 2007 to hand-pollinate the remaining plants in the attempt to produce viable seed. In addition to minimal fruit production, there was very little success in cloning trees. Furthermore, micropropagation techniques, typically used for propagation of immature seeds, have not been successful. Therefore, very few plants were represented *ex situ*. OANRP and OPEP wanted to see if hand-pollinations, both within a population and among populations, would yield viable seed. It did, and the seedlings were easily propagated. Therefore, hand-pollinations continued as the method to collect propagules for outplantings and genetic storage. The following are details studied and adopted by both agencies.
- **Pollen Collection**: At the stage where pollen collection is best, the stigmas should be pointed and not split at the top. Scrape flowers from bottom up with the comb end of the eyebrow brush. Avoid collecting nectar. Tap/wipe pollen into weighing paper or tap in vial. Label the paper (pencil) or vial (sharpie) with the founder number and date. Estimate pollen quantity by comparing amount to the different size pin heads in small glass vial in kit. Wrap up the paper and place it in a small container. Place vial in thermos. Minimize amount of time the thermos is open. Take pictures of the flower and plant and complete the Collection Form. Upon returning to the truck, place thermos at the feet of the passenger and set air conditioning to feet level. At the office, remove vial and place pollen in pollen drawer of seed lab refrigerator. Place thermos in seed lab chest freezer.

Pollination & Collection Methods

Pollination: Bring forms, thermos with pollen and pollen kit in field to pollinate. On the day of the field visit, remove the pollen from the frig and place in the thermos just prior to departure. Place thermos at the feet of the passenger and set air conditioning to feet level. Flowers should be pollinated when they are not wilting and the stigmas are V-shaped at the tip of the flower. Place pollen on the tops of the flowers (stigmas) using the brush end of the eyebrow brush in kit. If flowers are beginning to wilt, try to place pollen on the freshest-looking flowers with straight corolla tubes. Tape a folded aluminum plant tag onto a long, thin branch if the flowers can not be reached. Fill out Pollination Form. Write the founder of the pollen donor and the date on the inside of a bird band and wrap around the peduncle. Take pictures and label as can (#2).

Color-coded pollen donor on branch and camera

Labeled fruit cluster on camera

Straight corolla tubes; can pollinate

Bending; too old to pollinate

If it is raining, do not pollinate. If it is drizzly but not extremely windy, create a rain hat to protect newly pollinated flowers. Fold "Rite in the Rain"® paper into a triangle, bend triangle in half, and position over flowers. Bend back the two bottom ends to reinforce. Poke 2 holes at ends, and use plant tag wire to create a "chin strap" for the hat. Try to position leaves, tie, and hat to keep paper off of flowers (#3).

Pollination & Collection Methods

Fruit Collection: Fruit should be collected as it begins to dry out and colors fade to more browns. The head (infructescence) will begin to open up at the mouth (top). Fruit should not need to be pulled from plant; fruit should be easily removed from peduncle. If the head is fully open at the mouth (#4), and does not easily come off plant, it is OK to pull infructescence off. The best way to confirm maturity is that if the seeds are not attached inside the head (meaning you can lift out the individual seeds by gently pulling up on the pappus), then the whole head can be collected. If the head is out of reach, poke it with a stick. It will begin to come off the peduncle and can be pushed off with the stick. If the head does not move at the first poke, document and revisit in one week. Take pictures of the immature fruit (#5).

Reintroduction Plan

Population Unit	Reintroduction Site(s)	Number of Plants to be planted	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population.	Plant Size	Pot Size
Makaha	Makaha (MAK-B)	125	Immature plants	Hand-pollinations from all sites	12 extant + 3 extirpated	25cm minimum	1 gal. tall tree
Pualii	North Pualii (PUA-A)	125	Immature plants	Hand-pollinations from all sites	12 extant + 3 extirpated	25cm minimum	1 gal. tall tree
Pahole NAR	Keawapilau (PIL-A)	125	Immature plants	Hand-pollinations from all sites	12 extant + 3 extirpated	25cm minimum	1 gal. tall tree
Haleauau	Haleauau (SBW-B)	125	Immature plants	Hand-pollinations from all sites	12 extant + 3 extirpated	25cm minimum	1 gal. tall tree

Reintroduction Plan Comments

•All possible maternal-paternal combinations will be pursued via *in situ* hand-pollinations. The number of founders will be maximized at outplanting sites from what is available at every given year. Once all founders are represented, we will represent all appropriate crosses based on data collected from fitness study.

•The Pualii reintroduction began in January 2010. 24 plants were planted and more will be planted in November 2010.

• The Keawapilau reintroduction began in March 2010. 15 plants were planted and more will be planted in November 2010.

• The Makaha reintroduction site needs to be determined. It may be placed in the Subunit II fence which has yet to be built.

• The Haleauau reintroduction site also needs to be determined. Outplanting cannot begin until the larger Lihue fence is completed and ungulates are removed. An additional PU fence may be needed to ensure protection from ungulates.

• All plantings will receive supplemental watering when needed and additional care including pest control if necessary to better ensure survival at this critical stage since no genetic storage exists.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are there enough propagules in Genetic Storage?
Makaha	NO	NO	YES	YES	YES	NO	NO	NO	NO
Pualii	NO	NO	YES	YES	NO	NO	NO	NO	NO
Pahole NAR	NO	NO	YES	YES	NO	NO	NO	NO	NO
Haleauau	NO	NO	YES	NO	PARTIAL	NO	NO	NO	NO
Genetic Storage Population Units									
North Palawai	N/A	N/A	YES	YES	NO	NO	NO	NO	NO
Waianae Kai	N/A	N/A	YES	YES	YES	NO	NO	NO	NO
Napepeiauolelo	N/A	N/A	YES	YES	NO	NO	NO	NO	NO
No Management Designation									
Kaaikukai	N/A	N/A	NO	NO	NO	NO	NO	NO	NO
Kaluaa	N/A	N/A	NO	NO	NO	NO	NO	NO	NO

5 Year Action Plan for MFS PU

	Proposed Actions for the following years:				
Population Unit	MIP YEAR 7 October 1 2010 – September 31 2011	MIP YEAR 8 October 1 2011 – September 31 2012	MIP YEAR 9 October 1 2012 – September 31 2013	MIP YEAR 10 October 1 2013 – September 31 2014	MIP YEAR 11 October 1 2014 – September 31 2015
Makaha	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate •Reintroduce	•Monitor & Collect •Hand-pollinate •Reintroduce	•Monitor & Collect •Hand-pollinate •Reintroduce	•Monitor & Collect •Hand-pollinate
Pualii	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor	•Monitor & Collect •Hand-pollinate
Pahole NAR	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor	•Monitor & Collect •Hand-pollinate
Haleauau	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate •Reintroduce

5 Year Action Plan for Genetic Storage PU

	Proposed Actions for the following years:				
Population Unit	MIP YEAR 7 October 1 2010 – September 31 2011	MIP YEAR 8 October 1 2011 – September 31 2012	MIP YEAR 9 October 1 2012 – September 31 2013	MIP YEAR 10 October 1 2013 – September 31 2014	MIP YEAR 11 October 1 2014 – September 31 2015
Napepeiauolelo	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate
North Palawai	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate
Waianae Kai	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate	•Monitor & Collect •Hand-pollinate

Hibiscus brackenridgei subsp. *mokuleianus*

- **Scientific name:** *Hibiscus brackenridgei* (A. Gray) subsp. *mokuleianus* (M. Roe) D. Bates
- **Hawaiian name:** mao hau hele
- **Family:** Malvaceae (Mallow family)
- **Federal status:** Listed endangered November 10, 1994
- **Requirements for MIP Stability**
  - 4 Population Units (PU) (high fire risk)
  - 50 reproducing individuals in each PU (short-lived perennial)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology:** *Hibiscus brackenridgei* is found at three separate areas on Oahu. Plants at each site differ from those of the other areas. The three areas are: 1) Waialua (152-366 m), (including the Kaimuhole and Palikea Gulch, Kihakapu and Puulu, Kaomoku nui PUs), 2) Kealia (107-213 m), (including the Haili to Kawaiu PU), 3) the Makua (98-146 m) and Keaau (195-293 m) PUs. *Hibiscus brackenridgei* plants from the southwestern tip of Molokai at an elevation of about 60 m (*H. brackenridgei* var. *molokaiana*) are morphologically similar to the Makua plants (see the Taxonomic Background section, below). The differences are evident in the plants' stature, branching pattern, and the morphology of the leaves, stems, and flowers. These differences are retained when plants from the three areas are grown together in a common garden (Lau pers. comm. 2000), showing that morphological differences among the plants of the three areas are attributable to underlying genetic differences. For the purpose of the Makua Implementation Plan (IP), each grouping of plants is referred to as a type (Waialua, Kealia, Makua). These types, however, likely represent parts of what originally was a morphological continuum, and the discovery of additional populations (e.g. Keaau) may blur the distinctions made here.

Hibiscus brackenridgei subsp. *mokuleianus*

The plants of the Waialua area represent typical *H. brackenridgei* subsp. *mokuleianus* as described in the literature. The trees are usually single-trunked, commonly 4-7 m (13-23 ft) tall (Lau pers. comm. 2000), and reportedly reach up to 12 m (39 ft) in height (Roe 1961). The Kealia plants are shorter, and commonly measure 2-6 m (6.5-20 ft) tall. Most branch near ground level to form a small tree with multiple trunks. The main branches of both the Waialua and Kealia types grow upwards. The Makua-Molokai type is a rambling shrub whose main branches extend outwards to form a plant wider than tall.

The stems of the Waialua plants are densely armed with spines, each of which arises from a red pustule. Stems of the Kealia plants range from moderately spiny to completely spineless, and the stems of the Makua-Molokai plants are completely spineless. Leaves of all of the types are shaped like a maple leaf, with 5-7 lobes. The leaves of the Waialua and Kealia types measure15-25 cm (5.9-9.8 in) across. Those of the Makua-Molokai type are smaller, measuring 10-15 cm (3.9-5.9 in) across. The flowers of all three types are borne in the leaf axils of the outermost stems, which often project beyond the crown of the plant. All types have five-petaled flowers measuring about 12-14 cm (4.7-5.5 in) in diameter. The flowers of the Waialua and Kealia types are yellow with streaks or splotches of dark red at the center, while the Makua-Molokai type's flowers are yellow with a solid dark red center.

Hibiscus brackenridgei subsp. *mokuleianus*

Wild plants of all types go dormant and lose their leaves at the beginning of the summer dry season, usually by June. They remain dormant and leafless until new growth appears at the onset of the wet season, generally by October.

There are clear differences in growth rates between the types when they are grown in well watered common gardens, with the Waialua plants being the fastest growing and the Kealia plants being the slowest. With all of the types, wild plants are invariably slower growing than plants of the same stock in cultivation (Lau pers. comm. 2000). The age at which cultivated plants flower also varies widely between the types. Waialua plants typically begin flowering when they are only half a year to two years old, while Kealia plants typically do not begin to flower until they are two to four years old. Several cultivated plants of Makua stock were observed to flower before they were six months old (Lau pers. comm. 2000).

The taxon's seed dispersal agents are unknown. The seeds of cultivated individuals have been observed to remain viable in garden soil for at least 15 years, and in the wild, seedlings are often found at locations where no mature plants have been seen in many years (Lau pers. comm. 2000).

Hibiscus brackenridgei subsp. *mokuleianus*

- **Population trends:** In 1950 the target taxon was observed in gulches in the Waialua area as being "a large tree, occurring in pure stands or in association with *Erythrina*" (Hatheway 1952). During a survey of these same gulches in 2000, four mature trees and a few additional immature plants were found at five spots in three adjoining gulches. By 2006, additional surveys in the Waialua populations had found 11 mature plants, nearly 1300 immatures, and 65 seedlings. A massive fire in August 2007 burned an estimated 97% of these plants. Since that time, plants have come back at many sites, and currently have a total of 31 mature plants. Numbers of immature plants and seedlings have fluctuated exponentially since the fire, with nearly 1400 immatures and 13 seedlings in 2009, but only 137 immatures and 3 seedlings in 2010. When the Kealia plants were first found in 1986 there were 24 saplings, all one or two years old. There was no sign of mature plants at the site (Lau pers. comm. 2000), indicating that the colony had disappeared for a while, and had reappeared during a particularly good period for recruitment. Over the last five years, this population unit has remained fairly stable, with numbers fluctuating up and down between 3-8 matures, 1-5 immatures, and 0-9 seedlings. Parts of the Kealia PU have burned in the past, though the area around the extant plants does not appear to have burned in recent years. The Makua population has also oscillated recently, with between 9-18 matures, 2-27 immatures, and 0-68 seedlings. This area has burned many times over in the past, but not since 1995. Due to it's recent discovery, population trends for the Keaau site are unknown, though it is noteworthy that this area has not burned in recent years. The Waialua fire was the most significant impact to this species ever witnessed. Aside from fire damage, it is likely that the size of a population is largely dependent on rainfall, with large numbers being found after a series of wet years, which would allow for the survival and rapid growth of seedlings and saplings. However, long-term population trends may be difficult to discern due to short-term fluctuations in the numbers of plants.

Hibiscus brackenridgei subsp. *mokuleianus*

- **Habitat:** *Hibiscus brackenridgei* in the Waialua area occurs in dry gulches, in gulch bottoms and on lower to middle gulch slopes. The area is dominated by alien grasses, with scattered alien trees forming a very open canopy. In the few areas where native elements persist, these elements include native dry forest tree species such as *wiliwili* (*Erythrina sandwicensis*), *lonomea* (*Sapindus oahuensis*), and/or *lama* (*Diospyros sandwicensis*). The Kealia plants are situated on open ledges and bluffs with a mix of native and alien grasses, shrubs, and trees including *alahe'e* (*Psydrax odorata*) . The Makua plants grow on rocky slopes in an area that is drier and more open than any of the other Oahu sites. This area has burned many times over in the past, but not since 1995. The vegetation there now consists of a mix of native and alien shrubs and grasses, a few trees, *wiliwili* (*Erythrina sandwicensis*), *naio* (*Myoporum sandwicense*). The natural vegetation in this extremely dry area may have been a mix of grass and shrubs with scattered trees or groves of trees forming native shrubland or grassland. In Keaau, plants are located along dry rocky slopes dominated by alien grass (*Panicum maximum*, including both short and tall forms). A portion of the population occurs on stepped rocks with soil pockets. Parts of the surrounding area contain large rock tallus and an open canopy primarily composed of native trees, including wiliwili (*Erythrina sandwicensis*) and alahee (*Psydrax odorata*), aalii (*Dodonaea viscosa*), *naio* (*Myoporum sandwicense*) and iliee (*Plumbago zeylanica*). The understory vegetation at this site contains mostly non-native grasses and shrubs. There are currently cattle grazing in the area on grasses and possibly native shrubs.

Hibiscus brackenridgei subsp. *mokuleianus*

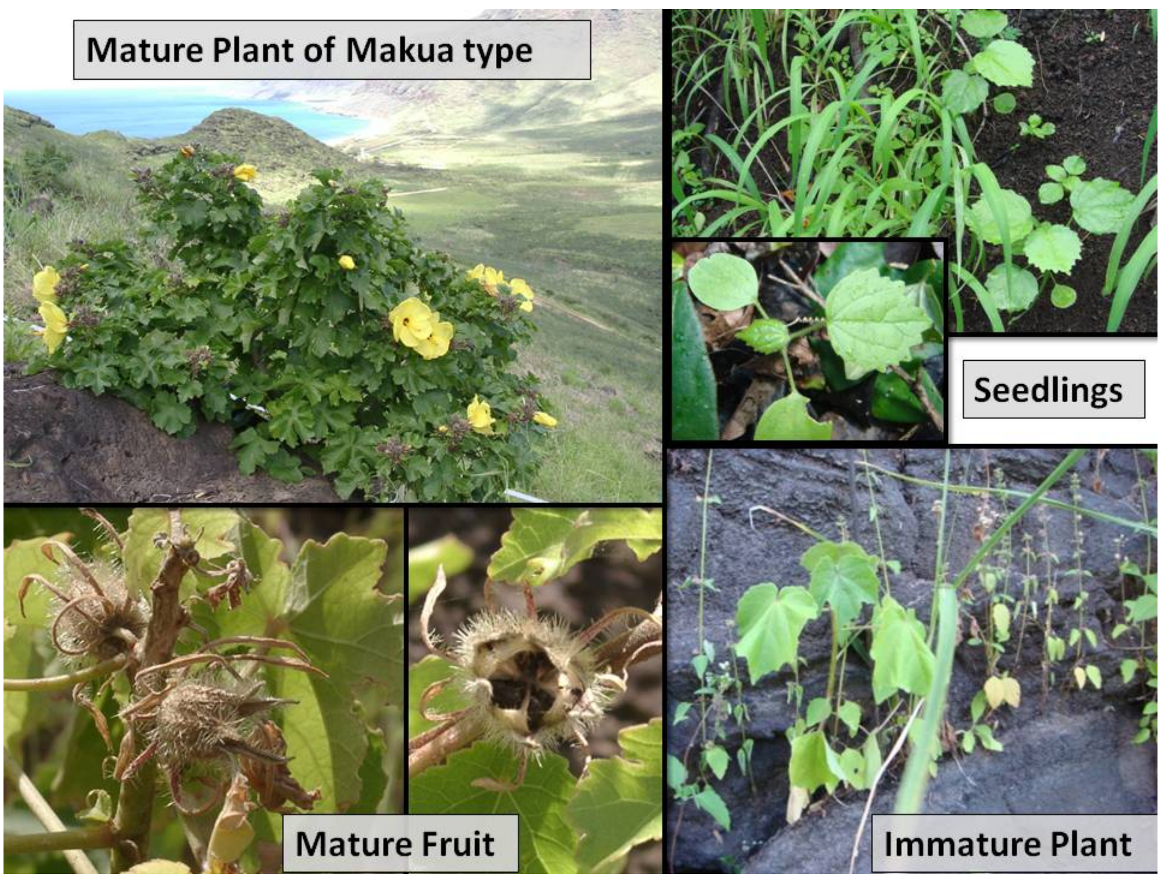
- **Taxonomic background:** *Hibiscus brackenridgei* occurs only in the Hawaiian Islands. The species includes two named subspecies and an unnamed one (Wilson 1993). The plants of Maui, Lanai, and Hawaii are assigned to *H. brackenridgei* subsp. *brackenridgei*. The extinct Kauai population of *H. brackenridgei*, was formerly assigned to *H. brackenridgei* subsp. *mokuleianus* (Bates 1990), has been reassessed as not belonging to any of the three currently named subspecies. It remains to be named (Wilson 1993).
- The Makua plants morphologically match *H. brackenridgei* subsp. *molokaiana*, which had been previously recorded only from West Molokai. For the purposes of the IP, the target taxon consists of the various Oahu and Molokai populations of typical *H. brackenridgei* subsp. *mokuleianus* and typical *H. brackenridgei* subsp. *molokaiana*, in addition to populations falling between these two morphological extremes. The target taxon is called *H. brackenridgei* subsp. *mokuleianus* in this plan, but the name is used in a sense wider than the original sense of the name. The name *H. brackenridgei* subsp. *mokuleianus* in the strict original sense applies only to the tall spiny-stemmed trees of the Waialua type.
- The plants at the Keaau site do not appear to be an exact morphological match to the type of plants at the Makua PU. These two sites are the only ones known from the leeward side of Oahu. The Keaau plants appear to be taller and have longer branches than the Makua plants and may have a slightly different flowering period (J. Lau, pers. comm. 2010). Like the Makua type, the stems do not have spines. These differences will be investigated more as this stock is added to the living collections and compared with other types.

Modified from Makua Implementation Team (MIT). 2003. Final Makua Implementation Plan. Prepared for the U.S. Army Garrison, Schofield Barracks, HI..

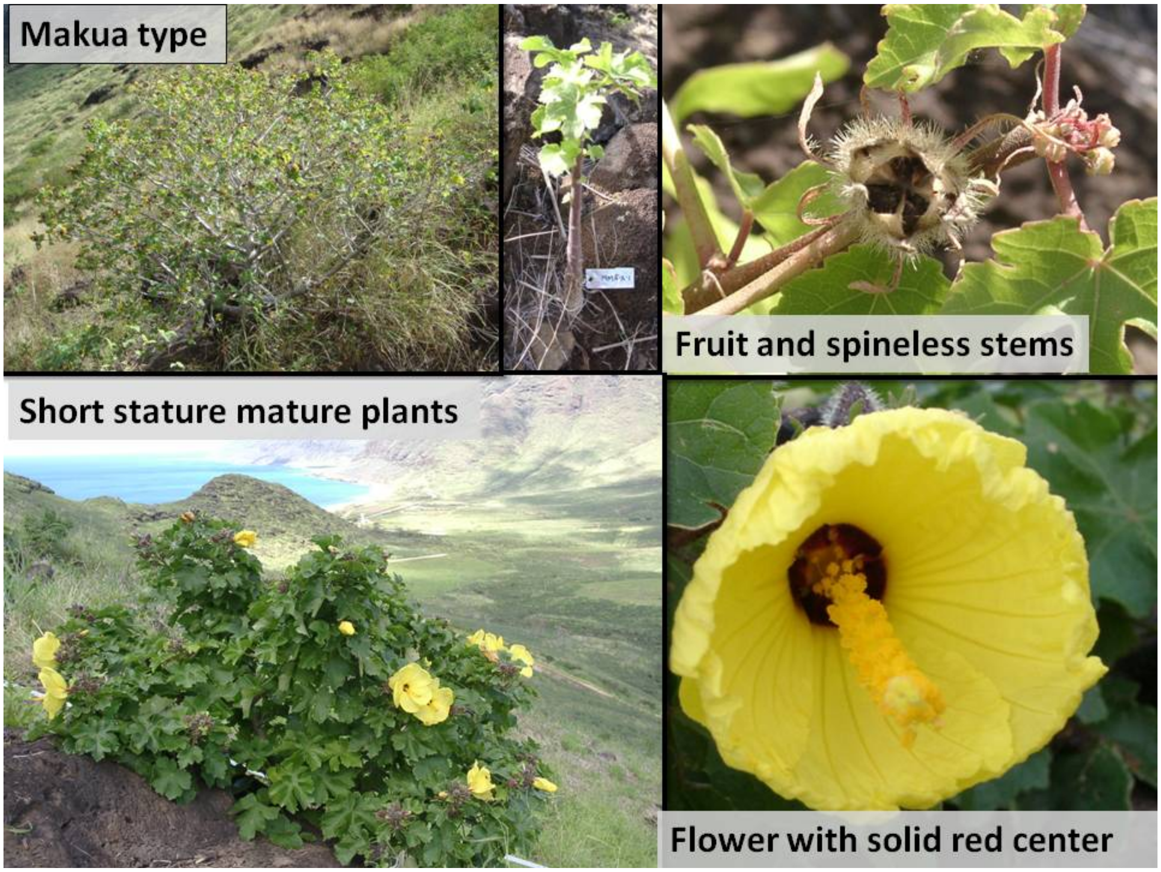
Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
ALL	Jan- May	Feb-Nov	Feb-Nov	Hermaphroditic	Sphingid moths*	14 ± 5	Physical Dormancy (PY)

* The flowers of the Makua plants do not open until 2:00-7:00 pm and remain open until early morning to about noon (Lau pers. comm. 2000). The flowers on the Keaau plants may close earlier in the day than the Makua plants (Lau pers. comm. 2010) as observed during a survey in February 2010. In a common garden, Sphinx moths or hawk moths (family Sphingidae) can be observed visiting the flowers of *H. brackenridgei* at dusk and into the evening (Lau pers. comm. 2000). These moths resemble hummingbirds as they hover in front of the flower while sipping the flowers' nectar with their long tongues. Presumably they pollinate the flowers when brushing up against the flower's anthers and stigmas as they feed. There are several native species of sphinx moths in addition to several introduced ones. In addition to observations of the flowers' being visited by sphinx moths, the light color of the flowers, their being borne conspicuously beyond the leaves of the plant, and particularly their opening in the afternoon, support the supposition that the primary pollinators of the target taxon are these moths. (excerpt from MIP 2003)

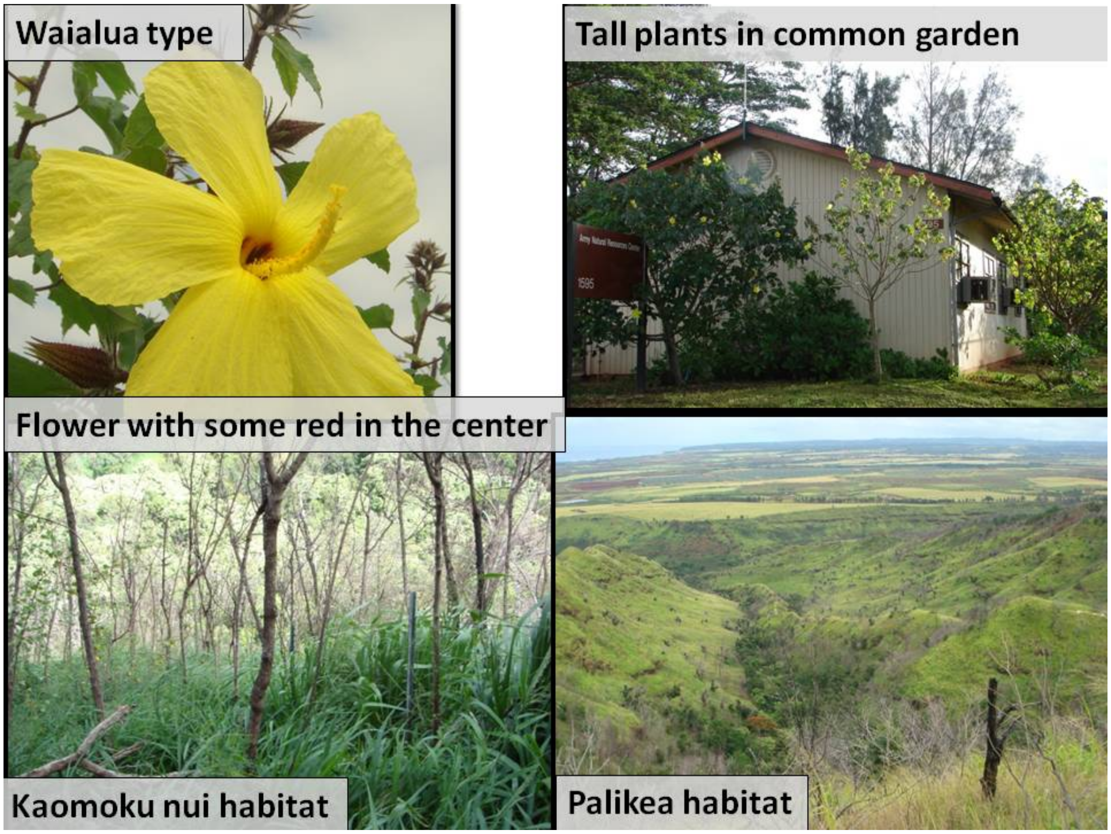


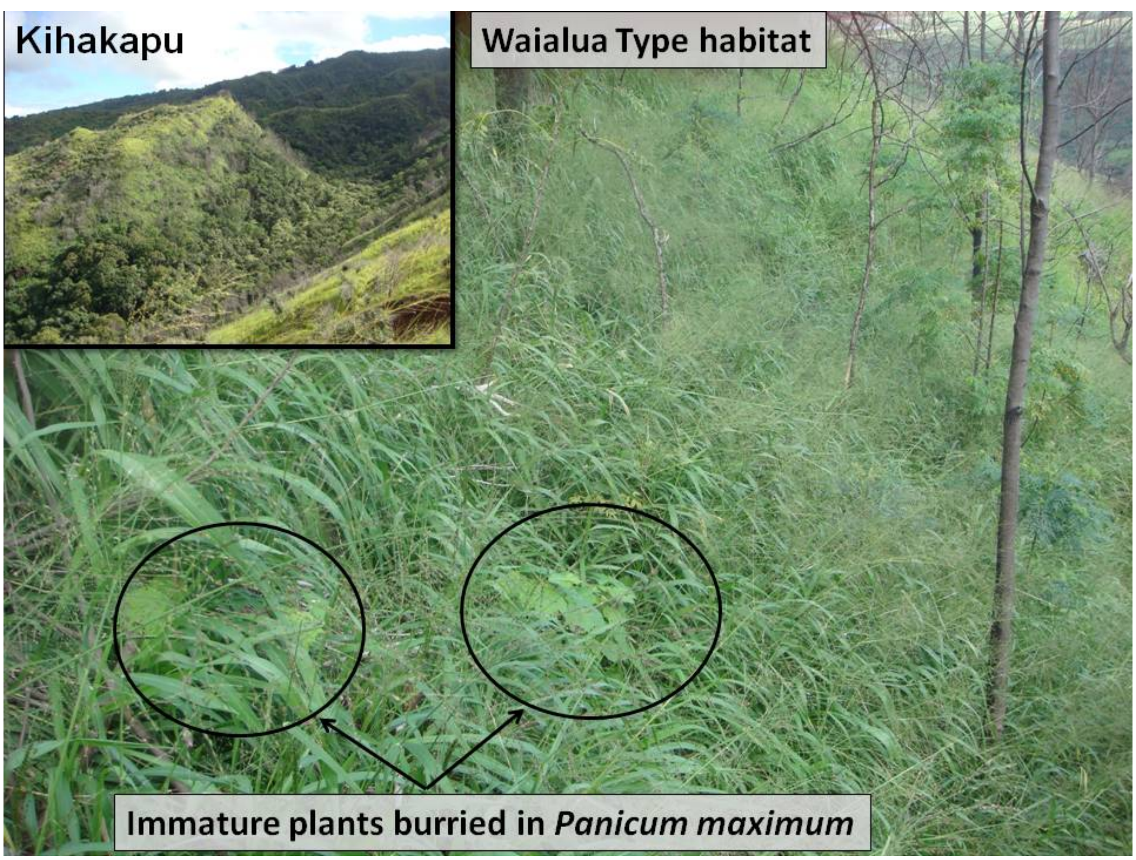
Map removed to protect rare resources



Kealia type

There are currently no good pictures of this type or of the habitat in the wild sites at Kealia and Kawaiu or from the DMR reintroduction. OANRP will work to document this type and habitat in the next year.


Waialua type
Tall plants in common garden
Flower with some red in the center
Kaomoku nui habitat
Palikea habitat


Kihakapu
Waialua Type habitat
Immature plants burried in *Panicum maximum*

Species Occurance

Map removed, available upon request

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Keeau	in situ and Augmentation*	MMR	Keaau
Makua	in situ and Augmentation	MMR	Lower Ohikilolo
Haili to Kawaiu	in situ and Augmentation	None	Haili to Kealia 1 & 2
Kaimuhole and Palikea Gulch	in situ	None	Alaiheihe and Kaimuhole Palikea Gulch Kihakapu and Puulu (all LKN subunits I-IV)
Genetic Storage Population Units			
Kaomoku nui	in situ	None	PU fence
Kihakapu and Puulu	in situ	None	Kihakapu and Puulu

*= outplanting not done yet

Comments: Management for the Kaimuhole and Palikea Gulch, Kaomoku nui and Kihakapu and Puulu PUs is contingent on landowner approval. OANRP is currently able to monitor and collect from these sites under a Right of Entry permit with the landowner (Castle and Cooke) that must be renewed every six months. Any other management is not currently permitted.

Population Structure

- Seedling and immature plants have been observed at all PU and viable seeds are produced at all PUs.

- Immature plants have been observed to become mature and flower at all sites. Survivorship of the smaller size classes is unknown for all PUs. Observations of the Kaomoku nui, Kaimuhole and Palikea Gulch, Kihakapu and Puulu PUs show that mortality of immature plants is especially high where *Panicum maximum* dominates. This is reflected in the large fluctuations in population estimates for these sites. Many seedlings and immature plants are observed in the spring, but only the plants in areas with less *P. maximum* are found to survive through the summer.

- In areas that were burned and open after the Waialua fire of August 2007, hundreds of seedlings and immature plants were observed. Since then, the grass has come back into the sites and smothered most smaller plants. The plants that seem to escape the dominance of the grass are found clinging to rocky areas where the grass cannot become thick. These areas are often lower to mid-slope at the tops of small rocky ledges. From plants in these areas, fruit and seeds are often dispersed onto the base of the cliffs. The shelves at the base of these cliffs are usually dominated by *P. maximum*.

Population Estimate History (mature/immature/seedling)

Population Monitoring History							
	2002	2004	2006	2007	2008	2009	2010
Manage For Stability Population Units							
Keeau *in situ*						5/2/0	3/7/0
Makua *in situ*	11/11/0	18/8/11	16/4/0	10/4/18	11/2/68	11/27/1	9/8/0
Makua augmented					23/0/0	20/0/0	24/24/0
Haili to Kawaiu *in situ*		1/16/2	5/6/0	8/4/9	6/3/9	5/2/0	5/1/0
Haili to Kawaiu outplanted			12/9/0	26/2/0	15/1/0	3/0/0	3/0/0
Kaimuhole and Palikea Gulch		7/218/8	7/230/8	1/8/0	6/1012/0	4/1114/10	17/101/3
Genetic Storage Population Units							
Kaomoku Nui	2/750/0		14/0/0	0/0/0	0/250/300	1/114/0	8/8/0
Kihakapu and Puulu		6/316/57	6/316/57	1/0/0	1/0/0	2/144/3	6/28/0

COMMENTS:

- Numbers of mature plants had minor variations for most populations over the past decade, while immature plants and seedlings varied exponentially at Makua and Waialua populations
- Though individual in situ population numbers are relatively small, they appear relatively stable, despite the notable drop in numbers in Waialua post-fire in 2007

Monitoring Plan

- All PUs will be monitored annually for population structure, trends and all threats.
- All individuals at outplanting sites will be monitored twice annually for reproductive status, vigor and growth.
- New seedlings at all sites will be counted and areas with seedlings will be delineated on sketch maps. Only *in situ* mature and immature plants that have been cloned will be tagged and monitored to track survivorship and growth.
- Seedling survivorship data will be analyzed and methods will be further developed at the Makua site.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Mature Seed, Living Collection	*In situ* + reintroductions	Seed (-18C / 20% RH)	10+ yrs	Yes	Re-collect from *in situ* and reintroductions

Genetic Storage Plan Comments: Due to the threat of fire, clones (cuttings) have been taken to create an *ex situ* living collection of plants from all PUs. Since seed of this species can be stored for at least 10 years with no decrease in viability, we will move from living collections to seed storage for genetic storage goals. Seed will be collected from reintroductions or *in situ* PU. The only difficulty experienced with seed collections are low seed set, possibly due to the introduced insect, *Niesthrea lousianica* Sailer (Rhopalidae). This insect has been observed covering the inside of dehisced fruit, and seeds have been observed empty or rotten, with partial endosperm and often no embryo, and with slits surrounding the hilum of the seed coat. Since these observations, we have discovered that if collections are made early in the fruiting season, seed set is often higher. This method will be applied to future collections. Additional methods may need to be researched and applied to achieve quality collections.

Reintroduction Plan

Manage for Stability Population Units	Reintro-duction Site(s)	Number of Plants to be planted	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population	Plant Size	Pot Size
Keeau	KEA-C *	100	Plants from cuttings	Keaau	6	>20 cm.	1 gal. round or tall
Makua	MMR-F	58	Plants from cuttings	Makua	29	>20 cm.	1 gal. round or tall
Haili to Kawaiu	DMR-A	not active	Plants from cuttings	Haili to Kawaiu	17	>20 cm.	1 gal. round or tall
Haili to Kawaiu	DMR-B*	100	Plants from cuttings	Haili to Kawaiu	17	>20 cm.	1 gal. round or tall
Kaimuhole and Palikea Gulch	TBD	TBD	Plants from cuttings	Kaimuhole and Palikea Gulch, Kihakapu and Puulu, Kaomoku nui	TBD	>20 m.	1 gal. round or tall
No Management Population Units							
Kaluakauila	MMR-C,D,E	not active	Plants from cuttings	Makua	29	>20 cm.	1 gal. round or tall
Makua Range Control	MMR-B	not active	Plants from cuttings	Makua	29	>20 cm.	1 gal. round or tall
Makua Range Control	MMR-G* (*inter-situ* site)	100	Plants from cuttings	Makua	29	>20 cm.	1 gal. round or tall

Comments: *= not started yet

Reintroduction Plan Comments

- All reintroductions will be established using clones of wild plants.
- The 'No Management' sites are used as back-up collections of the cloned stock. The Kaluakauila sites have been recruiting new seedlings and immature plants.
- Reintroduction success may depend on good site selection as *P. maximum* will return to unmanaged sites and kill the outplanted plants.
- Challenges at the reintroduction sites in the Haili to Kawaiu PU and at Kaluakauila, including threats from fire, ungulates, weeds and invertebrates, as well as a general lack of recruitment and poor survivorship, have resulted in the abandonment of the Kaluakauila sites and a need for increased management at Haili to Kawaiu.
- The Kaimuhole and Palikea Gulch PU may require reintroductions once the fence is complete and management begins. If onsite management does not enable this PU to meet stablility targets, reintroductions will be used to increase numbers.
- The reintroduction in the Haili to Kawaiu PU (DMR-A) began in November 2005 but has not been successful so far. The plants are often observed covered in *Sicyos pachycarpa* and *P. maximum* and in poor health. This site will be resurveyed to locate the best planting areas and revisit management strategies for the *P. maximum*.
- The augmentation of the Makua PU (MMR-F) began in February 2008 and will continue until all available founders are represented. This augmentation will be complete by 2012. The planting site is within the wild population (MMR-A) and sites were chosen to fill in gaps where there were no wild plants. These have been successful and seedlings have been observed under the planted individuals.
- The 'No Management' site at Makua (MMR-B) will be replaced with a new inter-situ collection (MMR-G) near the Range Control buildings at MMR. The MMR-B site was not large enough to accommodate all of the founders in good planting sites so the MMR-G site must include larger and be easier to manage.
- Augmentation of the Keaau PU will begin when the fence is complete.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are there enough propagules in Genetic Storage?
Keeau	NO	NO	NO	NO	NO	NO	NO	NO	NO
Makua	NO	NO	YES	YES	NO	YES	NO	NO	NO
Haili to Kawaiu	NO	NO	NO	NO	NO	NO	NO	NO	NO
Kaimuhole and Palikea Gulch	NO	NO	NO	NO	NO	NO	NO	NO	NO
Genetic Storage Population Units									
Kaomoku nui	N/A	N/A	NO	NO	NO	NO	NO	NO	NO
Kihakapu and Puulu	N/A	N/A	NO	NO	NO	NO	NO	NO	NO

5 Year Action Plan

	Proposed Actions for the following years:				
Population Unit	MIP YEAR 7 October 1 2010 – September 31 2011	MIP YEAR 8 October 1 2011 – September 31 2012	MIP YEAR 9 October 1 2012 – September 31 2013	MIP YEAR 10 October 1 2013 – September 31 2014	MIP YEAR 11 October 1 2014 – September 31 2015
Keaau	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect
Makua	•Monitor & Collect •Reintroduce	•Monitor & Collect •Reintroduce	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect
Haili to Kawaiu	•Monitor & Collect •Reintroduce	•Monitor & Collect •Reintroduce	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect
Kaimuhole and Palikea Gulch	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect •Fence?
Kaomoku Nui	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect
Kihakapu and Puulu	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect •Fence?

Further requirements fuels control around MFS PU are listed in the 2007 MMR BO and discussed in the ERMUP for Lower Ohikilolo.

Phyllostegia mollis

- **Scientific name:** *Phyllostegia mollis* Benth.
- **Hawaiian name:** unknown
- **Family:** Lamiaceae (Mint family)
- **Federal status:** Listed endangered on 29 Oct 1991
- **Requirements for OIP Stability**
  - 3 Population Units (PUs)
  - 100 reproducing individuals (short-lived perennial with tendency for large declines or fluctuations in population size)
  - Threats controlled
  - Genetic storage collections from all PUs
  - Tier 1 stabilization priority
  - Stable population structure
- ***Description and biology:** *Phyllostegia mollis* is a suberect perennial herb. Its leaves are ovate to occasionally elliptic-ovate and oppositely arranged. The leaf blades measure 6-24 cm long by 2.5-7.0 cm wide, and are covered by fine pubescence. The flowers are borne in inflorescences 8-17 cm long, which usually consist of a principle axis and two shorter lateral branches immediately below. The corollas are white and 8.5-12.0 mm long. The nutlets are about 2-3 mm long. *Phyllostegia mollis* may also reproduce vegetatively and can form a clonal patch of several plants.
- ***Known distribution:** *Phyllostegia mollis* is endemic to the island of Oahu. It has been recorded from the windward side of the Waianae Mountains and was collected once from Makiki in the Honolulu portion of the Koolau Mountains. Recorded elevations for the species range from 455-855 m.

**excerpts & modifications from:* OANRP Staff. Oct 2008. Final Implementation Plan for O'ahu Training Areas: Schofield barracks Military Reservation, Schofield Barracks East Range, Kawailoa Training Area, Kahuku Training Area and Dillingham Military Reservation.

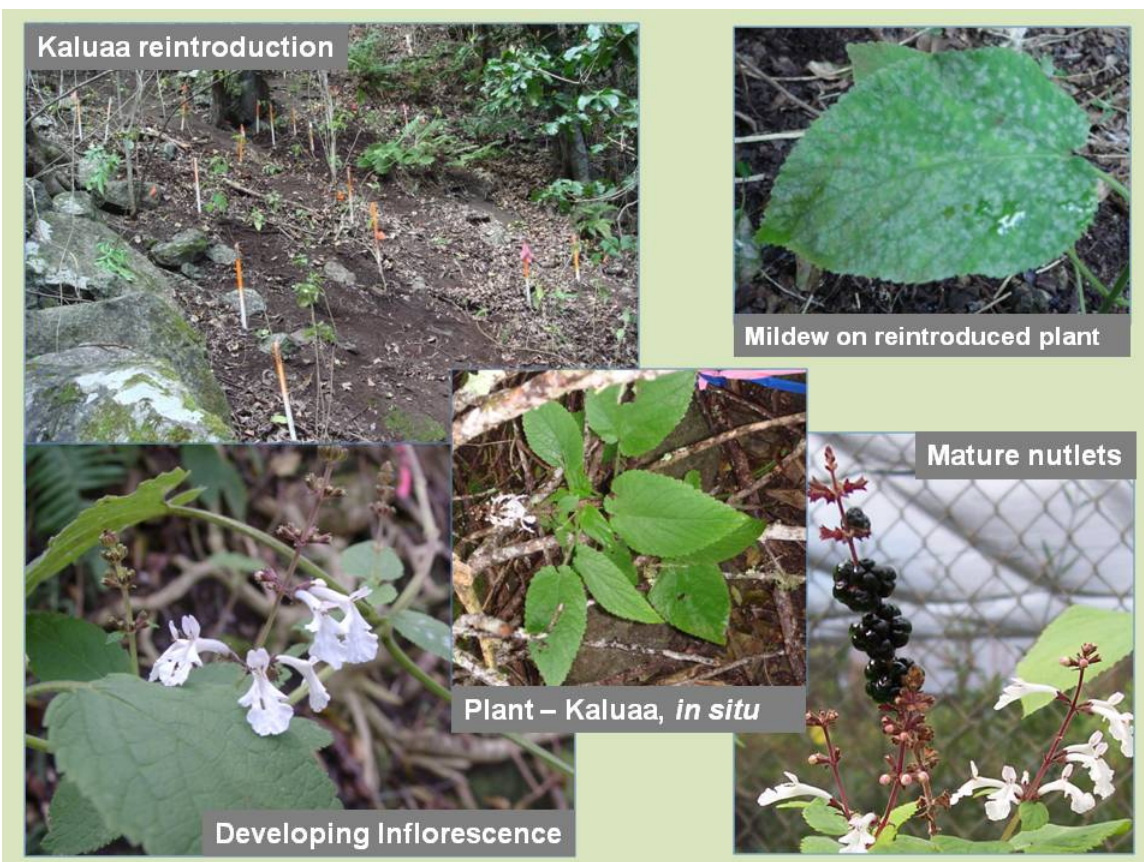
Phyllostegia mollis

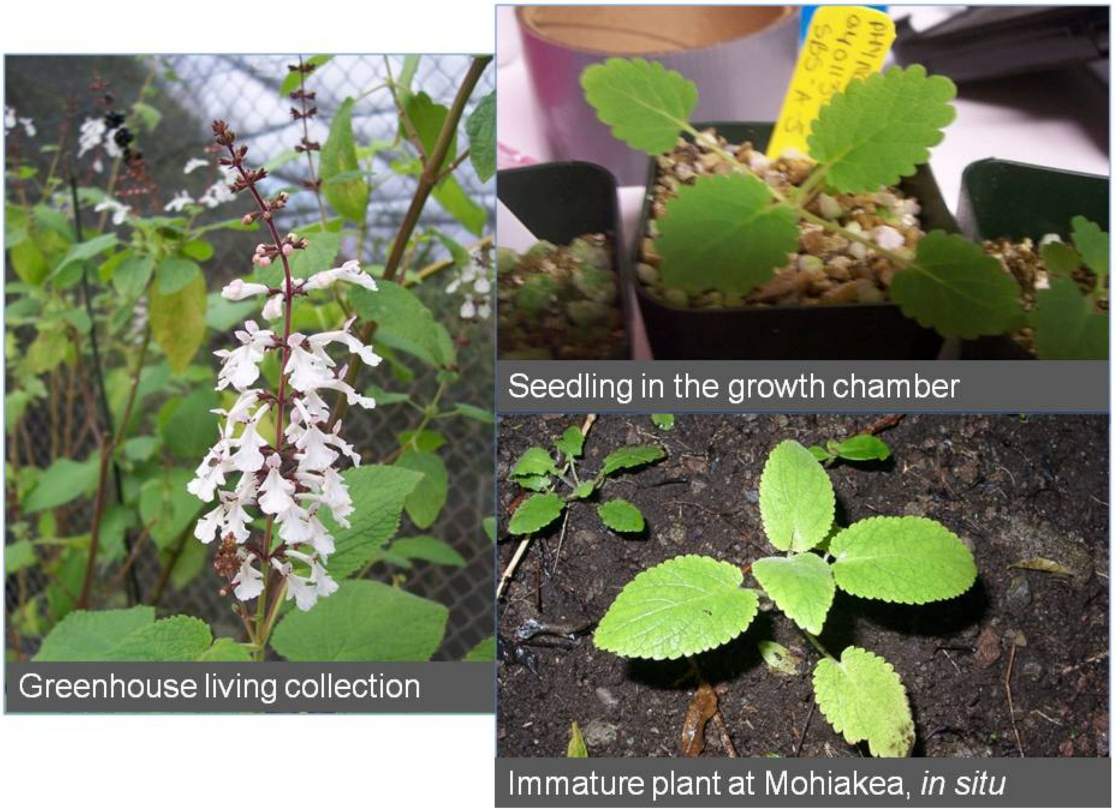
- ***Population trends:** *Phyllostegia mollis* has been declining in range. There are several population units known from previous decades that are now extirpated. Population sizes are also falling. During a botanical survey of the Schofield Barracks Military Reservation (SBMR) in 1994, 19 mature plants were found in South Mohiakea Gulch. This population has declined to one known immature plant in poor health. No *P. mollis* populations are known to be extant in the Koolau Mountains and in the northern Waianae Mountains.
- ***Habitat:** *Phyllostegia mollis* is found in gulch bottoms and on gulch slopes. It usually occurs in mesic forests dominated by a diverse mix of tree species.
- ***Taxonomic background:** There are currently 32 recognized Hawaiian species in the genus *Phyllostegia.* There are also two non-Hawaiian members of the genus, one in Tahiti and the other in Tonga. Certain *Phyllostegia* populations from Molokai and Maui were included within *P. mollis* in the first edition of the Manual of Flowering Plants of Hawaii (Wagner *et al. 1990).* Subsequent study led to a taxonomic rearrangement of *P. mollis*, in which the Molokai and Maui populations were separated from *P. mollis* and recognized as constituting a distinct species endemic to Molokai and Maui, *P. pilosa (*Wagner 1999). The sole founder of the extirpated population in Pualii gulch is a possible hybrid between *P. mollis* and *Phyllostegia parviflora* var. *lydgatei* according to genetic analyses performed by Dr. Cliff Morden (UH Manoa).

Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit	Dormancy
All	Nov to July*	Nov to May	Nov to August	Hermaphroditic	Presumed Insect**	3-4	Non-dormant (ND)

- *Greenhouse plants tend to flower in the spring
- **Lindqvist, C. & V.A. Albert. 2002. Origin of the Hawaiian Endemic Mints within North American *Stachys* (Lamiaceae). American Journal of Botany **89**(10): 1709-1724.
- Birds are assumed to play a role in seed dispersal





Greenhouse living collection

Seedling in the growth chamber

Immature plant at Mohiakea, *in situ*

Species Occurrence

Map removed, available upon request

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Ekahanui	Reintroduction	None	Ekahanui
Kaluaa	in situ and Augmentation	None	Kaluaa & Waieli
Pualii	Reintroduction*	None	North Pualii
Genetic Storage Population Units			
Mohiakea	in situ	OIP (SBW)	Mohiakea
Huliwai	in situ	None	None
Waieli	in situ and Augmentation*	None	Kaluaa & Waieli

Population Structure Comments: Seedlings have been repeatedly observed at the in situ site at the Mohiakea PU. Many of these have survived and become mature plants. Seedlings have also been observed at the reintroduction site in the Kaluaa PU. These incidental observations indicate that recruitment from seed is still possible once reintroductions become established. At this time, it is difficult to determine what a stable structure would be, however many more seedlings and immature plants would be needed to reach stability targets.

* Future Outplanting

Population Estimate History (Mature/Immature/Seedlings)

Population Monitoring History						
Population Unit	2000	2006	2007	2008	2009	2010
Ekahanui (in situ)	2/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
Ekahanui (reintroduction)			19/0/0	35/0/0	9/0/0	4/0/0
Kaluaa (in situ)	no data	no data	0/1/0	1/0/0	1/0/0	1/0/0
Kaluaa (augmentation)		18/10/5	16/38/0	18/10/5	19/9/5	16/7/0
Pualii (in situ)	1/0/0*	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
Mohiakea (in situ)	5/0/0	0/1/2	0/0/0	0/4/0	3/1/1	0/1/0
Huliwai (in situ)	0/3/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0
Waieli (in situ)	2/1/0	1/0/0	0/0/0	0/0/0	0/0/0	0/0/0

* PUA-A – the date that this PU was extirpated is unknown, but it was 2000 or prior.

Monitoring Plan

- All PU will be monitored annually for population structure, trends and threats.
- All individuals at outplanting sites will be monitored twice annually for reproductive status, vigor and growth. In addition, reproductive fecundity will be estimated for matures at outplantings. This is due to the fact that outplanting methodology will focus on seed production as the main indicator of success.
- New seedlings at all sites will be counted and areas with seedlings will be delineated on sketch maps. Seedling counts and survivorship will be monitored. Survivorship may be monitored via photo points. New immature plants at all sites will be tagged and monitored to track survivorship and growth.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Cuttings, Mature Seed	Reintroductions	Seed banking, Micropropagation, Living Collection	TBD (no decline after 2yrs.)	Yes	Collections will be made from reintroductions as needed.

Genetic Storage Plan Comments: Seed storage protocols are still being developed. Complete five-year results, with storage condition recommendations, will be available in 2011. Seeds show no decline in viability after 2 years of cold, dry storage. To allow for as much in situ regeneration as possible, collections for genetic storage are not made from wild plants. Collections from wild plants are grown and outplanted. Seed collections from the outplanted individuals will be stored to represent all available founders. Clones from all founders are held in micropropagation at Lyon Arboretum. These collections will be used to produce more plants for reintroductions and serve as genetic storage until collections for seed storage is completed.

Reintroduction Plan

Population Unit	Reintroduction Site(s)	Number of Plants to be planted	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population.	Plant Size	Pot Size
Ekahanui	EKA-C	0†	Plants from cuttings	EKA-B-1 HUL-A-1	1 1	>20cm., multi-branched	6" bulb pot
Ekahanui	EKA-D* (site TBD)	150	Plants from cuttings	EKA-B-1 HUL-A-1	1 1	>20cm., multi-branched	6" bulb pot
Kaluaa€	KAL-C Gulch 3	150	Plants from cuttings	SBS-A SBW-A	11	>20cm., multi-branched	6" bulb pot
Kaluaa€	KAL-E* (site TBD)	150	Plants from cuttings	KAL-D	1	>20cm., multi-branched	6" bulb pot
Pualii	PUA-B*	150	Plants from cuttings	PUA-A	1	>20cm., multi-branched	6" bulb pot

* Reintroduction not started yet

† This is an existing reintroduction with only 4 remaining plants. We will not plant more plants here. We will pursue another location in Ekahanui. If there is not a more appropriate habitat for *P. mollis* in Ekahanui, we may return to this site.

€ We will pursue planting in Ekahanui and Pualii first. We will hold off on planting back into KAL-C or KAL-E until we test sites in the other PUs and refine reintroduction process.

Reintroduction Plan Comments

- Plants will be grown from clones from the original *in situ* founders.
- Containers will be 6" pots or 6" bulb pans to promote rhizome growth and produce a plant with as many stems as possible.
- Plants will be treated regularly with fungicides to prevent mildew prior to planting.
- Reintroduction sites will be chosen to mimic the last remaining *in situ* sites. These areas are steep talus slopes just below cliffs/crest. If possible presence of ground water near the surface (seeps) will be utilized to select sites. We will initially plant a small number of plants at potential sites and use the first year's survivorship to indicate preferred locations for larger outplantings.
- Plants at the reintroductions at Kaluaa and Ekahanui have survived for several years but overall the performance of these sites has been moderate. We haven't planted many plants, but mortality rates are high. Seedlings have been observed under outplantings at Kaluaa in the past. Due to an observed short life span and recruitment from seed, the goal of future outplantings is to increase seed production to create a substantial soil seedbank. This goal will be accomplished by increasing the number of individuals planted at a time (after preferred locations have been determined), and by planting plants as close together as possible.
- It has yet to be determined if single-founder or multiple-founder outplantings will produce higher seed set. Fecundity will be monitored at all sites. Founder representation and locations may be changed to incorporate results.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slugs	BTB	Are there enough propagules in Genetic Storage?
Ekahanui	NO	NO	PARTIAL	PARTIAL	PARTIAL	NO	NO	N/A	YES
Kaluaa	NO	NO	YES	YES	NO	NO	NO	N/A	YES
Pualii	NO	NO	YES	PARTIAL	NO	NO	NO	N/A	YES
Genetic Storage PU									
Mohiakea	NO	NO	YES	NO	NO	NO	NO	N/A	YES
Huliwai	NO	NO	NO	NO	NO	NO	NO	N/A	YES
Waieli	NO	NO	PARTIAL	NO	NO	NO	NO	N/A	YES

5 Year Action Plan

	Proposed Actions for the following years:				
Manage for Stability Population Units	OIP YEAR 3 Oct.2010-Sept. 2011	OIP YEAR 4 Oct.2011-Sept. 2012	OIP YEAR 5 Oct.2012-Sept. 2013	OIP YEAR 6 Oct.2013-Sept. 2014	OIP YEAR 7 Oct.2014-Sept. 2015
Ekahanui	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor	•Monitor
Kaluaa	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect •Reintroduce	•Monitor & Collect •Reintroduce	•Monitor & Collect •Reintroduce
Pualii	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor •Reintroduce	•Monitor	•Monitor
Genetic Storage Population Units					
Mohiakea	•Monitor & Collect	•Monitor & Collect •Begin Lihue MU fence construction	•Monitor & Collect •Complete Lihue MU fence •Ungulate Removal	•Monitor & Collect •Ungulate Removal	•Monitor & Collect •Reintroduce •Ungulate Removal
Huliwai	•Monitor	•Monitor	•Monitor	•Monitor	•Monitor
Waieli	•Monitor & Collect •Removal of ungulates from fence	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect	•Monitor & Collect

CHAPTER 3: MIP/OIP RARE PLANT STABILIZATION PLANS

3.1 INTRODUCTION

RARE PLANT STABILIZATION STATUS UPDATES

This section has an update for each of the 51 MIP/OIP plant taxa. Each begins with a review of the requirements for stabilization and is followed by a brief discussion of highlights from rare plant stabilization work conducted in last year and a list of priority actions scheduled for the next year. All management actions for threat control are discussed in detail the Ecosystem Management section. There are three tables in each update: Taxon Status Summary, Threat Control Summary and the Genetic Storage Summary. The format for each update and definitions for terms used in each table are discussed in detail in this example below:

Example Species Status Update

Requirements for Stability

•**Population Units (PUs):** Three PUs are designated for most species. However, 4 PUs have been designated for taxa meeting the following criteria:
- in both Makua Action Area (AA) and Oahu AA (Ex: *Plantago princeps*)
- PUs in high fire threat area (Ex: *Chamaesyce celastroides*)
- no extant wild plants; all PUs are dependent on reintroductions (Ex: *Cyanea superba*)

Two taxa have one PU (*Myrsine juddii* and *Schiedea trinervis*) and *Labordia cyrtandrae* has two PUs. These taxa have large and nearly continuous distributions and will be managed for stability across all known sites.

• **[25-100] reproducing individuals in each PU**: This varies for each taxa and is based on the number of extant individuals, average life span, life form, breeding system, history of large fluctuations in population size and other factors listed the final MIP and OIP.

• **Stable Population Structure:** This is not clearly defined for any species. OANRP will continue to develop definitions based on observations and survivorship studies of in situ sites. OANRP believe that most MIP/OIP taxa do not have a population structure that can maintain stability goals, but this has not been studied.

• **Threats controlled:** Threat control includes fences, weed control, arthropod and rodent control and fire prevention. All known threats to MFS PUs must be controlled.

• G**enetic storage of all PUs:** Genetic storage from 50 founders from each PU. If there are less than 50 plants in a PU, storage goals are considered to be met when all available founders are represented in storage. Storage goals may be met by maintaining plants from each founder in a nursery living collection, in micropropagation storage at Harold L. Lyon Arboretum, or by keeping an adequate number of seeds in proven storage conditions at the OANRP Seed Lab or at the National Center for Genetic Resources Preservation (NCGRP)**.**

Major Highlights/Issues for MIP Year 6/OIP Year 3

Notable projects from the 1 September 2009 to 31 August 2010 (MIP Year 6 and OIP Year 3) reporting year are discussed here for each taxon. Background information for this discussion can be found in reports from prior years and other OIP and MIP documents and only new information is presented here.

For each taxon, the number of hours spent in the field last year on monitoring, hand-pollinating, collecting for genetic storage and on reintroduction is presented. These hours include transport time, safety briefing, hiking time to and from work site, gear preparation time and reintroduction site preparation. Often, more than one species can be visited and monitored in a day and so each individual action takes less total time since transport and prep time are split between multiple species. However, for species where transport and prep time are a large part of the effort, this will be reflected in the number of staff hours spent.

Staff time spent on threat control (fencing, weeding, rat control, slug and arthropod control) is not included. Details on those actions are discussed in the Ecosystem Restoration Management Unit Plan for each Management Unit (MU). The number of hours spent for each taxon changes every year as new plants are found, new reintroductions are established and collection goals are met. The data presented this year reflect rare plant priorities for the last reporting year and these may change in the coming year. The five taxa that received the most staff attention in the last year are (in descending order): *Cyanea superba* subsp. *superba*, *Schiedea obovata*, *Schiedea kaalae, Labordia cyrtandrae* and *Hesperomannia arbuscula*. Seven taxa received 0-1 hours in the last year: *Schiedea trinervis*, *Viola oahuensis*, *Dubautia herbstobatae*, *Huperzia nutans*, *Melicope lydgatei* and *Myrsine juddii*. These species have no reintroductions, several stable PUs and less potential impact from Army training, so have been a lower priority.

The other actions discussed in this section include identifying the PUs that were visited, comments on population trends, updates on progress on threat control actions (fences, etc.), notes on the status of the genetic storage collections and a discussion of ongoing research.

Plans for MIP Year 7/OIP Year 4

This section includes actions to be scheduled for the next year. Most actions listed in here should be started in the next year, although some lower priority projects are included that may only be accomplished as staff time allows. The actions included here are plans for surveying, monitoring, collecting for genetic storage, planting reintroductions and ongoing threat control projects.

Taxon Status Summary

Action Area: In

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluakauila	Manage reintroduction for stability	0	0	0	125	3	0	113	24	1	125	3	0	More plants were added to the reintroduction sites
Kapuna	Genetic Storage	0	0	0	0	0	0	2	0	0	0	0	0	The remaining wild plants died in the last year
Makua	Manage for stability	10	38	5	38	0	0	28	83	3	48	38	5	More plants were added to the reintroduction sites many outplants matured and the wild site declined
Punapohaku	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change
	Total for Taxon:	11	38	5	163	3	0	144	107	4	174	41	5	

Action Area: Out

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Genetic Storage	30	4	0	0	0	0	30	4	0	30	4	0	*No monitoring in the last year*
Leeward Puu Kaua	Genetic Storage	9	0	0	0	0	0	9	0	0	9	0	0	No monitoring in the last year
Makaha	Genetic Storage	12	0	0	0	0	0	10	0	0	12	0	0	New plants were discovered during surveys
Manuwai	Manage for stability	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring showed no change
Waianae Kai Makai	Genetic Storage	45	35	25	0	0	0	46	35	25	45	35	25	Monitoring showed no change
Waianae Kai Mauka	Manage for stability	16	4	0	0	0	0	43	25	4	16	4	0	Monitoring of this wild site showed a significant decline from the estimate made in 2005
	Total for Taxon:	112	43	25	0	0	0	138	64	29	112	43	25	

The Taxon Status Summary, shown above, displays the current status of the wild and outplanted plants for each PU next to the totals from the previous year for comparison. The PUs are grouped into those with plants that are located inside the MIP or OIP AA (In) and PUs where all plants are outside of both AAs (Out).

Population Unit Name: Some changes to the PU names were made in the last year and these are noted in the updates for each taxon. Only PUs designated to be ‘Manage for Stability’ (MFS), ‘Manage Reintroduction for Stability/Storage,’ or ‘Genetic Storage’ (GS) are shown in the table. Other PUs with ‘No Management’ designations are not managed and will not be reported.

Management Designation: For PUs with naturally occurring (*in situ*) plants remaining, the designation is either ‘Manage for Stability’ or ‘Genetic Storage’. Some MFS PUs will be augmented with outplantings to reach stability goals. When reintroductions alone will be used to reach stability, the designation is ‘Manage Reintroduction for Stability.’ When a reintroduction will be used for producing propagules for genetic storage, the designation is ‘Manage Reintroduction for Storage’. Changes were made to these designations for some taxa in the last year and these are explained in the update discussion.

Current Mature, Immature, Seedling (Wild): These first three columns display the most up to date population estimates of the wild (in situ) plants in each PU. These numbers are generated from OANRP monitoring data, data from the Oahu Plant Extinction Prevention Program (OPEP) and Oahu NARS staff. The estimates may have changed from last year if estimates were revised after new monitoring data was taken or if the PUs have been split or merged since the last reporting period. The most recent estimate is used for all PUs, but some have not been monitored in several years. Several PU have not been visited yet by OANRP and no plants are listed in the population estimates. As these sites are monitored, estimates will be revised.

Current Mature, Immature, Seedling Augmented: The second set of three columns display the numbers of individuals OANRP and partner agencies have outplanted into each PU. This includes augmentations of in situ sites, reintroductions into nearby sites and introductions into new areas.

NRS Mature, Immature and Seedling 2009: This displays the **SUM** of the number of *wild and outplanted* mature, immature plants and seedlings from the previous year’s report. These numbers should be compared to those in the next three columns to see the change observed over the last year.

Total Mature, Immature, Seedling: The **SUM** of the *current* numbers of *wild and outplanted* individuals in each PU. This number will be used to determine if each PU has reached stability goals. These last three columns can be compared with the NRS 2009 estimates to see the change observed over the last year.

Population Trend Notes: Comments on the general population trend of each PU is given here. This may include notes on whether the PU was monitored in the last year, a brief discussion of the changes in population numbers from the previous estimates, and some explanation of whether the change is due to new plants being discovered in the same site, a new site being found, reintroductions or augmentations that increased the numbers or fluctuations in the numbers of wild plants. In some cases where the numbers have not changed, NRS has monitored the PU and observed no change. When the PU has not been monitored, the same estimate from the previous year is repeated.

Threat Control Summary

Action Area: In

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaluakauila	Manage reintroduction for stability	Yes	Yes	Yes	No	No	No
Kapuna	Genetic Storage	No	No	No	No	No	No
Makua	Manage for stability	Yes	Partial	No	No	No	No
Punapohaku	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Halona	Genetic Storage	No	No	No	No	No	No
Leeward Puu Kaua	Genetic Storage	No	No	No	No	No	No
Makaha	Genetic Storage	No	No	No	No	No	No
Manuwai	Manage for stability	No	No	No	No	No	No
Waianae Kai Makai	Genetic Storage	Yes	No	No	No	No	Partial
Waianae Kai Mauka	Manage for stability	No	Partial	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Management Designation: Designations for PUs with ongoing management are listed. Population Units that are MFS are the first priority for complete threat control. PUs that are managed in order to secure genetic storage collections receive the management needed for collection (ungulate and rodent control) as a priority but may be a lower priority for other threat control.

Threat Columns: The six most common threats are listed in the next columns. To indicate if the threat is noted at each PU, a shaded box is used. If the threat is not present at that PU, it is not shaded. OANRP will develop this threat table in the next year to account for other potential threats such as arthropods other than the BTB, the fungal rust (*Puccinia psidii*) and other plant pathogens as they are identified and the threat evaluated. Threat control is defined as: Yes = All sites within the PU have the threat controlled; No = All sites within the PU have no threat control; Partial = At least one site within the PU has threat control.

Ungulates: This threat is indicated if pigs, goats or cattle have been observed at any sites within the PU. This threat is controlled (Yes) if a fence has been completed and all ungulates removed from the site. 'Partial' is used when at least one of the sites within the PU is fenced. Most PUs are threatened by pigs, but others are threatened by goats and cattle as well. The same type of fence is used to control for all three types of ungulates on Oahu.

Weeds: This threat is indicated at all PUs for all IP taxa. This threat is controlled if weed control has been conducted in the vicinity of the sites for each PU. If only some of the sites have had weed control, 'Partial' is used.

Rats: This threat is indicated for any PUs where damage from rodents has been confirmed by OANRP staff. This includes fruit predation and damage to stems or any part of the plant. The threat is controlled if the PU is protected by snap traps and bait stations. For some taxa, rats are not known to be a threat, but the sites are within rat control areas for other taxa so the threat is considered controlled. In these cases, the box is not shaded but control is 'Yes' or 'Partial.'

BTB: BTB stands for the Coffee Black Twig Borer (*Xylosandrus compactus*). This threat is indicated for any PUs where damage from BTB has been confirmed by OANRP staff. This is known to be a threat for all *Alectryon macrococcus* var. *macrococcus* and *Flueggea neowawraea*. Other MIP/OIP taxa may be affected and will be monitored for damage. Effective control methods do not exist at this time.

Slugs: This threat is indicated for several IP taxa as confirmed by OANRP staff. Currently, slug control is conducted under an Experimental Use Permit from Hawaii State Department of Agriculture, which permits the use of Sluggo® around the recruiting seedlings of *Cyanea superba* subsp. *superba* in Kahanahaiki Gulch on Makua Military Reservation. Until the label is changed to allow for application in a forest setting, all applications must be conducted under this permit.

Fire: This threat is indicated for PUs that occur on Army lands within the high fire threat area of the Makua AA, and some PUs within the Schofield West Range AA and Kahuku Training Area that have been threatened by fire within the last ten years. Similarly, PUs that are not on Army land were included if there is a history of fires in that area. This includes the PUs below the Honouliuli Contour Trail, the gulches above Waialua where the 2007 fire burned including Puulu, Kihakapu, Palikea, Kaimuhole, Alaiheihe, Manuwai, Kaomoku iki, Kaomoku nui and Kaawa and PUs in the Puu Palikea area that were threatened by the Nanakuli fire. Threat control conducted by OANRP includes removing fuel from the area with pesticides, marking the site with Seibert Stakes for water drops, and installing fuel-breaks in fallow agricultural areas along roads.

Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Neraudia angulata							
Halona	30	4	0	0	0	11	8
Kapuna	0	0	2	1	0	2	2
Leeward Puu Kaua	9	0	0	0	0	1	1
Makaha	12	0	11	2	0	10	8
Makua	10	38	62	2	0	29	13
Manuwai	0	0	7	0	0	2	2
Punapohaku	1	0	0	0	0	1	1
Waianae Kai Makai	45	35	0	0	0	0	0
Waianae Kai Mauka	16	4	1	0	0	7	4

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
5	0	63	39

Number (#) of Potential Founders: These first columns list the current number of live *in situ* immature and mature plants in each PU. These plants have been collected from already, or may be collected from in the future. The number of dead plants from which collections were made in the past is also included to show the total number of plants that could potentially be represented in genetic storage for each PU since collections began. Immature plants are included as founders for all taxa, but they can only serve as founders for some. For example, for *Hibiscus brackenridgei* subsp. *mokuleianus*, cuttings can be taken from immature plants for propagation. In comparison, for *Sanicula mariversa,* cuttings cannot be taken and seed is the only propagule used in collecting for genetic storage. Therefore, including immature plants in the number of potential founders for *S. mariversa* gives an over-estimate. The ‘Manage reintroduction for stability/storage’ PUs have no potential founders. The genetic storage status of the founder stock used for these reintroductions is listed under the source PU.

Partial Storage Status: To meet the IP genetic storage goal for each PU for taxa with seed storage as the preferred genetic storage method, at least 50 seeds must be stored from 50 plants. Next year, the number of seeds needed for each plant (50) will be changed to account for original viability of seed collections. In order to show intermediate progress, this column displays the number individual plants that have collections of >10 seeds in storage. For taxa where vegetative collections will be used to meet storage goals, a minimum of three clones per plant in either the Lyon Micropropagation Lab, the Army nurseries or the State’s Pahole Mid-elevation Nursery is required to meet stability goals. Plants with one or more representatives in either the Lyon Micropropagation Lab or a nursery are considered to partially meet storage goals. The number of plants that have met this goal at each location is displayed.

Storage Goals Met: This column displays the total number of plants in each PU that have met the IP genetic storage goals. As discussed above, a plant is considered to meet the storage goal if it has 50 seeds in storage or three clones in micropropagation or three in a nursery. For some PUs, the number of founders has increased in the last year, therefore, it is feasible that NRS could be farther from reaching collection goals than last year. Also, as seeds age in storage, plants are outplanted, or explants contaminated, this number will drop. In other PUs where collections have been happening for many years, the number of founders represented in genetic storage may exceed the number of plants currently extant in each PU. In some cases, plants that are being grown for reintroductions are also being counted for genetic storage. These plants will eventually leave the greenhouse and the genetic storage goals will be met by retaining clones of all available founders or by securing seeds in storage. This column does not show the total number of seeds in storage; in some cases thousands of seeds have been collected from one plant.

3.2 ABUTILON SANDWICENSE

Requirements for Stability

- 4 Population Units (PUs) (4 due to presence in both Makua and Oahu AA)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Makaha Makai PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage collections of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 289 hours on management for this species in the last year.
- Fence construction continued for the Manuwai MU. This will protect a portion of the Kaawa to Puulu PU.
- Fence construction was completed for the Ekahanui Subunit III MU. No ungulates were found inside the fence after completion and this fence now protects the Ekahanui portion of the Ekahanui and Huliwai PU.
- Cultural surveys for the fence for the Makaha Makai PU were completed and several new plants were found.
- Genetic storage collections continued at the Makaha Makai and the Ekahanui and Huliwai PUs.
- Additional plants were added to the reintroduction in the Kaluakauila PU but more plants were observed to have died there and the outplanting continues to decline. Despite being grown from clones of a mature plant that has flowered in the nursery, no plants have been observed to have flowered in the outplanting site yet.
- A small outplanting using stock from the Ekahanui and Huliwai PU that was grown by TNC was completed in the Ekahanui Subunit I fence. This is an augmentation of the PU.
- Surveys and monitoring of known sites in the Kaawa to Puulu PU were conducted. Population estimates were revised to include several new plants, bringing it close to the goal of 50 reproducing plants.
- Seeds of this species were classified as having physical dormancy (ES-3).

Plans for OIP Year 4

- Conduct census monitoring of all Manage for Stability PUs.
- Collect seed for genetic storage at the Makaha Makai and the Ekahanui and Huliwai PUs.
- Continue to monitor sites in the Kaawa to Puulu PU to revise estimates and determine if the stability goal of 50 reproducing plants is met and how many will be protected by the Manuwai MU fence.
- Continue construction of the Manuwai MU fence.
- Conduct surveys in Kahanahaiki and Makua to find more stock to supplement the reintroduction of the single clone at the Kaluakauila PU.
- Develop a strategy to improve survivorship in the Kaluakauila PU or select another site to manage the Kahanahaiki stock.
- Work with the Navy program to begin to prioritize and survey PUs with historic records, but no known plants (Halona, South Mikilua, Nanakuli).
- Secure agreements with the Board of Water Supply to construct a fence to protect the Makaha Makai PU.

Table 3.1a Taxon Status Summary

Action Area: In

TaxonName: Abutilon sandwicense **TaxonCode: AbuSan**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaawa to Puulu	Manage for stability	47	72	2	0	0	0	31	77	5	47	72	2	A thorough census of the known area found more plants
Kahanahaiki	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kaluakauila	Manage reintroduction for stability	0	0	0	0	13	0	0	19	0	0	13	0	The reintroduction continued to decline
Keaau	Genetic Storage	1	0	10	0	0	0	1	0	10	1	0	10	No monitoring in the last year
Makaha Makai	Manage for stability	73	27	6	0	0	0	73	27	6	73	27	6	A few more plants were found in the past year but were not added to the estmate yet. A thorough monitoring in the next year will revise the estimate to include the new site.
Makaha Mauka	Genetic Storage	5	58	4	0	0	0	5	58	4	5	58	4	Monitoring showed no change
	Total for Taxon:	126	157	22	0	13	0	110	181	25	126	170	22	

Action Area: Out

TaxonName: Abutilon sandwicense **TaxonCode: AbuSan**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Makaleha	Genetic Storage	2	2	40	0	0	0	2	2	40	2	2	40	No monitoring in the last year
Ekahanui and Huliwai	Manage for stability	14	17	11	0	10	0	16	28	0	14	27	11	Small changes were noted during monitoring in the last year including several new seedlings
Halona	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Nanakuli	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
North Mikilua	Genetic Storage	2	39	0	0	0	0	2	39	0	2	39	0	No monitoring in the last year
South Mikilua	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Waianae Kai	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year
West Makaleha	Genetic Storage	0	2	0	0	0	0	0	2	0	0	2	0	No monitoring in the last year
	Total for Taxon:	20	60	51	0	10	0	22	71	40	20	70	51	

Table 3.1b Threat Control Summary

Action Area: In

TaxonName: Abutilon sandwicense

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaawa to Puulu	Manage for stability	No	No	No	No	No	Partial
Kahanahaiki	Genetic Storage	No	No	No	No	No	No
Kaluakauila	Manage reintroduction for stability	Yes	Yes	Yes	No	No	No
Keaau	Genetic Storage	No	No	No	No	No	No
Makaha Makai	Manage for stability	No	Partial	No	No	No	No
Makaha Mauka	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Abutilon sandwicense

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
East Makaleha	Genetic Storage	No	No	No	No	No	No
Ekahanui and Huliwai	Manage for stability	Partial	Partial	No	No	No	Partial
North Mikilua	Genetic Storage	Yes	No	No	No	No	No
Waianae Kai	Genetic Storage	Partial	No	No	No	No	Partial
West Makaleha	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.1c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Abutilon sandwicense							
East Makaleha	2	2	0	0	0	0	0
Ekahanui and Huliwai	14	17	3	14	0	0	10
Kaawa to Puulu	47	72	0	0	0	0	0
Kahanahaiki	0	0	1	0	0	1	0
Keaau	1	0	0	0	0	0	0
Makaha Makai	73	27	1	20	0	1	15
Makaha Mauka	5	58	0	4	0	0	3
North Mikilua	2	39	0	0	0	0	0
Waianae Kai	2	0	0	1	0	0	1
West Makaleha	0	2	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
39	0	2	29

3.3 ALECTRYON MACROCOCCUS VAR. MACROCOCCUS

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial with reproductive problems)
  - *This goal is met for the Makaha PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues for MIP Year 6

- Staff spent 158 hours on management for this species in the last year. This time was spent revising counts and establishing air-layers from trees in the Makaha and South Mohiakea Pus, monitoring trees in the Waianae Kai PU, Makua PU and the Kahanahaiki to West Makaleha PU and tending to the living collection at Waimea Botanical Garden.
- Construction of the Kaluaa and Waieli MU Sub-Unit IIB fence is complete. This fence secures reintroduction habitat for the Central Kaluaa to Central Waieli PU and protects the remaining trees.
- A total of four air-layers were collected from four trees in Makaha and South Mohiakea in the last year. One had no roots when collected and is dead, two have established in the greenhouse and the remaining one failed on the mist bench.
- Fruit was collected from a few trees in the Makaha and Makua PUs and several seedlings are being propagated from both.
- One dead tree was observed in each of these PUs in the last year: Waianae Kai, Mohiakea and Makua.
- A single live immature tree was observed in Pahole in the last year. No other live immature trees are known from the Kahanahaiki to West Makaleha PU.

Plans for MIP Year 7

- Monitor the sites that have not been recently observed in the Kahanahaiki to West Makaleha, Waianae Kai and Makaha PUs.
- Continue to install air-layers on healthy trees in the Makua and Makaha PUs.
- Maintain and expand the greenhouse living collection for genetic storage. These collections will be used to produce additional material for air-layering and grafting.
- Search for trees in all PUs that have fruit and continue to collect mature fruit for propagation and send to the National Center for Genetic Resources Preservation (Fort Collins, CO) for storage viability testing in liquid nitrogen.

Table 3.2a Taxon Status Summary

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus TaxonCode: AleMacMac

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to West Makaleha	Manage for stability	35	5	0	0	2	0	36	6	0	**35**	**7**	**0**	Small changes were noted during monitoring in the last year
Makua	Manage for stability	20	0	0	0	0	0	22	0	0	**20**	**0**	**0**	Small changes were noted during monitoring in the last year
South Mohiakea	Genetic Storage	3	0	0	0	0	0	4	0	0	**3**	**0**	**0**	Small changes were noted during monitoring in the last year
	Total for Taxon:	58	5	0	0	2	0	62	6	0	**58**	**7**	**0**	

Action Area: Out

TaxonName: Alectryon macrococcus var. macrococcus TaxonCode: AleMacMac

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa to Central Waieli	Manage for stability	17	1	0	0	5	0	17	6	0	**17**	**6**	**0**	One plant was observed while conducting management in the last year, but it was not a complete montioring.
Makaha	Manage for stability	63	5	2	0	0	0	63	5	2	**63**	**5**	**2**	Monitoring showed no change
Waianae Kai	Genetic Storage	5	0	0	0	0	0	6	0	0	**5**	**0**	**0**	Small changes were noted during monitoring in the last year
	Total for Taxon:	85	6	2	0	5	0	86	11	2	**85**	**11**	**2**	

Table 3.2b Threat Control Summary

Action Area: In

TaxonName: Alectryon macrococcus var. macrococcus

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki to West Makaleha	Manage for stability	Partial	Partial	No	No	No	No
Makua	Manage for stability	Partial	No	Partial	No	No	No
South Mohiakea	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Alectryon macrococcus var. macrococcus

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central Kaluaa to Central Waieli	Manage for stability	Partial	Partial	No	No	No	No
Makaha	Manage for stability	Partial	Partial	No	No	No	No
Waianae Kai	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.2c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Alectryon macrococcus var. macrococcus							
Central Kaluaa to Central Waieli	17	1	0	0	0	1	0
Kahanahaiki to West Makaleha	35	5	0	0	0	0	0
Makaha	63	5	0	0	0	4	0
Makua	20	0	1	0	1	2	1
South Mohiakea	3	0	1	0	0	0	0
Waianae Kai	5	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	1	7	1

3.4 CENCHRUS AGRIMONIOIDES VAR. AGRIMONIOIDES

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Central Ekahanui PU and the Kahanahaiki and Pahole PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 238 hours managing this species in the past year. This time was spent collecting for reintroductions in all PUs and monitoring reintroduction sites.
- The Ekahanui MU fence is complete and ungulates are being removed from the Central Ekahanui PU.
- Collections were made from all PUs for propagation to supplement outplantings and expand the nursery living collection.
- Many additional plants and seedlings were found within *in situ* sites in the Kahanahaiki and Pahole PU.
- Seedling, immature and mature F1 plants are established within older reintroduction sites in the Central Ekahanui and Kahanahaiki and Pahole PUs.
- Clones of founders from all PUs are being maintained as a living collection in the nursery for genetic storage. Seed collections from the reintroductions for genetic storage will continue as the rest of the founders are added. Once founders are represented in reintroductions and seed storage, the nursery living collection will no longer be used to meet genetic storage goals.

Plans for MIP Year 7

- Conduct census monitoring at all Manage for Stability PUs.
- Complete eradication of ungulates from the Ekahanui MU fence.
- Establish a new reintroduction site in Makaha for the Makaha and Waianae Kai PU.
- Complete reintroduction at the Central Ekahanui PU and the Kahanahaiki and Pahole PU.
- Continue collection of mature seed for genetic storage from the reintroductions in the Central Ekahanui PU and the Kahanahaiki and Pahole PU.

Table 3.3a Taxon Status Summary

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides TaxonCode: CenAgrAgr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki and Pahole	Manage for stability	84	14	103	274	38	15	331	31	39	**358**	**52**	**118**	More plants were added to the reintroduction sites and many new seedlings were observed
	Total for Taxon:	84	14	103	274	38	15	331	31	39	**358**	**52**	**118**	

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides TaxonCode: CenAgrAgr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Ekahanui	Manage for stability	37	8	5	50	14	34	93	9	42	**87**	**22**	**39**	Small changes were noted during monitoring of the wild sites in the last year and more plants were added to the reintroduction sites
Makaha and Waianae Kai	Manage for stability	6	0	0	3	0	0	8	0	0	**9**	**0**	**0**	Small changes were noted during monitoring in the last year
South Huliwai	Genetic Storage	18	2	0	0	0	0	18	2	0	**18**	**2**	**0**	Monitoring showed no change
	Total for Taxon:	61	10	5	53	14	34	119	11	42	**114**	**24**	**39**	

Table 3.3b Threat Control Summary

Action Area: In

TaxonName: Cenchrus agrimonioides var. agrimonioides

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki and Pahole	Manage for stability	Partial	Partial	Partial	No	No	No

Action Area: Out

TaxonName: Cenchrus agrimonioides var. agrimonioides

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central Ekahanui	Manage for stability	Partial	Yes	No	No	No	No
Makaha and Waianae Kai	Manage for stability	Partial	No	No	No	No	No
South Huliwai	Genetic Storage	No	Yes	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.3c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cenchrus agrimonioides var. agrimonioides							
Central Ekahanui	37	8	9	9	0	27	16
Kahanahaiki and Pahole	84	14	31	49	0	44	52
Makaha and Waianae Kai	6	0	6	3	0	5	4
South Huliwai	18	2	5	7	0	16	11

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
68	0	92	83

3.5 CHAMAESYCE CELASTROIDES VAR. KAENANA

Requirements for Stability

- 4 Population Units (PUs) (high fire threat)
- 25 reproducing individuals in each population (long-lived perennial)
    - *This goal is met for all four MFS PUs (Makua, East of Alau, Kaena, Puaakanoa).*
- Stable population structure
- Threats controlled
    - Complete genetic storage of all PUs

Major Highlights/Issues for MIP Year 6

- Staff spent 283 hours managing this species in the past year. Most of this time was spent collecting for genetic storage in the Kaena, East of Alau, Makua, and Puaakanoa PUs; and monitoring fire damage to the North Kahanahaiki PU.
- The July 24, 2010 fire at Makua Military Reservation burned through the North Kahanahaiki PU potentially impacting all of the plants there. (Makua Fire Report ES-2) Very few plants from this site have genetic storage representation. It is likely that many plants did survive and further surveys will determine how many plants remain. Although the fire did threaten the Kaluakauila and Puaakanoa PUs, post-fire surveys saw that these plants were spared.
- The following changes were made to PU names: Kaena (East of Alau) to East of Alau; Kaena and Keawaula (Kaena) to Kaena; Kaena and Keawaula (Keawaula) to Keawaula.
- No changes in population estimates were made during monitoring of the East Kahanahaiki, Kaluakauila, Puaakanoa, Makua, East of Alau, Kaena and Keawaula PUs in the last year. The Waianae Kai PU was not monitored.
- Weed control and fuel-load reduction for fire prevention has continued at the Makua and Puaakanoa PUs.
- UH Botany graduate student Melody Euaparadorn was given OANRP funding to support her pollination research on the breeding system and pollination biology of this species (ES- 5).

Plans for MIP Year 7

- Conduct monitoring at all Manage for Stability PUs.
- Continue seed collections for genetic storage.
- Continue to facilitate research on *Chamaesyce* by Dr. Cliff Morden of the UH Botany Department. Results for *C. celastroides* var. *kaenana* are expected in December 2010. Work with Melody Euaparadorn will continue as well.
- Monitor accessible plants in the Waianae Kai PU and begin genetic storage collections
- Encourage MMR Range Control to install fuel breaks to protect the North Kahanahaiki and Puaakanoa PUs from wildfire. Install fuel break to protect the East of Alau PU.
- Make one bulk collection of seeds for extensive seed storage testing to finalize storage protocol for this species

Table 3.4a Taxon Status Summary

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana **TaxonCode: ChaCelKae**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Kahanahaiki	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	Monitoring showed no change
Kaluakauila	Genetic Storage	11	2	0	0	0	0	8	4	0	11	2	0	A thorough census of the known area found more plants
Makua	Manage for stability	125	2	0	0	0	0	118	16	0	125	2	0	A thorough census of the known area found more plants
North Kahanahaiki	Genetic Storage	110	28	0	0	0	0	177	0	0	110	28	0	
Puaakanoa	Manage for stability	132	16	0	0	0	0	160	10	0	132	16	0	Monitoring showed no change
	Total for Taxon:	380	48	0	0	0	0	465	30	0	380	48	0	

Action Area: Out

TaxonName: Chamaesyce celastroides var. kaenana **TaxonCode: ChaCelKae**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East of Alau	Manage for stability	26	1	0	0	0	0	21	0	1	26	1	0	A thorough census of the known area found more plants
Kaena	Manage for stability	300	0	0	0	0	0	300	0	0	300	0	0	This estimate has not been revised since 2005. No monitoring to detect smaller size classes has been done yet, but they are observed to be there.
Keawaula	Genetic Storage	53	2	2	0	0	0	53	2	2	53	2	2	Monitoring showed no change
Waianae Kai	Genetic Storage	33	0	0	0	0	0	33	0	0	33	0	0	No monitoring in the last year
	Total for Taxon:	412	3	2	0	0	0	407	2	3	412	3	2	

Table 3.4b Threat Control Summary

Action Area: In

TaxonName: Chamaesyce celastroides var. kaenana

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
East Kahanahaiki	Genetic Storage	No	No	No	No	No	No
Kaluakauila	Genetic Storage	No	No	No	No	No	No
Makua	Manage for stability	Yes	Yes	No	No	No	Yes
North Kahanahaiki	Genetic Storage	No	No	No	No	No	No
Puaakanoa	Manage for stability	No	Partial	No	No	No	No

Action Area: Out

TaxonName: Chamaesyce celastroides var. kaenana

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
East of Alau	Manage for stability	No	No	No	No	No	No
Kaena	Manage for stability	No	Yes	No	No	No	No
Keawaula	Genetic Storage	No	No	No	No	No	No
Waianae Kai	Genetic Storage	No	No	No	No	No	Partial

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.4c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Chamaesyce celastroides var. kaenana							
East Kahanahaiki	2	0	0	1	0	0	0
East of Alau	26	1	0	22	0	0	20
Kaena	300	0	0	57	0	2	55
Kaluakauila	11	2	2	2	0	0	0
Keawaula	53	2	0	22	0	0	13
Makua	125	2	21	71	0	0	59
North Kahanahaiki	110	28	18	14	0	0	11
Puaakanoa	132	16	0	17	0	4	7
Waianae Kai	33	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
206	0	6	165

3.6 CHAMAESYCE HERBSTII

Requirements for Stability

- 3 Population Units (PU)
- 25 reproducing individuals in each PU (long-lived perennial)
    - *This goal is met for the Kapuna to Pahole PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 362 hours managing this species in the past year.
- Reintroductions at the Kapuna to Pahole PU and Makaha PU continued with new founders. An F1 generation (seedlings and immature plants) is being established at both sites.
- Detailed population monitoring of the Makaha PU began. This monitoring will begin to provide survivorship data for the younger age classes over the next several years.
- Collections of leaf material for genetic research by Dr. Cliff Morden at the UH Botany Department were completed. Results are expected in December 2010.
- Collections of mature seed for propagation for reintroduction continued from the Pahole to Kapuna PU
- Drafted plan for continued stage class modeling of the Makaha PU and submitted to Tiffany Knight (Assoc. Professor, Washington Univ. in St. Louis) for review
- Monitoring has shown a decline in the number of in situ mature plants in the Kapuna to Pahole PU.
- Three species of *Hylaeus* were observed visiting flowers of this species in the Makaha PU. Two of the species are possibly new, undescribed species, while the third species is a candidate for federal listing.

Plans for MIP Year 7

- Conduct monitoring and continue to track survivorship of F1 plants.
- Supplement the reintroductions at the Makaha PU and the Kapuna to Pahole PU.
- Collect seeds from unrepresented founders in the Kapuna to Pahole PU to propagate for outplanting until every founder is represented at at least one outplanting. Once this is complete, prioritize further collections along with all other actions necessary for stabilization.
- Collection for genetic storage will begin once the remaining founders are represented in the outplantings and mature.
- Make one bulk collection from either Makaha PU or augmentation of Kapuna to Pahole PU for additional seed storage testing to finalize storage protocol.
- Monitor the reintroduction in the Makaha PU in February 2011 and analyze survivorship within each defined stage class.
- Work with Tiffany Knight on developing a plan for using the demography data collected to populate a matrix model in order to project the population trajectory for the reintroduction in the Makaha PU.

Table 3.5a Taxon Status Summary

Action Area: In

TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna to Pahole	Manage for stability	26	35	1	38	52	0	57	74	0	**64**	**87**	**1**	More plants were added to the reintroduction and 6 wild mature plants died
West Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	To be reintroduced when the MU fence is complete
	Total for Taxon:	26	35	1	38	52	0	57	74	0	**64**	**87**	**1**	

Action Area: Out

TaxonName: Chamaesyce herbstii **TaxonCode: ChaHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	19	124	26	19	29	28	**19**	**124**	**26**	More plants were added to the reintroduction sites and recruitment of new plants has been observed
	Total for Taxon:	0	0	0	19	124	26	19	29	28	**19**	**124**	**26**	

Table 3.5b Threat Control Summary

Action Area: In

TaxonName: Chamaesyce herbstii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kapuna to Pahole	Manage for stability	Partial	Partial	No	No	No	No
West Makaleha	Manage reintroduction for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Chamaesyce herbstii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makaha	Manage reintroduction for stability	Yes	Yes	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.5c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Chamaesyce herbstii							
Kapuna to Pahole	26	35	30	20	0	13	13

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
20	0	13	13

3.7 CHAMAESYCE ROCKII

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable Population Structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 2 Priority

Major Highlights/Issues OIP Year 3

- Staff spent 22 hours managing this species in the past year. This time was spent monitoring plants in the Kawainui to Koloa and Kaipapau PU, collecting samples for genetic analyses and updating older observations from the Kaukonahua to Kipapa PU.
- A new plant was found during surveys in the Kawainui to Koloa and Kaipapau PU. Population estimates were revised after older observations were updated.
- Collections of leaf material for genetic analyses by Dr. Cliff Morden of the UH Botany Department to better define PUs continued in the last year. More material needs to be collected from other PUs. Results are expected in April 2011.

Plans for OIP Year 4

- Monitor and survey the Helemano PU and the Waiawa and Waimano PU.
- Secure an agreement with Hawaii Reserves Inc. for construction of the Koloa MU fence and to conduct conservation work in Koloa.
- Continue to survey the Kawainui to Koloa and Kaipapau PU for more plants.
- When mature fruit is observed during monitoring, collect to initiate seed storage testing
- Continue to facilitate research on *Chamaesyce* by the UH Manoa Botany Department by collecting leaf samples for genetic testing from additional plants in the Waiawa and Waimano PU and the Helemano PU.
- Determine the feasibility of a bulk seed storage collection from Koloa.

Table 3.6a Taxon Status Summary

Action Area: In

TaxonName: Chamaesyce rockii **TaxonCode: ChaRoc**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano	Manage for stability	7	1	0	0	0	0	7	1	0	**7**	**1**	**0**	No monitoring in the last year
Kaukonahua to Kipapa	Genetic Storage	14	2	0	0	0	0	28	2	0	**14**	**2**	**0**	Thorough monitoring in the last year showed a decline
Kawaiiki	Genetic Storage	48	2	0	0	0	0	48	2	0	**48**	**2**	**0**	No monitoring in the last year
Kawainui to Koloa and Kaipapau	Manage for stability	37	13	2	0	0	0	43	16	3	**37**	**13**	**2**	Thorough monitoring in the last year showed a decline
	Total for Taxon:	106	18	2	0	0	0	126	21	3	**106**	**18**	**2**	

Action Area: Out

TaxonName: Chamaesyce rockii **TaxonCode: ChaRoc**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halawa summit	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Kaluanui and Maakua	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Waiawa and Waimano	Manage for stability	15	0	0	0	0	0	15	0	0	**15**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	15	0	0	0	0	0	15	0	0	**15**	**0**	**0**	

Table 3.6b Threat Control Summary

Action Area: In

TaxonName: Chamaesyce rockii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano	Manage for stability	Yes	Partial	No	No	No	No
Kaukonahua to Kipapa	Genetic Storage	No	No	No	No	No	No
Kawaiiki	Genetic Storage	No	No	No	No	No	No
Kawainui to Koloa and Kaipapau	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Chamaesyce rockii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Waiawa and Waimano	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.6c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Chamaesyce rockii							
Helemano	7	1	0	0	0	0	0
Kaukonahua to Kipapa	14	2	0	0	0	0	0
Kawaiiki	48	2	0	0	0	0	0
Kawainui to Koloa and Kaipapau	37	13	0	0	0	0	0
Waiawa and Waimano	15	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.8 CYANEA ACUMINATA

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Makaleha to Mohiakea PU and the Helemano-Punaluu Summit Ridge to North Kaukonahua PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 14 hours managing this species in the past year. This time was spent monitoring new plants in Koloa and updating older records from Makaleha to Mohiakea. Additional time was spent surveying areas within this PU.
- New plants were observed during surveys of the Makaleha to Mohiakea PU and a new plant was observed in the Koloa MU.
- The Kaipapau PU will be expanded to include this new site in Koloa and the name has been changed to Kaipapau and Koloa.
- The Kaala MU fence is not adequate in keeping pigs out. Ungulate sign is still observed within the Kaala MU and a fence line to extend the Waianae Kai section has been surveyed and OANRP is waiting on the MOU with the State of Hawaii.

Plans for OIP Year 4

- Complete repairs and additions to the Kaala MU fence
- Continue to monitor fruit development to determine stage of maturity for collection or whether fruit are aborting prematurely. This needs to be determined prior to continuing genetic storage collections from all PUs.
- Begin construction of the Schofield Barracks Lihue fence, which will protect most known plants in the Makaleha to Mohiakea PU.
- Survey for additional plants in the Kahana and South Kaukonahua PU and then begin to prioritize and survey PU with historic records, but no known plants (Pia, Kawaiiki, Konahuanui and Kaipapau).

Table 3.7a Taxon Status Summary

Action Area: In

TaxonName: Cyanea acuminata **TaxonCode: CyaAcu**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano-Punaluu Summit Ridge to North Kaukonahua	Manage for stability	59	13	7	0	0	0	59	13	7	59	13	7	No monitoring in the last year
Kahana and South Kaukonahua	Manage for stability	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year
Kawaiiki	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Makaleha to Mohiakea	Manage for stability	103	43	0	0	0	0	89	38	0	103	43	0	New plants were discovered during surveys
	Total for Taxon:	164	56	7	0	0	0	150	51	7	164	56	7	

Action Area: Out

TaxonName: Cyanea acuminata **TaxonCode: CyaAcu**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahana and Makaua	Genetic Storage	11	3	0	0	0	0	11	3	0	11	3	0	No monitoring in the last year
Kaipapau and Koloa	Genetic Storage	1	0	0	0	0	0	0	0	0	1	0	0	New plants were discovered during surveys
Kaluanui and Maakua	Genetic Storage	13	8	0	0	0	0	13	8	0	13	8	0	No monitoring in the last year
Konahuanui	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Pia	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Puukeahiakahoe	Genetic Storage	3	0	0	0	0	0	3	0	0	3	0	0	No monitoring in the last year
Puuokona	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	28	11	0	0	0	0	27	11	0	28	11	0	

Table 3.7b Threat Control Summary

Action Area: In

TaxonName: Cyanea acuminata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano-Punaluu Summit Ridge to North Kaukonahua	Manage for stability	No	No	No	No	No	No
Kahana and South Kaukonahua	Manage for stability	No	No	No	No	No	No
Makaleha to Mohiakea	Manage for stability	Partial	Partial	No	No	No	No

Action Area: Out

TaxonName: Cyanea acuminata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahana and Makaua	Genetic Storage	No	No	No	No	No	No
Kaipapau and Koloa	Genetic Storage	No	No	No	No	No	No
Kaluanui and Maakua	Genetic Storage	No	No	No	No	No	No
Puukeahiakahoe	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.7c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cyanea acuminata							
Helemano-Punaluu Summit Ridge to North Kaukonahua	59	13	0	4	0	0	4
Kahana and Makaua	11	3	0	0	0	0	0
Kahana and South Kaukonahua	2	0	0	0	0	0	0
Kaipapau and Koloa	1	0	0	0	0	0	0
Kaluanui and Maakua	13	8	0	0	0	0	0
Makaleha to Mohiakea	103	43	0	0	0	0	0
Puukeahiakahoe	3	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
4	0	0	4

3.9 CYANEA CRISPA

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage collections of all PUs
- Tier 2 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 8 hours managing this species in the past year. This time was spent monitoring the reintroduction in Helemano. No other management was conducted in the last year.

Plans for OIP Year 4

- Work with OPEP and Kualoa Ranch staff to monitor and collect from the Kahana and Makaua PU
- Collect additional propagules from the Kawaiiki PU to supplement the Helemano PU
- As time allows, survey for additional plants in Manage for Stability PUs and collect for genetic storage

Table 3.8a Taxon Status Summary

Action Area: In

TaxonName: Cyanea crispa **TaxonCode: CyaCri**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano	Manage reintroduction for storage	0	0	0	0	3	0	0	3	0	0	3	0	Monitoring showed no change
Kaipapau	Genetic Storage	0	2	0	0	0	0	0	2	0	0	2	0	No monitoring in the last year
Kawaiiki	Manage for stability	2	4	0	0	0	0	2	4	0	2	4	0	No monitoring in the last year
	Total for Taxon:	2	6	0	0	3	0	2	9	0	2	9	0	

Action Area: Out

TaxonName: Cyanea crispa **TaxonCode: CyaCri**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Aihualama	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
Kahana and Makaua	Manage for stability	7	7	0	0	0	0	7	7	0	7	7	0	No monitoring in the last year
Kapakahi	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kawaipapa	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Maakua	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Maunawili	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Pia	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Pukele	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Wailupe	Manage for stability	5	1	0	0	0	0	5	1	0	5	1	0	No monitoring in the last year
	Total for Taxon:	13	8	0	0	0	0	13	8	0	13	8	0	

Table 3.8b Threat Control Summary

Action Area: In

TaxonName: Cyanea crispa

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano	Manage reintroduction for storage	Yes	No	No	No	No	No
Kaipapau	Genetic Storage	No	No	No	No	No	No
Kawaiiki	Manage for stability	No	No	Yes	No	No	No

Action Area: Out

TaxonName: Cyanea crispa

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Aihualama	Genetic Storage	No	No	No	No	No	No
Kahana and Makaua	Manage for stability	No	No	No	No	No	No
Wailupe	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.8c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyanea crispa							
Aihualama	1	0	0	0	0	0	0
Kahana and Makaua	7	7	2	1	2	0	3
Kaipapau	0	2	0	0	0	0	0
Kawaiiki	2	4	14	0	1	0	0
Wailupe	5	1	0	5	0	0	5

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
6	3	0	8

3.10 CYANEA GRIMESIANA SUBSP. OBATAE

Requirements for Stability

- 4 Population Units (PU) (in both Makua and Oahu AA)
- 100 reproducing individuals in each PU (short-lived perennial with large fluctuations in population size and recent history of decline)
  - *This goal is met for the Palikea (South Palawai) PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 309 hours managing this species in the past year. About half of this time was spent establishing reintroductions and the rest monitoring and collecting from both *in situ* and reintroductions in all PUs. In addition, 103 hours were spent re-stocking rat control grids to protect the plants in the West Makaleha *in situ* site.
- Collections of mature seed for reintroductions and genetic storage continued at the Makaha, Palikea (South Palawai), and the Pahole to West Makaleha PUs.
- Reintroductions continued at Palikea (South Palawai), South Ekahanui, Pahole to West Makaleha, Central and South Kaluaa PUs. A single young immature plant was observed within the South Ekahanui reintroduction.
- A cultural survey for the West Makaleha MU fence was completed.
- Several more plants in the reintroduction at the Palikea (South Palawai) PU began to flower, bringing the total mature plants to 100 and meeting this stabilization target

Plans for MIP Year 7

- Conduct census monitoring, focusing on recruitment, at all sites in the spring and fall of 2011.
- Supplement reintroductions at Pahole to West Makaleha, Palikea (South Palawai), Central and South Kaluaa, and South Ekahanui PUs and continue propagation for the new reintroduction at Makaha.
- Continue to collect for genetic storage from new and unrepresented founders
- Determine if need to expand to year-round rodent control at unprotected sites
- Pursue SLN label for Sluggo
- Determine what limits seedling recruitment at sites where viable fruit is readily available on plants. Studies to determine if fruit are naturally dispersed and trials to identify sites with conditions favorable for germination will be considered.
- Continue seed storage tests at temperatures below -18C

Table 3.9a Taxon Status Summary

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Pahole to West Makaleha	Manage for stability	5	6	4	35	9	0	32	18	4	**40**	**15**	**4**	More plants were added to the reintroduction sites
Palikea Gulch	Genetic Storage	0	1	0	0	0	0	0	1	0	**0**	**1**	**0**	Monitoring showed no change
	Total for Taxon:	5	7	4	35	9	0	32	19	4	**40**	**16**	**4**	

Action Area: Out

TaxonName: Cyanea grimesiana subsp. obatae **TaxonCode: CyaGriOba**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa	Manage for stability	1	1	0	23	16	0	29	23	0	**24**	**17**	**0**	The number of plants alive in the reintroduction site continued to decline
Makaha	Manage for stability	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	Monitoring showed no change
North branch of South Ekahanui	Genetic Storage	0	0	0	36	18	0	31	0	0	**36**	**18**	**0**	More plants were added to the reintroduction sites
Palikea (South Palawai)	Manage for stability	11	23	1	86	7	0	92	37	0	**97**	**30**	**1**	More plants were added to the reintroduction sites and several more matured
South Kaluaa	Genetic Storage	0	0	0	4	17	0	4	10	0	**4**	**17**	**0**	More plants were added to the reintroduction sites
	Total for Taxon:	13	24	1	149	58	0	157	70	0	**162**	**82**	**1**	

Table 3.9b Threat Control Summary

Action Area: In

TaxonName: Cyanea grimesiana subsp. obatae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Pahole to West Makaleha	Manage for stability	Yes	Partial	Partial	No	No	No
Palikea Gulch	Genetic Storage	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Cyanea grimesiana subsp. obatae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central Kaluaa	Manage for stability	Yes	Yes	Partial	No	No	No
Makaha	Manage for stability	Yes	No	No	No	No	No
North branch of South Ekahanui	Genetic Storage	Yes	Yes	Yes	No	No	No
Palikea (South Palawai)	Manage for stability	Yes	Yes	Yes	No	No	No
South Kaluaa	Genetic Storage	Yes	No	Partial	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.9c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyanea grimesiana subsp. obatae							
Central Kaluaa	1	1	0	1	0	1	1
Makaha	1	0	0	1	0	1	1
Pahole to West Makaleha	5	6	5	10	0	8	10
Palikea (South Palawai)	11	23	6	13	5	9	13
Palikea Gulch	0	1	0	0	0	0	0
South Kaluaa	0	0	1	1	0	1	1

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
26	5	20	26

3.11 CYANEA KOOLAUENSIS

Requirements for Stability

- 3 Population Units (PU)
- 50 reproducing individuals per MFS PU (short-lived perennial)
  - *This goal is met for the Kaipapau, Koloa, and Kawainui PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 26 hours managing this species in the past year. This time was spent updating and re-surveying older records from the Opaeula to Helemano PU and Kaipapau, Koloa and Kawainui PU. New plants were observed, several known plants could not be relocated, and estimates were revised accordingly at both PUs.
- A CDUA (Conservation District Use Application) was submitted to the OCCL (Office of Conservation and Coastal Lands). Included in this application is the request for the Lower Peahinaia and Koloa MU fence construction.

Plans for OIP Year 4

- Obtain CDUP (Conservation District Use Permit) and Kamehameha Schools 20 Year License Agreement to pursue fencing for the Lower Opaeula PU (Lower Peahinaia Fence)
- Secure an agreement with Hawaii Reserves Inc. for construction of the Koloa MU fence and to conduct conservation work in Koloa.
- Survey the lower Helemano drainage for more plants within the Opaeula to Helemano PU and the Kaukonahua PU to locate more plants
- Monitor fruit development to determine stage of maturity for collection or whether fruit are aborting prematurely. This needs to be determined prior to conducting genetic storage collections from all PUs.

Table 3.10a Taxon Status Summary

Action Area: In

TaxonName: Cyanea koolauensis **TaxonCode: CyaKoo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaipapau, Koloa and Kawainui	Manage for stability	55	16	6	0	0	0	57	26	6	**55**	**16**	**6**	Thorough monitoring showed a decline
Kamananui-Kawainui Ridge	Genetic Storage	6	2	0	0	0	0	6	2	0	**6**	**2**	**0**	No monitoring in the last year
Kaukonahua	Manage for stability	14	2	0	0	0	0	14	2	0	**14**	**2**	**0**	No monitoring in the last year
Kawaiiki	Genetic Storage	3	4	0	0	0	0	3	4	0	**3**	**4**	**0**	No monitoring in the last year
Lower Opaeula	Genetic Storage	3	1	0	0	0	0	3	1	0	**3**	**1**	**0**	No monitoring in the last year
Opaeula to Helemano	Manage for stability	13	8	0	0	0	0	14	5	0	**13**	**8**	**0**	Small changes were noted during monitoring in the last year
Poamoho	Genetic Storage	12	0	0	0	0	0	12	0	0	**12**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	106	33	6	0	0	0	109	40	6	**106**	**33**	**6**	

Action Area: Out

TaxonName: Cyanea koolauensis **TaxonCode: CyaKoo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halawa	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Halawa-Kalauao Ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Lulumahu	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Waialae Nui	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Waiawa to Waimano	Genetic Storage	3	0	0	0	0	0	3	0	0	**3**	**0**	**0**	No monitoring in the last year
Wailupe	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	No monitoring in the last year
Waimalu	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	4	0	0	0	0	0	4	0	0	**4**	**0**	**0**	

Table 3.10b Threat Control Summary

Action Area: In

TaxonName: Cyanea koolauensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaipapau, Koloa and Kawainui	Manage for stability	No	Partial	No	No	No	No
Kamananui-Kawainui Ridge	Genetic Storage	No	No	No	No	No	No
Kaukonahua	Manage for stability	No	No	No	No	No	No
Kawaiiki	Genetic Storage	No	No	No	No	No	No
Lower Opaeula	Genetic Storage	No	No	No	No	No	No
Opaeula to Helemano	Manage for stability	Partial	No	Partial	No	No	No
Poamoho	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Cyanea koolauensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Waiawa to Waimano	Genetic Storage	No	No	No	No	No	No
Wailupe	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.10c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyanea koolauensis							
Kaipapau, Koloa and Kawainui	55	16	0	0	0	0	0
Kamananui-Kawainui Ridge	6	2	0	0	0	0	0
Kaukonahua	14	2	1	0	0	0	0
Kawaiiki	3	4	0	0	0	0	0
Lower Opaeula	3	1	0	0	0	0	0
Opaeula to Helemano	13	8	0	0	0	0	0
Poamoho	12	0	0	0	0	0	0
Waiawa to Waimano	3	0	0	0	0	0	0
Wailupe	1	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.12 CYANEA LONGIFLORA

Requirements for Stability

- 3 Population Units (PUs)
- 75 reproducing individuals in each PU (short-lived perennial with fluctuating population numbers and trend of local decline)
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 154 hours managing this species in the past year. Most of this time was spent monitoring and collecting for reintroduction and genetic storage from all in situ sites.
- Ungulate removal continued in the Upper Kapuna MU fence. This is the only remaining site where ungulates are a threat to this species.
- A new mature plant was observed and a few plants died in the Kapuna to West Makaleha PU in the last year. A few new dead plants were also observed in the Makaha and Waianae Kai PU.
- Collections for genetic storage and reintroduction continued in all PUs.
- The reintroduction at West Makaleha was planted in 2005 and now has mature plants. Survivorship for this reintroduction is 70% (16/23). The survivorship for the Keawapilau reintroduction started in 2008 is 55% (6/11). These small sites will help guide a strategy for site selection and plant size in future outplantings.

Plans for MIP Year 7

- Conduct census monitoring at all Manage for Stability PUs.
- Work with NARS to develop an augmentation strategy for the Pahole PU and the Kapuna to West Makaleha PU.
- Begin reintroduction into the Makaha portion of the Makaha and Waianae Kai PU.
- Continue to collect mature seeds from unrepresented individuals in all PUs for genetic storage. Since fruit appears to be aborting on many plants, continue to monitor fruit collections to ensure collection of mature seed and possibly explore limiting factors for fruit maturation.
- Determine strategy to prevent rat damage to plants in the Kapuna to West Makaleha PU.
- Continue to conduct seed storage testing at temperatures below -18C.

Table 3.11a Taxon Status Summary

Action Area: In

TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kapuna to West Makaleha	Manage for stability	21	15	0	20	3	0	39	18	0	**41**	**18**	**0**	A thorough census of the known area found more plants
Pahole	Manage for stability	63	64	11	0	0	0	56	49	2	**63**	**64**	**11**	A thorough census of the known area found more plants
	Total for Taxon:	84	79	11	20	3	0	95	67	2	**104**	**82**	**11**	

Action Area: Out

TaxonName: Cyanea longiflora **TaxonCode: CyaLon**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha and Waianae Kai	Manage for stability	3	8	0	0	0	0	3	6	0	**3**	**8**	**0**	A thorough census of the known area found more plants
	Total for Taxon:	3	8	0	0	0	0	3	6	0	**3**	**8**	**0**	

Table 3.11b Threat Control Summary

Action Area: In

TaxonName: Cyanea longiflora

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kapuna to West Makaleha	Manage for stability	Partial	Partial	Partial	No	No	No
Pahole	Manage for stability	Yes	Partial	No	No	No	No

Action Area: Out

TaxonName: Cyanea longiflora

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makaha and Waianae Kai	Manage for stability	Yes	No	No	No	No	No

[shaded] = Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.11c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Cyanea longiflora							
Kapuna to West Makaleha	21	15	5	15	1	12	16
Makaha and Waianae Kai	3	8	2	2	1	2	2
Pahole	63	64	9	42	1	4	42

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
59	3	18	60

3.13 CYANEA ST.-JOHNII

Requirements for Stability

- 3 Population Units
- 50 reproducing individuals per MFS PU (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 218 hours managing this species in the past year. OANRP and OPEP worked together on this species. This time was spent conducting hand-pollination and collecting fruit from the Helemano, Waimano, Ahuimanu-Halawa Summit Ridge and Waiahole-Waiawa Summit Ridge PUs. It was also spent scoping a PU fence for the Ahuimanu-Halawa Summit Ridge PU. In addition, 516 hours were spent beginning fence construction for the Waimano PU.
- Despite the continuing decline of the Waimanalo-Wailupe Summit Ridge PU, two additional mature and two immature plants were found just north of the known plants this year.
- Scoped the fenceline for the Ahuimanu-Halawa PU. Pigs were seen in the area and had killed two small plants and damaged another. This fence is a high priority and is waiting a decision from the Department of Transportation was to whether they will proceed with construction. If they decline and OANRP takes the lead of fence construction, we need to conduct cultural surveys and apply for and receive a CDUP before construction.
- OPEP and OANRP continued hand-pollination of this species. Efforts were directed at cross-pollinating among PUs in an attempt to yield mature fruit. Actions were based on last year's results, indicating that seed set increased significantly with cross-pollinating among individuals within a PU, and seed viability was typically higher in larger PUs. This year, Helemano and Waimanalo-Wailupe Summit Ridge were crossed, Halawa and Waimanalo-Wailupe Summit Ridge were crossed, and Waiawa and Waimano will be crossed (October).
- Seedlings are being maintained in growth chambers and will be moved into the nursery when they are large enough to be transplanted. To the best of our knowledge, no agency has attempted to propagate this species.

Plans for OIP Year 4

- Work with OPEP and Lyon Arboretum to develop protocols for transferring plants from micropropagation to nursery potting media
- Work with OPEP to continue pollination and breeding system studies and collect propagules for genetic storage and augmentation
- Prioritize monitoring by OPEP/OANRP of the Waihee-Waimalu summit Ridge PU and the North of Puu Pauao PU
- Survey for additional plants at all sites
- Build the Ahuimanu-Halawa PU fence
- Complete the Waimano PU fence

Table 3.12a Taxon Status Summary

Action Area: In

TaxonName: Cyanea st.-johnii TaxonCode: CyaStj

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano	Manage for stability	4	1	0	0	0	0	5	0	0	4	1	0	Population counts were revised after updating old observations
North of Puu Pauao	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year. This site has not been visited since 1994, so it is not known how many plants are there.
	Total for Taxon:	4	1	0	0	0	0	5	0	0	4	1	0	

Action Area: Out

TaxonName: Cyanea st.-johnii TaxonCode: CyaStj

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ahuimanu-Halawa Summit Ridge	Manage for stability	8	3	0	0	0	0	11	3	1	8	3	0	Thorough monitoring showed a decline. Pigs were observed killing and damaging plants in the last year.
Waiahole-Waiawa Summit Ridge	Genetic Storage	6	3	0	0	0	0	11	3	1	6	3	0	Thorough monitoring in the last year showed a decline
Waihee-Waimalu summit ridge	Genetic Storage	10	0	0	0	0	0	10	0	0	10	0	0	No monitoring in the last year
Waimanalo-Wailupe Summit Ridge	Genetic Storage	6	4	0	0	0	0	7	0	0	6	4	0	New plants were discovered during surveys but the previously known plants continued to decline
Waimano	Manage for stability	14	5	0	0	0	0	14	5	0	14	5	0	Monitoring showed no change
	Total for Taxon:	44	15	0	0	0	0	53	11	2	44	15	0	

Table 3.12b Threat Control Summary

Action Area: In

TaxonName: Cyanea st.-johnii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano	Manage for stability	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Cyanea st.-johnii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ahuimanu-Halawa Summit Ridge	Manage for stability	No	No	No	No	No	No
Waiahole-Waiawa Summit Ridge	Genetic Storage	No	No	No	No	No	No
Waihee-Waimalu summit ridge	Genetic Storage	No	No	No	No	No	No
Waimanalo-Wailupe Summit Ridge	Genetic Storage	No	No	No	No	No	No
Waimano	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.12c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyanea st.-johnii							
Ahuimanu-Halawa Summit Ridge	8	3	0	3	1	0	3
Helemano	4	1	1	1	4	0	4
Waiahole-Waiawa Summit Ridge	6	3	0	2	2	0	3
Waihee-Waimalu summit ridge	10	0	0	0	0	0	0
Waimanalo-Wailupe Summit Ridge	6	4	0	2	2	0	2
Waimano	14	5	0	3	3	0	4

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
11	12	0	16

3.14 CYANEA SUPERBA

Requirements for Stability

- 4 Population Units (PUs) (in both Makua and Oahu AAs, no extant wild plants and all PUs are dependent on reintroduction)
- 50 reproducing individuals in each PU (long-lived perennial with a history of precipitous decline, extirpated in the wild, and extremely low genetic variability)
  - *This goal is met for the Pahole to Kapuna PU.*
- Threats controlled
- Stable population structure
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 503 hours managing this species in the past year. Much of this time was spent continuing to outplant into existing reintroduction sites in the Kahanahaiki, Pahole and Makaha PUs and monitoring these sites. In addition, 460 hours were spent monitoring rat predation rates on mature fruits to assess the impact of rat control in Kahanahaiki compared with Pahole, where there was no control. UH graduate student Richard Pender contributed 140 hours to this effort as well. Another 480 hours were spent treating the sites in Kahanahaiki with Sluggo® and following the fate of the newly established immature plants there.
- Thirty-six plants in the Kahanahaiki PU produced fruit in the 2009-2010 season. This fruiting event allowed us to compare, for the first time, the survival of seedlings at a high (once every two weeks) vs. a low (once a month) regime of slug baiting. Statistical comparison between the two groups will be made 1 year from the start of application (March 2010-2011).
- Reintroductions continued in the Makaha, Kahanahaiki and the Pahole to Kapuna PUs.
- After the 2009-2010 fruiting season, naturally occurring F1 seedlings were observed at 18 of the 36 (50%) fruiting plants in the Kahanahaiki PU. Four of the plants that produced mature fruit in the 2008-2009 season produced seedlings which are still extant (86 seedlings). All together, there were 163 immature F1 plants remaining in July 2010.
- A study on the effect of rat control on depredation of *C. superba* fruit in Kahanahaiki was conducted. Results showed that rat control significantly decreased predation of available mature fruit on more than 30 plants at Kahanahaiki (4%) when compared with Pahole (48%). For more details, see the discussion in the Research Chapter.
- Seedlings and immature F1 plants are also present at reintroductions in Pahole and Kapuna.
- UH Botany graduate student, R. Pender, continued his study of pollination biology at the Kahanahaiki PU.

Plans for MIP Year 7

- Continue to supplement the reintroductions at Makaha, Kahanahaiki and the Pahole to Kapuna PUs.
- Pursue fencing plans for East Makaleha with the State of Hawaii
- Continue to track seedlings at both the Kahanahaiki PU and the Pahole to Kapuna PU, treat the areas with Sluggo and monitor for potential benefits of slug control.
- Pursue Special Local Needs (SLN) labeling of Sluggo for use in natural areas devoid of *Achatinella.*
- Continue alien fern control under mature plants at reintroduction sites to clear substrate to enhance germination.
- Develop plans for a seed sowing trial to determine microhabitats that will support germination.

Table 3.13a Taxon Status Summary

Action Area: In

TaxonName: Cyanea superba subsp. superba **TaxonCode: CyaSupSup**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	0	0	0	48	285	67	35	356	345	**48**	**285**	**67**	More plants were added to the reintroduction sites and lots of recruitment has been observed
Pahole to Kapuna	Manage reintroduction for stability	0	0	0	121	183	9	95	100	255	**121**	**183**	**9**	More plants were added to the reintroduction sites and lots of recruitment has been observed
	Total for Taxon:	0	0	0	169	468	76	130	456	600	**169**	**468**	**76**	

Action Area: Out

TaxonName: Cyanea superba subsp. superba **TaxonCode: CyaSupSup**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central and East Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	The reintroduction will begin once the MU fence is complete
Makaha	Manage reintroduction for stability	0	0	0	0	95	0	0	95	0	**0**	**95**	**0**	More plants were added to the reintroduction sites
	Total for Taxon:	0	0	0	0	95	0	0	95	0	**0**	**95**	**0**	

Table 3.13b Threat Control Summary

Action Area: In

TaxonName: Cyanea superba subsp. superba

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki	Manage for stability	Yes	Yes	Yes	No	Partial	No
Pahole to Kapuna	Manage reintroduction for stability	Yes	Partial	No	No	No	No

Action Area: Out

TaxonName: Cyanea superba subsp. superba

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central and East Makaleha	Manage reintroduction for stability	No	No	No	No	No	No
Makaha	Manage reintroduction for stability	Yes	Yes	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.13c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyanea superba subsp. superba							
Kahanahaiki	0	0	6	3	3	3	3

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
3	3	3	3

3.15 CYRTANDRA DENTATA

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Pahole to Kapuna to West Makaleha PU.*
- Threats controlled
- Stable population structure
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 47 hours developing protocols for more intensive monitoring of the Kahnahaiki PU and updating older observations in the Pahole to Kapuna to West Makaleha PU.
- Work continued on a license agreement with Kamehameha Schools for fencing and other management at the Opaeula and Kawaiiki PU.
- A cultural survey of the Lower Opaeula MU was completed
- Baseline stage class transition data was collected from a subset of plants in June 2010 for the Kahanahaiki PU.
- In July 2010, a subset of 10 mature plants was tagged. These plants will be tracked for a year in order to determine the mean fecundity for a mature plant at the Kahanahaiki PU.
- Predation was observed on immature fruit and motion-sensing cameras were deployed to further investigate.

Plans for MIP Year 7

- Assist the State of Hawaii in clearing the Upper Kapuna MU fence of ungulates.
- Monitor the Opaeula PU and determine fence line placement for the Lower Opaeula MU.
- Begin genetic storage collections from the Kawaiiki PU, Opaeula PU, and the Central Makaleha PU.
- Conduct monitoring work with Botanist Joel Lau to update population estimates of pure *C. dentata* in the Kawaiiki PU.
- Monitor the subset of plants (50) in the Kahanahaiki PU in June 2011 and analyze survivorship within each defined stage class.
- July 2010 through July 2011, ten mature plants in the Kahanahaiki PU will be tracked to determine average fecundity.
- In October 2010, ten seed sow plots will be installed in the Kahanahaiki PU to assess the germination rate. In addition, twelve bags containing 200 seed each will be buried in order to investigate the seed bank for this PU.
- Data collected will be compiled and Tiffany Knight (Assoc. Professor, Washington Univ. in St. Louis) will analyze demographic data.

Table 3.14a Taxon Status Summary

Action Area: In

TaxonName: Cyrtandra dentata — TaxonCode: CyrDen

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Manage for stability	65	142	0	0	0	0	156	57	27	**65**	**142**	**0**	Monitoring showed a decline in mature plants, but the overall total did not change much. Different age class definitions used in previous observations may affect these estimates. Seedlings are observed at the site but were not counted this year.
Kawaiiki (Koolaus)	Manage for stability	15	31	39	0	0	0	15	31	39	**15**	**31**	**39**	No monitoring in the last year
Opaeula (Koolaus)	Manage for stability	16	12	0	0	0	0	16	12	0	**16**	**12**	**0**	No monitoring in the last year
Pahole to West Makaleha	Manage for stability	577	615	238	0	0	0	577	615	238	**577**	**615**	**238**	Monitoring showed no change
	Total for Taxon:	673	800	277	0	0	0	764	715	304	**673**	**800**	**277**	

Action Area: Out

TaxonName: Cyrtandra dentata — TaxonCode: CyrDen

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Makaleha	Genetic Storage	3	0	0	0	0	0	3	0	0	**3**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	3	0	0	0	0	0	3	0	0	**3**	**0**	**0**	

Table 3.14b Threat Control Summary

Action Area: In

TaxonName: Cyrtandra dentata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki	Manage for stability	Yes	Yes	Yes	No	No	No
Kawaiiki (Koolaus)	Manage for stability	No	No	No	No	No	No
Opaeula (Koolaus)	Manage for stability	No	No	No	No	No	No
Pahole to West Makaleha	Manage for stability	Partial	Partial	No	No	No	No

Action Area: Out

TaxonName: Cyrtandra dentata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central Makaleha	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.14c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyrtandra dentata							
Central Makaleha	3	0	0	0	0	0	0
Kahanahaiki	46	158	0	23	0	0	22
Kawaiiki (Koolaus)	15	31	0	0	0	0	0
Opaeula (Koolaus)	16	12	0	0	0	0	0
Pahole to West Makaleha	577	615	0	49	0	1	50

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
72	0	1	72

3.16 CYRTANDRA SUBUMBELLATA

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (short-lived perennial)
    - *This goal is met for the Punaluu PU.*
- Threats controlled
- Stable population structure
- Complete genetic storage of all PUs
- Tier 3 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 4 hours managing this species in the past year. This time was spent monitoring the Kaukonahua PU.
- A new site was discovered during snail surveys in Punaluu in the last year and this plant will be managed as part of the Punaluu PU.
- No other management was conducted in the last year.

Plans for OIP Year 4

- Survey for additional plants while conducting management in the Kaukonahua PU and the Kahana PU.
- Select another MFS PU if there are no remaining plants in the Kaukonahua PU.

Table 3.15a Taxon Status Summary

Action Area: In

TaxonName: Cyrtandra subumbellata **TaxonCode: CyrSub**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaukonahua	Manage for stability	0	0	0	0	0	0	2	0	1	0	0	0	The remaining wild plants died in the last year
Punaluu	Manage for stability	201	0	0	0	0	0	200	0	0	201	0	0	A new plant was discovered during surveys
	Total for Taxon:	201	0	0	0	0	0	202	0	1	201	0	0	

Action Area: Out

TaxonName: Cyrtandra subumbellata **TaxonCode: CyrSub**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahana	Manage for stability	8	7	0	0	0	0	8	7	0	8	7	0	No monitoring in the last year
Uwao	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year
	Total for Taxon:	10	7	0	0	0	0	10	7	0	10	7	0	

Table 3.15b Threat Control Summary

Action Area: In

TaxonName: Cyrtandra subumbellata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaukonahua	Manage for stability	No	No	No	No	No	No
Punaluu	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Cyrtandra subumbellata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahana	Manage for stability	No	No	No	No	No	No
Uwao	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.15c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyrtandra subumbellata							
Kahana	8	7	0	0	0	0	0
Kaukonahua	0	0	0	0	0	0	0
Punaluu	201	0	0	0	0	0	0
Uwao	2	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.17 CYRTANDRA VIRIDIFLORA

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (intermediate long-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 2 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 70 hours managing this species in the past year. Most of this time was spent monitoring plants in the Helemano and Opaeula PU and the Kawainui and Koloa PU.

Plans for OIP Year 4

- Finalize the route of the Koloa MU fence and secure a license agreement with Hawaii Reserves Inc.
- Collect fruit for seed storage testing
- Survey the South Kaukonahua to Kipapa summit PU and Koloa PU to locate more plants

Table 3.16a Taxon Status Summary

Action Area: In

TaxonName: Cyrtandra viridiflora **TaxonCode: CyrVir**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano and Opaeula	Manage for stability	39	13	6	0	0	0	46	15	6	**39**	**13**	**6**	Monitoring in the last year showed a decline
Kawainui and Koloa	Manage for stability	16	4	0	0	0	0	25	6	1	**16**	**4**	**0**	Monitoring of some of the sites in the last year showed a decline
South Kaukonahua to Kipapa summit	Manage for stability	2	0	0	0	0	0	0	2	0	**2**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	57	17	6	0	0	0	71	23	7	**57**	**17**	**6**	

Action Area: Out

TaxonName: Cyrtandra viridiflora **TaxonCode: CyrVir**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaalaea	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Kaluanui to Maakua Ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	

Table 3.16b Threat Control Summary

Action Area: In

TaxonName: Cyrtandra viridiflora

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano and Opaeula	Manage for stability	Partial	Partial	Partial	No	No	No
Kawainui and Koloa	Manage for stability	No	No	No	No	No	No
South Kaukonahua to Kipapa summit	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Cyrtandra viridiflora

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaluanui to Maakua Ridge	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.16c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Cyrtandra viridiflora							
Helemano and Opaeula	39	13	0	7	0	0	5
Kaluanui to Maakua Ridge	0	0	0	0	0	0	0
Kawainui and Koloa	16	4	0	1	0	0	1
South Kaukonahua to Kipapa summit	2	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
8	0	0	6

3.18 DELISSEA WAIANAEENSIS

Requirements for Stability

- 4 Population Units (PUs) (in both Makua and Oahu AAs)
- 100 reproducing individuals in each PU (short-lived perennial with population fluctuations and local declines, potentially an obligate out-crosser)
  - *This goal is met for* the *Kahanahaiki to Keawapilau PU, the Ekahanui PU and the Kaluaa PU.*
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 426 hours managing this species in the past year. About half of this time was spent planting into the existing reintroduction sites. The rest of the time was spent monitoring those sites and collecting from additional plants for genetic storage and reintroduction.
- The Palikea Gulch PU was redefined to only include the wild plants from within that gulch. The reintroduction of that stock in Kapuna has been given its own PU. This will now be consistent with the other PUs where reintroductions are managed separately from the founder PU (e.g. Kealia PU stock at the Kaluakauila PU). Collections continued from the wild plants in the Palikea Gulch PU.
- Construction of the Manuwai MU fence began this year for protection of future reintroduction areas.
- Outplanting continued in the Kahanahaiki to Keawapilau, Ekahanui, and Kaluaa PUs.
- UH graduate student Richard Pender continued a pollination biology study in Kahanahaiki and Pahole.
- Baseline stage class transition data was collected in February of 2010 for one of the reintroductions in the Kaluaa PU. The draft plan for continued stage class modeling at this site was submitted to Tiffany Knight (Assoc. Professor, Washington Univ. in St. Louis) for review.

Plans for MIP Year 7

- Conduct bi-annual census monitoring at all Manage for Stability PUs.
- Continue to supplement the augmentations in the Kahanahaiki to Keawapilau, Ekahanui and Kaluaa PUs in order to balance founders at these Manage for Stability PUs. Begin planting in the Waieli region of the Kaluaa PU.
- Collect fruit from any new founders for propagation and genetic storage.
- Complete Manuwai MU fence construction.
- Continue molecular study of *D. waianaeensis* with Bishop Museum.
- Finalize stage class monitoring plan with Tiffany Knight and conduct internal review. Re-monitor the reintroduction at the Kaluaa PU in February 2011 and analyze survivorship within each defined stage class.
- Work with Tiffany Knight on developing a plan for using the demography data collected to populate a matrix model in order to project the population trajectory for the reintroduction site in the Kaluaa PU.

Table 3.17a Taxon Status Summary

Action Area: In

TaxonName: Delissea waianaeensis **TaxonCode: DelWai**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Keawapilau	Manage for stability	5	0	0	166	47	0	156	28	0	171	47	0	More plants were added to the reintroduction sites and a few died
Kaluakauila	Manage reintroduction for storage	0	0	0	31	11	0	12	35	0	31	11	0	Many of the plants began to flower and a few have died
Kapuna	Manage reintroduction for storage	0	0	0	60	0	0	64	8	0	60	0	0	Ten reintroduced plants have died and the remaining are all now mature
Palikea Gulch	Genetic Storage	3	4	0	0	0	0	3	4	1	3	4	0	Small changes were noted during monitoring in the last year
South Mohiakea	Genetic Storage	2	4	4	0	0	0	3	3	4	2	4	4	Small changes were noted during monitoring in the last year
	Total for Taxon:	10	8	4	257	58	0	238	78	5	267	66	4	

Action Area: Out

TaxonName: Delissea waianaeensis **TaxonCode: DelWai**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	2	1	0	125	162	0	85	67	62	127	163	0	More plants were added to the reintroduction site and over 130 F1s were observed. No seedlings were observed this year, but they may have been missed. Some of the seedlimngs observed in 2009 should have been counted as immature plants.
Kaluaa	Manage for stability	4	4	0	177	138	2	84	26	1	181	142	2	More plants were added to the reintroduction sites and many matured. Lots of F1s were observed
Kealia	Genetic Storage	0	0	0	0	0	0	2	0	0	0	0	0	NARS staff report that these plants have died and no plants remain at this site
Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	The reintroduction will begin once the MU fence is complete
Palawai	Genetic Storage	3	3	0	0	0	0	3	3	0	3	3	0	No monitoring in the last year
	Total for Taxon:	9	8	0	302	300	2	174	96	63	311	308	2	

Table 3.17b Threat Control Summary

Action Area: In

TaxonName: Delissea waianaeensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki to Keawapilau	Manage for stability	Partial	Partial	Partial	No	No	No
Kaluakauila	Manage reintroduction for storage	Yes	No	Partial	No	No	No
Kapuna	Manage reintroduction for storage	Yes	Yes	No	No	No	No
Palikea Gulch	Genetic Storage	No	No	No	No	No	No
South Mohiakea	Genetic Storage	Yes	Yes	No	No	No	No

Action Area: Out

TaxonName: Delissea waianaeensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ekahanui	Manage for stability	Yes	Partial	Partial	No	No	No
Kaluaa	Manage for stability	Yes	Yes	No	No	No	No
Kealia	Genetic Storage	No	No	No	No	No	No
Manuwai	Manage reintroduction for stability	No	No	No	No	No	No
Palawai	Genetic Storage	Yes	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.17c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Delissea waianaeensis							
Ekahanui	2	1	4	6	0	4	6
Kahanahaiki to Keawapilau	5	0	8	11	1	4	11
Kaluaa	4	4	1	5	0	5	5
Kealia	0	0	2	2	0	2	2
Palawai	3	3	3	6	0	0	6
Palikea Gulch	3	4	5	7	4	1	7
South Mohiakea	2	4	4	3	0	5	4

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
40	5	21	41

3.19 DUBAUTIA HERBSTOBATAE

Requirements for Stability

- 3 Population Units (PU)
- 50 reproducing individuals in each PU (short-lived perennial)
    - *This goal is met for the both the Ohikilolo Mauka PU and Ohikilolo Makai PU*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- A few new plants were discovered while conducting other management work within the Ohikilolo Mauka PU. Some plants are accessible (for collection purposes).
    - No other management was conducted for this species in the last year.

Plans for MIP Year 7

- Conduct a thorough monitoring of the Ohikilolo Mauka PU and Ohikilolo Makai PU over the next two years.
- Conduct thorough monitoring of the Makaha PU in the next year to determine the need to augment or reintroduce stock to meet the stability goal of 50 reproducing plants.
- Continue pollination study of nursery plants to determine if enough seed can be produced to meet genetic storage goals for the Makaha, Kamaileunu and Waianae Kai PUs. OANRP will compare seed set of nursery stock to stock at the West Range Baseyard’s interpretive garden to determine the best seed source for meeting genetic storage goals.
- Collect cuttings from unrepresented plants while monitoring the Makaha PU and the Waianae Kai PU

Table 3.18a Taxon Status Summary

Action Area: In

TaxonName: Dubautia herbstobatae **TaxonCode: DubHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Genetic Storage	70	0	0	0	0	0	70	0	0	70	0	0	No monitoring in the last year
Makaha/Ohikilolo	Genetic Storage	350	0	0	0	0	0	350	0	0	350	0	0	No monitoring in the last year
Ohikilolo Makai	Manage for stability	358	0	0	0	0	0	358	0	0	358	0	0	No monitoring in the last year
Ohikilolo Mauka	Manage for stability	386	6	0	0	0	0	382	6	0	386	6	0	New plants were discovered during surveys
	Total for Taxon:	1164	6	0	0	0	0	1160	6	0	1164	6	0	

Action Area: Out

TaxonName: Dubautia herbstobatae **TaxonCode: DubHer**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Makaha	Manage for stability	36	1	0	0	0	0	36	1	0	36	1	0	No monitoring in the last year
Waianae Kai	Genetic Storage	10	4	0	0	0	0	10	4	0	10	4	0	No monitoring in the last year
	Total for Taxon:	46	5	0	0	0	0	46	5	0	46	5	0	

Table 3.18b Threat Control Summary

Action Area: In

TaxonName: Dubautia herbstobatae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Keaau	Genetic Storage	No	No	No	No	No	No
Makaha/Ohikilolo	Genetic Storage	Partial	No	No	No	No	No
Ohikilolo Makai	Manage for stability	Yes	No	No	No	No	No
Ohikilolo Mauka	Manage for stability	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Dubautia herbstobatae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kamaileunu	Genetic Storage	No	No	No	No	No	No
Makaha	Manage for stability	No	No	No	No	No	No
Waianae Kai	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.18c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Dubautia herbstobatae							
Kamaileunu	0	0	1	1	1	1	1
Keaau	70	0	0	0	0	0	0
Makaha	36	1	4	12	0	6	12
Makaha/Ohikilolo	350	0	0	1	0	0	0
Ohikilolo Makai	358	0	0	0	0	0	0
Ohikilolo Mauka	386	6	0	1	0	0	1
Waianae Kai	10	4	0	5	0	4	5

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
20	1	11	19

3.20 EUGENIA KOOLAUENSIS

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial, doubled target number due to threat from Ohia rust (*Puccinia psidii*))
  - *This goal is met for the Kaunala PU and the Pahipahialua PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 355 hours managing this species in the past year. Most of this time was spent doing thorough census monitoring of the Oio, Pahipahialua, Kaleleiki and Kaunala PUs. Some time was also spent monitoring and collecting from the Palikea and Kaimuhole PU. Time was also spent developing protocols to monitor the *Puccinia psidii* rust and more intensive monitoring of the smaller trees.
- The *Puccinia psidii* rust remains uncontrolled in wild populations. Research by Janice Uchida at UH to develop control techniques have yet to yield significant results. See the section on the rust in the Research Chapter for further discussion.
- Protocols were developed to monitor a subset of 50 plants <2m, once a year at the Kaunala PU and Pahipahialua PU. Data collected will be used to quantitatively inform management on current survivorship and growth rate trends for this stage class.
- The Aimuu PU was monitored for the first time in ten years and population estimates were revised.
- Weeds remain a threat to the survivorship of seedlings and immature plants at all sites
- Fire remains a significant threat for most PUs especially the Palikea and Kaimuhole PU and all sites in Kahuku where 80% of the population resides.

Plans for OIP Year 4

- Increase the living collection of trees in the nursery by collecting cuttings from additional founders, prioritizing those that may otherwise be lost. Collect mature fruit from wild trees when available.
- Determine if the tree in Kaimuhole Gulch is still alive after the 2007 fire
- Prioritize weed management for the fenced sites in Kahuku Training Area and the Kaleleiki PU.
- Investigate permit options for using Tebuconizale in a natural area (see Research Chapter).
- Monitor a subset of *E. koolauensis* plants <2m at Pahipahilua and Kaunala to quantitatively evaluate current survivorship and growth rate trend.
- Obtain a fruit collection from greenhouse plants to send to the National Center for Genetic Resources Preservation for liquid nitrogen seed storage testing.

Table 3.19a Taxon Status Summary

Action Area: In

TaxonName: Eugenia koolauensis TaxonCode: EugKoo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Aimuu	Genetic Storage	5	19	6	0	0	0	0	0	0	5	19	6	This site was visisted by OANRP for the first time this year
Kaiwikoele and Kamananui	Genetic Storage	6	62	19	0	0	0	16	16	15	6	62	19	A thorough census of the known area found more immature plants, dead mature plants and seedlings were observed
Kaleleiki	Genetic Storage	122	159	0	0	0	0	25	30	250	122	159	0	New plants were discovered during surveys and estimates for the known site were revised to count all plants over two meters as mature. No seedlings were observed.
Kaunala	Manage for stability	59	111	137	0	0	0	48	93	6	59	111	137	A thorough census of the known area found more plants
Ohiaai and East Oio	Genetic Storage	5	1	9	0	0	0	5	8	10	5	1	9	Several of the smaller immature plants at this site have died since last monitoring
Oio	Manage for stability	22	17	15	0	0	0	18	56	0	22	17	15	A thorough census found a few more mature trees and seedlings were observed but showed a decline for immature trees
Pahipahialua	Manage for stability	50	33	377	0	0	0	57	234	1	50	33	377	A thorough census was done and found a decline in larger plants, but many more seedlings than had been previously observed. The number of immature trees was significantly less than the previous estimate.
	Total for Taxon:	269	402	563	0	0	0	169	437	282	269	402	563	

Action Area: Out

TaxonName: Eugenia koolauensis TaxonCode: EugKoo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Hanaimoa	Genetic Storage	2	1	1	0	0	0	2	1	1	2	1	1	No monitoring in the last year
Palikea and Kaimuhole	Genetic Storage	3	0	0	0	0	0	3	0	0	3	0	0	Monitoring showed no change
Papali	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	5	1	1	0	0	0	5	1	1	5	1	1	

Table 3.19b Threat Control Summary

Action Area: In

TaxonName: Eugenia koolauensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Aimuu	Genetic Storage	No	No	No	No	No	No
Kaiwikoele and Kamananui	Genetic Storage	No	No	No	No	No	No
Kaleleiki	Genetic Storage	Partial	Yes	No	No	No	No
Kaunala	Manage for stability	Yes	Yes	No	No	No	Partial
Ohiaai and East Oio	Genetic Storage	No	Partial	No	No	No	No
Oio	Manage for stability	Yes	Yes	No	No	No	Partial
Pahipahialua	Manage for stability	Yes	Yes	No	No	No	Partial

Action Area: Out

TaxonName: Eugenia koolauensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Hanaimoa	Genetic Storage	No	No	No	No	No	No
Palikea and Kaimuhole	Genetic Storage	No	No	No	No	No	Partial

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.19c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Eugenia koolauensis							
Aimuu	5	19	0	0	0	0	0
Hanaimoa	2	1	0	0	0	0	0
Kaiwikoele and Kamananui	6	62	0	0	0	0	0
Kaleleiki	122	159	0	0	0	0	0
Kaunala	59	111	4	0	0	0	0
Ohiaai and East Oio	5	1	1	0	0	2	0
Oio	22	17	2	0	0	3	1
Pahipahialua	50	33	3	0	0	7	2
Palikea and Kaimuhole	3	0	0	0	0	1	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	13	3

3.21 FLUEGGEA NEOWAWRAEA

Requirements for Stability

- 4 Population Units (PU) (due to presence in both MMR and Oahu AAs)
- 50 reproducing individuals in each PU (long-lived perennial, dioecious, low to no reproduction, all senescent, major pest problems)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues for MIP Year 6

- Staff spent 330 hours managing this species in the past year. A third of this time was spent establishing reintroductions in the Makaha, Pualii and Kahanahaiki to Kapuna PUs. The other time was spent monitoring these reintroductions, collecting clones from unrepresented trees and tending to the collections at Waimea Botanical Garden.
- All plants are still alive at the outplanting sites established in the Makaha and Keawapilau. The majority of plants in the Makaha PU are healthy, but the majority of plants in the Keawapilau reintroduction (in the Kahanahaiki to Kapuna PU) are moderate.
- A small planting site in Pualii was established using five trees grown from seed collected from the nursery living collection. These trees are all still alive and mostly healthy.
- Clones from 15 of the 36 known trees are established in a living collection at the Pahole Mid-Elevation Nursery. Collections from 2 additional trees were established in the last year by the State Horticulturist and OANRP staff via grafting. These are the first trees to be cloned using grafting techniques. Seventeen trees are now represented *ex situ*.

Plans for MIP Year 7

- Continue to use grafting, air-layering and other vegetative propagation techniques to secure stock from unrepresented trees.
    - Large, cloned nursery stock will be cloned using sapling root stock and approach graft techniques. Root stock will be acquired from Leeward Community College, as they have large trees planted that produce larger quantities of fruit.
    - Efforts to propagate unrepresented *in situ* founders will be via cuttings
- Continue to work to determine the sex of the 3 remaining unknown trees.
- Continue to collect seeds for propagation and genetic storage from the greenhouse collection. The saplings grown from these collections will be used to continue reintroductions.
- Continue to collect and store pollen from male trees in the living collection and in the wild from unrepresented individuals
- Reintroduce into the Makaha and Kahanahaiki to Kapuna PUs

Table 3.20a Taxon Status Summary

Action Area: In

TaxonName: Flueggea neowawraea **TaxonCode: FluNeo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Kapuna	Manage for stability	7	0	0	0	64	0	7	61	0	7	64	0	A few of the reintroduced plants died
Ohikilolo	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change
West Makaleha	Genetic Storage	5	0	0	0	0	0	5	0	0	5	0	0	Monitoring showed no change
	Total for Taxon:	13	0	0	0	64	0	13	61	0	13	64	0	

Action Area: Out

TaxonName: Flueggea neowawraea **TaxonCode: FluNeo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central and East Makaleha	Manage for stability	5	0	0	0	0	0	5	0	0	5	0	0	Monitoring showed no change
Halona	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year
Kauhiuhi	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
Makaha	Manage for stability	10	0	0	0	25	0	10	15	0	10	25	0	More plants were added to the reintroduction sites
Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	0	0	0	The reintroduction will begin once the MU fence is complete
Mikilua	Genetic Storage	0	0	0	0	0	0	1	0	0	0	0	0	The only tree in this PU was observed to be dead in 2009.
Mt. Kaala NAR	Genetic Storage	3	0	0	0	0	0	3	0	0	3	0	0	Monitoring showed no change
Nanakuli, south branch	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
	Total for Taxon:	22	0	0	0	25	0	23	15	0	22	25	0	

Table 3.20b Threat Control Summary

Action Area: In

TaxonName: Flueggea neowawraea

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki to Kapuna	Manage for stability	Partial	Partial	Partial	No	No	No
Ohikilolo	Genetic Storage	Yes	No	No	No	No	No
West Makaleha	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Flueggea neowawraea

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central and East Makaleha	Manage for stability	No	No	No	No	No	No
Halona	Genetic Storage	No	No	No	No	No	No
Kauhiuhi	Genetic Storage	No	No	No	No	No	No
Makaha	Manage for stability	Partial	Partial	No	No	No	No
Manuwai	Manage reintroduction for stability	No	No	No	No	No	No
Mikilua	Genetic Storage	Yes	No	No	No	No	No
Mt. Kaala NAR	Genetic Storage	No	No	No	No	No	No
Nanakuli, south branch	Genetic Storage	No	No	No	No	No	No

(shaded) = Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.20c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Flueggea neowawraea							
Central and East Makaleha	5	0	1	1	0	3	2
Halona	2	0	0	0	0	1	0
Kahanahaiki to Kapuna	7	0	0	2	0	2	2
Kauhiuhi	1	0	0	0	0	1	0
Makaha	10	0	0	0	0	7	2
Mikilua	0	0	1	0	0	0	0
Mt. Kaala NAR	3	0	0	1	1	1	1
Nanakuli, south branch	1	0	0	0	0	1	0
Ohikilolo	1	0	1	0	0	1	1
West Makaleha	5	0	0	0	0	3	2

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
4	1	20	10

3.22 GARDENIA MANII

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (long-lived perennial; large percentage of non-flowering/ fruiting plants)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 121 hours managing this species in the past year. This time was spent establishing and collecting air-layers from the Haleauau and Kaluaa and Maunauna PUs, updating older records from the Kaukonahua PU, and collecting flowers from the Helemano and Poamoho PU. In addition, rare plant surveys surveys were conducted in Haleauau, but did not locate any new trees.
- The trees in the Waianae range have been the first priority for genetic storage collections since only six trees are known to remain (4 from the Haleauau PU and two from the Kaluaa and Maunauna PU). Clones from five trees (including one dead tree) are now established in the nursery.
- In the effort to collect fruit from the Haleauau PU and Helemano and Poamoho PU, it was observed that flowers may be functionally dioecious. Two flower types have been identified. Types vary in pollen presence/absence, anther length and color, and stigma size and shape. Flowers with anthers that contain pollen have not developed into fruit. Flowers collected from the Helemano and Poamoho PU in the last year showed the same trend.

Plans for OIP Year 4

- Conduct monitoring of all Manage for Stability PUs.
- Continue air-layer collection efforts to secure genetic representation of the remaining two individuals of Waianae stock (SBW-A-1 and C-2) and a sampling of Koolau stock particularly from the Manage for Stability PUs.
- Continue pollination and breeding system studies. Many more plants need to be visited to observe flowers and fruit production before dioecy can be concluded. Non-invasive methods to investigate stigma receptivity will be determined and applied.
- Continue to determine the fencing, collection, and threat control strategies for individuals in the Helemano and Poamoho PU and the Lower Peahinaia PU.
- Begin construction of the Lihue MU fence for protection of the Haleauau PU.

Table 3.21a Taxon Status Summary

Action Area: In

TaxonName: Gardenia mannii **TaxonCode: GarMan**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haleauau	Manage for stability	4	0	0	0	0	0	4	0	0	**4**	**0**	**0**	One of the wild trees was observed to be in poor health in the last year and may die soon.
Helemano and Poamoho	Manage for stability	14	0	0	0	0	0	14	0	0	**14**	**0**	**0**	Monitoring showed no change, however several of the trees that were healthy in 2009 are now in poor health and may die in the next year
Kaiwikoele, Kamananui, and Kawainui	Genetic Storage	20	0	0	0	0	0	20	0	0	**20**	**0**	**0**	No monitoring in the last year
Kaukonahua	Genetic Storage	1	0	0	0	0	0	2	0	0	**1**	**0**	**0**	One of the wild plants died in the last year
Lower Peahinaia	Manage for stability	37	1	0	0	0	0	37	1	0	**37**	**1**	**0**	No monitoring in the last year
Opaeula	Genetic Storage	8	0	0	0	0	0	8	0	0	**8**	**0**	**0**	No monitoring in the last year
Opaeula/Helemano	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	85	1	0	0	0	0	86	1	0	**85**	**1**	**0**	

Table 3.21a Taxon Status Summary

Action Area: Out

TaxonName: Gardenia mannii **TaxonCode: GarMan**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ihiihi-Kawainui ridge	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year
Kahana and Makaua	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kaipapau to Punaluu	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kalauao	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kaluaa and Maunauna	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	Monitoring showed no change
Kamananui-Malaekahana Summit Ridge	Genetic Storage	13	0	0	0	0	0	13	0	0	13	0	0	No monitoring in the last year
Kapakahi	Genetic Storage	4	0	0	0	0	0	4	0	0	4	0	0	No monitoring in the last year
Manana-Waimano Ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Pukele	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
Waialae Nui	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	22	0	0	0	0	0	22	0	0	22	0	0	

Table 3.21b Threat Control Summary

Action Area: In

TaxonName: Gardenia mannii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Haleauau	Manage for stability	Partial	No	No	No	No	No
Helemano and Poamoho	Manage for stability	No	No	No	No	No	No
Kaiwikoele, Kamananui, and Kawainui	Genetic Storage	No	No	No	No	No	No
Kaukonahua	Genetic Storage	No	No	No	No	No	No
Lower Peahinaia	Manage for stability	No	No	No	No	No	No
Opaeula	Genetic Storage	No	No	No	No	No	No
Opaeula/Helemano	Genetic Storage	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Gardenia mannii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ihiihi-Kawainui ridge	Genetic Storage	No	No	No	No	No	No
Kaluaa and Maunauna	Genetic Storage	No	No	No	No	No	Partial
Kamananui-Malaekahana Summit Ridge	Genetic Storage	No	No	No	No	No	No
Kapakahi	Genetic Storage	No	No	No	No	No	No
Pukele	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.21c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Gardenia mannii							
Haleauau	4	0	3	0	0	3	0
Helemano and Poamoho	14	0	0	0	0	0	0
Ihiihi-Kawainui ridge	2	0	0	0	0	0	0
Kaiwikoele, Kamananui, and Kawainui	20	0	0	0	0	0	0
Kaluaa and Maunauna	2	0	0	0	0	2	0
Kamananui-Malaekahana Summit Ridge	13	0	0	0	0	0	0
Kapakahi	4	0	0	0	0	0	0
Kaukonahua	1	0	0	0	0	0	0
Lower Peahinaia	37	1	0	0	0	0	0
Opaeula	8	0	0	0	0	0	0
Opaeula/Helemano	1	0	0	0	0	0	0
Pukele	1	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
0	0	5	0

3.23 GOUANIA VITIFOLIA

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (suspected dioecy)
  - *This goal is met for the Keaau PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PU

Major Highlights/Issues for MIP Year 6

- Staff spent 30 hours collecting for genetic storage from both the Keaau and Waianae Kai PUs.
- An aerial survey was conducted near the Keaau PU in the last year, but no new plants were observed.
- Seeds of this species were classified as having physical dormancy (ES-3).

Plans for MIP Year 7

- Survey historic locations in Makaleha and select a reintroduction site there or in Makaha.
- Complete scoping the proposed fence line and facilitate the cultural survey for the Keaau MU fence.
- Continue to collect for genetic storage.
- Complete repairs to the Keaau Valley road to facilitate access for management and fire response.

Table 3.22a Taxon Status Summary

Action Area: In

TaxonName: Gouania vitifolia TaxonCode: GouVit

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Manage for stability	60	1	0	0	0	0	60	1	0	**60**	**1**	**0**	Monitoring showed no change
	Total for Taxon:	60	1	0	0	0	0	60	1	0	**60**	**1**	**0**	

Action Area: Out

TaxonName: Gouania vitifolia TaxonCode: GouVit

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	The reintroduction will begin once the MU fence is complete
Makaleha or Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	The reintroduction will begin once the MU fence is complete
Waianae Kai	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	Monitoring showed no change
	Total for Taxon:	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	

Table 3.22b Threat Control Summary

Action Area: In

TaxonName: Gouania vitifolia

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Keaau	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Gouania vitifolia

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Waianae Kai	Genetic Storage	Yes	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.22c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Gouania vitifolia							
Keaau	60	1	2	46	11	5	36
Waianae Kai	2	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
46	11	5	36

3.24 HEDYOTIS DEGENERI VAR. DEGENERI

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
    - *This goal is met for the Kahanahaiki to Pahole PU.*
- Threats controlled
- Stable population structure
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 133 hours monitoring and collecting seeds for genetic storage in the last year.
- Construction of the Manuwai MU fence is underway. This fence will protect the Manuwai portion of the Alaiheihe to Manuwai PU.
- Seed collections for genetic storage continued from the Alaiheihe to Manuwai and the Central Makaleha and West branch of East Makaleha PUs.

Plans for MIP Year 7

- Conduct monitoring and genetic storage collection at all Manage for Stability PUs.
- Survey for new locations in the East branch of East Makaleha PU.
- Determine a strategy to protect the Central Makaleha and West branch of East Makaleha PU from ungulates.
- Request permission from NARS to conduct a bulk collection of fruit from the Kahanahaiki to Pahole PU to complete seed storage testing.

Table 3.23a Taxon Status Summary

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri TaxonCode: HedDegDeg

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	186	204	100	0	0	0	186	204	100	186	204	100	No monitoring in the last year
	Total for Taxon:	186	204	100	0	0	0	186	204	100	186	204	100	

Action Area: Out

TaxonName: Hedyotis degeneri var. degeneri TaxonCode: HedDegDeg

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Alaiheihe and Manuwai	Manage for stability	21	2	0	0	0	0	27	6	0	21	2	0	Thorough monitoring in the last year showed a decline
Central Makaleha and West Branch of East Makaleha	Manage for stability	23	33	4	0	0	0	23	33	4	23	33	4	Monitoring showed no change
East branch of East Makaleha	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	44	35	4	0	0	0	50	39	4	44	35	4	

Table 3.23b Threat Control Summary

Action Area: In

TaxonName: Hedyotis degeneri var. degeneri

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki to Pahole	Manage for stability	Partial	Partial	No	No	No	No

Action Area: Out

TaxonName: Hedyotis degeneri var. degeneri

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Alaiheihe and Manuwai	Manage for stability	No	No	No	No	No	No
Central Makaleha and West Branch of East Makaleha	Manage for stability	No	No	No	No	No	No
East branch of East Makaleha	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.23c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis degeneri var. degeneri							
Alaiheihe and Manuwai	21	2	7	26	1	2	26
Central Makaleha and West Branch of East Makaleha	23	33	23	31	0	4	28
East branch of East Makaleha	0	0	0	0	0	0	0
Kahanahaiki to Pahole	186	204	12	45	0	4	32

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
102	1	10	86

3.25 HEDYOTIS PARVULA

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Ohikilolo PU and the Halona PU.*
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 18 hours monitoring in situ sites in the Ohikilolo PU in the last year. The sites appeared intact but since every plant was not visited no changes were made to population estimates.

Plans for MIP Year 7

- Secure agreemants with the State of Hawaii to pursue fencing plans for East Makaleha which will protect future reintroduction sites.
- Make a bulk fruit collection from the Ohikilolo PU to complete storage testing.

Table 3.24a Taxon Status Summary

Action Area: In

TaxonName: Hedyotis parvula TaxonCode: HedPar

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ohikilolo	Manage for stability	120	28	40	0	0	0	120	28	40	**120**	**28**	**40**	The site was visited but not thoroughly monitored in the last year so estimates were not revised
	Total for Taxon:	120	28	40	0	0	0	120	28	40	**120**	**28**	**40**	

Action Area: Out

TaxonName: Hedyotis parvula TaxonCode: HedPar

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Makaleha	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	The reintroduction will begin once the MU fence is complete
Halona	Manage for stability	97	35	19	0	0	0	97	35	19	**97**	**35**	**19**	No monitoring in the last year
	Total for Taxon:	97	35	19	0	0	0	97	35	19	**97**	**35**	**19**	

Table 3.24b Threat Control Summary

Action Area: In

TaxonName: Hedyotis parvula

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ohikilolo	Manage for stability	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Hedyotis parvula

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
East Makaleha	Manage reintroduction for stability	No	No	No	No	No	No
Halona	Manage for stability	Yes	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.24c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hedyotis parvula							
East Makaleha	0	0	0	0	0	0	0
Halona	97	35	0	70	0	2	62
Ohikilolo	120	28	5	84	0	0	78

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
154	0	2	140

3.26 HESPEROMANNIA ARBORESCENS

Requirements for Stability

- 3 population units (PUs)
- 25 reproducing individuals (long-lived perennial)
  - *This goal is met for the Kamananui to Kaluanui PU and the Kaukonahua PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 52 hours managing this species in the past year. This time was spent monitoring and collecting from plants in the Koloa section of the Kamananui to Kaluanui PU and in the Poamoho and Kaukonahua PUs.
- Surveys of the historic site in Palikea Gulch found no plants.
- A bulk fruit collection was made from the Kaukonahua PU, but due to low seed set (44 filled seeds / 1092 total possible seeds from 30 fruit) this was not sufficient to begin seed storage testing.
- A bulk fruit collection was attempted from the Poamoho PU but plants were visited to late in the season. A significant decline was observed at this PU.

Plans for OIP Year 4

- Monitor and survey the Lower Opaeula PU to locate more plants and revise population estimates.
- Continue to collect for seed storage testing. Possibly re-visit Kaukonahua PU and visit Kamananui to Kaluanui PU.
- Obtain a license agreement with Kamehameha Schools to begin MU fence construction at the Lower Opaeula PU.
- Survey for plants in a PU with historic records but no known plants (Kapakahi, Halawa, Waimano, Niu-Waimanalo Summit Ridge, Ohiaai Ridge).

Table 3.25a Taxon Status Summary

Action Area: In

TaxonName: Hesperomannia arborescens TaxonCode: HesArbo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamananui to Kaluanui	Manage for stability	56	46	14	0	0	0	56	46	14	**56**	**46**	**14**	No monitoring in the last year
Kaukonahua	Manage for stability	76	56	124	0	0	0	76	56	124	**76**	**56**	**124**	The site was visited but not completely monitored in the last year so the estimates were not revised
Lower Opaeula	Manage for stability	9	15	0	0	0	0	9	15	0	**9**	**15**	**0**	No monitoring in the last year
Ohiaai ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Palikea Gulch	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	Monitoring showed no change
Poamoho	Genetic Storage	22	8	3	0	0	0	38	16	3	**22**	**8**	**3**	Thorough monitoring in the last year showed a decline
	Total for Taxon:	163	125	141	0	0	0	179	133	141	**163**	**125**	**141**	

Action Area: Out

TaxonName: Hesperomannia arborescens TaxonCode: HesArbo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halawa	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Kapakahi	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Niu-Waimanalo Summit Ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
Waimano	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	

Table 3.25b Threat Control Summary

Action Area: In

TaxonName: Hesperomannia arborescens

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kamananui to Kaluanui	Manage for stability	No	No	No	No	No	No
Kaukonahua	Manage for stability	No	No	No	No	No	No
Lower Opaeula	Manage for stability	No	No	No	No	No	No
Palikea Gulch	Manage for stability	No	No	No	No	No	No
Poamoho	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.25c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Hesperomannia arborescens							
Kamananui to Kaluanui	56	46	0	0	0	0	0
Kaukonahua	76	56	1	0	0	0	0
Lower Opaeula	9	15	0	0	0	0	0
Palikea Gulch	0	0	3	0	0	0	0
Poamoho	22	8	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.27 HESPEROMANNIA ARBUSCULA

Requirements for Stability

- 4 Population Units (PUs)
- 75 reproducing individuals in each PU (long-lived perennial but with low seed set, tendency for large declines or fluctuations in population size, and recent severe population declines)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 431 hours managing this species in the past year. 115 hours were spent planning and outplanting the first two reintroductions for this species and the rest of the time was spent monitoring, hand-pollinating and collecting from the remaining in situ sites.
- The Kapuna PU has been changed to include the reintroduction in Keawapilau. It is now called the Pahole NAR PU and will be managed for stability. This new MFS PU replaces the Waianae Kai PU, which was changed to genetic storage. The reintroduction into the new Pualii PU has been selected to replace the North Palawai PU and Pualii will be managed for stability. Both the new Pahole NAR and Pualii PUs were selected over the North Palawai and Waianae Kai PUs based on habitat quality and a better guarantee of long-term management. The Haleauau and Makaha PUs remained the other two MFS PUs.
- Fencing was completed at the Napepeiauolelo genetic storage PU.
- 31 immature plants resulted from the 76 seedlings germinated from last year's pollination efforts and are being grown for reintroduction.
- A total of 39 plants were outplanted this year into Pualii and Upper Kapuna, as a result of the managed breeding efforts over the last several years.
- Hand pollinations were conducted again this year. Efforts were focused on collecting fruit from the Makaha PU and the Haleauau PU. This was the first year the only plant in the Haleauau PU was observed flowering. Unfortunately, none of the six inflorescences pollinated set fruit. T, as is typically observed in plants the first couple years after they reach maturity. Only a single plant produced mature fruit this year. It was in Makaha and the only reproductive plant in Makaha. It was the first time this plant has produced mature fruit and the third time it was flowered. Unfortunately only eight seeds were produced. The pollen donor was not from Haleauau and therefore the Haleauau plant remains unrepresented. However, it was observed to have grown and appeared much healthier.
- All nursery plants from the 2007 and 2008 crosses were measured quarterly as part of the pollination study to measure fitness of offspring. It's been determined that shifting the measuring regime to yearly will be adequate enough to capture variation.
- The Palawai PU was monitored and the only remaining plant is in very poor health and will most likely die soon.
- The Napepeiauolelo PU was monitored and one of the four plants had died and two of the remaining three are poor and are not likely to reach maturity.
- Surveys in Haleauau and Palawai (Honouliuli) failed to locate any new individuals.

Plans for MIP Year 7

- Monitor all plants in all PUs
- Continue surveys for additional populations (SBMR, Waianae Kai, Makaha, Honouliuli)
- Pollinations will be conducted next year to target under-represented crosses
- Clone greenhouse plants with air layers
- Assist Oahu NARS staff in the removal of ungulates from the Upper Kapuna MU fence

- Continue reintroductions into both the Pahole NAR and Pualii PUs with stock produced by hand-pollinations.

Table 3.26a Taxon Status Summary

Action Area: In

TaxonName: Hesperomannia arbuscula TaxonCode: HesArbu

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haleauau	Manage for stability	1	0	0	0	0	0	0	1	0	1	0	0	Monitoring showed no change
Pahole NAR	Manage reintroduction for stability	0	0	0	0	15	0	0	0	0	0	15	0	The reintroduction was begun in the last year
	Total for Taxon:	1	0	0	0	15	0	0	1	0	1	15	0	

Action Area: Out

TaxonName: Hesperomannia arbuscula TaxonCode: HesArbu

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage for stability	3	3	0	0	0	0	2	4	0	3	3	0	One of the wild plants matured in the last year
Napepeiauolelo	Genetic Storage	0	3	0	0	0	0	0	4	0	0	3	0	One of the wild plants died in the last year
North Palawai	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change
Pualii	Manage reintroduction for stability	0	0	0	0	24	0	0	0	0	0	24	0	The reintroduction began in the last year
Waianae Kai	Genetic Storage	2	1	0	0	0	0	2	1	0	2	1	0	Monitoring showed no change
	Total for Taxon:	6	7	0	0	24	0	5	9	0	6	31	0	

Table 3.26b Threat Control Summary

Action Area: In

TaxonName: Hesperomannia arbuscula

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Haleauau	Manage for stability	Yes	No	No	No	No	No
Pahole NAR	Manage reintroduction for stability	Yes	Yes	No	No	No	No

Action Area: Out

TaxonName: Hesperomannia arbuscula

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makaha	Manage for stability	Yes	Yes	No	No	No	No
Napepeiauolelo	Genetic Storage	Yes	Yes	No	No	No	No
North Palawai	Genetic Storage	Yes	No	No	No	No	No
Pualii	Manage reintroduction for stability	Yes	Yes	No	No	No	No
Waianae Kai	Genetic Storage	Yes	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.26c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Hesperomannia arbuscula							
Haleauau	1	0	0	0	0	0	0
Makaha	3	3	1	0	0	1	1
Napepeiauolelo	0	3	0	0	0	0	0
North Palawai	1	0	16	0	2	8	3
Waianae Kai	2	1	8	0	1	2	2

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	3	11	6

3.28 HIBISCUS BRACKENRIDGEI SUBSP. MOKULEIANUS

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 265 hours managing this species in the past year. This time was spent monitoring in all PUs to update population estimates and collect additional clones for genetic storage.
- An aerial survey of the Keaau PU and the surrounding areas did not locate any additional plants. This survey was conducted in February 2010, when the plants were flowering and easier to spot from the air. Future aerial surveys will focus on the north side of Keaau Valley and in the mauka sections that have appropriate habitat.
- A new mature plant and six new immature plants were observed during monitoring of the new Keaau PU in the last year and three had died since being observed in June of 2009. Collections were made and will be used for genetic storage and future reintroductions.
- The name of the Kihakapu PU has been changed to 'Kihakapu and Puulu' to include the sites within that adjacent gulch. These sites have always been included in the counts for this PU and this change is meant to show this.
- OARNP contracted the construction of a 35-acre fuel-break in the *Panicum maximum* dominated fallow agriculture fields along of Kaukonahua Road above Waialua for the second year in a row. This break is in an area where the August 2007 fire crossed the road before burning the *Hibiscus* in the Kaomoku Nui PU, Kihakapu and Puulu PU and the Kaimuhole and Palikea Gulch PU.
- Clones from a total of 35 plants from the fire-threatened Kaomoku Nui PU, Kihakapu and Puulu PU and Kaimuhole and Palikea Gulch PU were collected in the last year for genetic storage. In addition, clones of two plants from the Kealia site were also collected for genetic storage and future reintroductions.
- Several sites had significantly fewer plants. Immature plants observed in 2008 and 2009, were not seen in areas with thick *Panicum maximum*. Since the fire in August 2007 burned some of the native and non-native canopy at several sites, the grass seems to have increased in cover, further restricting the *Hibiscus* to marginal sites where the grass cannot dominate.
- Five of the eleven mature plants reported in the Makua PU for 2009, were observed to have died in the last year. There are now six mature plants. Seedlings under wild plants were observed several times during the last year and 23 were found during the most recent census.
- Monitoring of the augmentation at the Makua PU found that seven of the 55 outplanted individuals have died, however, at least nineteen of these plants flowered in the last year and seedlings were observed under them. Thirty-two plants were added to this site in the last year. They are planted into unoccupied sites within the wild plants and this year make up the most of the mature individuals at that site.
- The reintroduction site at DMR for the Haili to Kawaiu PU has continued to decline. There are now just three plants remaining of the 45 outplanted there in 2005, 2006 and 2008.
- Monitoring of the older reintroductions in Kaluakauila which burned in fires of 2003 and 2006 found seventeen immature plants that had come from individuals planted there in 2002. This site is not actively managed.

Plans for MIP Year 7

- Conduct census monitoring of all Manage for Stability PUs and continue to collect clones from all PUs for genetic storage
- Complete cultural surveys for fencing at the Keaau PU
- Begin the Environmental Assessment for fence construction of the Keaau PU
- Continue to augment the Makua PU with plants grown from clones of all the wild plants
- Select a new reintroduction site for the Haili to Kawaiu PU and begin planting
- Begin another inter-situ planting at MMR Range Control to hold the living collection of the Makua PU and investigate new sites to hold living collections of all other PUs
- Prioritize areas that have not been visited recently for surveys to locate more plants
- Pursue alternate living collection planting sites

Table 3.27a Taxon Status Summary

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus TaxonCode: HibBraMok

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makua	Manage for stability	6	11	23	24	24	0	31	27	1	**30**	**35**	**23**	More plants were added to the reintroduction sites and many seedlings were observed
	Total for Taxon:	6	11	23	24	24	0	31	27	1	**30**	**35**	**23**	

Action Area: Out

TaxonName: Hibiscus brackenridgei subsp. mokuleianus TaxonCode: HibBraMok

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haili to Kawaiu	Manage for stability	6	1	0	3	0	0	20	2	0	**9**	**1**	**0**	The reintroduction continued to decline in the last year
Kaimuhole and Palikea Gulch	Manage for stability	13	153	5	0	0	0	4	1141	10	**13**	**153**	**5**	All of the sites monitored in the last year showed a decline. A few sites were not visited and likely have fewer plants but the estimates were not yet revised. These will be monitored in the next year.
Kaomoku Nui	Genetic Storage	8	8	0	0	0	0	1	114	0	**8**	**8**	**0**	Thorough monitoring in the last year showed a decline
Keaau	Manage for stability	3	7	0	0	0	0	5	2	0	**3**	**7**	**0**	A few more plants were observed in the known sites and two of the known mature plants died
Kihakapu and Puulu	Genetic Storage	6	26	0	0	0	0	2	144	3	**6**	**26**	**0**	Thorough monitoring in the last year showed a decline
	Total for Taxon:	36	195	5	3	0	0	32	1403	13	**39**	**195**	**5**	

Table 3.27b Threat Control Summary

Action Area: In

TaxonName: Hibiscus brackenridgei subsp. mokuleianus

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makua	Manage for stability	Partial	Partial	No	No	No	Yes

Action Area: Out

TaxonName: Hibiscus brackenridgei subsp. mokuleianus

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Haili to Kawaiu	Manage for stability	No	Partial	No	No	No	No
Kaimuhole and Palikea Gulch	Manage for stability	No	No	No	No	No	Partial
Kaomoku Nui	Genetic Storage	Partial	No	No	No	No	Partial
Keaau	Manage for stability	No	No	No	No	No	No
Kihakapu and Puulu	Genetic Storage	No	No	No	No	No	Partial

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.27c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Hibiscus brackenridgei subsp. mokuleianus							
Haili to Kawaiu	6	1	6	0	0	11	7
Kaimuhole and Palikea Gulch	13	153	8	1	0	32	19
Kaomoku Nui	8	8	9	1	0	15	6
Keaau	3	7	3	1	0	6	3
Kihakapu and Puulu	6	26	3	3	0	18	12
Makua	6	11	26	20	0	29	29

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
26	0	111	76

3.29 HUPERZIA NUTANS

Requirements for Stability

- 3 population units (PUs)
- Help to develop propagation techniques
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- One site in the Koloa and Kaipapau PU was monitored in the last year. A collection of fruiting strobili with spores from one plant was made. Some were put into storage and the rest were plated on agar, however nothing has germinated yet.

Plans for OIP Year 4

- Continue to develop propagation techniques using *H. phyllanthus.*
- Work with the Oahu Plant Extinction Prevention Program to monitor all known plants and conduct surveys to locate more.
- Obtain a license agreement from Hawaii Reserves Inc. to construct the Koloa MU fence.

Table 3.28a Taxon Status Summary

Action Area: In

TaxonName: Huperzia nutans TaxonCode: HupNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahana and North Kaukonahua	Manage for stability	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	No monitoring in the last year
Koloa and Kaipapau	Manage for stability	3	2	0	0	0	0	3	2	0	**3**	**2**	**0**	Monitoring showed no change
South Kaukonahua	Manage for stability	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	9	2	0	0	0	0	9	2	0	**9**	**2**	**0**	

Table 3.28b Threat Control Summary

Action Area: In

TaxonName: Huperzia nutans

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahana and North Kaukonahua	Manage for stability	No	No	No	No	No	No
Koloa and Kaipapau	Manage for stability	No	No	No	No	No	No
South Kaukonahua	Manage for stability	No	No	No	No	No	No

(shaded) = Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.28c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Huperzia nutans							
Kahana and North Kaukonahua	5	0	1	0	0	0	0
Koloa and Kaipapau	3	2	0	0	0	0	0
South Kaukonahua	1	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.30 LABORDIA CYRTANDRAE

Requirements for Stability

- 100 individuals from East Makaleha to North Mohiakea (serves as 2 PUs), 50 individuals from the Manana area (long-lived perennial; dioecious; low seed set)
- Stable population structure
- Threats controlled
- Complete genetic storage of both PUs
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 433 hours managing this species in the past year. This time was spent monitoring, hand-pollinating and collecting from the remaining in situ sites in both PUs.
- 6 additional plants were found in the East Makaleha to North Mohiakea PU this year and a few died. The majority of the plants have been observed to be declining in vigor. Many sites are heavily over-grown with weeds and some are still impacted by pigs.
- Five mature plants in the reintroductions at the Kaala MU died in the last year. Thirteen of the 23 plants reintroduced in 2003, remain at the three outplanting sites above Makaleha. The reintroduction site at Haleauau has 12 plants remaining of the 15 planted in 2004 and 2006.
- The current Kaala MU fence is not adequate in excluding pigs from the MU. There has been documented damage to *L. cyrtandrae* and the ungulate threat level for the PU is high. A fence extension to the Waianae Kai section has been surveyed and OANRP is waiting on the MOU with the State of Hawaii.
- Managed breeding efforts continued at Kaala. Using refined methods and timing based on lessons learned last year, OANRP were able to pollinate over twice as many flowers (300) and include two more females than the previous year, for a total of 6 females. Immature fruit is still developing on the plants and fruit checks will begin in October 2010.
- OPEP and OANRP visited the Manana individual 2 times in the last year in an effort to collect pollen from the lone male plant. Pollen was collected and was applied to a flowering plant in the nursery. At this time, the plant is still holding immature fruit.
- Significant control of *Hedychium gardenerianum has been ongoing around populations of L. cyrtandrae.* In September 2009, aerial surveys to map the extent of the *H. gardenerianum infestation* were conducted in Haleauau. This weed is a major threat to the habitat for *L. cyrtandrae* and a control strategy is being developed.

Plans for OIP Year 4

- Complete construction of Kaala MU fence extension and eradicate pigs
- Begin Lihue fence.
- Continue to hand-pollinate additional females and collect fruit for propagation and storage.
- Survey historic sites in the Koolau Mountains to find additional plants
- Monitor and determine the sex of newly discovered and other unknown plants.
- Reintroduce plants into pig-free areas in the Kaala MU once the fence extension is complete.

Table 3.29a Taxon Status Summary

Action Area: In

TaxonName: Labordia cyrtandrae TaxonCode: LabCyr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
East Makaleha to North Mohiakea	Manage for stability	72	4	0	13	13	0	87	16	0	85	17	0	New plants were discovered during surveys and a few more wild and reintroduced plants have died
	Total for Taxon:	72	4	0	13	13	0	87	16	0	85	17	0	

Action Area: Out

TaxonName: Labordia cyrtandrae TaxonCode: LabCyr

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Manana	Manage for stability	1	0	0	0	0	0	1	0	0	1	0	0	Monitoring showed no change
	Total for Taxon:	1	0	0	0	0	0	1	0	0	1	0	0	

Table 3.29b Threat Control Summary

Action Area: In

TaxonName: Labordia cyrtandrae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
East Makaleha to North Mohiakea	Manage for stability	Partial	Partial	No	No	No	No

Action Area: Out

TaxonName: Labordia cyrtandrae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Manana	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.29c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Labordia cyrtandrae							
East Makaleha to North Mohiakea	72	4	3	5	4	13	10
Manana	1	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
5	4	13	10

3.31 LOBELIA GAUDICHAUDII SUBSP. KOOLAUENSIS

Requirements for Stability

- 3 population units (PU)
- 100 reproducing individuals (short-lived perennial; monocarpic; inconsistent flowering)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 3 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 7 hours managing this species in the past year. This time was spent monitoring the plants at both the Kaukonahua PU and the Kawaiiki PU. Flowers and immature fruit were observed in both PUs.
- The population estimate for the Kaukonahua PU was revised to show a small decline from the previous estimate conducted in May 2009.
- We can only currently identify this species by the flowers. Since both subspecies of this taxon cohabitate the Kawaiiki PU, we are unable to estimate the number of immature plants.

Plans for OIP Year 4

- In the coming year, OANRP will attempt to collect seed from the Kaukonahua PU for additional storage testing and genetic storage.
- Prioritize with partner agencies future fences for the protection of this species

Table 3.30a Taxon Status Summary

Action Area: In

TaxonName: Lobelia gaudichaudii subsp. koolauensis   TaxonCode: LobGauKoo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaukonahua	Manage for stability	1	29	1	0	0	0	1	35	1	**1**	**29**	**1**	Small changes were noted during monitoring in the last year
Kawaiiki	Genetic Storage	15	0	0	0	0	0	2	0	0	**15**	**0**	**0**	Monitoring showed no change
	Total for Taxon:	16	29	1	0	0	0	3	35	1	**16**	**29**	**1**	

Action Area: Out

TaxonName: Lobelia gaudichaudii subsp. koolauensis   TaxonCode: LobGauKoo

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kipapa	Manage for stability	0	100	20	0	0	0	0	100	20	**0**	**100**	**20**	No monitoring in the last year
Waiawa to Waimano	Manage for stability	0	200	0	0	0	0	0	200	0	**0**	**200**	**0**	No monitoring in the last year
	Total for Taxon:	0	300	20	0	0	0	0	300	20	**0**	**300**	**20**	

Table 3.30b Threat Control Summary

Action Area: In

TaxonName: Lobelia gaudichaudii subsp. koolauensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaukonahua	Manage for stability	No	No	No	No	No	No
Kawaiiki	Genetic Storage	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Lobelia gaudichaudii subsp. koolauensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kipapa	Manage for stability	No	No	No	No	No	No
Waiawa to Waimano	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.30c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Lobelia gaudichaudii subsp. koolauensis							
Kaukonahua	1	29	0	4	0	0	3
Kawaiiki	15	0	2	2	0	0	2
Kipapa	0	100	0	0	0	0	0
Waiawa to Waimano	0	200	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
6	0	0	5

3.32 MELANTHERA TENUIFOLIA

Requirements for Stability

- 3 Population Units (PUs)
- 50 genetically unique individuals in each PU (short-lived perennial with tendency to reproduce vegetatively)*
  - *This goal is met for all three MFS PUs (Mt. Kaala NAR PU, the Ohikilolo PU and the Kamaileunu and Waianae Kai PU).*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

* It is difficult to distinguish genetic individuals, since vegetative reproduction creates identical adjacent plants. Genetic studies suggest that plant material separated by >2 m is genetically distinct.

Major Highlights/Issues Year 6

- Staff spent 64 hours managing this species in the past year. This time was mostly spent monitoring the PUs with a high fire threat, including Kaluakauila, Keawaula, Ohikilolo and Mt. Kaala NAR and collecting clones from additional plants for genetic storage.
- Construction of the Manuwai MU fence is underway. When completed, it will protect the Mt. Kaala NAR PU.
- Many new plants were discovered in an under-surveyed section of the Kaluakauila PU in February 2010. A fire at MMR in July 2010, burned all of the newly discovered plants, but left some areas intact (ES-2). The population estimates were revised after post-fire surveys. Cuttings (clonal) were made from several of the remaining plants to supplement the existing nursery living collection.
- The population estimate for the Keawaula PU was revised after surveys in the last year found many more plants.
- A few plants were found at a new site in Makaha in the last year. These will be managed as part of the Kamaileunu and Waianae Kai PU. Also, two new clumps of plants were noted within the Ohikilolo PU in the last year.
- A temperature data logger has been maintained at one wild site in the Ohikilolo PU to help determine what temperature fluctuations may stimulate germination in situ. Additional dataloggers still need to be placed at other sites to capture the temperature range across the elevation gradient of this taxon.

Plans for Year 7

- Complete the Manuwai MU fence, which will protect plants in the Mt. Kaala NAR PU.
- Revisit small PUs that are highly threatened by fire from training at MMR and collect clones from new founders to expand the greenhouse genetic storage collections.
- Determine how greenhouse plants will be used to produce seed for storage.
- Continue studies to investigate dormancy-breaking mechanisms in order to determine the storage potential of seeds collected for genetic storage goals.
- Deploy additional data loggers at higher elevation sites in the Ohikilolo PU.
- Determine a strategy to protect the Kamaileunu and Waianae Kai PU from ungulate threats.

Table 3.31a Taxon Status Summary

Action Area: In

TaxonName: Melanthera tenuifolia TaxonCode: MelTen

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	11	2	2	0	0	0	11	2	2	**11**	**2**	**2**	No monitoring in the last year
Kaluakauila	Genetic Storage	92	71	1	0	0	0	64	20	40	**92**	**71**	**1**	A thorough census of the known area found more plants but some were burned in the 2010 fire
Keawaula	Genetic Storage	60	33	0	0	0	0	45	15	0	**60**	**33**	**0**	A thorough census of the known area found more plants
Ohikilolo	Manage for stability	1233	0	0	0	0	0	1233	0	0	**1233**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	1396	106	3	0	0	0	1353	37	42	**1396**	**106**	**3**	

Action Area: Out

TaxonName: Melanthera tenuifolia TaxonCode: MelTen

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu and Waianae Kai	Manage for stability	883	269	297	0	0	0	880	269	297	**883**	**269**	**297**	A few more plants were observed in the known sites
Mt. Kaala NAR	Manage for stability	300	0	0	0	0	0	300	0	0	**300**	**0**	**0**	The site appeared stable when monitored in the last year, but estimates were not revised
	Total for Taxon:	1183	269	297	0	0	0	1180	269	297	**1183**	**269**	**297**	

Table 3.31b Threat Control Summary

Action Area: In

TaxonName: Melanthera tenuifolia

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki	Genetic Storage	Partial	No	No	No	No	No
Kaluakauila	Genetic Storage	Yes	No	No	No	No	No
Keawaula	Genetic Storage	No	No	No	No	No	No
Ohikilolo	Manage for stability	Yes	Partial	No	No	No	Partial

Action Area: Out

TaxonName: Melanthera tenuifolia

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kamaileunu and Waianae Kai	Manage for stability	No	No	No	No	No	No
Mt. Kaala NAR	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.31c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Melanthera tenuifolia							
Kahanahaiki	11	2	25	1	0	25	16
Kaluakauila	92	71	0	2	0	11	11
Kamaileunu and Waianae Kai	883	269	0	0	0	0	0
Keawaula	60	33	0	0	0	0	0
Mt. Kaala NAR	300	0	0	0	0	0	0
Ohikilolo	1233	0	35	15	0	16	13

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
18	0	52	40

3.33 MELICOPE LYDGATEI

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals (long-lived perennial with threats from invertebrates)
- Threats controlled
- Stable population structure
- Surveys to find one additional PU
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- A couple of hours were spent monitoring and collecting cuttings from a single plant in the Kawaiiki and Opaeula PU. This was done while visiting the site for a cultural survey of the proposed fence. No other management was conducted in the last year.

Plans for OIP Year 4

- Conduct a survey and monitoring trip for the Kawaiiki and Opaeula PU to update population status and collect for genetic storage.
- Conduct surveys for additional PUs.
- A longer-term license agreement that will cover fencing actions should be coming in the next year. This will allow OANRP and KWMP to pursue fencing which will protect about half of the plants in the Kawaiiki to Opaeula PU.

Table 3.32a Taxon Status Summary

Action Area: In

TaxonName: Melicope lydgatei TaxonCode: MelLyd

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaiwikoele-Kawainui Ridge	Manage for stability	3	0	0	0	0	0	3	0	0	3	0	0	No monitoring in the last year
Kawaiiki and Opaeula	Manage for stability	42	0	0	0	0	0	42	0	0	42	0	0	Parts of this PU were visited in the last year. A sinlge plant was observed while surveying for fence construction but a complete monitoring was not done.
Poamoho	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	45	0	0	0	0	0	45	0	0	45	0	0	

Action Area: Out

TaxonName: Melicope lydgatei TaxonCode: MelLyd

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Manana	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	0	0	0	0	0	0	0	0	0	0	0	0	

Table 3.32b Threat Control Summary

Action Area: In

TaxonName: Melicope lydgatei

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaiwikoele-Kawainui Ridge	Manage for stability	No	No	No	No	No	No
Kawaiiki and Opaeula	Manage for stability	No	No	No	No	No	No
Poamoho	Genetic Storage	No	No	No	No	No	No

(shaded) = Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.32c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Melicope lydgatei							
Kaiwikoele-Kawainui Ridge	3	0	0	0	0	1	1
Kawaiiki and Opaeula	42	0	1	0	0	0	0
Poamoho	0	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	1	1

3.34 MYRSINE JUDII

Requirements for Stability

- Maintain at least 75 reproducing individuals throughout the range of this species (from Kaukonahua to Kamananui-Koloa) (Long lived perennial)
    - *This goal is met for the only PU (Kaukonahua to Kamananui-Koloa).*
- Stable population structure
- Threats controlled
- Complete genetic storage from across Kaukonahua to Kamananui-Koloa
- Tier 2 stabilization priority

Major Highlights/Issues OIP Year 3

- No management was conducted in the last year

Plans for OIP Year 4

- OANRP will continue to refine population estimates and collect GPS data to create a more accurate description of species distribution.

Table 3.33a Taxon Status Summary

Action Area: In

TaxonName: Myrsine juddii **TaxonCode: MyrJud**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaukonahua to Kamananui-Koloa	Manage for stability	455	0	0	0	0	0	455	0	0	455	0	0	This is an estimate for the entire range in the Northern Koolaus and has not been updated in the last year
	Total for Taxon:	455	0	0	0	0	0	455	0	0	455	0	0	

Table 3.33b Threat Control Summary

Action Area: In

TaxonName: Myrsine juddii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaukonahua to Kamananui-Koloa	Manage for stability	Partial	Partial	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.33c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Myrsine juddii							
Kaukonahua to Kamananui-Koloa	455	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.35 NERAUDIA ANGULATA

Requirements for Stability

- 4 Population Units (PUs) (high fire threat)
- 100 reproducing individuals in each Manage for Stability PU (short-lived perennial, mostly dioecious, prone to large declines or fluctuations in population size)
  - *This goal is met for the Kaluakauila PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 328 hours managing this species in the past year. About a third of this time was spent reintroducing plants to existing sites. The other time was spent monitoring and collecting from the remaining in situ sites.
- The wild sites in the Makua PU were observed to have declined over the past year, but more surveys need to be completed to verify the latest observations.
- Thirty-four additional plants were added to the reintroduction in the Makua PU. F1 seedlings and immature plants have been observed beneath outplanted individuals.
- No new plants were observed at the historic site in Manuwai.
- Construction began on the Manuwai MU fence. It will protect the historic site and secure habitat for future reintroduction.
- The Waianae Kai Makai PU fence was completed and will protect this site from goats.
- Monitoring of the Waianae Kai Mauka PU showed a significant decline from previous estimates made in 2005. An upper fenceline to complete the MU fence was scoped and planned in the last year and is ready to be built. The lower fence was completed in 2009. Collections of clones from seven plants were made for genetic storage and possible future reintroductions.
- One of the reintroduction sites in the Kaluakauila PU (MMR-F) has many plants reaching over 2 m in height. One plant planted in 2004 is now 2.36 meters in height and 5.7 cm at the base. Few seedlings have been observed and none were observed during monitoring in the last year. The reintroduction site at lower Kaluakauila has not performed as well and a new site will be selected in the next year.
- The remaining wild plants in the Kapuna PU died in the last year. This leaves the single plant at the Punapohaku PU as the only wild site with var. *dentata.* Clones of all the known plants from PUs with var. *dentata* (Kapuna, Punapohaku and Manuwai) are used in the reintroductions for the Kaluakauila PU and kept in the nursery for genetic storage.
- A new site with two mature plants was observed in Makaha and will be managed as part of the Makaha PU. This site was not well surveyed and may have additional plants.
- The known site in Makaha was monitored and collections were made from three new plants. This monitoring was not completed and this site will be visited again in the next year to collect clones from additional founders. The site appeared to be stable and the estimate was not revised.
- The July 2010 fire in Makua burned within 20 meters of a reintroduction site in the Kaluakauila PU and within 60 meters of the wild plant at the Punapohaku PU.

Plans for MIP Year 7

- Complete the Manuwai MU fence.
- Complete PU fences around the Waianae Kai Mauka PU.
- Continue to supplement the Kaluakauila PU and select a new area for the lower site
- Continue to supplement the Makua PU and search for another outplanting site.

- Conduct census monitoring at all MFS PUs
- Continue to collect clones from new founders at wild populations in order to meet genetic storage goals with living collections in the greenhouse.
- Continue monitoring wild and outplanted plants to guide reintroduction plans and gather further information about life histories, sex ratios, reproductive strategies, and habitat requirements.
- Continue weeding operations below cliffs of populations to improve conditions for regeneration.

Table 3.34a Taxon Status Summary

Action Area: In

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluakauila	Manage reintroduction for stability	0	0	0	125	3	0	113	24	1	**125**	**3**	**0**	More plants were added to the reintroduction sites
Kapuna	Genetic Storage	0	0	0	0	0	0	2	0	0	**0**	**0**	**0**	The remaining wild plants died in the last year
Makua	Manage for stability	10	38	5	38	0	0	28	83	3	**48**	**38**	**5**	More plants were added to the reintroduction sites many outplants matured and the wild site declined
Punapohaku	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	Monitoring showed no change
	Total for Taxon:	11	38	5	163	3	0	144	107	4	**174**	**41**	**5**	

Action Area: Out

TaxonName: Neraudia angulata **TaxonCode: NerAng**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Genetic Storage	30	4	0	0	0	0	30	4	0	**30**	**4**	**0**	No monitoring in the last year
Leeward Puu Kaua	Genetic Storage	9	0	0	0	0	0	9	0	0	**9**	**0**	**0**	No monitoring in the last year
Makaha	Genetic Storage	12	0	0	0	0	0	10	0	0	**12**	**0**	**0**	New plants were discovered during surveys
Manuwai	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	Monitoring showed no change
Waianae Kai Makai	Genetic Storage	45	35	25	0	0	0	46	35	25	**45**	**35**	**25**	Monitoring showed no change
Waianae Kai Mauka	Manage for stability	16	4	0	0	0	0	43	25	4	**16**	**4**	**0**	Monitoring of this wild site showed a significant decline from the estimate made in 2005
	Total for Taxon:	112	43	25	0	0	0	138	64	29	**112**	**43**	**25**	

Table 3.34b Threat Control Summary

Action Area: In

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaluakauila	Manage reintroduction for stability	Yes	Yes	Yes	No	No	No
Kapuna	Genetic Storage	No	No	No	No	No	No
Makua	Manage for stability	Yes	Partial	No	No	No	No
Punapohaku	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Neraudia angulata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Halona	Genetic Storage	No	No	No	No	No	No
Leeward Puu Kaua	Genetic Storage	No	No	No	No	No	No
Makaha	Genetic Storage	No	No	No	No	No	No
Manuwai	Manage for stability	No	No	No	No	No	No
Waianae Kai Makai	Genetic Storage	Yes	No	No	No	No	Partial
Waianae Kai Mauka	Manage for stability	No	Partial	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.34c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Neraudia angulata							
Halona	30	4	0	0	0	11	8
Kapuna	0	0	2	1	0	2	2
Leeward Puu Kaua	9	0	0	0	0	1	1
Makaha	12	0	11	2	0	10	8
Makua	10	38	62	2	0	29	13
Manuwai	0	0	7	0	0	2	2
Punapohaku	1	0	0	0	0	1	1
Waianae Kai Makai	45	35	0	0	0	0	0
Waianae Kai Mauka	16	4	1	0	0	7	4

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
5	0	63	39

3.36 NOTOTRICHIUM HUMILE

Requirements for Stability

- 4 Population Units (PUs) (4 due to high fire risk to PU)
- 25 reproducing individuals in each PU (long-lived perennial)
    - *This goal is met for all four MFS PUs (Kaluakauila PU, the Makua (south side) PU, the Waianae Kai PU and the Kaimuhole and Palikea PU).*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 50 hours managing this species in the past year. This time was spent monitoring in situ sites with small populations or high fire threats in the Kaluakauila, Waianae Kai, Keawaula, Kaimuhole and Palikea Gulch and Keawapilau PUs and the living collection at Waimea Botanical Garden. Time was also spent assessing the fire damage to the Punapohaku and Kaluakauila PUs from the July 2010 fire at MMR (ES-2).
- Fence construction for the Waianae Kai PU was completed.
- A few more plants were found in a new site in Makaha during fence surveys in the last year. They will be managed as part of the Makaha PU.
- OARNP contracted the construction of a 35-acre fuel-break in the *Panicum maximum* dominated fallow agriculture fields along Kaukonahua Road above Waialua for the second year in a row. This break is in an area where the August 2007 fire crossed the road before burning within a few meters of the plants in the Kaimuhole and Palikea PU.

Plans for MIP Year 7

- Conduct census monitoring at all MFS PUs. Several PU have not been thoroughly monitored in several years.
- Continue to maintain the living collection of clones from the smallest and most fire-threatened PUs in the greenhouse and at Waimea Botanical Garden and select another PU to represent with a living collection at Waimea Botanical Garden.
- Mating and breeding system studies will be initiated with plants in the greenhouse that will be transplanted into larger containers or planted in the ground to promote flowering.
- Develop a strategy to monitor and collect from the Keaau, Nanakuli, Makua (East Rim) & Makaha PUs. These have not been observed recently and have had few or no collections for genetic storage.
- Continue to collect from founders in the Kaimuhole and Palikea Gulch and Kolekole (east side) PUs.
- Assess the ungulate threat to the Kaimuhole and Palikea Gulch (Kihakapu) PU and consider PU fence options if necessary.
- Make bulk fruit collections from large wild population sites to compare in situ seed set with the low seed set observed at the Waimea Botanical Garden in August 2009.

Table 3.35a Taxon Status Summary

Action Area: In

TaxonName: Nototrichium humile TaxonCode: NotHum

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	71	7	0	0	0	0	67	10	0	**71**	**7**	**0**	A new site with two plants was discovered in the last year.
Kaluakauila	Manage for stability	198	35	0	0	0	0	198	35	0	**198**	**35**	**0**	No monitoring in the last year
Keaau	Genetic Storage	21	31	0	0	0	0	21	31	0	**21**	**31**	**0**	No monitoring in the last year
Keawaula	Genetic Storage	138	5	0	0	0	0	138	5	0	**138**	**5**	**0**	Monitoring showed no change
Makua (East rim)	Genetic Storage	1	0	0	0	0	0	1	0	0	**1**	**0**	**0**	No monitoring in the last year
Makua (south side)	Manage for stability	56	1	0	6	0	0	66	1	0	**62**	**1**	**0**	Small changes were noted during monitoring in the last year
Punapohaku	Genetic Storage	302	14	7	0	0	0	302	14	7	**302**	**14**	**7**	Post fire surveys have not yet confirmed, but up to 16 plants may have died in the 2010 Makua fire. Estimates wil lbe revised in the coming year after surveys of all the sites
	Total for Taxon:	787	93	7	6	0	0	793	96	7	**793**	**93**	**7**	

Table 3.35a Taxon Status Summary

Action Area: Out

TaxonName: Nototrichium humile TaxonCode: NotHum

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaimuhole and Palikea Gulch	Manage for stability	55	4	0	0	0	0	53	5	0	**55**	**4**	**0**	Small changes were noted during monitoring in the last year
Keawapilau	Genetic Storage	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	Monitoring showed no change
Kolekole (east side)	Genetic Storage	12	0	0	0	0	0	12	0	0	**12**	**0**	**0**	No monitoring in the last year
Makaha	Genetic Storage	22	5	0	0	0	0	15	3	0	**22**	**5**	**0**	New plants were discovered during surveys
Nanakuli	Genetic Storage	5	0	0	0	0	0	5	0	0	**5**	**0**	**0**	No monitoring in the last year
Puu Kaua (Leeward side)	Genetic Storage	2	0	0	0	0	0	2	0	0	**2**	**0**	**0**	No monitoring in the last year
Waianae Kai	Manage for stability	199	105	0	0	0	0	199	105	0	**199**	**105**	**0**	Monitoring showed no change
	Total for Taxon:	300	114	0	0	0	0	291	113	0	**300**	**114**	**0**	

Table 3.35b Threat Control Summary

Action Area: In

TaxonName: Nototrichium humile

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki	Genetic Storage	Partial	Partial	Partial	No	No	No
Kaluakauila	Manage for stability	Yes	Partial	Partial	No	No	No
Keaau	Genetic Storage	No	No	No	No	No	No
Keawaula	Genetic Storage	No	No	No	No	No	No
Makua (East rim)	Genetic Storage	Partial	No	No	No	No	No
Makua (south side)	Manage for stability	Partial	Partial	No	No	No	No
Punapohaku	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Nototrichium humile

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaimuhole and Palikea Gulch	Manage for stability	No	No	No	No	No	Partial
Keawapilau	Genetic Storage	No	No	No	No	No	No
Kolekole (east side)	Genetic Storage	Partial	No	No	No	No	No
Makaha	Genetic Storage	No	Partial	No	No	No	No
Nanakuli	Genetic Storage	No	No	No	No	No	No
Puu Kaua (Leeward side)	Genetic Storage	No	No	No	No	No	No
Waianae Kai	Manage for stability	Partial	No	No	No	No	Partial

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.35c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Nototrichium humile							
Kahanahaiki	71	7	1	3	0	10	9
Kaimuhole and Palikea Gulch	55	4	0	0	0	25	22
Kaluakauila	198	35	0	5	0	0	4
Keaau	21	31	0	0	0	0	0
Keawapilau	5	0	0	0	0	5	2
Keawaula	138	5	0	0	0	9	8
Kolekole (east side)	12	0	0	0	0	10	6
Makaha	22	5	0	0	0	0	0
Makua (East rim)	1	0	0	0	0	0	0
Makua (south side)	56	1	0	0	0	0	0
Nanakuli	5	0	0	0	0	0	0
Punapohaku	302	14	1	0	0	11	10
Puu Kaua (Leeward side)	2	0	0	0	0	0	0
Waianae Kai	199	105	0	0	0	4	2

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
8	0	74	63

3.37 PHYLLOSTEGIA HIRSUTA

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 31 hours managing this species in the past year. This time was spent monitoring and collecting from in situ sites.
- Collections of vegetative propagules were made from a new wild plant in the Haleauau to Mohiakea PU and from two new plants in the Hapapa to Kaluaa PU. These are becoming established in the greenhouse and will be used as genetic storage and for future reintroductions.
- Surveys of a site (ELI-B) in the Hapapa to Kaluaa PU observed no plants from where a single plant was known of in 2006.
- No plants were observed during surveys of the SBE-A site in the Kaukonahua PU. In 2001, 6 plants were observed.
- A new site with a single mature plant was observed during snail surveys in Kawainui in the last year. This site will be managed as part of the Kaipapau and Kawainui Genetic Storage PU.

Plans for OIP Year 4

- Conduct census monitoring at the Haleauau to Mohiakea PU and the Hapapa to Kaluaa Manage for Stability PU.
- Re-collect the putative hybrid at Crispa Rock in the Kaipapau and Kawainui PU.
- Continue surveys in the Koloa MU.
- Begin construction of the Schofield Barracks Lihue Fence.
- Establish clones of the nursery living collection at the Lyon Arboretum micropropagation lab.
- Collect propagules from Mohiakea and Makaha-Waianae Kai Ridge PUs for a possible augmentation in the Kaala MU.
- Complete the Kaala fence extension and eradicate pigs from the fenced area.
- Continue to monitor recently extirpated sites (Palawai and Huliwai) for any new founders.
- Begin site preparation at Kaluaa for future outplanting

Table 3.36a Taxon Status Summary

Action Area: In

TaxonName: Phyllostegia hirsuta **TaxonCode: PhyHir**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haleauau to Mohiakea	Manage for stability	8	10	0	0	0	0	8	10	0	8	10	0	One site was monitored in the last year and appeared stable. The estimates were not revised since all sites were not observed.
Helemano and Opaeula	Genetic Storage	13	2	6	0	0	0	13	2	6	13	2	6	No monitoring in the last year
Helemano to Poamoho	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
Kaipapau and Kawainui	Genetic Storage	9	0	0	0	0	0	9	0	0	9	0	0	No monitoring in the last year
Kaukonahua	Genetic Storage	0	0	0	0	0	0	4	2	0	0	0	0	The wild plants died in the last year
Kawaiiki	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Laie & Puu Kainapuaa	Manage for stability	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	31	12	6	0	0	0	35	14	6	31	12	6	

Action Area: Out

TaxonName: Phyllostegia hirsuta **TaxonCode: PhyHir**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Hapapa to Kaluaa	Manage for stability	3	10	1	0	0	0	3	11	3	3	10	1	Small changes were noted during monitoring of the wild sites in the last year
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kaluanui	Genetic Storage	5	0	0	0	0	0	5	0	0	5	0	0	No monitoring in the last year
Makaha-Waianae Kai Ridge	Genetic Storage	2	0	0	0	0	0	2	0	0	2	0	0	No monitoring in the last year
Palawai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	10	10	1	0	0	0	10	11	3	10	10	1	

Table 3.36b Threat Control Summary

Action Area: In

TaxonName: Phyllostegia hirsuta

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Haleauau to Mohiakea	Manage for stability	No	No	No	No	No	No
Helemano and Opaeula	Genetic Storage	No	No	No	No	No	No
Helemano to Poamoho	Genetic Storage	No	No	No	No	No	No
Kaipapau and Kawainui	Genetic Storage	No	No	Partial	No	No	No
Kaukonahua	Genetic Storage	No	No	No	No	No	No
Kawaiiki	Genetic Storage	No	No	No	No	No	No
Laie & Puu Kainapuaa	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Phyllostegia hirsuta

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ekahanui	Genetic Storage	Yes	No	No	No	No	No
Hapapa to Kaluaa	Manage for stability	Partial	No	Partial	No	No	No
Huliwai	Genetic Storage	No	No	No	No	No	No
Kaluanui	Genetic Storage	No	No	No	No	No	No
Makaha-Waianae Kai Ridge	Genetic Storage	No	No	No	No	No	No
Palawai	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.36c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Phyllostegia hirsuta							
Ekahanui	0	0	0	0	0	0	0
Haleauau to Mohiakea	8	10	0	0	1	0	1
Hapapa to Kaluaa	3	10	1	1	0	2	1
Helemano and Opaeula	13	2	1	0	0	0	0
Helemano to Poamoho	1	0	0	0	0	0	0
Huliwai	0	0	3	0	0	1	1
Kaipapau and Kawainui	9	0	0	0	0	0	0
Kaluanui	5	0	0	0	0	0	0
Kaukonahua	0	0	0	0	0	0	0
Kawaiiki	0	0	0	0	0	0	0
Laie & Puu Kainapuaa	0	0	0	0	0	0	0
Makaha-Waianae Kai Ridge	2	0	0	0	0	0	0
Palawai	0	0	1	0	0	1	0

Total # Plants w/ >=10 Seeds in SeedLab	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
1	1	4	3

3.38 PHYLLOSTEGIA KAALAENSIS

Requirements for Stability

- 4 Population Units (PUs) (in both Makua and Oahu AA, no extant wild plants and all PUs are dependant on reintroduction)
- 50 genetically unique, reproducing individuals in each PU (short-lived perennial, reproduce vegetatively)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 18 hours managing this species in the past year. This time was spent monitoring the existing reintroduction sites.
- Genetic storage goals are met with all available founders (8) represented at Lyon Arboretum at the Micropropagation Lab.
- Construction of the Manuwai MU fence is underway. This fence will protect habitat for future outplanting sites.
- Trials to grow plants for new reintroductions using a new bulb-pan container are ongoing.
- A single plant was observed remaining in the Makaha PU reintroduction site. All plants were thought to be dead as of August 2009, but one appears to have remained alive since March of 2007 and produced another shoot this year. The last remaining plant from the Pahole PU reintroduction was observed to be dead in the last year. This plant remained alive from November 2004 when it was planted until August of 2010 when it was observed dead.

Plans for Year MIP 7

- Complete the Manuwai MU fence to secure sites for reintroductions
- Continue to refine horticulture methods in order to produce plants that may be better able to become established and survive in reintroductions.
- Once these plants are available, OANRP will select a site or sites that will allow for more frequent monitoring and management. Experimental treatments will be used to better understand what is causing such high mortality in outplanting sites.

Table 3.37a Taxon Status Summary

Action Area: In

TaxonName: Phyllostegia kaalaensis TaxonCode: PhyKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keawapilau to Kapuna	Manage for stability	0	0	0	0	0	0	1	0	0	**0**	**0**	**0**	The remaining plant at the reintroduction site died
Pahole	Manage for stability	0	0	0	0	0	0	1	0	0	**0**	**0**	**0**	The remaining plant at the reintroduction site died
Palikea Gulch	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	0	0	0	0	0	0	2	0	0	**0**	**0**	**0**	

Action Area: Out

TaxonName: Phyllostegia kaalaensis TaxonCode: PhyKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	1	0	0	0	0	**0**	**1**	**0**	A reintroduced plant previously thought to be dead was observed with one live stem in the last year
Manuwai	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	The reintroduction will begin once the MU fence is complete
Waianae Kai	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	0	0	0	0	1	0	0	0	0	**0**	**1**	**0**	

Table 3.37b Threat Control Summary

Action Area: In

TaxonName: Phyllostegia kaalaensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Keawapilau to Kapuna	Manage for stability	Yes	Partial	No	No	No	No
Pahole	Manage for stability	Yes	No	No	No	No	No
Palikea Gulch	Genetic Storage	No	No	No	No	No	No

Action Area: Out

TaxonName: Phyllostegia kaalaensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makaha	Manage reintroduction for stability	Yes	Yes	No	No	No	No
Manuwai	Manage reintroduction for stability	No	No	No	No	No	No
Waianae Kai	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit
Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.37c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Phyllostegia kaalaensis							
Keawapilau to Kapuna	0	0	1	1	1	0	1
Pahole	0	0	4	0	2	2	2
Palikea Gulch	0	0	5	0	3	1	3
Waianae Kai	0	0	4	1	2	2	2

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
2	8	5	8

3.39 PHYLLOSTEGIA MOLLIS

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals (short-lived perennial with tendency for large declines or fluctuations in population size)
- Threats controlled
- Complete genetic storage from all PUs
- Tier 1 stabilization priority
- Stable population structure

Major Highlights/Issues OIP Year 3

- Staff spent 47 hours managing this species in the past year. This time was spent monitoring the reintroduction sites and the few remaining wild plants.
- Recruitment continues to be observed at the Mohiakea PU with three new immature plants observed in the last year under the single mature plant, which has since died. These plants and a single wild plant at Kaluaa are the only extant wild plants.
- The reintroduction sites were not supplemented in the last year and both continued to slowly decline. Only four of the sixty-three plants outplanted in 2007 and 2008 remain at the reintroduction site in Ekahanui. No regeneration has been observed here.
- In Kaluaa, twenty-one of the 103 plants outplanted from 2006-2008 remain. Five seedlings were first observed within the planting site in 2009 and two immature plants still remain and are healthy.

Plans for OIP Year 4

- Conduct census monitoring at all Manage for Stability PUs and collect from any additional founders
- Continue to supplement planting sites for the Ekahanui PU and the Kaluaa PU
- Survey for new reintroduction sites within the larger Ekahanui MU fence, the Waieli III fence and within the larger Kaluaa MU
- Begin construction of the Lihue fence

Table 3.38a Taxon Status Summary

Action Area: In

TaxonName: Phyllostegia mollis **TaxonCode: PhyMol**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Mohiakea	Genetic Storage	1	3	0	0	0	0	0	3	0	1	3	0	Small changes were noted during monitoring in the last year
	Total for Taxon:	1	3	0	0	0	0	0	3	0	1	3	0	

Action Area: Out

TaxonName: Phyllostegia mollis **TaxonCode: PhyMol**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	0	0	0	4	0	0	9	0	0	4	0	0	The reintroduction continued to decline
Huliwai	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kaluaa	Manage for stability	1	0	0	16	7	0	20	9	5	17	7	0	The reintroduction continued to decline
Pualii	Manage for stability	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Waieli	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	Monitoring showed no change
	Total for Taxon:	1	0	0	20	7	0	29	9	5	21	7	0	

Table 3.38b Threat Control Summary

Action Area: In

TaxonName: Phyllostegia mollis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Mohiakea	Genetic Storage	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Phyllostegia mollis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ekahanui	Manage for stability	Partial	Partial	Partial	No	No	No
Huliwai	Genetic Storage	No	No	No	No	No	No
Kaluaa	Manage for stability	Yes	Yes	No	No	No	No
Pualii	Manage for stability	Yes	Partial	No	No	No	No
Waieli	Genetic Storage	Partial	No	No	No	No	No

= Threat to Taxon within Population Unit
No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled
No=All PopRefSites within Population Unit have no threat control
Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.38c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Phyllostegia mollis							
Ekahanui	0	0	1	0	1	1	1
Huliwai	0	0	1	1	1	0	1
Kaluaa	1	0	0	0	0	1	0
Mohiakea	1	3	12	1	5	3	5
Pualii	0	0	1	0	1	1	1
Waieli	0	0	5	3	4	2	4

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
5	12	8	12

3.40 PLANTAGO PRINCEPS VAR. PRINCEPS

Requirements for Stability

- 4 Population Units (PUs) (in both Makua and Oahu AA)
- 50 reproducing individuals in each PU (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic representation of all PUs in storage

Major Highlights/Issues MIP Year 6

- Staff spent 101 hours managing this species in the past year. This time was spent monitoring and collecting for genetic storage from the in situ sites and monitoring the reintroduction at Waieli.
- Fruit collections were made from ten plants in the Ekahanui PU, a single plant in the Pahole PU and five from the Halona PU for genetic storage and future reintroductions.
- At the reintroduction site at Waieli, about half of the 47 plants outplanted there from 2008-2009 are remaining and most are healthy. No recruitment has been observed.

Plans for MIP Year 7

- Conduct census monitoring at all Manage for Stability populations.
- Secure genetic storage collections from unrepresented plants.
- Complete ungulate removal from the Ekahanui MU fence.
- Begin construction of the Schofield Barracks Lihue fence.
- Begin planning for an augmentation of the Ohikilolo PU.
- Determine a reintroduction site within the larger Ekahanui management unit.
- Continue to augment the Waieli PU.

Table 3.39a Taxon Status Summary

Action Area: In

TaxonName: Plantago princeps var. princeps TaxonCode: PlaPriPri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
North Mohiakea	Manage for stability	10	16	2	0	0	0	10	16	2	**10**	**16**	**2**	No monitoring in the last year
Ohikilolo	Manage for stability	11	0	0	0	0	0	11	0	0	**11**	**0**	**0**	No monitoring in the last year
Pahole	Genetic Storage	1	1	0	0	0	0	2	6	6	**1**	**1**	**0**	Thorough monitoring in the last year showed a decline
	Total for Taxon:	22	17	2	0	0	0	23	22	8	**22**	**17**	**2**	

Action Area: Out

TaxonName: Plantago princeps var. princeps TaxonCode: PlaPriPri

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ekahanui	Manage for stability	29	36	7	0	0	0	29	37	7	**29**	**36**	**7**	Small changes were noted during monitoring in the last year
Halona	Manage for stability	29	43	0	0	0	0	29	43	0	**29**	**43**	**0**	Monitoring showed no change
North Palawai	Genetic Storage	2	0	0	0	0	0	1	2	0	**2**	**0**	**0**	Small changes were noted during monitoring in the last year
Waieli	Manage reintroduction for storage	0	0	0	9	15	0	8	17	0	**9**	**15**	**0**	Small changes were noted during monitoring of the reintroduction site in the last year
	Total for Taxon:	60	79	7	9	15	0	67	99	7	**69**	**94**	**7**	

Table 3.39b Threat Control Summary

Action Area: In

TaxonName: Plantago princeps var. princeps

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
North Mohiakea	Manage for stability	Partial	No	No	No	No	No
Ohikilolo	Manage for stability	Yes	No	No	No	No	No
Pahole	Genetic Storage	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Plantago princeps var. princeps

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ekahanui	Manage for stability	Partial	No	Yes	No	No	No
Halona	Manage for stability	No	No	No	No	No	No
North Palawai	Genetic Storage	No	No	No	No	No	No
Waieli	Manage reintroduction for storage	Yes	Yes	Yes	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.39c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Plantago princeps var. princeps							
Ekahanui	29	36	20	54	0	3	49
Halona	29	43	5	22	0	3	22
North Mohiakea	10	16	11	13	0	3	12
North Palawai	2	0	3	1	0	0	1
Ohikilolo	11	0	14	17	0	0	10
Pahole	1	1	1	3	1	0	2

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
110	1	9	96

3.41 PRITCHARDIA KAALAE

Requirements for Stability

- 3 Population Units (PUs)
- 25 reproducing individuals in each PU (long-lived perennial)
    - *This goal is met for the Ohikilolo PU and Makaleha to Manuwai PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues Year 6

- Staff spent 294 hours managing this species in the past year. Half of this time was spent monitoring and outplanting into existing reintroduction sites. About 19 hours were spent collecting seeds for reintroduction from the rat baited area in the East Makaleha section of the Makaleha to Manuwai PU. At Ohikilolo, 15 hours were spent collecting mature fruit from the baited area. Another 29 hours were spent collecting from outlying trees in the Makaleha to Manuwai PU. In addition, for rat control in the last year, 169 hours were spent at East Makaleha and 142 hours at Ohikilolo.
- Construction of the Manuwai MU fence continued. This fence will protect the *P. kaalae* in part of the Makaleha to Manuwai PU.
- Rat control continues to be successful in allowing the development of mature fruit and the establishment of seedlings within the Ohikilolo PU and the baited section of the Makaleha to Manuwai PU.
- Collections of seed for reintroduction continued in the Ohikilolo PU and Makaleha to Manuwai PU.
- It was confirmed with NCGRP that the drying protocol at the Army Seed Lab was not achieving the ideal moisture content for seeds of this species. Genetic storage collections have been put on hold until drying protocols are established.
- Continued expansion of the reintroduction sites in the Ohikilolo PU with an additional 44 plants and the East Ohikilolo to West Makaleha PU with 50 plants.

Plans for Year 7

- Conduct monitoring at all Manage for Stability PUs.
- Collect from unrepresented founders from the Ohikilolo and Makaleha to Manuwai PU for reintroduction.
- Continue to expand the reintroductions to balance founders the Ohikilolo PU and East Ohikilolo to West Makaleha PU.
- Investigate the feasibility of using seed sowing to augment reintroduction sites.
- Complete the large scale Manuwai MU fence.
- Survey the Makaleha to Manuwai PU to revise population estimates.
- Monitor the Waianae Kai PU and determine feasibility of accessing the plants in the Makaha PU.
- NCGRP will test different drying protocols to determine the most effective way to dry seeds to the proper moisture content. This will enable us to test viability of seeds at different temperatures to determine the ideal temperature for seed storage of this species and allow genetic storage collections to continue.

Table 3.40a Taxon Status Summary

Action Area: In

TaxonName: Pritchardia kaalae TaxonCode: PriKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ohikilolo	Manage for stability	75	644	12	2	380	0	76	1021	20	**77**	**1024**	**12**	More plants were added to the reintroduction sites, another outplanted individual began to flower
Ohikilolo East and West Makaleha	Manage reintroduction for stability	0	0	0	0	209	0	0	122	0	**0**	**209**	**0**	More plants were added to the reintroduction sites
	Total for Taxon:	75	644	12	2	589	0	76	1143	20	**77**	**1233**	**12**	

Action Area: Out

TaxonName: Pritchardia kaalae TaxonCode: PriKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Genetic Storage	4	0	0	0	0	0	4	0	0	**4**	**0**	**0**	No monitoring in the last year
Makaleha to Manuwai	Manage for stability	102	10	2	0	0	0	70	4	0	**102**	**10**	**2**	A thorough census of the known area found more mature plants and several new seedlings and immature plants in the rat control area
Waianae Kai	Genetic Storage	4	5	0	0	0	0	4	5	0	**4**	**5**	**0**	No monitoring in the last year
	Total for Taxon:	110	15	2	0	0	0	78	9	0	**110**	**15**	**2**	

Table 3.40b Threat Control Summary

Action Area: In

TaxonName: Pritchardia kaalae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Ohikilolo	Manage for stability	Yes	Partial	Partial	No	No	No
Ohikilolo East and West Makaleha	Manage reintroduction for stability	Yes	Yes	No	No	No	No

Action Area: Out

TaxonName: Pritchardia kaalae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makaha	Genetic Storage	No	No	No	No	No	No
Makaleha to Manuwai	Manage for stability	No	No	Partial	No	No	No
Waianae Kai	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.40c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Pritchardia kaalae							
Makaha	4	0	0	0	0	0	0
Makaleha to Manuwai	102	10	0	0	0	22	14
Ohikilolo	75	644	0	0	13	28	11
Waianae Kai	4	5	0	0	1	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	14	50	25

3.42 PTERIS LYDGATEI

Requirements for Stability:

- 3 population units (PUs)
- 50 reproducing individuals (short-lived perennial)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 8 hours monitoring the Helemano PU in the last year to update population estimates.

Plans for OIP Year 4

- A license agreement with Kamehameha Schools that will cover fencing actions should be obtained in the next year. This will allow OANRP to pursue fencing at the Kawainui PU.
- Work with OPEP to monitor and search for new plants
- Develop collection and propagation protocols with OPEP and Lyon Arboretum

Table 3.41a Taxon Status Summary

Action Area: In

TaxonName: Pteris lidgatei **TaxonCode: PteLid**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano	Manage for stability	0	2	2	0	0	0	0	2	2	0	2	2	Monitoring showed no change
Kawaiiki	Manage for stability	3	0	0	0	0	0	3	0	0	3	0	0	No monitoring in the last year
Kawainui	Genetic Storage	0	1	0	0	0	0	0	1	0	0	1	0	No monitoring in the last year
North Kaukonahua	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
South Kaukonahua	Manage for stability	6	0	0	0	0	0	6	0	0	6	0	0	No monitoring in the last year
	Total for Taxon:	9	3	2	0	0	0	9	3	2	9	3	2	

Action Area: Out

TaxonName: Pteris lidgatei **TaxonCode: PteLid**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kaluanui	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Waimano	Genetic Storage	0	2	0	0	0	0	0	2	0	0	2	0	No monitoring in the last year
	Total for Taxon:	0	2	0	0	0	0	0	2	0	0	2	0	

Table 3.41b Threat Control Summary

Action Area: In

TaxonName: Pteris lidgatei

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano	Manage for stability	No	No	No	No	No	No
Kawaiiki	Manage for stability	No	No	No	No	No	No
Kawainui	Genetic Storage	No	No	No	No	No	No
North Kaukonahua	Genetic Storage	No	No	No	No	No	No
South Kaukonahua	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Pteris lidgatei

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kaluanui	Genetic Storage	No	No	No	No	No	No
Waimano	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.41c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Pteris lidgatei							
Helemano	0	2	0	0	0	0	0
Kaluanui	0	0	0	0	0	0	0
Kawaiiki	3	0	0	0	0	0	0
Kawainui	0	1	0	0	0	0	0
North Kaukonahua	0	0	0	0	0	0	0
South Kaukonahua	6	0	0	0	0	0	0
Waimano	0	2	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

3.43 SANICULA MARIVERSA

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial with infrequent, inconsistent flowering)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues for Year 6

- Staff spent 66 hours managing this species in the past year. This time was spent monitoring and collecting from the in situ sites.
- The Keaau PU fence was completed.
- Genetic storage collections were made from the Kamaileunu PU where a large number of plants was observed this year.
- The Makua PU and the Keaau PU were both visited to collect for genetic storage and appeared stable, but population estimates were not updated for this year.
- NRS re-monitored the Kamaileunu seed sowing plots established in 2008. Plots were installed to determine how many newly-produced seeds become seedlings when dispersed to ground in situ and how many may remain as a persistent seedbank. Monitoring data from 2009 showed that the mean germination rate of sown seed was 70%. In 2010, one new seedling germinated from the initial 2008 sowing, suggesting that seeds can remain alive on the soil surface and germinate after the second winter (1.5 yrs later). The mean survivorship of plants that germinated in 2009 to 2010 was 50%.
- During monitoring of the Kamaileunu seed sow plots, some predation to seedlings was observed. Rat scat was collected from within the plots and some of the snipped petioles appeared damaged in a way consistent with rat predation. It is not possible to say for sure what is causing predation but with further monitoring this may become clear.
- At Kamaileunu, data was collected from plants tagged in 2007 for demographic modeling and sent to Tiffany Knight for analysis. Tags were pulled from all observed mature plants and for plants that could not be clearly tied to a particular tag.
- Temperature data loggers have been placed at all wild sites to record in situ temperature fluctuations to help determine how they might affect germination in situ. All data loggers have been collected and replaced at least once, so have up to a year of data to date.
- Replicate seed sowing study at Kamaileunu PU and initiate it at Ohikilolo PU to get a concurrent data set for both sites, unless very few plants produce seed.

Plans for Year 7

- Conduct census monitoring of all Manage for Stability PU.
- Collect mature seed for storage and dormancy/germination studies.
- Re-monitor seed sowing plots to determine long-term survivorship.
- Conduct selective *Schinus terebinthifolius* control at the Puu Kawiwi and Kamaileunu PUs with care; avoid negatively impacting extant individuals.

Table 3.42a Taxon Status Summary

Action Area: In

TaxonName: Sanicula mariversa **TaxonCode: SanMar**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Manage for stability	11	300	40	0	0	0	11	300	40	**11**	**300**	**40**	The site was visited in the last year and appeared stable. It was not completely monitored so the estimates from the previous year were not changed.
Ohikilolo	Manage for stability	3	112	0	0	0	0	3	112	0	**3**	**112**	**0**	The site was visited in the last year and appeared stable. It was not completely monitored so the estimates from the previous year were not changed.
	Total for Taxon:	14	412	40	0	0	0	14	412	40	**14**	**412**	**40**	

Action Area: Out

TaxonName: Sanicula mariversa **TaxonCode: SanMar**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kamaileunu	Manage for stability	11	637	343	0	0	0	10	178	13	**11**	**637**	**343**	Many plants were observed in the last year
Puu Kawiwi	Genetic Storage	2	11	0	0	0	0	2	11	0	**2**	**11**	**0**	The site was visited in the last year and appeared stable. It was not completely monitored so the estimates from the previous year were not changed.
	Total for Taxon:	13	648	343	0	0	0	12	189	13	**13**	**648**	**343**	

Table 3.42b Threat Control Summary

Action Area: In

TaxonName: Sanicula mariversa

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Keaau	Manage for stability	Yes	No	No	No	No	No
Ohikilolo	Manage for stability	Yes	Partial	No	No	No	No

Action Area: Out

TaxonName: Sanicula mariversa

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kamaileunu	Manage for stability	Yes	No	No	No	No	No
Puu Kawiwi	Genetic Storage	Yes	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.42c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Sanicula mariversa							
Kamaileunu	11	637	41	36	0	1	34
Keaau	11	300	42	43	0	0	31
Ohikilolo	3	112	92	19	0	0	19
Puu Kawiwi	2	11	2	3	0	0	3

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
101	0	1	87

3.44 SANICULA PURPUREA

Requirements for Stability

- 3 population units (PUs)
- 100 reproducing individuals (short-lived perennial, inconsistent flowering)
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs
- Tier 2 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 12 hours monitoring the Schofield-Waikane Trail Summit PU in the past year and the population estimate was revised.
- The Wailupe-Waimanalo Summit Ridge was monitored by OPEP in the last year and two mature plants are known from that site.
- The Poamoho PU was visited while conducting other management in the area and the site appeared to be stable.

Plans for OIP Year 4

- Revisit and monitor the North of Puu Pauao PU.
- Revise estimates for the Poamoho PU.
- Monitor the reintroduction in the Opaeula-Punaluu Summmit Ridge PU.

Table 3.43a Taxon Status Summary

Action Area: In

TaxonName: Sanicula purpurea **TaxonCode: SanPur**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
North of Puu Pauao	Manage for stability	0	21	0	0	0	0	0	21	0	0	21	0	No monitoring in the last year
Opaeula-Punaluu Summit Ridge	Manage reintroduction for storage	0	0	0	1	2	1	1	2	1	1	2	1	No monitoring in the last year
Poamoho Trail Summit	Manage for stability	2	10	12	0	0	0	2	10	12	2	10	12	No monitoring in the last year
Schofield-Waikane Trail Summit	Manage for stability	2	40	0	0	0	0	2	25	0	2	40	0	Monitoring showed no change
	Total for Taxon:	4	71	12	1	2	1	5	58	13	5	73	13	

Action Area: Out

TaxonName: Sanicula purpurea **TaxonCode: SanPur**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Wailupe-Waimanalo Summit Ridge	Genetic Storage	2	0	0	0	0	0	0	0	0	2	0	0	OPEP observed plants at this site in the last year
	Total for Taxon:	2	0	0	0	0	0	0	0	0	2	0	0	

Table 3.43b Threat Control Summary

Action Area: In

TaxonName: Sanicula purpurea

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
North of Puu Pauao	Manage for stability	No	No	No	No	No	No
Opaeula-Punaluu Summit Ridge	Manage reintroduction for storage	No	No	No	No	No	No
Poamoho Trail Summit	Manage for stability	No	No	No	No	No	No
Schofield-Waikane Trail Summit	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Sanicula purpurea

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Wailupe-Waimanalo Summit Ridge	Genetic Storage	No	No	No	No	No	

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.43c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Sanicula purpurea							
North of Puu Pauao	0	21	0	0	0	0	0
Poamoho Trail Summit	2	10	0	2	0	0	0
Schofield-Waikane Trail Summit	2	40	0	0	0	0	0
Wailupe-Waimanalo Summit Ridge	2	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
2	0	0	0

3.45 SCHIEDEA KAALAE

Requirements for Stability

- 4 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Kaluaa and Waieli PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues for MIP Year 6

- Staff spent 452 hours managing this species in the past year. About half of this time was spent planting reintroductions and the rest of the time was spent monitoring those planting sites and collecting from wild plants for genetic storage. This includes time spent working at two large planting sites as part of doctoral research by UH Botany Ph.D. Candidate (and OANRP employee) Lauren Weisenberger to determine the effects of inbreeding and outbreeding on *S. kaalae*.
- OANRP assisted in the growing, outplanting, and monitoring of more than 1400 *S. kaalae* Weisenberger's study.
- The small PU fence for the Kapuna reintroduction was repaired and seedlings are still observed regenerating beneath the outplantings. There are now eight immature plants and thirteen seedlings around the remaining plants at this site.
- The reintroductions at the South Ekahanui PU were monitored and only sixteen of the 89 plants outplanted here in 2004 and 2005 remain. There have been no observations of regeneration of seedlings at this site.
- The Kaluaa PU reintroductions are also slowly declining. Recruitment of seedlings has been observed there are currently three of these F1 immature plants remaining at one of the reintroduction sites. The other larger reintroduction has not had any recruitment observed.

Plans for MIP Year 7

- Conduct census monitoring of all Manage for Stability PUs.
- Continue to collect clones or seeds for genetic storage from all in situ plants.
- Pursue labeling of Sluggo® for field use at all appropriate sites.
- Complete removal of ungulates from the South Ekahanui MU.
- At the Kahana PU, support OPEP and fellow KMWP member Kualoa Ranch in building a fence to protect the only remaining unfenced wild plants before pigs kill them. OANRP will provide fencing material and two staff to this project.
- Begin to collect seed for storage from the reintroductions in the Kaluaa and Waieli, South Ekahanui, Pahole and Makaua PUs.
- Expand the greenhouse collections of clones when appropriate in situ material is available. Continue to use the plants in the nursery living collection to produce propagules for storage and reintroduction.
- Continue to support research by L. Weisenberger on *S. kaalae.*
- Balance founders at existing reintroduction and/or augmentation sites.

Table 3.44a Taxon Status Summary

Action Area: In

TaxonName: Schiedea kaalae — TaxonCode: SchKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Pahole	Manage for stability	2	0	0	35	12	13	42	12	0	**37**	**12**	**13**	Several outplanted matures died. Seedlings were observed under reintroduced plants
	Total for Taxon:	2	0	0	35	12	13	42	12	0	**37**	**12**	**13**	

Action Area: Out

TaxonName: Schiedea kaalae — TaxonCode: SchKaa

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahana	Genetic Storage	6	1	0	3	0	0	9	1	0	**9**	**1**	**0**	No monitoring in the last year
Kaluaa and Waieli	Manage for stability	0	0	0	72	6	0	82	10	0	**72**	**6**	**0**	Monitoring of the reintroduction showed a decline
Maakua (Koolaus)	Manage for stability	10	0	0	0	0	0	10	0	0	**10**	**0**	**0**	No monitoring in the last year
Makaua (Koolaus)	Genetic Storage	1	0	0	6	27	0	7	27	0	**7**	**27**	**0**	No monitoring in the last year
North Palawai	Genetic Storage	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	No monitoring of this historic site in the last year
South Ekahanui	Manage for stability	12	0	0	16	0	0	35	7	0	**28**	**0**	**0**	Thorough monitoring of the reintroduction in the last year showed a decline
	Total for Taxon:	29	1	0	97	33	0	143	45	0	**126**	**34**	**0**	

Table 3.44b Threat Control Summary

Action Area: In

TaxonName: Schiedea kaalae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Pahole	Manage for stability	Yes	Partial	No	No	No	No

Action Area: Out

TaxonName: Schiedea kaalae

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahana	Genetic Storage	Partial	No	No	No	No	No
Kaluaa and Waieli	Manage for stability	Yes	Yes	Yes	No	No	No
Maakua (Koolaus)	Manage for stability	No	No	No	No	No	No
Makaua (Koolaus)	Genetic Storage	Yes	No	No	No	No	No
North Palawai	Genetic Storage	Yes	No	No	No	No	No
South Ekahanui	Manage for stability	Yes	Partial	Partial	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.44c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Schiedea kaalae							
Kahana	6	1	3	3	6	6	8
Kaluaa and Waieli	0	0	1	1	1	1	1
Maakua (Koolaus)	10	0	1	2	4	2	4
Makaua (Koolaus)	1	0	1	0	1	1	0
North Palawai	0	0	1	1	0	1	1
Pahole	2	0	0	2	1	2	2
South Ekahanui	12	0	6	13	2	14	13

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
22	15	27	29

3.46 SCHIEDEA NUTTALII

Requirements for Stability

- 3 Population Units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Kahanahaiki to Pahole PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 240 hours managing this species in the past year. More than half of this time was spent by staff planting into existing reintroduction sites and establishing a new large planting site in Kahanahaiki as part of doctoral research by UH Botany Ph.D. Candidate (and OANRP employee) Lauren Weisenberger to determine the effects of inbreeding and outbreeding.
- OANRP assisted in the growing, outplanting, and monitoring of 150 *S. nuttallii* for L. Weisenberger's study. These plants are not counted in the PU totals.
- Twenty plants were added to the reintroduction at the Puu 2210 site in the Kahanahaiki to Pahole PU in the last year. At least nine immature plants and over a hundred seedlings were observed beneath the outplantings in August 2010.
- The reintroduction at the Switchbacks site in Pahole has had recruitment of seedlings, some of which have grown into mature plants. There are now new F1 plants beneath four of the mature outplanted individuals there. Eighteen additional plants were outplanted to this site in the last year.
- Fifteen plants grown from clones of the Kahanahaiki plants were added to the reintroduction site at the Makaha PU in January 2010. All are alive and healthy as of August 2010.
- There is only one wild individual remaining in the Kahanahaiki site.

Plans for MIP Year 7

- Conduct census monitoring of all Manage for Stability PUs.
- Continue to supplement all of the reintroduction sites until all founders are represented.
- Determine reintroduction strategy for the Kapuna to Keawapilau PU and select outplanting sites in both gulches.
- Collect from the reintroduction sites for genetic storage.
- Continue to support research by UH Botany Ph.D. Candidate Lauren Weisenberger to determine the effects of inbreeding and outbreeding on *S. nuttallii.*

Table 3.45a Taxon Status Summary

Action Area: In

TaxonName: Schiedea nuttallii TaxonCode: SchNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	12	1	0	118	21	115	100	22	19	**130**	**22**	**115**	More plants were added to the reintroduction sites, F1 seedlings and immature plants were observed
Kapuna-Keawapilau Ridge	Manage for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	The reintroduction has not yet begun
	Total for Taxon:	12	1	0	118	21	115	100	22	19	**130**	**22**	**115**	

Action Area: Out

TaxonName: Schiedea nuttallii TaxonCode: SchNut

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	21	0	0	6	0	0	**21**	**0**	**0**	More plants were added to the reintroduction sites
	Total for Taxon:	0	0	0	21	0	0	6	0	0	**21**	**0**	**0**	

Table 3.45b Threat Control Summary

Action Area: In

TaxonName: Schiedea nuttallii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki to Pahole	Manage for stability	Yes	Partial	No	No	No	No
Kapuna-Keawapilau Ridge	Manage for stability	Yes	Yes	No	No	No	No

Action Area: Out

TaxonName: Schiedea nuttallii

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Makaha	Manage reintroduction for stability	Yes	Yes	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.45c Genetic Storage Summary

Population Unit Name	# of Potential Founders			Partial Storage Status			StorageGoals Met
	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Schiedea nuttallii							
Kahanahaiki to Pahole	12	1	52	18	2	39	32
Kapuna-Keawapilau Ridge	0	0	4	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
18	2	39	32

3.47 SCHIEDEA OBOVATA

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals in each PU (short-lived perennial which is prone to large fluctuations)
    - *This goal is met for the Kahanahaiki to Pahole PU and Keawapilau to West Makaleha PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 461 hours managing this species in the past year. Almost 300 hours of this time was spent planting into existing sites and establishing and monitoring a large planting site in Kahanahaiki as part of doctoral research by UH Botany Ph.D. Candidate (and OANRP employee) Lauren Weisenberger to determine the effects of inbreeding and outbreeding. The rest of the time was spent monitoring existing planting sites and the remaining wild sites.
- OANRP assisted in the growing, outplanting, and monitoring of 700 *S. obovata* in Kahanahaiki as part of Weisenberger's study. These plants are not included in population counts for the PUs.
- New plants were observed at all three of the remaining wild sites (two in West Makaleha and Keawapilau). At the larger wild site in Northwest Makaleha, several hundred seedlings were observed.
- Continued to balance founders at existing reintroduction sites. The numbers of seedlings and immature plants at most reintroduction sites continues to increase. All active reintroductions in the Kahanahaiki to Pahole PU have seedlings and immature plants beneath established outplantings. The large reintroduction site in Keawapilau was also observed to have several hundred seedlings in the last year and planting was completed here.
- Sites were evaluated for the future Makaha reintroduction.

Plans for MIP Year 7

- Conduct census monitoring at all Manage for Stability PUs.
- Continue to balance founders at existing reintroduction sites and develop the reintroduction strategy for the Makaha PU.
- Continue slug control research with Sluggo® in the field.
- Continue to support research by UH Botany graduate student Lauren Weisenberger to determine the effects of inbreeding and outbreeding on *S. obovata.* Results will aid in development of a strategy for the Makaha reintroduction.
- Collect seeds for genetic storage from completed reintroductions, including mature F1 plants.

Table 3.46a Taxon Status Summary

Action Area: In

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki to Pahole	Manage for stability	0	0	0	191	358	297	144	110	15	**191**	**358**	**297**	More plants were added to the reintroduction sites and lots of recruitment is observed
Keawapilau to West Makaleha	Manage for stability	32	127	535	229	285	294	182	73	0	**261**	**412**	**829**	More plants were added to the reintroduction sites and lots of recruitment is observed
	Total for Taxon:	32	127	535	420	643	591	326	183	15	**452**	**770**	**1126**	

Action Area: Out

TaxonName: Schiedea obovata **TaxonCode: SchObo**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Makaha	Manage reintroduction for stability	0	0	0	0	0	0			0	**0**	**0**	**0**	The reintroduction will begin in once the Makaha subunit II fence is complete.
	Total for Taxon:	0	0	0	0	0	0			0	**0**	**0**	**0**	

Table 3.46b Threat Control Summary

Action Area: In

TaxonName: Schiedea obovata

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki to Pahole	Manage for stability	Yes	Partial	Partial	No	No	No
Keawapilau to West Makaleha	Manage for stability	Partial	Partial	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.46c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Schiedea obovata							
Kahanahaiki to Pahole	0	0	9	5	1	6	5
Keawapilau to West Makaleha	32	127	44	73	1	18	72

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
78	2	24	77

3.48 SCHIEDEA TRINERVIS

Requirements for Stability

- Maintain one PU with at least 150 reproducing individuals
  - *This goal is met for the Kalena to East Makaleha PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage from 50 individuals across the range of the species
- Tier 1 stabilization priority

Major Highlights/Issues for OIP Year 3

- Staff spent 1 hour monitoring plants during other management work in the Kaala MU.
- The Kaala MU fence is not complete. Ungulate sign is still observed within the Kaala MU. A fence line to extend the Waianae Kai section has been surveyed and OANRP is waiting on the MOU with the State of Hawaii to complete this section.
- A few plants were re-discovered in East Makaleha. This is the western-most occurrence of this species. These plants will be within the proposed East Makaleha MU fence.
- Stored seeds have been tested for ten years. There has been no observed decline in viability at the preferred storage conditions.

Plans for OIP Year 4

- Complete the Kaala MU fence and eradicate all pigs from fence
- Continue mapping all known plants
- Collect for genetic storage to balance collections from across entire distribution of plants

Table 3.47a Taxon Status Summary

Action Area: In

TaxonName: Schiedea trinervis **TaxonCode: SchTri**

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kalena to East Makaleha	Manage for stability	179	198	313	0	0	0	179	198	318	**179**	**198**	**313**	Small changes were noted during monitoring in the last year
	Total for Taxon:	179	198	313	0	0	0	179	198	318	**179**	**198**	**313**	

Table 3.47b Threat Control Summary

Action Area: In

TaxonName: Schiedea trinervis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kalena to East Makaleha	Manage for stability	Partial	Partial	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.47c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	# of Potential Founders: Current Imm.	# of Potential Founders: NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	Partial Storage Status: # Plants >=1 Microprop	Partial Storage Status: # Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Schiedea trinervis							
Kalena to East Makaleha	179	198	16	49	2	0	48

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
49	2	0	48

3.49 STENOGYNE KANEHOANA

Requirements for Stability

- 3 Population Units (PUs)
- 100 reproducing individuals in each PU (long-lived perennial with a history of precipitous decline, extirpated in the wild, and extremely low genetic variability)
- Stable population structure
- Threats controlled
- Complete genetic representation in storage of all PUs
- Tier 1 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 77 hours managing this species in the past year. This time was spent planting and monitoring the existing reintroduction sites in Central Kaluaa and monitoring the remaining plant in Haleauau.
- The Central Kaluaa (Gulch 2) PU and Central Kaluaa (South Fenceline) PU were combined into one MFS PU called Central Kaluaa. Another MFS PU will be created using reintroductions once a site is determined.
- The Haleauau plant flowered again this year.
- Sixteen plants total were added to the reintroductions in the Central Kaluaa PU. Seven plants were observed flowering in one of the sites in the last year. Several plants in the reintroduction at Hapapa died in the last year.
- Stock from both the Haleauau PU and the Central Kaluaa PU flowered at the Schofield nursery this year. Staff were able to cross-pollinate the different stocks by hand. Fruit set was low, and only 5 seeds were collected. None have germinated but the viability assay is still ongoing.
- Leaf samples were collected from different stems of the wild plant in the Haleauau PU and from the greenhouse clones of both founders. The leaves were brought to UH Botany faculty Dr. Cliff Morden for genetic analyses. A draft report was delivered at the beginning of OIP Year 4 and will be reviewed by OANRP and finalized. Results will be available in next year's report.
- Both founders are represented in genetic storage both as a living collection in the greenhouse and at the Micropropagation Lab at Lyon Arboretum.

Plans for OIP Year 4

- Manage nursery collection to promote flowering. Continue research in pollination and continue to hand-pollinate. This includes collecting pollen, testing pollen viability, and pollinating all flowering plants, both in situ and ex situ.
- Continue to supplement all outplanting sites with clones from the nursery collection
- Select a site for the third MFS PU

Table 3.48a Taxon Status Summary

Action Area: In

TaxonName: Stenogyne kanehoana TaxonCode: SteKan

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Haleauau	Manage for stability	1	0	0	0	0	0	1		0	**1**	**0**	**0**	Monitoring showed no change
	Total for Taxon:	1	0	0	0	0	0	1		0	**1**	**0**	**0**	

Action Area: Out

TaxonName: Stenogyne kanehoana TaxonCode: SteKan

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Central Kaluaa	Manage for stability	0	0	0	7	57	0	0	73	0	**7**	**57**	**0**	Plants were added to the reintroduction sites and several were observed flowering
To be Determined (Makaha)	Manage reintroduction for stability	0	0	0	0	0	0	0	0	0	**0**	**0**	**0**	This reintroduction will begin when the site is selected and the MU fences are complete
	Total for Taxon:	0	0	0	7	57	0	0	73	0	**7**	**57**	**0**	

Table 3.48b Threat Control Summary

Action Area: In

TaxonName: Stenogyne kanehoana

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Haleauau	Manage for stability	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Stenogyne kanehoana

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Central Kaluaa	Manage for stability	Yes	Yes	Partial	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.48c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Stenogyne kanehoana							
Central Kaluaa	0	0	1	0	1	1	1
Haleauau	1	0	0	0	1	1	1

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	2	2	2

3.50 TETRAMOLOPIUM FILIFORME

Requirements for Stability

- 4 Population Units (PUs) (in both MMR and Oahu AA)
- 50 reproducing individuals in each PU (short-lived perennial)
    - *This goal is met for the Ohikilolo PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 19 hours monitoring the Puhawai PU reintroduction site in the last year.
- A living collection of clones from plants in the Kalena PU and Puhawai PU is maintained for collecting seeds for genetic storage and outplanting.
- All 31 reintroduced plants in the Puhawai site were observed to be dead in the last year, but two immature and two mature F1 plants were seen and were healthy.
- No decline was detected in viability of stored seeds after ten years of storage at preferred conditions. Test results and modeling suggest decline in viability as soon as the next year. Low seed set has continued to complicate interpretation of viability results.

Plans for MIP Year 7

- Continue to maintain the living collection from the Kalena PU and Puhawai PU.
- Begin to collect cuttings from the Waianae Kai PU.
- Conduct census monitoring of all Manage for Stability PUs. In the case of the Ohikilolo PU, a sampling protocol will need to be developed as the PU is so large.
- Augment the Puhawai PU with stock collected from the greenhouse living collection.
- Begin construction of the Schofield Barracks Lihue fence.

Table 3.49a Taxon Status Summary

Action Area: In

TaxonName: Tetramolopium filiforme — TaxonCode: TetFil

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Kahanahaiki	Genetic Storage	45	0	0	0	0	0	45	0	0	45	0	0	No monitoring in the last year
Kalena	Manage for stability	9	0	6	0	0	0	9	0	6	9	0	6	No monitoring in the last year
Keaau	Genetic Storage	30	41	17	0	0	0	30	41	17	30	41	17	No monitoring in the last year
Makaha/Ohikilolo Ridge	Genetic Storage	300	0	0	0	0	0	300	0	0	300	0	0	No monitoring in the last year
Ohikilolo	Manage for stability	2542	582	21	0	0	0	2542	582	21	2542	582	21	No monitoring in the last year
Puhawai	Manage for stability	1	0	0	2	2	0	1	2	0	3	2	0	Small changes were noted during monitoring in the last year
	Total for Taxon:	2927	623	44	2	2	0	2927	625	44	2929	625	44	

Action Area: Out

TaxonName: Tetramolopium filiforme — TaxonCode: TetFil

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Waianae Kai	Manage for stability	30	8	1	0	0	0	30	8	0	30	8	1	No monitoring in the last year
	Total for Taxon:	30	8	1	0	0	0	30	8	0	30	8	1	

Table 3.49b Threat Control Summary

Action Area: In

TaxonName: Tetramolopium filiforme

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Kahanahaiki	Genetic Storage	No	No	No	No	No	No
Kalena	Manage for stability	No	No	No	No	No	No
Keaau	Genetic Storage	No	No	No	No	No	No
Makaha/Ohikilolo Ridge	Genetic Storage	No	No	No	No	No	No
Ohikilolo	Manage for stability	Yes	No	No	No	No	No
Puhawai	Manage for stability	No	No	No	No	No	No

Action Area: Out

TaxonName: Tetramolopium filiforme

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Waianae Kai	Manage for stability	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.49c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Tetramolopium filiforme							
Kahanahaiki	45	0	36	86	0	0	53
Kalena	9	0	0	9	0	7	7
Keaau	30	41	0	17	0	0	2
Makaha/Ohikilolo Ridge	300	0	0	0	0	0	0
Ohikilolo	2542	582	1	114	0	1	39
Puhawai	1	0	9	5	0	1	5
Waianae Kai	30	8	0	1	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	**Total # Plants w/ >=1 Microprop**	**Total # Plants w/ >=1 Army Nursery**	**Total # Plants that Met Goal**
232	0	9	106

3.51 VIOLA CHAMISSONIANA SUBSP. CHAMISSONIANA

Requirements for Stability

- 4 Population Units (PUs) (in both MMR and Oahu AA)
- 50 reproducing individuals in each PU (short-lived perennial)
    - *This goal is met for the Ohikilolo PU.*
- Stable population structure
- Threats controlled
- Complete genetic storage of all PUs

Major Highlights/Issues MIP Year 6

- Staff spent 26 hours monitoring and collecting for genetic storage from the Makaleha PU in the last year.
- A re-collection interval of ten years has been temporarily established based ten-year storage results of one collection. Additional collections and temperatures need to be tested to confirm the preferred storage conditions.

Plans for MIP Year 7

- Continue to collect seeds for genetic storage from the greenhouse collection of clones from the Puu Hapapa, Puu Kumakalii and Makaleha PUs.
- Continue to collect clones from new founders in the Puu Hapapa PU.
- Search historic sites within the Kamaileunu PU.
- Monitor the Puu Kumakalii, Makaha and Halona PUs to determine if they will reach the stability goal of 50 reproducing plants with threat control. If not, OANRP will begin to strategize reintroduction plans.

Table 3.50a Taxon Status Summary

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana TaxonCode: VioChaCha

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Keaau	Genetic Storage	40	10	0	0	0	0	40	10	0	**40**	**10**	**0**	No monitoring in the last year
Makaha/Ohikilolo Ridge	Genetic Storage	7	0	0	0	0	0	7	0	0	**7**	**0**	**0**	No monitoring in the last year
Ohikilolo	Manage for stability	435	10	0	0	0	0	435	10	0	**435**	**10**	**0**	No monitoring in the last year
Puu Kumakalii	Manage for stability	44	0	0	0	0	0	44	0	0	**44**	**0**	**0**	No monitoring in the last year
	Total for Taxon:	526	20	0	0	0	0	526	20	0	**526**	**20**	**0**	

Action Area: Out

TaxonName: Viola chamissoniana subsp. chamissoniana TaxonCode: VioChaCha

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Halona	Manage for stability	41	3	0	0	0	0	41	3	0	**41**	**3**	**0**	No monitoring in the last year
Kamaileunu	Genetic Storage	35	0	0	0	0	0	35	0	0	**35**	**0**	**0**	No monitoring in the last year
Makaha	Manage for stability	37	2	0	0	0	0	37	2	0	**37**	**2**	**0**	No monitoring in the last year
Makaleha	Genetic Storage	34	1	0	0	0	0	34	1	0	**34**	**1**	**0**	The site was visited in the last year and appeared stable so the estimate from 2008 was not revised.
Puu Hapapa	Genetic Storage	13	5	0	0	0	0	13	5	0	**13**	**5**	**0**	No monitoring in the last year
	Total for Taxon:	160	11	0	0	0	0	160	11	0	**160**	**11**	**0**	

Table 3.50b Threat Control Summary

Action Area: In

TaxonName: Viola chamissoniana subsp. chamissoniana

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Keaau	Genetic Storage	No	No	No	No	No	No
Makaha/Ohikilolo Ridge	Genetic Storage	No	No	No	No	No	No
Ohikilolo	Manage for stability	Yes	Partial	No	No	No	No
Puu Kumakalii	Manage for stability	Yes	No	No	No	No	No

Action Area: Out

TaxonName: Viola chamissoniana subsp. chamissoniana

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Halona	Manage for stability	No	No	No	No	No	No
Kamaileunu	Genetic Storage	No	No	No	No	No	No
Makaha	Manage for stability	Partial	No	No	No	No	No
Makaleha	Genetic Storage	No	No	No	No	No	No
Puu Hapapa	Genetic Storage	Yes	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.50c Genetic Storage Summary

Population Unit Name	# of Potential Founders: Current Mature	Current Imm.	NumWild Dead	Partial Storage Status: # Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	StorageGoals Met: # Plants that Met Goal
Viola chamissoniana subsp. chamissoniana							
Halona	41	3	0	2	0	5	2
Kamaileunu	35	0	0	0	0	0	0
Keaau	40	10	0	0	0	0	0
Makaha	37	2	0	0	0	0	0
Makaha/Ohikilolo Ridge	7	0	0	0	0	0	0
Makaleha	34	1	0	2	0	11	6
Ohikilolo	435	10	0	1	0	2	2
Puu Hapapa	13	5	1	7	0	9	8
Puu Kumakalii	44	0	0	11	0	14	11

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
23	0	41	29

3.52 VIOLA OAHUENSIS

Requirements for Stability

- 3 population units (PUs)
- 50 reproducing individuals in each PU (short-lived perennial)
  - *This goal is met for the Helemano and Opaeula PU.*
- Threats controlled
- Complete genetic storage of all PUs
- Tier 2 stabilization priority

Major Highlights/Issues OIP Year 3

- Staff spent 1 hour total monitoring plants in the Helemano and Opaeula PU and the Koloa PU while conducting other management.

Plans for OIP Year 4

- Continue to survey for new plants in the Koloa PU and the Kaukonahua PU.
- Begin to prioritize and survey PUs with historic records, but few or no known plants
- Collect to begin seed storage testing.
- Obtain a license agreement with Hawaii Reserves Inc. for construction of the Koloa MU fence.

Table 3.51a Taxon Status Summary

Action Area: In

TaxonName: Viola oahuensis TaxonCode: VioOah

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Helemano and Opaeula	Manage for stability	163	146	22	0	0	0	163	146	22	163	146	22	Monitoring showed no change
Kamananui	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
Kaukonahua	Manage for stability	25	0	0	0	0	0	25	0	0	25	0	0	No monitoring in the last year
Kawaiiki	Genetic Storage	13	9	11	0	0	0	13	9	11	13	9	11	No monitoring in the last year
Koloa	Manage for stability	31	8	6	0	0	0	36	9	6	31	8	6	Population counts were revised after updating old observations
Poamoho	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
	Total for Taxon:	233	163	39	0	0	0	238	164	39	233	163	39	

Action Area: Out

TaxonName: Viola oahuensis TaxonCode: VioOah

Population Unit Name	Management Designation	Current Mature (Wild)	Current Immature (Wild)	Current Seedling (Wild)	Current Augmented Mature	Current Augmented Immature	Current Augmented Seedling	NRS Mature 2009	NRS Immature 2009	NRS Seedling 2009	Total Mature	Total Immature	Total Seedling	Population Trend Notes
Ahuimanu-Halawa Summit Ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Kaneohe-Moanalua Summit Ridge	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Konahuanui	Genetic Storage	0	0	0	0	0	0	0	0	0	0	0	0	No monitoring in the last year
Waiahole-Waiawa Summit Ridge	Genetic Storage	1	0	0	0	0	0	1	0	0	1	0	0	No monitoring in the last year
Waimalu to Kahaluu Summit	Genetic Storage	50	0	0	0	0	0	50	0	0	50	0	0	No monitoring in the last year
	Total for Taxon:	51	0	0	0	0	0	51	0	0	51	0	0	

Table 3.51b Threat Control Summary

Action Area: In

TaxonName: Viola oahuensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Helemano and Opaeula	Manage for stability	Partial	Partial	No	No	No	No
Kamananui	Genetic Storage	No	No	No	No	No	No
Kaukonahua	Manage for stability	No	No	No	No	No	No
Kawaiiki	Genetic Storage	Partial	No	No	No	No	No
Koloa	Manage for stability	No	No	Partial	No	No	No

Action Area: Out

TaxonName: Viola oahuensis

PopulationUnitName	ManagementDesignation	Ungulates Managed	Weeds Managed	Rats Controlled	BTB Managed	Slugs Managed	Fire Managed
Waiahole-Waiawa Summit Ridge	Genetic Storage	No	No	No	No	No	No
Waimalu to Kahaluu Summit	Genetic Storage	No	No	No	No	No	No

= Threat to Taxon within Population Unit

No Shading = Absence of threat to Taxon within Population Unit

Yes=All PopRefSites within Population Unit have threat controlled

No=All PopRefSites within Population Unit have no threat control

Partial=Some PopRefSites within Population Unit have threat controlled

Table 3.51c Genetic Storage Summary

	# of Potential Founders			Partial Storage Status			StorageGoals Met
Population Unit Name	Current Mature	Current Imm.	NumWild Dead	# Plants >= 10 in SeedLab	# Plants >=1 Microprop	# Plants >=1 Army Nursery	# Plants that Met Goal
Viola oahuensis							
Helemano and Opaeula	163	146	0	0	0	0	0
Kamananui	1	0	0	0	0	0	0
Kaukonahua	25	0	0	0	0	0	0
Kawaiiki	13	9	0	0	0	0	0
Koloa	31	8	0	0	0	0	0
Waiahole-Waiawa Summit Ridge	1	0	0	0	0	0	0
Waimalu to Kahaluu Summit	50	0	0	0	0	0	0

Total # Plants w/ >=10 Seeds in SeedLab	Total # Plants w/ >=1 Microprop	Total # Plants w/ >=1 Army Nursery	Total # Plants that Met Goal
0	0	0	0

CHAPTER 4: MIP *ACHATINELLA MUSTELINA* MANAGEMENT

The MIP stabilization plan for *Achatinella mustelina* outlines protection measures for each of six Evolutionarily Significant Units (ESU) in the Waianae Mountains. Each ESU is considered a genetically distinct group and thus important to conserve in stabilizing the taxon. In order to reach stability for *A. mustelina*, OANRP must work towards attaining the goals below.

4.1 *ACHATINELLA MUSTELINA* STABILIZATION PLAN SUMMARY

4.1.1 Long Term Goals

- Manage snail populations at eight field locations to encompass the extant range of the species and all six genetically defined ESUs. ESU-B and ESU-D each have two populations of special interest because of their extensive geographic area.
- Maintain at least 300 snails per population.
- Maintain captive populations for each of the six recognized ESUs.

Control all threats at each managed field location.

This update will cover the following sections: captive propagation, genetic issues, monitoring, reintroduction, threats, threat control development, research and ESU status updates. Each ESU status update contains highlights from the reporting year and plans for the upcoming year.

4.1.2 Captive Propagation

The MIP captive propagation goal is stated above. The following questions were posed in the 2009 report and at the 2010 snail IT meeting, a subcommittee was formed to address them. The subcommittee has not yet met but it is OANRP's goal to convene this group this fall to present at the 2011 Snail IT meeting. The questions posed in considering how to meet this goal were:

1. What is the minimum number of snails required and of what size classes to consider an ESU adequately represented? The MIP says 50 snails per ESU but does not specify size classes required.
2. What is the recollection interval and what triggers recollection: low numbers, slow reproduction, age structure consideration?
3. What is the purpose of the captive population? Many of these ESUs span large geographic areas and the MIP 300 snails target can be met by managing only a portion of this range. Is the captive population just for restoration of managed sites if they are extirpated or severely reduced in numbers? Or is it to represent the ESU across its range?
4. What reduction in the wild population would trigger using a captive population in this manner?

Captive populations of *Achatinella mustelina* have not performed well and are currently at very low numbers. Per the recommendation of the Tree Snail Lab, OANRP will not collect any new *A. mustelina* for long-term captive rearing until these issues are resolved. Reasons for this decline are unclear but active investigation in order to resolve any propagation technique issues are underway. OANRP fully support making changes to the laboratory conditions to best suit each tree snail taxon and maximize population growth and success in the lab. Over the last year, the UH tree snail lab has attempted to cultivate fungal stock from wild sources to diversify the food supplied to lab snails. In addition, the laboratory is experimenting with varying day length within the growth chambers to determine the effect on population growth. Results from both these studies are still pending. Also, the Army purchased one new state of the art incubator for the lab. The 2010 Captive Snail Propagation Summary table for *A. mustelina* is included below.

Captive Snail Propagation Summary for *Achatinella mustelina*

Population	ESU	Date	# juv	# sub	# adult	# Individuals
Peacock Flats	A	1995	0	0	6	**6**
		2003	–	–	–	**21**
		Apr-04	8	11	4	**23**
		Sep-05	3	15	2	**20**
		Aug-06	1	12	3	**16**
		Jul-07	0	9	2	**11**
		Aug-08	0	3	3	**6**
		Aug-09	0	2	0	**2**
		Aug-10	0	0	2	**2**
ʻŌhikilolo – Makai	B1	2003	0	0	10	**10**
		Apr-04	27	0	4	**31**
		Sep-05	15	8	0	**23**
		Aug-06	3	9	0	**12**
		Jul-07	1	9	1	**11**
		Aug-08	0	9	0	**9**
		Aug-09	0	8	0	**8**
		Aug-10	0	6	1	**7**
ʻŌhikilolo – Mauka	B1	2003	0	0	8	**8**
		Apr-04	20	5	0	**25**
		Sep-05	18	7	0	**25**
		Aug-06	0	21	2	**23**
		Jul-07	0	12	1	**13**
		Aug-08	0	11	1	**12**
		Aug-09	0	10	0	**10**
		Aug-10	0	4	0	**4**
Ka'ala S ridge	B2	2003	0	0	10	**10**
		Apr-04	23	0	6	**29**
		Sep-05	19	5	0	**24**
		Aug-06	4	11	0	**15**
		Jul-07	0	4	1	**5**
		Aug-08	0	3	1	**4**
		Aug-09	0	2	1	**3**
		Aug-10	0	1	0	**1**
Alaiheihe Gulch	C	2003	0	0	10	**10**
		Apr-04	14	4	4	**22**
		Sep-05	17	5	0	**22**
		Aug-06	2	20	0	**22**
		Jul-07	2	21	0	**23**
		Aug-08	1	20	0	**21**
		Aug-09	0	17	0	**17**
		Aug-10	0	0	11	**11**
Palikea Gulch	C	2003	0	0	10	**10**
		Apr-04	20	1	8	**29**
		Sep-05	22	3	2	**27**
		Aug-06	12	13	0	**25**
		Jul-07	0	22	2	**24**
		Aug-08	0	20	1	**21**
		Aug-09	0	17	1	**18**
		Aug-10	0	8	1	**8**
Schofield Barracks West Range	C	2003	0	0	10	**10**
		Apr-04	15	1	9	**25**
		Sep-05	27	1	2	**30**
		Aug-06	8	22	0	**30**
		Jul-07	2	28	0	**30**
		Aug-08	0	26	1	**27**
		Aug-09	0	23	1	**24**
		Aug-10	0	17	2	**19**

Population	ESU	Date	# juv	# sub	# adult	# Individuals
10,000 snails	D1	2001	0	0	9	**9**
		2003	–	–	–	**29**
		Apr-04	8	22	0	**30**
		Sep-05	3	24	3	**30**
		Aug-06	1	24	3	**28**
		Jul-07	7	14	4	**25**
		Aug-08	8	13	0	**21**
		Aug-09	9	2	0	**11**
		Aug-10	0	8	2	**10**
Schofield South Range	D1	2003	0	0	10	**10**
		Apr-04	18	7	3	**28**
		Sep-05	24	2	0	**26**
		Aug-06	11	12	0	**23**
		Jul-07	0	21	0	**21**
		Aug-08	0	15	3	**18**
		Aug-09	0	11	2	**13**
		Aug-10	0	7	4	**11**
Mākaha	D2	2003	0	0	10	**10**
		Apr-04	16	0	8	**24**
		Sep-05	23	0	3	**26**
		Aug-06	10	14	0	**24**
		Jul-07	5	17	0	**22**
		Aug-08	0	20	0	**20**
		Aug-09	0	10	0	**10**
		Aug-10	0	2	6	**8**
ʻĒkahanui - Honoʻuliʻuli	E	2003	0	0	10	**10**
		Apr-04	24	2	3	**29**
		Sep-05	22	2	0	**24**
		Aug-06	7	9	0	**16**
		Jul-07	2	9	1	**12**
		Aug-08	0	8	0	**8**
		Aug-09	0	6	0	**6**
		Aug-10	0	0	5	**5**
Palikea Lunch / former Pālehua	F	1997	1	0	0	**1**
		Apr-04	4	0	4	**8**
		Sep-05	20	0	2	**22**
		Aug-06	5	14	0	**19**
		Jul-07	1	15	0	**16**
		Aug-08	0	13	0	**13**
		Aug-09	0	3	0	**3**
		Aug-10	0	3	0	**3**
TOTAL		2003	–	–	–	**138**
TOTAL		Apr-04	–	–	–	**303**
TOTAL		Sep-05	–	–	–	**299**
TOTAL		Aug-06	–	–	–	**255**
TOTAL		Jul-07	–	–	–	**213**
TOTAL		Aug-08	–	–	–	**180**
TOTAL		Aug-09	–	–	–	**127**
TOTAL		Aug-10	–	–	–	**89**

Juvenile=<10mm, Subadult=>10mm no thickened lip, Adult=thickened lip

4.1.3 Genetic Issues

OANRP continues to assist in making collections for genetic investigations. The results of these additional collections will be discussed in the ESU sections. This year staff worked in conjunction with David Sischo in the UH genetics lab to determine the active status and availability of previous samples taken so as to minimize the total number of collections needed. Some samples taken as long as ten years ago are still usable while others have been used up and are no longer available for use.

4.1.4 Monitoring

OANRP propose the monitoring schedule included in the table below for each *A. mustelina* population reference site within each of the 8 managed populations. The Capture Mark Recapture method is abbreviated as CMR. OANRP will utilize the CMR method with a paint pen every three years to obtain trends in population numbers; this schedule will minimize snail handling and field site impacts. The ESU-A study site will be monitored annually in order to inform rat control management efforts already underway. Monitoring methods proposed for other sites were chosen based on habitat impact and population density considerations. The most important change that will be made to snail counts and surveys is methods standardization. Methods standardization includes: defined area of survey; time of year, use of binoculars; and whether or not survey is conducted during the day or at night.

The following are definitions for some of the content in the proposed monitoring table:

<u>Monitoring Method</u> – three options for population trend monitoring include Capture Mark Recapture (CMR), population count and population count-sweep. CMR involves the marking of snail shells one day and later recapturing snails to determine the proportion unmarked to marked in order to estimate true population size. Population count involves conducting a comprehensive survey of snails in a repeatable manner generally at a discrete and small (<30m x 30m) site. Population count-sweep is the same definition except applied across a larger landscape and involving a large group of surveyors moving across a site in a phalanx. Also included in this column is 'ground shell plot' used to track shell litter and predation.

<u>Purpose</u> – Any management related purpose for monitoring is listed in this column. If the column is left blank, assume that the main purpose if for reporting to the IT and USFWS.

<u>Method specifics</u> – For all sites, the number of observers and area surveyed will be standardized. Binoculars should always be used by observers when conducting population monitoring during both the day and night. If night surveys are used at a site, then they must be consistently used; day and night counts cannot be compared.

Proposed monitoring plan for *A. mustelina*

ESU	Pop Ref Site Code (s)	Monitoring Method	Frequency	Purpose	Method specifics	Notes
A	MMR-A - Snail Enclosure	CMR entire site	annually	guide rat control	paint pen, entire site, 2 days	continuing at K. Hall research plots
A	MMR-C (Hall Study Site)	CMR entire site	annually	guide rat control	paint pen, entire site, 2 days	continuing at K. Hall research plots
A	MMR-C (greater Maile Flats)	population count-sweep	every 3 years		3 days	

ESU	Pop Ref Site Code (s)	Monitoring Method	Frequency	Purpose	Method specifics	Notes
A	PAH-A State Snail Enclosure	population count	Quarterly/ OANRP monitor every 3 years			Hadfield Lab doing quarterly counts across entire snail exclosure for 30 minutes
A	Maile Flats MMR-C	Ground Shell Plots	annually	guide rat control		annually because rat grid is on-going
B1	MMR-E, F Ohikilolo	population count-sweep	every 3 years			
B1	MMR-H - Koiahi Gulch	population count	every 3 years			
B1	Ohikilolo	Ground Shell Plots	annually	guide rat control		
B2	LEH-C - Culvert 69	population count-sweep	every 3 years		night where you can walk	rappel survey to cliff spots
B2	LEH-D - Culvert 73	population count-sweep	every 3 years			
B2	LEH-J - Lower Down Culvert 69	population count	every 3 years			Habitat easily impacted by monitoring visits
B2	LEH-C, D	Ground Shell Plots	annually	monitor to say whether to start rat control		annually instead of quarterly because habitat easily impacted by monitoring visits
C	SBW-A, B, C - Haleauau	population count	every 6 months	guide additional collections	night survey combo with *E. rosea* seek and destroy	translocation monitoring
C	SBW-A - Haleauau	Ground Shell Plots	annually	guide rat control		
D1	KAL-A - Land of 10,000 Snails, SBS-B - Puu Hapapa	population count-sweep	annually		night and day	quarterly searches for *E. rosea*
D1	KAL-A - Land of 10,000 Snails, SBS-B - Puu Hapapa	Ground Shell Plots	annually	guide rat control		
D2	MAK-A - Makaha	population count-sweep	every 3 years		night and day	
D2	Makaha Misc MAK-A and MAK-B	Ground Shell Plots	annually	guide rat control		

ESU	Pop Ref Site Code (s)	Monitoring Method	Frequency	Purpose	Method specifics	Notes
E	EKA-A through EKA-F - Ekahanui	population count-sweep	every 3 years	guide rat control	sweep all sites	night survey where accessible and where previously surveyed at night
E	EKA-A - Ekahanui	Ground Shell Plots	annually	guide rat control		
F	PAK-A through PAK-L - Palikea, and MAU-A - Mauna Kapu	population count	every 3 years		sweep all sites	
F	PAK- M - Palikea	CMR-entire site	annually	guide rat control	paint pen, entire Hall study site, 2 days	continuing at K. Hall research plots
F	PAK-A thru PAK-M Palikea	Ground Shell Plots	annually	guide rat control		

4.1.5 Reintroduction

OANRP drafted rare snail reintroduction protocols in collaboration with the State of Hawaii, the Navy, UH Snail experts and the U.S. Fish and Wildlife Service (USFWS). In 2007, a final draft of these Rare Snail Reintroduction Guidelines was provided to the USFWS for approval as official guidelines. These guidelines have yet to be officially adopted by USFWS. OANRP is still lacking an official protocol for conducting this activity. The first planned reintroduction for *A. mustelina* will be at the KAL-A site within ESU D1. Snails were removed to captivity for a short time because of severe *E. rosea* predation. After a *Euglandina* exclosure is constructed and predator free, the snails will be reintroduced (See ESU D1 for more details). In addition, OANRP plans to construct an exclosure on the Koolau Summit where lab reared *Achatinella lila* can be reintroduced (See Chapter 5 OIP Snail for details).

4.1.6 Threats

<u>Jackson's Chameleons</u>

Seven Jackson's chameleons were collected from the Puu Kumakalii area of Schofield Barracks (ESU-D2), above 2500 ft within the known range of *Achatinella*. These are the first observations of Jackson's chameleons in the Waianae Mountains at these elevations. Gut contents included snails in four endemic genera from two families, including four individuals of *Achatinella mustelina* and native insects in five genera. Details of these findings are included in Appendix 4-1, Holland et al. 2009. In response to this new observed threat, OANRP plan to conduct outreach to educate the general public and soldiers about the impacts of pet releases to the wild (See Chapter 1, Public Outreach Update). In addition, OANRP are funding a University of Hawaii Graduate Assistant (GA) working with Principle Investigator Dr. Brendan Holland (UH tree snail lab) to investigate range size, habitat utilization, reproductive seasonality and feeding strategies in various habitats of Jackson's chameleons. OANRP staff will likely accompany the GA in the field.

Meanwhile, OANRP will continue to survey for and document any chameleons discovered within native habitat.

4.1.7 Threat Control Development

<u>Using Detector Dogs to find *Euglandina rosea*</u>

OANRP funded the Working Dogs for Conservation (WDFC) again this winter to determine the applicability of detector dogs as a *Euglandina rosea* search tool. When they left in 2009, detector dogs had approximately 250 successful encounters with *E. rosea.* Dogs had to be very near to the snail and often had to pass over it more than once to find it. Often *E. rosea* is buried under leaf litter and rocky substrate complicating detection. Because the scent difficulty is similar to crime scene detection work which requires over 400 successful encounters, the 2009 trial was deemed incomplete and inconclusive. The intent of the return visit was to supplement the number of successful encounters to exceed 400. In addition, at the end of the 2010 visit, a formal trial was conducted comparing detection dogs to human teams and both had similar success rates. Dogs seemed to excel in finding small, immature, *E. rosea* which may have application in clearing predator exclosures. The WDFC trial results are included as Appendix 4-2.

Although this trial was not as successful as OANRP had hoped, along the way Staff made contact with a local dog trainer who has agreed to conduct training at no cost to determine if using a dog that is accustomed to the climate and field conditions in Hawaii may have more success targeting *E. rosea*. Work with this local contact is ongoing. OANRP provide *E. rosea* for training and have made two field visits thus far.

<u>Exclosure Designs</u>

E. rosea barrier research continued over this reporting period. OANRP built test boxes for new designs and collaborated with Dr. Holland from the UH Snail Lab. The latest design incorporates three different designs in one final product. It includes two kinds of physical barriers and one electrical barrier. No *E. rosea* escaped from either the rows of wire mesh or electrical barriers. For more details about the designs tested and results see Appendix 4-3. There are plans to build two new snail exclosures in the coming year at Puu Hapapa (KAL-A) and Poamoho Summit (KLO-B).

4.1.8 Research

OANRP contributed to the following six research projects:

1) *Euglandina rosea* prey trail preference tracking studies

The UH Tree Snail Conservation Lab conducted trials in the lab with live *E. rosea* to determine if simple small molecules present in prey slime trails could be used to attract the predators, and to determine if *E. rosea* have a detectable preference in tracking slime trails of different prey species. The long term objective is predator control, assuming a successful means of attracting *E. rosea* is devised. Simple sugars and amino acids were used, as well as slime trails of three different species of prey, in order to begin to understand tracking preferences in *E. rosea*.

Prey slime trail preference trials were conducted using three prey taxa, including the endemic endangered Oahu tree snail *Achatinella lila*, the giant African snail *Achatina fulica*, and the common introduced Asian snail *Bradybaena similaris*. Trials were conducted in the laboratory on branches of ohia, *Metrosideros polymorpha* which is an important host tree for Hawaiian tree snails. Y-shaped ohia branches were used to simulate tree snail habitat and test *E. rosea*'s ability to track and pursue prey via slime trails in trees. The ohia branches also offered trails of two different species simultaneously, as well as one branch with slime trail versus one without. Results of our trials show that *E. rosea* significantly favored branches with slime trails versus water, choosing the branch with slime trail 90% of the time, and that the predatory snails exhibited no significant preference between *B. similaris* and *A. fulica*, or *B. similaris* and *A. lila*. However, *E. rosea* showed a statistically significant preference for *A. lila* over *A. fulica*.

None of the small molecules were found to attract *E. rosea* relative to water controls. The lab team has submitted the results of this study for peer reviewed publication, and if accepted, the study will be included in next year's report.

2) Jackson’s Chameleon Biology

The Army is funding a Jackson’s chameleon Graduate assistantship (see Section 4.1.6 in this Chapter).

3) Predatory Garlic Snails

Snail surveys have been conducted by staff from the Center for Conservation Research and Training (CCRT) at UH on Kaala for the garlic snail, *Oxychilus alliarius*. These predators are present on Kaala but impacts on native snails, particularly endangered *A. mustelina*, are difficult to quantify. It is very likely that some of these surveys will continue into the next year. The Army is considering funding a project proposal submitted by the CCRT that would assess the potential impacts on *Achatinella* species by studying the distribution of *O. alliarius.* Such a project would provide a basic understanding of *O. alliarius* habitat utilization, current distribution, provide estimates of population densities and perhaps even determine methods for control.

4) Predatory Flatworms

Staff camped in the Koolaus with Dr. Shinji Sugiura, a visiting specialist studying the predatory flatworm, *Platydemus manokwari*. After three days in the northern Koolaus, he concluded that the area is too high in elevation and too cold for survival of this flatworm. During his research time in Hawaii over the last two years, Dr. Sugiura has not observed *P. manokwari* in Hawaii above 2,000 foot elevation. This is good news for native snails because this flatworm is a serious threat to snails that live at lower elevations. He plans to present the results of his two year study at UH in October 2010.

5) Predatory behavior of newly-hatched *Euglandina rosea*

Adult *E. rosea* attack various species of snails and prefer prey smaller than themselves. However, how newly hatched *E. rosea* attack prey has never been reported. The UH Tree Snail Conservation Lab conducted a feeding experiment, demonstrating that newly hatched *E. rosea* juveniles (0.03–0.04 g) attacked and ate prey snails (*Bradybaena similaris*, Bradybaenidae) of various sizes (0.02–0.10 g). Although non-gregarious predators generally attack prey much smaller than themselves, *E. rosea* juveniles also attacked prey larger than themselves. Also, juvenile *E. rosea* hatched from the same egg clutch did not cannibalize one another. Furthermore, when *E. rosea* juveniles were experimentally presented with small endemic Hawaiian snails (Tornatellides spp., Achatinellidae, <0.01 g), all attacked the prey and a few consumed the entire prey snail whole, including its shell. Therefore, newly hatched *E. rosea* are effective predators and potentially impact native snail faunas. This manuscript has been accepted for publication in the Journal of Molluscan Studies.

6) Culturing native leaf fungi

The UH Tree snail Conservation Lab currently provides a single species of cultured fungus to all captive snails, as a supplement to fresh native leaves. However, modern mycological studies have shown that dozens of different fungal species can occur on a single leaf surface, and it is currently not well-understood how many, or which species are most important in terms of nutritional health of tree snails. In an effort to obtain additional cultured leaf fungi, and to ultimately improve the health, growth rate and development of captive snails, the UH Tree Snail Lab used *Pisonia* leaves collected from Puu Hapapa and Pahole and cultured 16 different putative species of leaf fungus. Samples of all cultured leaf fungi have been sent to two collaborating labs, one at UH Hilo, and the other at the Southwest Texas Medical Center, for DNA sequence analysis. Once it is confirmed which fungi are native to Hawaii, the lab will culture selected fungi and initiate feeding trials to captive tree snails in the lab.

4.2 ESU UPDATES

The following section contains brief updates for each of the eight OANRP managed sites. Tables contain information about the current status of *A. mustelina* at each ESU. The following is an explanation of information contained in these status tables.

Population Reference Site. The first column lists the population reference code for each field site. This begins with a three-letter abbreviation for the gulch or area name. For example, MMR stands for Makua Military Reservation. Next, a letter code is applied in alphabetic order, according to the order of population discovery. This coding system allows OANRP to track each field site as a unique entity. This code is also linked to the Army Natural Resource geodatabase. In addition, the "common name" for the site is listed as this name is often easier to remember than the population reference code.

Management Designation. In the next column, the management designation is listed for each field site. The tables used in this report only display the sites chosen for Manage for Stability (MFS), where OANRP is actively conducting or planning to conduct management. These sites are generally the most robust sites in terms of snail numbers, habitat quality, and manageability. Other field sites where the OANRP has observed snails are tracked in the database under the designation 'no management.' In general, these sites include areas with low numbers of snails and degraded habitat or areas where management would be logistically challenging. The combined population total for sites designated as MFS should be at least 300 snails in order to meet stability requirements.

Population Numbers. The most current and most accurate monitoring data from each field site are used to populate the 'total snails' observed column and the numbers reported by 'size class' columns.

Threat Control. Shading indicates that the threat is applicable for the field site. 'Yes' indicates that a threat is being controlled, 'Partial' if some control is in place and 'No' if there is no current control underway.

4.2.1 ESU-A Pahole to Kahanahaiki

There are over 300 snails in ESU-A as shown in the status table below, therefore, this ESU meets part of the stabilization goals. Over this reporting period, the Kahanahaiki MU has been maintained as pig-free with a complete rat grid. Snail habitat within the fence is weeded for both canopy and understory weeds.

***Achatinella mustelina* in ESU-A Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MMR-A **Kahanahaiki Exclosure**	Manage for stability	95	2008/11/12	57	14	24	0	Yes	Yes	Yes	Yes
MMR-C **Maile Flats**	Manage for stability	250	2009/09/16	185	31	34	0	Yes	Yes	Yes	No
PAH-B **Pahole Exclosure**	Manage for stability	31	2010/08/13	19	6	6	0	Yes	Yes	Yes	Yes
	ESU Total :	376		261	51	64	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded box] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Achatinella mustelina **distribution in the Kahanahaiki portion of ESU-A - 2010**

Map removed, available upon request

Major Highlights/Issues Year 6

- The UH Tree Snail Lab assisted under the direction of OANRP staff with outplanting native canopy trees into the Pahole Snail Exclosure site. A total of 30 trees were dug up in Kahanahaiki where they were growing in dense mats. Species included: *Pisonia sandwicensis*, *Pipturis albidis*, and *Myrsine lessertiana*.
- OANRP obtained results from the short term snail removal to the lab conducted by Kevin Hall on 3/12/09. Ten snails were collected and 16 snails were returned at the end of the 6 month period in captivity. OANRP will document the long term survival of the ten marked adult snails that were returned, during annual CMR efforts.
- No rat predation was observed during this reporting period in ground shell plots. However, two live *E. rosea* were collected in GSPs.
- OANRP completed *Achatinella mustelina* surveys across MMR-C, Maile flats, Kahanahaiki Management Unit. Results of the surveys are presented in the map above.

Plans for Year 7

- Maintain and supplement Pahole exclosure outplantings and perform weed control.
- Work with David Sischo, UH geneticist, to determine if the Peacock Flats lab collection is indeed in ESU-A and compare it to genetic samples taken from wild KAP-C individuals.

4.2.2 ESU-B

ESU-B is a very large ESU. For management purposes it has been split into two portions. ESU-B1 includes snail occurrences on Ohikilolo Ridge and B2 includes occurrences in Central and East Makaleha. Each is discussed separately. Both B1 and B2 have met the IP goal of 300+ total snails.

ESU-B1 Ohikilolo

A survey was initiated here in April 2010 but has not yet been completed thus, for the time being older population status numbers are being used. No *E. rosea* have ever been observed at Ohikilolo and OANRP continue to be vigilant about gear inspection and cleaning.

***Achatinella mustelina* in ESU-B1 Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MMR-A **Kahanahaiki Exclosure**	Manage for stability	95	2008/11/12	57	14	24	0	Yes	Yes	Yes	Yes
MMR-C **Maile Flats**	Manage for stability	250	2009/09/16	185	31	34	0	Yes	Yes	Yes	No
PAH-B **Pahole Exclosure**	Manage for stability	31	2010/08/13	19	6	6	0	Yes	Yes	Yes	Yes
	ESU Total :	376		261	51	64	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- Began comprehensive population count proposed for every three years at MMR-H.
- Conducted a survey at MMR-H. Because no signs of rat predation were found, no rat baiting was initiated.
- The rat grid for the Ohikilolo forest patch (MMR-F) was reconfigured and in some areas bait stations were added in order to best cover habitat occupied by *A. mustelina*. Additional rat control was installed near one ground shell plot which showed evidence of recent rat predation.

Plans for Year 7

- Complete population count initiated in April 2010. In the future, conduct this entire count within one quarter.
- Maintain expanded rat grid.

ESU-B2 East and Central Makaleha

ESU-B2 covers a wide geographic area. *A. mustelina* are found on almost every ridge from Central to East Makaleha. Due to management limitations and the geographic spread of these sites, OANRP only plan to manage the three sites which fall within the proposed East Makaleha MU fence. Current numbers indicate that there are over 300 total snails at ESU B2 (LEH-C). For current *A. mustelina* status in ESU-B2, see the table below. Many of the snails within the two managed sites are located on steep slopes only accessible via rappel and thus these areas are not susceptible to pig impacts. The habitat across ESU-B2 is dissected by narrow ridges which drop off steeply on both sides into deep gulches. This terrain is too steep to construct an *E. rosea* exclosure similar to those existing in ESU-A. In addition, rat control will be difficult. OANRP have concerns about establishing rat baiting trails within this *Dicranopteris linearis* dominated habitat prior to the MU fence for fear that pigs and goats will use these trails.

The goat population is again increasing in this area. Significant goat damage to snail habitat continues to be observed. Goats are moving up into more intact native areas, expanding their range closer to the Kaala Road and more directly into core snail populations. Significant goat reductions are needed in the next year. DOFAW staff have been alerted to this issue and OANRP will continue to assist their staff in control efforts, to the extent allowable under current RCUH firearms use restrictions.

***Achatinella mustelina* in ESU-B2 Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
ESU: B2 East and Central Makaleha											
LEH-C East Branch of East Makaleha (culvert 69)	Manage for stability	430	2010-05-19	267	98	65	0	No	No	No	No
LEH-D East Branch of East Makaleha (culvert 73)	Manage for stability	39	2006-05-01	20	16	3	0	No	No	No	No
LEH-J East Makaleha (culvert 69 - lower down	Manage for stability	2	2006-11-16	2	0	0	0	No	No	No	No
	ESU Total:	471		289	114	68	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- New surveys were conducted in this ESU over this reporting period for the first time in four years. Ropes were used to access some steep areas for survey. OANRP will conduct a full population count every three years.
- Genetic samples were collected from a population just east of the Dupont Trail in order to determine if it should be placed in ESU B2 or C.
- Met with DOFAW regarding plans for the East Makaleha MU fence construction. This project is pending an MOU or similar agreement between the State of Hawaii and the Army.
- Ground Shell Plots monitoring was reduced from quarterly to annually because of habitat destruction in a steep area at LEH-D and no substantial finds at the other (LEH-C).

Plans for Year 7

- Consider collecting from the East Makaleha portion of this ESU for representation in the UH Tree Snail Lab, pending improvement of lab performance of *A. mustelina*.
- Control incipient canopy weeds within snail habitat in the upper portion of the East Makaleha MU including *Psidium cattelianum* and *Toona ciliata*.
- Meet with DOFAW to plan for construction of the East Makaleha MU fence.
- Continue to monitor ground shell plots annually rather than quarterly to reduce trampling impacts to native habitat.
- Support and encourage DOFAW goat control in East Makaleha.

4.2.3 ESU-C Schofield Barracks West Range (SBW), Alaiheihe and Palikea Gulches

The number of snails in ESU-C is extremely low (see the status table below). Access to the SBW sites was improved during this reporting period and thus OANRP have had access to conduct rat control on a monthly basis. Snails have not been seen alive in ALI-A since 2003 and in ALI-B since 2005.

Achatinella mustelina in ESU-C Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
ALI-A Palikea gulch	Manage for stability	0	2009/06/02	0	0	0	0	No	No	No	No
ALI-B Palikea gulch west. Just east of Alaiheihe/Palikea dividing ridge.	Manage for stability	0	2009/06/02	0	0	0	0	No	No	No	No
ANU-A Manuwai gulch	Manage for stability	1	2004/06/02	0	1	0	0	No	No	No	No
IHE-A Alaiheihe Gulch Western Most Site	Manage for stability	0	2005/03/22	0	0	0	0	No	No	No	No
IHE-B Alaiheihe middle site "Ptemac Site"	Manage for stability	3	2009/06/02	1	2	0	0	No	No	No	No
IHE-C Alaiheihe below Nalu's LZ, TT's spot	Manage for stability	0	2005/03/22	0	0	0	0	No	No	No	No
SBW-A North Haleauau Hame Ridge	Manage for stability	33	2009/05/22	23	7	3	0	Yes	No	Yes	No
SBW-B North Haleauau one ridge north of Hame	Manage for stability	9	2009/09/06	9	0	0	0	Yes	No	Yes	No
SBW-C North Haleauau just above Pouteria pair territory	Manage for stability	0	2009/09/06	0	0	0	0	No	No	No	No
	ESU Total :	46		33	10	3	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

- Threat to Taxon at Population Reference Site
No Shading - Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- Rat control grids continue to be maintained year-round within SBW-A and SBW-B where *A. mustelina* are still extant.
- Monitored the seven translocated *A. mustelina* from SBW-C where there is no ungulate fence into a fenced area inside SBW-B. Four of the seven translocated snails were seen on 6 September 2009.
- Located a new population of 14 snails in SBW approximately 400 meters south of the other SBW snail sites. Genetic analysis will determine which ESU they belong to and results will be presented at the IT meeting.
- Still waiting on genetic analysis to determine an ESU designation for snails found along Kamaohanui ridge and approximately 600 meters from SBW-B.

Plans for Year 7

- Secure additional collections to bolster lab population as necessary, pending *A. mustelina* improvement in the lab.
- Maintain rat control.
- Continue to monitor translocated snails at SBW-B.
- Begin construction of 1,800 acre Lihue fence which will pave the way for use of aerial rodenticide and benefit the *A. mustelina* in this ESU.
- Conduct weed control at SBW sites.

4.2.4 ESU-D North Kaluaa, Waieli, Puu Hapapa, SBS, and Makaha

ESU-D is by far the largest ESU geographically. For management purposes it has been split into two portions. D1 includes North Kaluaa, Waieli, Puu Hapapa, and SBS. D2 includes Makaha.

ESU D1 North Kaluaa, Waieli, Puu Hapapa and SBS

This ESU reaches stability goal numbers as the status table below shows. The most substantial remaining challenge is the high number of *E. rosea* observed in the area. A *Euglandina rosea* exclosure is slated for construction during the next reporting period. Large scale common native reintroduction was conducted by TNC and *A. mustelina* are observed utilizing these plantings.

***Achatinella mustelina* in ESU-D1 Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
KAL-A **Land of 10,000 snails**	Manage for stability	236	2009/12/02	107	57	72	0	Yes	Yes	Yes	Partial
SBS-B **Puu Hapapa**	Manage for stability	144	2009/07/14	77	34	33	0	No	No	Yes	No
	ESU Total :	380		184	91	105	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- Conducted current snail census surveys at KAL-A site.
- Determined and cleared the best route for a predator fence for the KAL-A site; see below for details. A total of three camping trips with an average of five personnel per trip were conducted related to this exclosure preparation.
- Performed area sweeps to remove *E. rosea.* Removed a total of 407 *E. rosea* in the past 18 months. Have also eliminated hundreds of *E. rosea* eggs.

- Collected 202 wild snails for the UH Snail Lab for temporary protection from *E. rosea* predation until predator exclosure is constructed. See below for additional details.
- Monitored ground shell plots where no *E. rosea* have been observed. This plot is no longer ideal because of a dramatic drop in *A. mustelina* in the trees above and because the habitat is open and exposed and thus not ideal for *E. rosea*.
- Conducted detection dog trial with WDFC at KAL-A. Dogs were able to detect immature *E. rosea* better than humans. See Appendix 4-2
- Presented at the 2010 Hawaii Conservation Conference about *E. rosea* predation within this ESU. For abstract see the Hawaii Conservation Alliance website.

Plans for Year 7

- Continue rat grid maintenance and ground shell plot monitoring.
- Remove *E. rosea* quarterly.
- Finish snail exclosure preparation and construction.
- Finalize restoration plan for KAL-A associated with *Schinus* removal and exclosure construction.
- Relocate ground shell plot.
- Return snails from the lab.

KAL-A Land of 10,000 snails

After a number of staff noticed a decline in *A. mustelina*, a thorough night survey was conducted on 2 Dec 2009 and a total of 236 snails were counted in 18 person hours. In April 2009, a total of 386 snails were counted in a similar timeframe. The numbers show that while there are still an appreciable number of snails here, their numbers are in steep decline. Over the past 18 months a total of 407 *E. rosea* have been collected here, by far the highest density OANRP staff have ever seen anywhere on Oahu. OANRP have instituted quarterly *E. rosea* sweeps at this site.

The observed decline in snail populations represented a loss of approximately 18 snails per month. OANRP met with USFWS and Dr. Hadfield to discuss plans to bring snails into the lab for temporary safe-keeping despite recent lab problems until a more permanent snail exclosure could be built. First, a total of 50 genetic samples were collected to determine that the snails there all showed similar genetic composition and could be included in the same exclosure. Over the next four months a total of 202 *A. mustelina* were collected, primarily from the areas that would be impacted by tree cutting to make room for the exclosure. This number of adults collected is higher than our population status table reflects for the number of matures. This discrepancy is due to staff time spent searching. A great deal more time was expended searching for snails to collect for the lab and staff climbed into tree canopies to find as many as possible within the proposed exclosure site.

OANRP spent two camping trips consisting of approximately 280 person hours clearing vegetation in preparation for exclosure construction. The canopy at KAL-A is dominated by huge *Schinus terebinthifolius*. OANRP were concerned that these trees could drop limbs and compromise the future exclosure perimeter. In addition, these trees were competing with native vegetation. See the photos below of clearing efforts. OANRP have concerns that eliminating too much of the canopy would increase the amount of light and heat exposure for host trees containing *A. mustelina*. Thus OANRP are writing a restoration plan while clearing continues.

Photos of clearing for Puu Hapapa exclosure

The table below shows the 202 snails that were collected and brought into the lab for captive rearing. Snails were collected on four separate occasions; twice in February, once in April and once in May. Until the genetic analyses were complete the snails were kept in separate terraria.

j = juvenile = < 8mm in length

s = subadult = > 8mm but not having a lip to signify reproductive adult

a = adult = having a lip to signify reproductive adult

***Achatinella mustelina* Puu Hapapa Laboratory Population Numbers 2010**

Population numbers by month	**February**	**March**	**April**	**May**	**June**	**July**	**August**
Field Site	**j/s/a**	**j/s/a**	**j/s/a**	**j/s/a**	**j/s/a**	**j/s/a**	**j/s/a**
Ieie	8/1/9	17/13/16	21/13/16	22/13/16	21/13/16	25/13/16	25/13/16
Outplant 1	12/10/19	16/13/15	21/13/14	26/12/14	28/12/14	27/12/14	27/12/14
Outplant 2	11/11/18	17/12/15	16/12/15	20/12/15	22/12/14	21/12/13	21/12/13
Shelter	11/0/10	18/14/15	23/14/15	26/14/15	27/14/15	30/14/14	30/14/14
Puu Hapapa 5	--	--	--	--	8/26/14	13/26/14	13/26/14
Total live at end of period	**120**	**181**	**193**	**205**	**256**	**264**	**264**
Deaths by size	0/0/0	3/0/1	4/0/1	4/1/0	6/1/1	4/0/2	0/0/0
Total Deaths	0	4	5	5	8	6	0
Total Births	0	18	17	17	16	14	0

ESU D2 Makaha

Based on the table presented in last year's report comparing Makaha and Puu Kalena, and the IT's recommendation, OANRP plan to manage Makaha for ESU D2. OANRP have observed a total of 130 *A. mustelina* at Makaha within the fence exclosure and its borders. A camping trip is planned for October 2010 when snail surveys will be conducted and the rat baiting grid set up.

Achatinella mustelina in Makaha ESU-D2 Manage for Stability Sites

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MAK-A Isolau ridge	Manage for stability	46	2009/06/17	27	7	12	0	Yes	Partial	No	No
MAK-B Kumaipo ridge crest	Manage for stability	21	2010/01/19	16	2	3	0	Yes	Partial	No	No
MAK-C Near pinnacle rocks. Includes Hesarb ridge.	Manage for stability	15	2010/01/21	13	1	1	0	Yes	No	No	No
MAK-D On ledge below ridge crest above MAK-A site.	Manage for stability	48	2009/06/18	34	10	4	0	Yes	No	No	No
MAK-E Ridge east of Cyasup exclosure	Manage for stability	36	2009/06/18	28	6	2	0	Yes	Yes	No	No
	ESU Total :	166		118	26	22	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded] = Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- Performed thorough surveys in two areas and obtained current snail numbers. There was a slight increase in snails observed from 89 total presented in last year's report to 166 total incorporating this year's new data.
- Conducted weed control in areas where *A. mustelina* is known.
- OANRP coordinated with rat researcher, Aaron Shiels, from the University of Hawaii during his work at Makaha. Makaha was used to compare rat density and range to the Kahanahaiki study site. The results of this project will be presented in a PhD dissertation in November 2010.

Plans for Year 7

- Install ground shell plots at sites in Makaha.
- Install predator control in Makaha following USFWS notification of diphacinone use per the pesticide label.
- Continue comprehensive snail surveys within Makaha MUs.
- Conduct weed control at manage for stability sites within this ESU.

4.2.5 ESU-E Puu Kaua/Ekahanui

No new surveys were conducted during this reporting period; therefore, the numbers of snails reported this year are identical to last year. The table below summarizes the current population numbers for each reference code within this ESU. Rat management is underway at all the known ESU-E sites with the exception of EKA-D and EKA-F. Snail surveys are scheduled for September 2010 to update population count.

***Achatinella mustelina* in ESU-E Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
EKA-A Mamane Ridge and Near Plapripri EKA-A	Manage for stability	183	2004/10/13	93	30	60	0	Yes	No	Yes	No
EKA-B Below north population of Tetlep. Between Plapri EKA-A, EKA-B and EKA-C	Manage for stability	55	2004/10/14	46	6	3	0	Yes	No	Yes	No
EKA-C At Plapripri EKA-C site	Manage for stability	6	2004/10/14	6	0	0	0	Yes	No	Yes	No
EKA-D Puu Kaua	Manage for stability	202	2004/10/12	158	31	13	0	Yes	No	No	No
EKA-E Amastra site	Manage for stability	13	2004/10/05	9	3	1	0	Yes	No	Yes	No
EKA-F from Plapri-C head along blue trail under cliffs mauka	Manage for stability	3	2006/02/01	2	1	0	0	Yes	No	No	No
EKA-G Cenagr	Manage for stability	2	2008/04/10	1	1	0	0	Yes	Yes	No	No
	ESU Total:	464		315	72	77	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- Completed the Ekahanui Subunit II fence construction.
- Conducted weed control at sites with *A. mustelina*.
- Monitored ground shell plot and no rat predation observed.

Plans for Year 7

- Monitor ground shell plot.
- Deploy rat snap trap grid across Ekahanui MU which will protect six of the seven population reference sites listed in the table above.
- Remove pigs from Subunit II fence.

- Contractor to conduct rat control every other week year-round to protect *A. mustelina* within this ESU.
- Perform thorough surveys in all known areas and obtain current snail numbers.

4.2.6 ESU-F Puu Palikea/Mauna Kapu (Palehua)

The Puu Palikea fence encompasses most of the known *Achatinella mustelina* locations within this ESU. There are over 300 total snails protected within this MU fence and snap trap grid.

***Achatinella mustelina* in ESU-F Manage for Stability Sites**

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
Achatinella mustelina											
MAU-A Mauna Kapu (Palehua)	Manage for stability	40	2010/05/11	26	9	5	0	No	No	Yes	No
PAK-A Puu Palikea-Ohia spot	Manage for stability	29	2008/04/22	26	0	3	0	Yes	Yes	Yes	No
PAK-B Iele Patch	Manage for stability	1	2008/10/29	1	0	0	0	Yes	Yes	Yes	No
PAK-C Steps spot	Manage for stability	33	2008/08/14	19	9	5	0	Yes	Yes	Yes	No
PAK-D Joel Lau's site	Manage for stability	20	2008/09/23	15	5	0	0	No	No	Yes	No
PAK-E Exogau site	Manage for stability	4	2006/05/22	3	0	1	0	Yes	Yes	Yes	No
PAK-F Dodonaea site	Manage for stability	5	2008/04/22	5	0	0	0	Yes	Yes	Yes	No
PAK-G Hame and Alani site just above Cyagri fence	Manage for stability	30	2006/01/25	13	11	6	0	Yes	Yes	Yes	No
PAK-H Mike Hadfield's study site at Puu Palikea	Manage for stability	19	2010/05/12	10	4	5	0	Yes	Yes	Yes	No
PAK-I One ridge truck side of E and F	Manage for stability	5	2006/01/26	4	0	1	0	No	No	Yes	No
PAK-K Pilo site	Manage for stability	36	2009/03/25	29	5	2	0	Yes	No	Yes	No
PAK-L Olapa site north of Puu Palikea	Manage for stability	32	2008/09/25	28	3	1	0	Yes	Yes	Yes	No
PAK-M Middle Site	Manage for stability	208	2009/09/23	151	40	17	0	Yes	No	Yes	No
	ESU Total :	462		330	86	46	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 6

- Initiated new population counts at three of the 13 population reference sites within this ESU. In the future we will conduct these counts within one quarter.
- OANRP continued monitoring three ground shell plots in ESU-F and the presence of *O. alliarius*, the predatory garlic snail, has been confirmed.

Plans for Year 7

- Complete population counts at population reference sites that were not surveyed last reporting period.
- Install MU scale snap trap grid across Puu Palikea MU.

CHAPTER 5: OIP *ACHATINELLA* SPECIES MANAGEMENT

The OIP stabilization plan for *Achatinella* outlines protection measures for each Geographic Unit (GU). GUs were designated based on closest geographic groupings with an emphasis on representing the entire range of the taxon in management. The term GU is used as a surrogate for genetically defined ESUs for *A. mustelina* in the MIP. CO1 analyses were conducted for Koolau *Achatinella*. These studies showed that there is less genetic variation between *A. sowerbyana* and *A. livida* than there is between any ESUs of *A. mustelina*. The reason for this relates to the comparative ages of the lineages, as well as of the Waianae and Koolau Mountains, and therefore shorter potential timeframe for genetic variation to develop for Koolau taxa (pers. comm. B. Holland 2010). In addition, a species such as *A. mustelina* with a comparatively much larger geographic range has further opportunities for genetic structure to develop among populations, due to the evolutionary effects of isolation by distance. Thus, the GU approach to managing Koolau *Achatinella* is conservative and a good starting point. That said, for some of the geographic nodes of Koolau *Achatinella*, there are no known extant populations and thus protection and management may not be possible. This will be determined only after extensive surveys are conducted within these GUs. In order to reach stability for Koolau *Achatinella*, OANRP must attain the goals below for each taxon.

OIP Long Term Goals:

- Manage extant population units (PUs) and additional reintroduction PUs, up to a total of six PUs within the action area to encompass the known geographical range of the species.
- Achieve at least 300 snails in each GU
- Maintain captive populations of each species
- Control all threats at each managed field location
- Tier 2 stabilization priority

5.1 *ACHATINELLA* STABILIZATION OVERVIEW

Most GUs are far from the stated OIP stability goals. The situation for Koolau *Achatinella* is less than optimistic at this point in time. There are only two large populations (>300 snails) known for any of these taxa, one for *A. byronii/decipiens* from the North Kaukonahua area and the other for *A. sowerbyana* in Opaeula. *A. bulimoides, A. lila* and *A. livida* only remain as a few small populations.

In March 2010, representatives of the OANRP, State DOFAW and USFWS met to discuss the possibility of obtaining funding for an Oahu Snail Extinction Prevention Program (OSEP) and produced a spreadsheet of specific priority projects and from this generated an associated staff time and cost. This detailed list is being used by DOFAW and USFWS to seek funding for staff positions similar to those of the Oahu Plant Extinction Prevention Program. The agencies listed above would form the Oahu Rare Snail Working Group (ORSWG) which would guide OSEP staff regarding these conservation actions for Koolau *Achatinella*. Leveraging assistance from other conservation partners, OANRP could justify promoting important Tier 2, snail-related fence projects such as the North Kaukonahua MU exclosure. Partnerships are essential if the conservation community is to succeed in reversing the downward trend of Koolau *Achatinella*.

5.1.1 Captive Propagation

In this year's data there are some dramatic declines in lab populations, even for taxa with previously stable or increasing trends (See Koolau *Achatinella* Captive Propagation Table below). Despite fastidious care, controlled conditions, and frequent monitoring at the UH Tree Snail Lab, decline continues without clear cause. An example of this is the decline observed for *A. lila* from 2009 to 2010. The decrease is mainly due to mortality in adult size class snails, and reasons for this are not clear at the present time. There is no evidence of pathogenic involvement, and in fact pathogens tend to impact juveniles more severely than adults. Adult *Achatinella* in captivity tend not to survive for more than a year or so, and one possibility for this is nutritional factors. UH lab staff are currently addressing this issue by culturing additional species of leaf fungus and trying to improve the situation in the near future. OANRP will convene a meeting of the captive propagation subcommittee to determine how this situation will play out for OANRP in meeting OIP *Achatinella* stability goals.

The following table summarizes the captive propagation status for each Koolau *Achatinella* taxon. *A. byronii* are listed as *A. decipiens* as of 2009. Although both *A. byronii* and *A. decipiens* are listed as endangered species, the UH lab geneticists have never been able to identify two separate species.

Koolau *Achatinella* Captive Propagation Data (2007-2010)

	August 2007	August 2008	August 2009	August 2010
Taxon	juv/sub/adult total	juv/sub/adult total	Juv/sub/adult total	Juv/sub/adult total
A. lila	215/246/8 470	151/372/21 544	175/363/118 656	129/287/0 416
A. sowerbyana	4/14/3 21	8/14/3 25	7/13/5 25	2/10/4 16
A. livida	50/66/6 122	28/75/5 108	17/51/17 85	2/44/8 54
A. byronii/A. decipiens	5/14/9 28	6/17/7 30	3/17/5 25	1/5/0 6
A. apexfulva	3/4/1 8	2/0/0 2	0/2/0 2	0/2/0 2
A. bulimoides	21/4/9 34	24/15/4 43	18/22/3 43	4/19/9 32

5.1.2 Genetic Issues

OANRP continue to assist *Achatinella* researchers, David Sischo and Dr. Holland in making genetic collections from field sites. Results are pending from these collections and will be presented and discussed at the 2011 IT by David Sischo. Details about samples made this year are presented within the taxon section bullets.

During the 2009 reporting period, OANRP collected 10 tissue samples for genetic analysis from each of three *A. lila* sites along the Punaluu cliffs. These samples were analyzed in combination with 23 additional samples obtained from the Tree Snail Conservation Lab at UH Manoa, to compare the *A. lila* lab population which was established in 1997, with seven adult snails from the Poamoho cliffs. The results of the haplotype analysis were presented at the 2010 Snail IT meeting. Results showed that all lab snails sampled thus far matched Poamoho haplotypes. These data will have important implications relevant to the Koolau reintroduction strategy. A discussion of how these results may affect management is included in the reintroduction discussion in Section 5.1.4.

5.1.3 Monitoring

The following monitoring proposal was presented in the 2009 year-end report. Monitoring snail populations in the Koolau Mountains can be a destructive undertaking. In the past, intensive monitoring has resulted in extensive trampling of habitat. In order to avoid negative impacts like this, OANRP propose to monitor these fragile sites only every three years. At sites where the habitat is not very susceptible to trampling (ex: sites along trails), OANRP have proposed annual monitoring. Trampling and habitat destruction are also concerns with establishing ground shell plots (GSPs) and thus they have not been established at many Koolau snail sites. Also, very few Koolau *Achatinella* sites have the areas of high population density required for placement of GSPs. The bold text in the table below indicates the monitoring that OANRP successfully completed during the 2010 reporting period. The proposed monitoring plan is ambitious and not surprisingly, OANRP was only able to conduct six of twenty-six proposed Koolau monitoring activities. One reason for the shortfall is that extensive staff time was spent coordinating and conducting work related to the *A. mustelina* KAL-A predator exclosure; therefore, less of the Rare Snail Conservation Specialist's time was available for Koolau work. This shortfall is added support for partnering with other conservation agencies to accomplish rare snail work. Inadequate attention is given to these critically endangered *Achatinella* species. Because they are all tier 2 and 3 taxa for OANRP, work with Koolau snails is done as a lower priority than tier 1 *Achatinella mustelina* work. The proposed annual monitoring may not be realistic for these sites. Planned monitoring should be staggered to avoid trying to conduct work at all sites within a given year.

Proposed monitoring schedule for Koolau *Achatinella*

Taxon Name	GU	Pop Ref Site Code (s)	Current accurate GU Total Snails	Monitoring Method	Frequency	Method specifics	Notes
Achbul	**A**	**KLO-A**	**5**	**Population counts**	**Annually**	**night**	**Current numbers critically low**
Achbyr/ dec	**A**	**SBE-B through SBE-E**	**6**	**Population counts**	**Every 3 years**	**night**	**Survey all four sites in combined trip**
Achbyr/ dec	B	KLO-D Puu Pauao	16	Population Count	Every 3 years	night	
Achbyr/ dec	C	KLO-B, KLO-C and **KLO-F**	259	Population Count	Every 3 years	night	
Achbyr/ dec	D	KLO-H, KLO-I	7	Population Count	Every 3 years	night	Current numbers critically low
Achbyr/ dec	E	KLO-E North Kaukonahua	445	Population Count- sweep	Every 3 years	night	Concerned about creating trails that pigs follow
Achbyr/ dec	E	KLO-E North Kaukonahua	445	Ground shell plots	annually		Not baited. Concerned about frequent visits impacting habitat so annual visits, not quarterly
Achlil	A	KLO-B North of Poamoho Trail	15	Population Count	Every 3 years	night	Only known site in GU

Taxon Name	GU	Pop Ref Site Code (s)	Current accurate GU Total Snails	Monitoring Method	Frequency	Method specifics	Notes
Achlil	B	KLO-C and KLO-F	11	Population Count	Every 3 years	night	
Achlil	C	KLO-D and KLO-E	66	Population Count	Every 3 years	night	
Achliv	A	KLO-A Crispa	86	Population Count	annually	night	
Achliv	**A**	**KLO-A Crispa**	**86**	**Ground Shell**	**annually**		**Rat control on going**
Achliv	B	KLO-B Northern	9	Population count	annually	night	Rat control on going
Achliv	**C**	**KLO-C Radio and PAP-A**	**18**	**Population count**	**annually**	**night**	**Rat control on going**
Achsow	A	No extant sites known	0	Survey			Priority for survey
Achsow	B	KLO-K Bloody Finger	28	Population Count	annually	night	Only extant site known, need surveys
Achsow	B	KLO-P Kawaiiki	1	Survey			Last observed in 1997 requires more survey
Achsow	C	KLO-J Hypalon	220	CMR entire site	every 3 years	Paint pen, 2 days	Pay close attention to site impacts. Can do more frequently if incidental observations show decline
Achsow	C	KLO-L 290	43	Population count	annually	night	Noted impacts from monitoring, focus on largest site in GU (KLO-J)
Achsow	C	KLO-M Shaka	47	Population count	annually	night	Noted impacts from monitoring, focus on largest site in GU (KLO-J)
Achsow	**D**	**KLO-C North of Poamoho Summit**	**177**	**Population count-sweep**	**annually**	night	
Achsow	D	KLO-FF South of Poamoho Summit	19	Population count	annually	night	
Achsow	D	KLO-GG Poamoho Trail upper 1/3	77	Population count-sweep	annually	night	Does not require helicopter to access
Achsow	E	KLO-A Poamoho Pond	35	Population count	annually	night	
Achsow	F	KLO-AA Little Italy	2	Survey	Every 3 years	Night	Priority on finding more snails w/in GU
Achsow	G	KLO-S, T, V	5	Survey	annually		Priority on finding more

Taxon Name	GU	Pop Ref Site Code (s)	Current accurate GU Total Snails	Monitoring Method	Frequency	Method specifics	Notes
							snails in GU

5.1.4 Reintroduction

During the 2009 reporting period, OANRP visited the proposed predator exclosure at Poamoho Summit with KS land managers and they support the project. They plan to include permission to construct the proposed exclosure in the pending 20-year license agreement. This protected site would be used to reintroduce snails from the *A. lila* captive population. OANRP would also like to translocate some wild *Achatinella* from nearby sites into the exclosure for protection, but per IT recommendations, will do so only after it is determined safe for them to share an exclosure with the lab reared *A. lila*. Genetics showed that this lab population is inbred. This does not automatically mean that these snails are not fit. At the 2010 meeting, the IT recommended conducting the reintroduction with captive *A. lila* first and monitoring closely for any signs of inbreeding depression. These results can then inform other projects within the predator exclosure. In addition, OANRP will be conservative regarding our approach to the potential for pathogen introduction. Although the Rare Snail reintroduction guidelines developed in 2007 were never officially adopted by the USFWS, OANRP plan to follow the sanitation precautions outlined in the document.

5.1.5 Threats

General threat updates for *Achatinella* are covered in the MIP Snail Chapter. *E. rosea* and rats are considered ubiquitous at all Koolau *Achatinella*. Rat control is currently being conducted at the most accessible snail locations and regular access to these sites is via helicopters. Weather often interferes with regular OANRP rat control visits. Rat control at unprotected sites is necessary for the conservation of these *Achatinella* taxa and has been included in the OSEP project list. Jackson's chameleons have not been observed in the northern Koolau Mountains by OANRP staff.

5.1.6 Threat Control Development

Threat control development updates are covered in the MIP Snail Chapter.

5.1.7 Research

All research projects discussed in the MIP Snail Chapter also apply to Koolau *Achatinella*. Results specific to Koolau taxa will be discussed within the taxa updates to follow.

5.2 GU UPDATES

The following section contains brief updates for each of the Koolau *Achatinella* taxa. There are no separate updates per GU, as with *A. mustelina* ESUs, because there fewer extant individuals to discuss.

5.2.1 *Achatinella curta, Achatinella leucorapphe, Achatinella apexfulva*

Major Highlights/Issues Year 3

- There are no known extant live snails of these taxa. One survey was conducted at the last known location of *A. apexfulva* on August 17, 2010, but no live snails were found. *A. curta* and *A. leucorraphe* were last identified live in the field in 1989.
- The current status of *A. apexfulva* in captivity is not promising. The two immature snails remaining in the lab are the only two known to remain in the world. There are no known *A. curta* or *A. leucorraphe* in the lab.

Plans for Year 4

- OANRP will conduct surveys next year for each of these taxa and will request assistance from partner agencies in these survey efforts.

5.2.2 *Achatinella bulimoides*

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
Achatinella bulimoides											
GU: A **Poamoho Cliffs**											
KLO-A **Poamoho Cliffs**	Manage for stability	5	2010/07/28	5	0	0	0	No	No	No	No
	GU Total:	5		5	0	0	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Laboratory populations of *A. bulimoides* have declined from 43 to 32 since last year.
- A license agreement was obtained from Kamehameha Schools for access to Punaluu.
- Surveys were performed July 27-29, 2010 in Punaluu and a total of five *A. bulimoides* were counted.

Plans for Year 4

- OANRP will conduct surveys next year for this taxon and will request assistance from partner agencies in these efforts. Previous to this only two had been seen in 2006.

5.2.3 *Achatinella byronii/decipiens*

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
Achatinella byronii / decipiens											
GU: A East Range											
SBE-A **Middle Waikakalaua-South Kaukonahua dividing ridge**	Manage for stability	0	2006/06/26	0	0	0	0	No	No	No	No
SBE-B **South Kaukonahua stream**	Manage for stability	1	2001/02/26	1	0	0	0	No	No	No	No
SBE-C **East Waikakalaua-South Kaukonahua dividing ridge**	Manage for stability	1	2001/02/26	1	0	0	0	No	No	No	No
SBE-D **West Waikakalaua-South Kaukonahua dividing ridge**	Manage for stability	1	2002/05/01	1	0	0	0	No	No	No	No
SBE-E **North branch of South Kaukonahua**	Manage for stability	3	1997/09/25	1	1	1	0	No	No	No	No
	GU Total:	6		4	1	1	0				
GU: B Puu Pauao											
KLO-D **Puu Pauao**	Manage for stability	16	2006/08/22	15	1	0	0	No	No	No	No
	GU Total:	16		15	1	0	0				
GU: C Poamoho											
KLO-A **South of Poamoho Trail**	Manage for stability	0	2004/12/01	0	0	0	0	No	No	No	No
KLO-B **Poamoho Cabin**	Manage for stability	23	2006/04/18	18	3	2	0	No	No	No	No
KLO-C **South of Poamoho Cabin**	Manage for stability	1	2001/06/13	0	0	0	1	No	No	No	No
KLO-F **North of Poamoho Trail**	Manage for stability	235	2010/07/28	162	62	11	0	No	No	Partial	No
KLO-G **Poamoho trail 1800 ft at A. apexfulva site**	Manage for stability	0	2007/08/31	0	0	0	0	No	No	No	No
	GU Total:	259		180	65	13	1				

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
GU: D Punaluu cliffs											
KLO-H **Windward cliffs opposite Peahinaia summit LZ**	Manage for stability	2	2006/05/04	2	0	0	0	No	No	No	No
KLO-I **East of 290**	Manage for stability	5	2009/04/06	5	0	0	0	No	No	No	No
	GU Total:	7		7	0	0	0				
GU: E North Kaukonahua											
KLO-E **North Kaukonahua**	Manage for stability	445	2009/08/31	355	50	40	0	No	No	No	No
	GU Total:	445		355	50	40	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

[shaded] = Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- A total of 235 *A. byronii/decipiens* were counted in Punaluu July 27-29, 2010. It is likely that this number would be higher if the entire site were surveyed.
- GU-E meets the 300+ snail goal.

Plans for Year 4

- OANRP will conduct night surveys over the next year at all sites with <30 remaining individuals that were not monitored during the 2010 reporting period. Assistance will be requested from partner agencies in these survey efforts.
- OANRP will develop a North Kaukonahua fence project proposal for the ORSWG to use in seeking funding.

5.2.4 *Achatinella lila*

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
Achatinella lila											
GU: A — Poamoho Summit											
KLO-A South of Poamoho Trail	Manage for stability	0	2004-12-01	0	0	0	0	No	No	No	No
KLO-B North of Poamoho Trail	Manage for stability	15	2008-08-12	12	2	1	0	No	No	Yes	No
	GU Total:	15		12	2	1	0				
GU: B — Peahinaia Summit											
KLO-C Peahinaia Summit	Manage for stability	2	2006-05-03	1	1	0	0	Partial	Yes	Yes	No
KLO-F Below Peahinaia Summit on windward side	Manage for stability	9	2006-05-04	8	1	0	0	No	No	No	No
	GU Total:	11		9	2	0	0				
GU: C — Opaeula-Punaluu Summit											
KLO-D Notch Site, Opaeula Fence	Manage for stability	3	2005-05-03	1	1	1	0	No	No	No	No
KLO-E Windward side below Sanpur outplanting	Manage for stability	42	2006-05-03	32	8	2	0	No	No	No	No
KLO-G East of 290	Manage for stability	21	2007-04-02	18	3	0	0	No	No	No	No
	GU Total:	66		51	12	3	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- Rat control was maintained at KLO-C and KLO-B as weather allowed.
- A three-year license agreement was obtained from KS for conservation work on their lands. It includes permission to work in Punaluu. A 20-year license is pending which will include permission to construct predator exclosure fencing.

Plans for Year 4

- OANRP will conduct night surveys over the next year at all sites with <30 remaining individuals and will request assistance from partner agencies in these survey efforts.
- Rat control will be maintained twice per quarter at KLO-B and KLO-C.
- Construct snail exclosure near Poamoho Trail Summit. It will primarily serve *A. lila,* but also be available for other species found in Punaluu.

5.2.5 *Achatinella livida*

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
Achatinella livida											
GU: A Crispa Rock											
KLO-A Crispa Rock	Manage for stability	86	2009-04-28	56	13	17	0	No	No	Yes	No
	GU Total:	86		56	13	17	0				
GU: B Northern											
KLO-B Northern	Manage for stability	9	2009-04-27	6	2	1	0	No	No	Yes	No
	GU Total:	9		6	2	1	0				
GU: C Radio											
KLO-C Radio	Manage for stability	6	2010-08-10	2	4	0	0	No	No	Yes	No
PAP-A Windward side of radio	Manage for stability	31	2010-08-10	17	12	2	0	No	No	No	No
	GU Total:	37		19	16	2	0				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

[shaded] = Threat to Taxon at Population Reference Site
No Shading = Absence of threat to Taxon at Population Reference Site
Yes=Threat is being controlled at PopRefSite
No=Threat is not being controlled at PopRefSite
Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

Major Highlights/Issues Year 3

- A comprehensive night survey was conducted at KLO-C, including a survey for the predatory flatworm, *Platydemus manokwari*. No *P. manokwari* were detected but staff did confirm the presence of *Oxychilus alliarius*, the garlic snail, which could explain the observed decline in *A. livida* over the last six years.
- Rat control continues at three of four *A. livida* sites on a 6-8 week basis as the weather allows.
- The GSP at KLO-A was monitored and no rat predation was detected.
- OANRP initiated rat monitoring via tracking tunnels. Data will be used to determine how to best configure and possibly intensify rat control efforts. Data may also be used to correlate rat activity levels with any observed predation.

Plans for Year 4

- OANRP will continue to maintain rat control and read the GSP. Rat tracking tunnels will be run once per quarter to establish a baseline of rat activity for guiding management.
- Surveys will be conducted at KLO-A and KLO-B.
- Continue plans for the Koloa MU fence project after a license agreement is obtained from Hawaii Reserves to protect the KLO-B snail habitat from further pig damage.

5.2.6 *Achatinella sowerbyana*

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
Achatinella sowerbyana											
GU: A Kawainui Ridge											
KLO-Q **Pinch ridge**	Manage for stability	0	2007-05-15	0	0	0	0	No	No	No	No
KLO-R **Freckled-Toothed Ridge**	Manage for stability	0	2007-05-15	0	0	0	0	No	No	No	No
	GU Total:	0		0	0	0	0				
GU: B Kawaiiki Ridge											
KLO-K **Bloody finger**	Manage for stability	28	2009-01-05	16	6	6	0	No	No	No	No
KLO-P **Ptelid gulch upstream from the Ptelid**	Manage for stability	1	1997-08-06	1	0	0	0	No	No	No	No
	GU Total:	29		17	6	6	0				

*This long table has been formatted to keep population reference sites within one GU together. In order to maximize use of space the bullets for this taxon are included between the status tables.

Major Highlights/Issues Year 3

- Maintained rat control at KLO-C, KLO-D, KLO-J, KLO-L, KLO-M, KLO-N, and KLO-O.
- Eighteen genetic samples were collected from KLO-K and KLO-L to facilitate *A. livida* versus *A. sowerbyana* analyses. Results are still pending.
- OANRP collected 10 samples from KLO-NN (Helemano drainage) that may be used to determine ESUs for *A. sowerbyana* by comparing to samples already collected from other sites.

Plans for Year 4

- OANRP will continue to maintain ongoing rat control efforts.
- OANRP will obtain genetics results from any outstanding collections.
- OANRP will continue to visit sites proposed in the monitoring schedule table in 5.1.3.

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control			
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina
GU: C Opaeula-Helemano											
KLO-BB Below Peahinaia trail in Helemano	Manage for stability	3	2004/07/21	2	0	1	0	Yes	Yes	No	No
KLO-CC Helemano southwest of KLO-12 transect	Manage for stability	1	2004/07/21	0	1	0	0	Yes	No	No	No
KLO-D Peahinaia Summit	Manage for stability	6	1997/09/04	0	0	0	6	Yes	Yes	Yes	No
KLO-DD Helemano Southwest of KLO-12 transect, middle site.	Manage for stability	1	2004/07/21	0	1	0	0	Yes	No	No	No
KLO-E Cyrvir, photopoint pole Peahinaia trail	Manage for stability	1	1998/05/28	0	0	0	1	Yes	Yes	No	No
KLO-EE Helemano Southwest of KLO 12 transect, eastern site.	Manage for stability	1	2004/07/21	0	1	0	0	Yes	No	No	No
KLO-F Peahinaia trail pulcherima like snails	Manage for stability	5	2006/07/18	2	3	0	0	Yes	No	No	No
KLO-G South ridge of Helemano fenceline	Manage for stability	0	2009/09/09	0	0	0	0	Yes	No	No	No
KLO-H Ilex spot near palm grass site at sta 260 KLO-12	Manage for stability	2	1997/06/06	1	0	1	0	Yes	Yes	No	No
KLO-HH West Helemano, below Palm grass site	Manage for stability	5	2004/12/01	4	1	0	0	Yes	Yes	No	No
KLO-I Above goose wing	Manage for stability	1	2003/08/27	1	0	0	0	Yes	Yes	No	No
KLO-II West Helemano, above stream 30m, below large flat ridge	Manage for stability	1	2004/12/01	1	0	0	0	Yes	No	No	No
KLO-J Hypalon	Manage for stability	220	2008/08/11	105	90	25	0	Yes	Yes	Yes	No
KLO-KK Second ridge off Peahinaia trail	Manage for stability	2	2006/05/02	1	0	1	0	Yes	Yes	No	No
KLO-L Sta 290 on summit trail along Peahinaia fence	Manage for stability	43	2008/09/16	17	16	10	0	Yes	Yes	Yes	No

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes Large	Medium	Small	Unk	Threat Control Ungulate	Weed	Rat	Euglandina
KLO-LL East of 290	Manage for stability	3	2007-04-02	3	0	0	0	No	No	No	No
KLO-M Shaka	Manage for stability	47	2008-09-17	30	11	6	0	Yes	Yes	Yes	No
KLO-N Lizard-back ridge	Manage for stability	1	2005-01-05	1	0	0	0	Yes	Yes	Yes	No
KLO-O Close to shelter just above waterfall in Opaeula fence	Manage for stability	3	2002-01-01	3	0	0	0	Yes	Yes	Yes	No
KLO-U Rich Ridge	Manage for stability	22	1997-12-11	0	0	0	22	No	No	No	No
KLO-Y KST and Shelter ridge junction	Manage for stability	1	2001-10-18	1	0	0	0	No	No	No	No
KLO-Z Peahinaia south side of goose-head ridge	Manage for stability	1	2003-08-27	0	0	0	1	Yes	Yes	No	No
	GU Total:	370		172	124	44	30				
GU: D Poamoho Summit & Trail											
KLO-C North of Poamoho Summit	Manage for stability	242	2009-01-01	0	0	0	242	No	No	Yes	No
KLO-GG Poamoho trail upper 1/3	Manage for stability	77	2008-05-05	63	9	5	0	No	No	No	No
	GU Total:	319		63	9	5	242				
GU: E Poamoho Pond											
KLO-A Poamoho Pond	Manage for stability	35	2006-08-23	25	6	4	0	No	No	No	No
	GU Total:	35		25	6	4	0				
GU: F Poamoho-North Kaukonahua Ridge											
KLO-AA Little Italy	Manage for stability	2	2004-05-19	2	0	0	0	No	No	No	No
	GU Total:	2		2	0	0	0				

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes: Large	Medium	Small	Unk	Threat Control: Ungulate	Weed	Rat	Euglandina
GU: G Lower Peahinaia											
KLO-S **Puu Roberto**	Manage for stability	0	2008-10-07	0	0	0	0	No	No	No	No
KLO-T **Near Frog Pond**	Manage for stability	0	1996-08-31	0	0	0	0	No	No	No	No
KLO-V **Lower Peahinaia trail Hesarb site**	Manage for stability	5	1999-12-13	0	0	0	5	No	No	No	No
	GU Total:	5		0	0	0	5				

Size Class Definitions

SizeClass	DefSizeClass
Large	>15 mm
Medium	7-15 mm
Small	<7 mm

[shaded] = Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

CHAPTER 6: OAHU ELEPAIO

6.1 OIP ELEPAIO MANAGEMENT 2010

Background

In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the Oahu Elepaio (*Chasiempis ibidis*) endangered species status under the federal Endangered Species Act and designated critical habitat on Oahu for the Elepaio in 2001. Under the terms of the Biological Opinion for Routine Military Training and Transformation dated 2003, Oahu Army Natural Resources Program (OANRP) is required to manage and monitor a minimum of 75 Oahu Elepaio pairs. The OANRP is required to conduct on-site management at Schofield Barracks West Range (SBW) for as many of the 75 pairs as possible, with the remaining number managed at off-site locations with cooperating landowners. The OANRP has conducted rat control and Elepaio monitoring at Schofield Barracks Military Reservation (SBMR) (1998-present), Ekahanui Gulch in the Honouliuli Preserve (2005-present), Moanalua Valley (2005-present), Palehua (2007-present), Makaha Valley (2005-2009), and Waikane Valley (2007-2008). The purpose of this chapter is to summarize rodent control efforts and Elepaio reproduction results at each of management sites, and to provide recommendations for improving the Elepaio program. This section also lists and discusses the terms and conditions for the implementation of reasonable and prudent measures outlined in the Biological Opinion.

Methods

Monitoring

Throughout the nesting season, from early January to late June, each Elepaio territory was visited at one or two-week intervals. The location and age of all birds observed and color band combination, if any, was noted on each visit. Nests were counted as successful if they fledged at least one chick, and nest success was calculated as the successful proportion of total active nests. Nest success was based only on nests known to have had eggs laid in them, as determined by observations of incubation. Some nests were abandoned for unknown reasons before eggs were laid. Reproduction was measured as the average number of fledglings produced per protected pair.

To facilitate demographic monitoring, Elepaio have been captured with mist-nets and marked with a standard aluminum bird band and a unique combination of three colored plastic bands. This is useful because it allows individual birds to be distinguished through binoculars and provides important information about the demography of the population, such as survival and movement of birds within and between years. It also makes it easier to distinguish birds from neighboring territories, yielding a more accurate population estimate. In most cases, Elepaio recordings were used to lure birds into a mist-net. Each bird was weighed, measured, inspected for molt, fat, and health, then released unharmed at the site of capture within one hour.

Rodent Control

Rodents were controlled with a combination of Victor® rat traps baited with peanut butter and molasses/peanut-butter flavored Ramik® mini-bars (0.005% diphacinone) placed in tamper-resistant plastic Protecta® rodent bait stations to shield it from rain and reduce the risk of poisoning to non-target species. Bait stations were secured in trees at least one meter off the ground to restrict access by dogs (*Canis familiaris*) and feral pigs (*Sus scrofa*). Snap traps baited with peanut butter were used to augment the control. Traps were tied to trees or rocks to prevent scavengers from removing them. Traps were counted as having caught a rodent if hair or tissue was stuck to the trap, and traps were cleaned with a wire brush after each capture so previous captures were not counted again.

Rodent control was conducted for the duration of the Elepaio nesting season. The number of bait stations and snap traps deployed varied among sites. Two snap traps and two bait stations were deployed in each

Elepaio territory at some sites (Palehua), but more were deployed at other sites. More stations and traps were deployed at sites where access was more restricted, particularly SBW. Traps and bait stations were checked and rebaited once a week for the first two to three months when rodent capture rate and take of bait were high, then about once every two weeks for the rest of the study period. Traps and bait stations were deliberately concentrated in sections of each territory known to have been used habitually for nesting, thereby increasing the efficiency of the control program. Application of diphacinone bait was conducted in compliance with U.S. Environmental Protection Agency registration numbers 61282-26 and special local need registrations HI-980005.

Results

The OANRP met the prescribed target of managing 75 Elepaio pairs for the 2010 breeding season. In general, rodents were controlled only in territories that contained a breeding pair. Rodents were also controlled in a few territories that contained a single male or were vacant in order to create a larger continuous control area, or because there was some turnover of territory occupancy and it was not clear at the beginning of a season which territories contained a pair.

After analyzing the 2000-2009 data, the IT recommended OANRP discontinue Elepaio management work in Makaha in order to focus efforts at Ekahanui, Moanalua, Palehua, and SBW. In 2010, OANRP conducted rat control and monitoring of birds at SBW and monitoring only at Palehua. Pono Pacific was contracted to conduct rat control and monitoring of Elepaio at Ekahanui and Moanalua, as well as rat control only at Palehua.

The results of management conducted for each area during the 2009-2010 are compiled below. The results from each area are presented in two ways. First, a map presents a compilation of all the known Elepaio territories within each Elepaio management unit. SBW is a combination of the separate gulches. The map denotes all of the territories that were baited (shaded/black) or un-baited (unshaded/white) in 2010 as well as the territories that contained pairs (◊), single males (∆), vacant [previously occupied territory] (□), and unknown status (○). Second, the data is presented in tabular form with the number of territories that were single or contained pairs. The table also presents the number of pairs territories in which rodent control was conducted, the number of active nests observed, total successful and failed nests, how many fledglings were observed, and the ratio of fledglings per pair.

Schofield Barracks West Range

Schofield Barracks West Range Territory Occupancy Status and Rat Control 2010

Map removed, available upon request

Schofield Barracks West Range Site Demographic Data

SBW (BAN, BAW, MOH, NWA)	2010	2009	2008	2007	2006	2005
Singles	5	9	6	11	5	12
Pairs	25	19	12	13	14	16
Pairs with Rat Control	22	14	11	6	14	16
Active Nests[1]	22	10	7	2	3	6
Successful Active Nests[2]	11/22=50%	6/10=60%	2/7=29%	0	0	3/6=50%
Unknown Nest Outcome[3]	5	2	4	2	3	3
Failed Active Nests	6	2	1	0	0	0
Family Groups Found[4]	9	9	3	3	3	2
Fledglings Observed[5]	25	16	7	3	3	6
Fledglings/Managed Pair[6]	1.14	1.14	0.64	0.50	0.21	0.38

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (sufficient time gap between visits).
[4]Total number of pairs observed with fledglings in which no nests were observed.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 50% (11/22) were successful in producing at least one fledgling, 27% (6/22) failed, and 23% (5/22) had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Nine family groups were observed with at least one fledgling when no prior nests were observed. A total of 25 fledglings were observed.

Rodent Control

Rodent control was initiated from 22 December 2009 and continued through 16 June 2010 in four gulches at SBW (BAN, BAW, MOH, NWA). A total of 22 pairs were managed during the 2009-2010 breeding season. Towards the end of the 2010 breeding season, three additional territories were observed to have pairs. These three territories will be included in the 2011 breeding season management efforts.

Schofield Barracks West Range Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits[1]
2001	45	2520	1490	59%	22	60	3,2,2
2002	50	5263	3156	60%	71	88	4,4,3
2003	60	6096	2768	45%	115	120	4,4,4
2004	64	3887	2715	70%	97	120	3,3,2
2005	90	6763	1900	28%	210	172	5,5,7,6
2006	72	5635	2782	49%	212	144	5,7,6,5
2007	58	3130	1704	54%	72	100	7,0,1,1
2008	70	5702	2028	36%	204	128	10,0,4,2
2009	57	5667	671	12%	80	114	10,9,9,9
2010	84	9875	1571	16%	228	170	14,11,13,12

[1]Number of site visits by gulch: NWA, BAN, MOH, BAW.

Site Survey

In 2010, OANRP spent six days during the breeding season surveying three gulches (South Haleauau, Guava, and Coffee) that are currently not being baited or monitored in an effort to better understand the population density of Elepaio in SBW. All of the results of these surveys are displayed in the map of SBW. Each of these gulches has been surveyed in the past, with Elepaio having been recorded in all three areas. Five days of the survey were spent in the large gulch of South Haleauau (SWA). Seventeen pairs and 12 single male territories were observed during those days. A sixth day was spent surveying Pulee, which is comprised of both Guava (GUA) and Coffee (COF) gulches (See map above). These are the two northern most gulches at SBW and Elepaio were observed in previous years. One pair and one single male territory were found in Guava gulch. Elepaio were not observed in Coffee gulch. At this time, the remoteness of the territories within these three gulches and access limitations due to heavy uses of the range prevent OANRP from managing these newer sites.

Summary

During the 2009-2010 breeding season, OANRP managed 51% (22/43) of all the unknown pairs at SBW.

The 2010 breeding season seemed to be another exceptional season with 1.14 fledglings/managed pair produced (same as 2009 season). OANRP have been able to access SBW with greater frequency in both the 2008-2009 and 2009-2010 breeding seasons. The increase in active nests, successful nests, fledglings found, and the fledglings/managed pair ratio is presumably related to this improved access. With the data collected it is difficult to tease out whether this is due directly to better breeding conditions or just increased management/monitoring. OANRP surmise that it is a combination of the two. The amount of bait taken remained relatively low in 2010 and the number of rats capture/number of traps/visit only increased slightly from 0.08 in 2009 to 0.11 in 2010. This improved access will continue through the 2010-2011 breeding season and possibly the next year due to construction on the range continuing. Once the construction is complete access to the range will be reduced due to increased usage for training.

OANRP was able to meet the requirement of managing 75 pairs by combining management in both on and off site locations. At the present time, if OANRP was to initiate management for Elepaio pairs in SWA it is likely that management at one of the off site locations would have to be dropped because of personnel and time constraints. If at some time in the future the use of targeted aerial application of rodenticide is permissible then OANRP would utilize this management technique to manage all of the territories (pair and single male) at SBW.

Honouliuli Forest Reserve - Ekahanui

Ekahanui Territory Occupancy Status and Rat Control 2010

Map removed, available upon request

Ekhananui Site Demographic Data

EKA	2010	2009	2008	2007	2006	2005
Singles	5	6	5	4	2	8
Pairs	32	39	20	19	22	20
Pairs with Rat Control	30	23	19	18	20	20
Active Nests[1]	12	15	11	7	10	8
Successful Active Nests[2]	1/12=8%	7/15=47%	6/11=55%	3/7=43%	3/10=30%	4/8=50%
Unknown Nest Outcome[3]	6	7	2	3	6	1
Failed Active Nests	5	1	3	1	1	3
Family Groups Found[4]	2	4	5	8	5	11
Fledglings Observed[5]	3	11	12	11	9	16
Fledglings/Managed Pair[6]	0.10	0.48	0.63	0.61	0.45	0.80

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of pairs observed with fledglings in which no nests were observed.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 8% (1/12) were successful in producing one fledgling, 42% (5/12) failed, and 50% (6/12) had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Two family groups were observed with one fledgling each when no prior nests were observed. A total of three fledglings were observed.

Rodent Control

Rodent control was initiated from 28 December 2009 and continued through 30 June 2010 at Ekahanui. A total of 30 pairs were managed during the 2009-2010 breeding season.

Ekahanui Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2005	61	12371	1495	12%	127	99	16
2006	61	12773	3603	28%	142	98	17
2007	59	14659	4745	32%	131	76	16
2008	59	12494	1062	9%	82	102	18
2009	68	10664	348	3%	96	124	17
2010	90	12168	342	3%	302	168	20

Summary

Overall, it was a very poor breeding season at Ekahanui. The .10 fledglings/managed pair produced was well below the average of .59 fledglings/managed pair observed over the previous five years. It has not been determined whether this poor reproductive output was due to poor environmental conditions at this management site or due to inadequate/insufficient monitoring during the season. The number of rat captures/number of traps/visit increased from 0.05 in 2009 to 0.09 in 2010, but the percent of bait take (3%) remained the same as in 2009. The increase in rats at this site may have been a contributing factor in the low reproductive out. Other sites on Oahu performed poorly as well during the 2010 breeding season.

There were 32 pair territories observed during the 2010 breeding season. This does not actually reflect a decrease of six pair territories from the previous year of 39 pair territories observed, but rather being unable to return to all of the known territories surveyed in 2009.

OANRP will be taking a new rodent control approach at Ekahanui for the 2011 breeding season with the implementation of a large scale rat trapping grid, which will encompass all known Elepaio territories within the Ekahanui fenced units. This large scale trapping grid will be based on the New Zealand Department of Conservation current best practice for killing trapping rats and similar to the grid being run currently at Kahanahaiki in the northern Waianae mountains (see Research Chapter: Kahanahaiki: Large Scale Trapping Grid).

Palehua

Palehua Territory Occupancy Status and Rat Control 2010

Map removed, available upon request

Palehua Site Demographic Data

HUA	2010	2009	2008	2007
Singles	1	2	5	7
Pairs	18	15	11	11
Pairs with Rat Control	18	15	11	11
Active Nests[1]	10	9	6	6
Successful Active Nests[2]	2/10=20%	6/9=67%	4/6=67%	3/5=50%
Unknown Nest Outcome[3]	0	0	0	0
Failed Active Nests	8	3	2	3
Family Groups Found[4]	2	4	4	4
Fledglings Observed[5]	4	14	10	7
Fledglings/Managed Pair[6]	0.22	0.93	0.91	0.64

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of pairs observed with fledglings in which no nests were observed.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 20% (2/10) were successful in producing one fledgling each and 60% (8/10) failed. Two family groups were observed with one fledgling each when no prior nests were observed. A total of four fledglings were observed.

Rodent Control

Rodent control was initiated from 12 January 2010 and continued through 18 June 2010 at Palehua. A total of 18 pairs were managed during the 2009-2010 breeding season.

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2007	32	5518	1729	31%	118	33	17
2008	33	3372	713	21%	36	35	9
2009[1]	37	5203	1137	22%	22	37	14
2010	42	7722	519	7%	99	45	21

[1]Feral pigs accessed bait stations on two occasions near the end of the season and consumed rodenticide.

Summary

Overall, it was a poor breeding season at Palehua. The .22 fledglings/managed pair produced was well below the average of .83 fledglings/managed pair observed over the previous three years. It has not been determined whether this poor reproductive output was due to poor environmental conditions at this management site or other unknown factors during the season. The number of rat captures/number of traps/visit increased from 0.04 in 2009 to 0.10 in 2010. The percent of bait taken was the lowest since management began in 2007. The increase in rats at this site may have been a contributing factor in the low reproductive out.

Moanalua Valley

Moanalua Territory Occupancy Status and Rat Control 2010

Map removed, available upon request

Moanalua Site Demographic Data

MOA	2010	2009	2008	2007	2006
Singles	8	7	3	5	4
Pairs	19	28	28	29	26
Pairs with Rat Control	17	24	25	26	22
Active Nests[1]	22	19	18	18	11
Successful Active Nests[2]	4/22=18%	7/19=37%	10/18=56%	7/18=39%	4/11=36%
Unknown Nest Outcome[3]	7	6	2	5	3
Failed Active Nests	11	6	6	6	4
Family Groups Found[4]	2	7	8	8	8
Fledglings Observed[5]	7	16	24	17	14
Fledglings/Managed Pair[6]	0.41	0.67	0.96	0.65	0.64

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of pairs observed with fledglings in which no nests were observed.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 18% (4/22) were successful in producing one fledgling, 50% (11/22) failed, and 32% (7/22) had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Two family groups were observed with at least one fledgling when no prior nests were observed. A total of seven fledglings were observed.

Rodent Control

Rodent control was initiated from 30 December 2009 and continued through 02 July 2010 at Moanalua. A total of 17 pairs were managed during the 2009-2010 breeding season.

Moanalua Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2006	66	16945	2340	14%	323	134	19
2007	81	14185	1707	12%	348	162	16
2008	87	13638	1622	12%	325	174	16
2009	78	12238	955	8%	239	150	15
2010	80	12720	1053	8%	343	160	20

Summary

Overall, it was a below average breeding season at Moanalua. The .41 fledglings/managed pair produced was below the average of .73 fledglings/managed pair observed over the previous four years. It has not been determined whether this poor reproductive output was due to poor environmental conditions at this management site or due to inadequate/insufficient monitoring during the season. The precent of bait taken (8%) and the number of rats captured/number of traps/visit (0.11) remained the same as in 2009. Whether rats were a contributing factor to the below average reproductive output at this site remains unclear.

There were 19 pair territories observed during the 2010 breeding season. A decrease of seven managed pair territories occurred before and/or during the 2010 breeding season. The reason for this decline in the number of previously managed pair territories is unknown.

OIP Summary

Management Actions 2010

- Conducted rodent control in a total of 87 territories with pairs at four management sites.
- Results from the data gathered revealed a large disparity of breeding success between the different Elepaio management sites. SBW was by far the most successful with 1.14 fledglings/managed pair with Moanalua following at .41 fledglings/managed pair, Palehua at .22 fledglings/managed pair, and Ekahanui at .10 fledglings/managed pair. With the data that was collected it is unclear why the breeding success was so poor for Ekahanui, Moanalua, and Palehua. The low reproductive out at these three sites may have been a combination of some or all of the following factors: environmental conditions, inadequate/insufficient monitoring, increased rat predation, or natural fluctuations.
- As these managed populations have begun to expand, OANRP is beginning to reach the point where it will not be feasible to continue to expand management to newer pair territories. It is going to get considerably more difficult to conduct management and monitor every territory year to year. The BO requires management for at least 75 pairs and OANRP buffers that number each year to make sure that threshold is reached. In order to realistically manage all of the territories within each MU, there needs to

be more efficient techniques available to use (ie. targeted aerial application of rodenticide). At this time, OANRP is working at installing a large scale rat trapping grid that covers the entire Ekahanui Elepaio management site.

- The table below summaries the number of managed pairs and reproductive output since 2005.

Summary of Elepaio Management Table

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings
2010[1]	87	18	15	39
2009[2]	81	29	24	60
2008[3]	74	25	20	56
2007[3]	78	18	26	46
2006[4]	69	11	17	33
2005[5]	44	7	16	25

[1]SBW, Ekahanui, Moanalua, Palehua
[2]SBW, Ekahanui, Makaha, Moanalua, Palehua
[3]SBW, Ekahanui, Makaha, Moanalua, Waikane, Palehua
[4]SBW, Ekahanui, Makaha, Moanalua
[5]SBW, Ekahanui, Makaha

Management Actions 2011

- Conducted rodent control and Elepaio monitoring at SBW, Ekahanui, Palehua, Moanalua to meet required 75 managed pairs.
- Implement large scale rat trapping grid at Ekahahuni.
- OANRP will create an Elepaio Specialist position that will begin in the 2011 breeding season to evaluate, Pono Pacific, the Elepaio contractors performance, data organization, yearly territory occupancy surveys at all sites, monitoring and banding.

Terms and Conditions for Implementation

Minimize direct impacts of military activities on survival and reproduction of Oahu Elepaio within the action area at Schofield Barracks Military Reserve (SBMR).

1. *The Army will report to the Service in writing at least semiannually (twice per year) the number of high explosive rounds that land above the fire break road, the locations where such rounds land, and whether these locations are within any known Elepaio territories.*

[No high explosive rounds landed above the firebreak road from 2009-2010]

2. *The Army will notify the Service within 24 hours of any fires that burn any portion of a known Elepaio territory and the number of Elepaio territories affected.*

[No fires affected any known Elepaio territories]

3. *The Army will limit training actions in the forest above the fire break road at SBMR in the Elepaio nesting season (January to May) to small numbers of troops (platoon or less) that remain in one location for short periods of time (one hour or less), to limit possible nest disturbance.*

[No training actions have occurred above the firebreak road]
4. *The depository designated to receive specimens of any Oahu Elepaio that are killed is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii, 96817 (telephone: 808/547-3511). If the B.P Bishop Museum does not wish to accession the specimens, the permittee should contact the Service's Division of Law Enforcement in Honolulu, Hawaii (telephone: 808/541-2681; fax: 808/541- 3062) for instructions on disposition*.

[No specimens were collected by OANRP staff]

<u>Minimize loss of Oahu Elepaio habitat at SBMR, Schofield Barracks East Range (SBER), and Kawailoa Training Area (KLOA).</u>

1. *The Army will report to the Service in writing on a semi-annual (twice per year) the number of fires above the fire break road, the area burned by each fire above the fire break road, including the amount of critical habitat burned, and how each fire was ignited or crossed the fire break road.*

[No fires occurred above the firebreak road]

2. *The Army will notify the Service within 24 hours of any instance in which training was not conducted in accordance with the Wildland Fire Management Plan (WFMP)*.

[All training was conducted in accordance with the WFMP]

<u>Manage threats to Oahu Elepaio and Oahu Elepaio habitat at SBMR, SBER, and KLOA.</u>

1. *The Army will report to the Service in writing annually the number of Elepaio territories in which rats were controlled, the location of each territory in which rats were controlled, the methods by which rats were controlled in each territory, the dates on which rat control activities were conducted in each territory, and the status of Elepaio in each territory from the previous year.*

[This report documents all of the above requirements]

2. *The Army, Service, and ornithological experts will formally reassess all impacts to Oahu Elepaio and Elepaio critical habitat that have occurred during the first five years following completion of this biological opinion. This formal review will occur before the end of calendar year 2008 and its purpose will be to reassess impacts from training exercises and, if necessary, correct any outstanding issues that are still impacting Elepaio and resulting in the loss suitable Elepaio habitat at SBMR. The feasibility of restoring critical habitat areas that have been lost also will be reassessed during this formal review.*

[Completed]

6.2 MIP ELEPAIO MANAGEMENT 2010

Background

The initial Biological Opinion (BO) that triggered the development of the Makua Implementation Plan (MIP) was issued in 1999. At that time, the Oahu Elepaio (*Chasiempis ibidis*) was not listed as an endangered species. The 1999 BO included recommendations related to Elepaio. These included conducting complete surveys of the Makua Action Area (AA) for Elepaio presence, monitoring of all known Elepaio within Makua Military Reservation (MMR) and installing and maintaining predator control grids around nesting pairs within MMR. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the Oahu Elepaio endangered species status under the Federal Endangered Species Act and in 2001 designated critical habitat on Oahu for the Elepaio. In the *Supplement to the Biological Opinion and Conference Opinion for Proposed Critical Habitat for Routine Military Training at Makua Military Reservation* issued in 2001, the recommendations from the 1999 BO became requirements. In September 2004, the USFWS issued another BO that covered newly designated critical habitat within the Makua AA for plants and Elepaio. This BO outlined additional requirements related to this critical habitat. The most recent BO issued in 2007 required the protection of all Elepaio pairs within the Makua AA.

Methods/Results

The methods section and the presentation of the results are the same as in OIP Elepaio management section of this year-end report.

Makua Territory Occupancy Status and Rat Control 2010

Map removed, available upon request

Makua Site Demographic Data

Makua	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Single Males	2	1	1	2	4	0	3	4	4	2
Single Females	0	0	1	1	1	1	0	0	0	0
Pairs	0	2	2	2	1	0	3	3	3	2
Pairs with Rat Control	0	2	2	2	1	0	3	3	3	2
Active Nests[1]	0	1	1	0	0	0	2	4	1	1
Successful Active Nests[2]	0	0	0	0	0	0	1/2=50%	1/4=25%	1/1=100%	1/1=100%
Unknown Active Nests[3]	0	1	0	0	0	0	1	2	0	0
Failed Active Nests	0	0	1	0	0	0	0	1	0	0
Family Groups Found[4]	0	0	0	0	0	0	0	0	0	0
Fledglings Found[5]	0	0	0	0	0	0	1	1	2	1
Fledglings/Pair[6]	0	0	0	0	0	0	0.33	0.33	0.67	0.50

[1] Nest containing eggs or nestlings.
[2] Total number of successful active nests observed.
[3] Total number of active nests with unknown outcome (time gap between visits).
[4] Total number of pairs observed with fledglings in which no nests were observed.
[5] Total number of fledglings observed from successful active nests and family groups.
[6] The ratio of fledglings per managed pair.

Reproductive Results

During four site visits in the 2010 breeding season, no pairs were observed (only single males). No nests or fledglings were observed.

Rodent Control

Rodent control was initiated for two territories (pair territories in 2009) in Lower Makua from 19 January 2010 and continued through 19 April 2010 at Makua. Only four site visits occurred in 2010 for restocking bait stations and resetting rat traps. This low number of site visits was not adequate to fully protect these territories if they contained pairs.

Makua Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	Sites[1]	# of Site Visits[2]
2000	12	736	310	42%	13	12	1	12
2001	18	1752	768	44%	33	31	1,2	12,3
2002	24	4234	1917	45%	59	37	1,2	15,3
2003	24	2979	916	31%	26	36	1,2	12,2
2004	24	3016	1838	61%	37	36	1,2	16,4
2005	10	932	406	44%	10	14	1	8
2006	12	192	172	90%	14	24	2	1
2007	12	384	365	95%	8	24	2	2
2008	16	628	178	28%	24	32	2	3
2009	12	810	115	14%	23	24	2	5
2010	12	576	179	31%	25	24	2	3

[1]Site: Kahanahaiki (1) and Lower Makua (2)
[2]Number of visits per site respectively.

MIP Summary

Management Actions 2010

- The limited number of site visits (4) during the 2010 breeding season to Lower Makua may have been inadequate to detect females in previous pair territories.

Management Actions 2011

- Conduct rat control in all pair territories and monitoring of Elepaio at Makua to meet the BO requirements.
- OANRP will create an Elepaio Specialist position that will begin in the 2011 breeding season to conduct yearly territory occupancy surveys at all territories within the Makua AA, monitoring and banding, and data entry and organization.

CHAPTER 7: RESEARCH PROGRAM

This chapter describes the status and outcome of actions carried out under the direction of the program's Research Specialist (RS) and Small Vertebrate Pest Program Manager. This section does not include all research projects supported by the program. Please refer to the appendices of this document to view additional research publications.

Pest species listed in Chapter 6 of the Status Reports for the Makua Implementation Plan and the Draft Oahu Implementation Plan 2006[12] included slugs (Mollusca: Gastropoda), the black twig borer (*Xylosandrus compactus*) and invasive ants. In the most recent year end report (2009[13]), we added *Sphagnum palustre* (an introduced bog moss) to our list of research subjects and described the installation of a large scale trapping grid for rats and mice. In conjunction with the trapping grid we are monitoring changes in native and alien vegetation, arthropods and mollusks, all of which are part of the diet of rats and may be affected by rat removal. Research findings are organized by pest species.

Statistical analyses in this section were performed with Minitab Release 14 software of Minitab Inc. (Ryan *et al*. 2005)[14]. Significance during hypothesis testing was characterized by p-values less than 0.05. Nonparametric statistical methods were used to analyze datasets with non-normally distributed residuals and dissimilar variation between groups, otherwise parametric methods were used.

7.1 BLACK TWIG BORER (BTB) TRAP DEPLOYMENT

7.1.1 Introduction

Xylosandrus compactus (black twig borer or BTB) is a major threat to a number of rare and endangered plants, notably *Flueggea neowawraea* (Euphorbiaceae). Published documentation is lacking, however OANRP and the DLNR have observed these species to suffer under BTB attack. Sequestered within the plant pith, BTB cannot be removed manually or with pesticides applied on the plant surface. Greenhouse collections of *F. neowawraea* are treated with the systemic insecticides Merit (Bayer Crop Research, Triangle Park, NC) applied as a root drench and Marathon (Olympic Horticultural Products, Mainland, PA) applied to the base of the plant in granular form. Neither is legal to use in a natural setting, but a Special Local Needs (SLN) Label (Nagamine and Kobashigawa 2003)[15] could be pursued with permission from the manufacturer, HDOA and USFWS. OANRP is currently engaged in the process of SLN approval for a molluscicide, Sluggo and have found the process to be lengthy. Rather than embark on this long process for BTB management, OANRP looked for solutions which could be put into use immediately if found to be effective.

In 2007 OANRP tested the efficacy of modified Japanese Beetle Traps equipped with high-release ethanol bait (AlphaScents, NJ) and insecticidal strips (Vaportape II™, Hercon® Environmental, Emigsville, PA) to reduce BTB gallery formation in a target tree species (*F. neowawraea*). Earlier tests

[12] OANRP 2005-2006 Status Reports for the Mākua Implementation Plan and the Draft Oʻahu Implementation Plan Chapter 6.1-6.13 http://manoa.hawaii.edu/hpicesu/DPW/2006_MIP/06.pdf. Accessed October 13, 2010.
[13] OANRP 2008-2009 Year End Report Chapter 6.1-6.6 http://manoa.hawaii.edu/hpicesu/DPW/2009_OIP/007.pdf. Accessed October 13, 2010.
[14] Ryan, B., B. Joiner and J. Cryer (2005) Minitab Handbook, Fifth Edition. Thomson Brooks/Cole, Belmont, CA, 505 pp.
[15] Nagamine, C. and L. Kobashigawa (2003) Special Local Need Labeling for Pesticides in Hawaii. *Pesticide Risk Reduction Education* 4: 1-4.

demonstrated this lure to effectively capture BTB (OANRP 2007)[16] but, prior to our experiment, it was unknown whether traps could be used to control BTB populations locally. We conducted a field experiment to determine whether a ring of traps placed around *F. neowawraea* could reduce attack rates relative to a control group.

Post-treatment results were mixed. While those trees receiving traps had a consistently lower rate of attack compared to the controls, these differences were not significant when adjusted for pre-existing differences between the two groups.

Despite the failure of trapping to appreciably reduce damage to *F. neowawraea*, the following conclusions may be made. First, it was discovered that baseline levels of attack were extremely high. At the peak of twig-borer season trees in the control group accumulated three new entry holes per 1 meter of bole length every two days. Second, the traps consistently yielded a steady number of beetles, at times as high as 100 or more. Each insect trapped was a gravid female due to the insects' somewhat unique reproductive behavior (Hara and Beardsley 1979[17]). Third, the traps did not exhibit a hypothesized potential counter-productive effect of increasing attack. Those trees that received traps had, on average, lower rates of attack than those trees without.

BTB research is now focused on the development of semiochemicals to reduce attack (Elsie Burbano, University of Hawaii Plant Environmental Protection Program *pers. comm.*) as well as the registration of the systemic insecticide Admire Pro® (Bayer Crop Sciences) for use in Koa tree plantations. This product is applied as a soil drench. Other possible avenues of BTB include the use of repellents. Also possible is the use of injection systems to more safely deliver systemic insecticides to the plant. OANRP will pursue work with outside researchers to test these products. Safe, legal deployment of any insecticide requires a change in its label. These changes are a minimum of three years away.

7.1.2 2009-2010 BTB Activities

No new BTB research was conducted this year. As the only available means of controlling BTB, traps were deployed in March 2009 in conjunction with *F. neowawraea* outplantings.

7.1.3 Methods

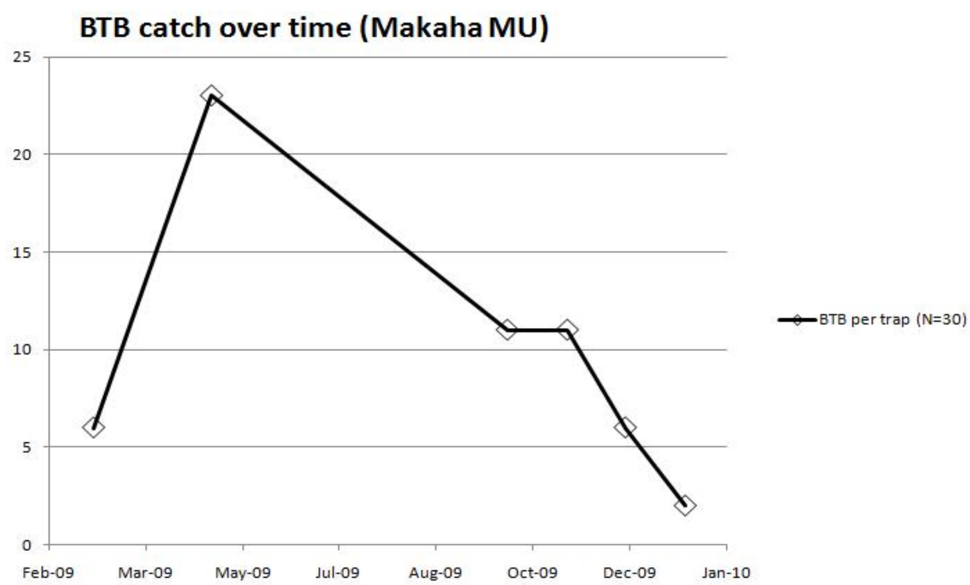
We deployed 30 modified Japanese Beetle Traps equipped with a high-release ethanol bait (AlphaScents, NJ) to serve as a sink for BTB at three *F. neowawraea* planting sites in Makaha MU (Population Reference Codes MAK-G, MAK-H, MAK-I). There are 10 traps at each site. Traps were placed at 5 m intervals throughout the outplanting area.

[16] OANRP 2007 Status Reports for the Mākua Implementation Plan and the Draft Oʻahu Implementation Plan Chapter 5.1-5.2 http://manoa.hawaii.edu/hpicesu/DPW/2007_YER/005.pdf. Accessed October 13, 2010.
[17] Hara, A. H. and J. W. Beardsley, Jr. (1979) The biology of the black twig borer, *Xylosandrus compactus* (Eichhoff), in Hawaii. *Pro. Hawaiian Entomol Soc.* 18 (1): 55-70

Three *F. neowawraea* outplanting sites where BTB traps were deployed.

Traps were deployed in March 2009 and visited approximately every two months through March 2010. It should be noted that the insecticidal strips need replacement every three weeks, therefore, it is likely that at least 50% of the time traps were inactive. Traps were discontinued in March 2010 following feedback that there was insufficient evidence to prove they reduce new BTB gallery formation in *F. neowawraea.* Please refer to 6.1.1 – 6.1.3 of the 2009 year end report (http://manoa.hawaii.edu/hpicesu/DPW/2009_OIP/007.pdf) for a full description of the BTB trap-out study which was used to inform our decision to discontinue traps.

7.1.4 Results



Average number of BTB per trap 2009-2010

Baits and insecticidal strips were replaced opportunistically through March 2010. Interpretation of the results, therefore, is limited to average number of BTB caught per trap on each of the dates shown in the figure above. Seasonal fluctuation of BTB at this site is difficult to determine given the irregular collection intervals.

7.2 SEEDLING RESPONSE TO LABEL AND LOW DOSE APPLICATION OF IRON PHOSPHATE (SLUGGO®) IN A FORESTED AREA

7.2.1 Introduction

The purpose of this on-going experiment is to determine whether Sluggo® applied at a rate of 0.01lbs. a.i./93m^2 once a month is equal to application bi-monthly as indicated by the survival of naturally occurring *Cyanea superba* subsp. *superba* (hereafter referred to as *C. superba*) seedlings over 1 year. This experiment directly relates to how Sluggo would be applied to maximize native plant recruitment in a forest setting should a Special Local Needs (24c) label be granted for this product within the State of Hawaii.

7.2.2 Methods

Thirty six *C. superba* in the Kahanahaiki Management Unit (KMU) produced fruit in the 2009-2010 season. This unprecedented fruiting event allowed us to compare, for the first time, the efficacy of Sluggo at intervals less frequent than two weeks while controlling for other factors likely to affect seedling recruitment (fruit production per plant and rat predation of fruit). Following a successful petition to the HDOA to allow for this experiment, we randomly divided these plants into two groups, one of which received Sluggo every two weeks to a distance of two m from the base of the plant (area per plant = 12.5 m^2), the other which received Sluggo once month. Any differences found between the two groups after one year (March 2010-March 2011) would be used to guide OANRP in long-term management of *C. superba* should additional SLN labeling be approved for Sluggo.

7.2.3 Results

Naturally occurring seedlings were observed at 18 of the 36 (50%) of fruiting plants. Four of these plants fruited in the 2008-2009 season and produced seedlings which are still extant (86 seedlings). Combined with the new seedlings from the last season, there were 163 immature plants remaining in July 2010. No difference in germination between the high and low dose groups are evident at this time, however, six additional months of data collection remain.

7.3 MOLLUSCICIDE SPECIAL LOCAL NEEDS LABELING (SLN) STATUS

7.3.1 Introduction

Since 2007 OANRP has been working with the manufacturer of Sluggo (Neudorff Co., Fresno, CA), to complete research in support of a label expansion which would allow it to be used for the protection of native plants. Under an Experimental Use Permit (EUP) granted by the Hawaii Department of Agriculture in 2007-2008, OANRP demonstrated that forest application successfully controls the target pest for up to two months after application with no detectable impacts to native snails. An EUP extension through the following year allowed OANRP to investigate Sluggo application on seedling emergence. Results from this study were presented in a summary of OANRP projects at the Center for Plant Conservation Symposium (St Louis, MO October 2009) and are included in proceedings planned for publication later in 2010.

7.3.2 Methods (Status)

A draft label was submitted to HDOA in June 2010. After receiving feedback from HDOA, the label was revised and resubmitted in August. OANRP has remained in regular communication with HDOA on the status of the application which has not yet been finalized. The draft label (below) includes changes approved by reviewers at the EPA, the Department of Health (DOH) and DLNR.

7.3.3 Results

10 August 2010 Sluggo Special Local Needs Label. "X" is used intentionally as a placeholder for information to be provided by HDOA upon registration. Only proposed changes are shown here. Standard wording in the national label is omitted.

SECTION 24(c) REGISTRATION

NEU1165M
SLUG AND SNAIL BAIT
FOR CONSERVATION PURPOSES
EPA Reg. No. 67702-3
EPA SLN No. HI – 10XXXXX

SUPPLEMENTAL LABELING INFORMATION FOR DISTRIBUTION AND USE ONLY IN FORESTED AREAS WITHIN THE STATE OF HAWAII

This label is valid until xx xx, 2015 or until otherwise amended, withdrawn, cancelled or suspended.

GENERAL INFORMATION FOR USE IN FORESTED AREAS

Purpose: For the control of slugs in forests and other natural areas to protect native, threatened and endangered Hawaiian plants.

GENERAL: NEU1165 Slug and Snail Bait is a unique blend of an iron phosphate active ingredient, originating from soil, with slug and snail bait additives. It is used as an ingredient in fertilizers. The bait which is not ingested by snails and slugs will degrade and become a part of the soil.

The bait is ingested by slugs and snails when they travel from their hiding places to plants. Ingestion, even in small amounts, will cause them to cease feeding. This physiological effect of the bait gives immediate protection to the plants even though the slugs and snails may remain in the area. After eating the bait, the slugs and snails may not be visible as they often crawl away to secluded places to die. Plant protection will be observed in the decrease in plant damage and the increase in seed germination and seedling survival. NEU1165M is effective against a wide variety of slugs and snails.

USE RESTRICTIONS: For control only of slugs and non-native snails in forests, offshore islands and other natural areas to protect native, threatened and endangered Hawaiian plants.

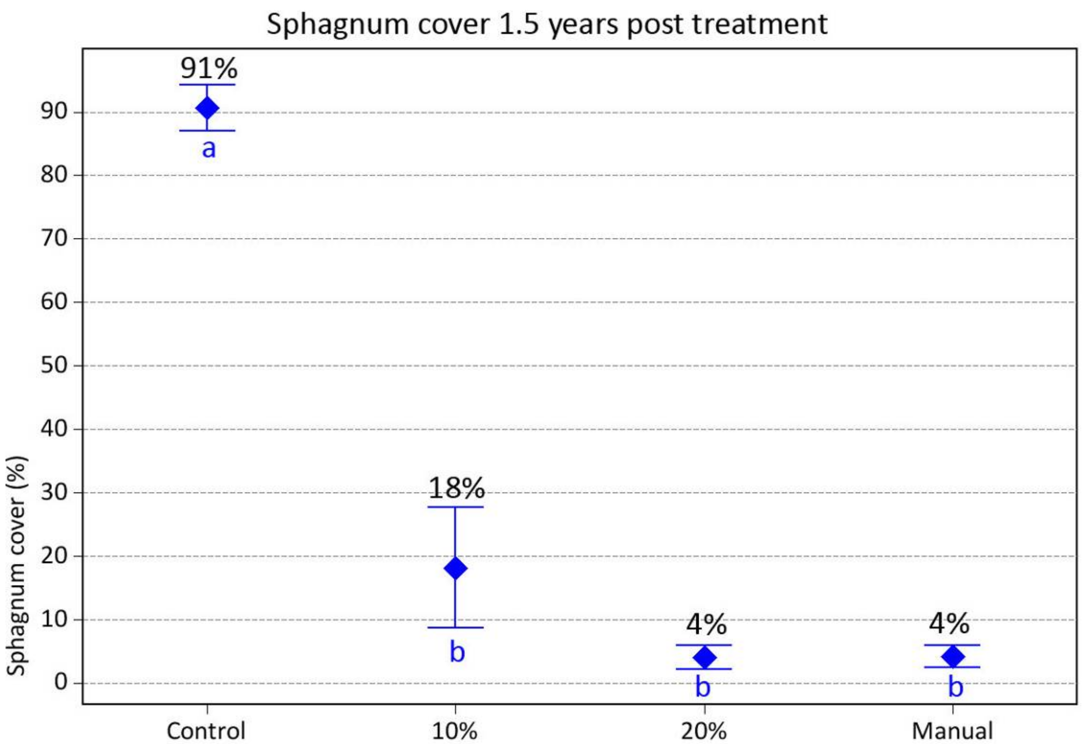
Area must be thoroughly searched by experienced malacologists during the day and at least one night prior to application of NEU1165M Slug and Snail Bait granules to ensure that non-target endemic Hawaiian snail species are not impacted. Do not apply in areas where it may come into contact with known populations of endemic Hawaiian snail species from the following rare families or subfamilies: *Amastridae*, *Achatinellinae* and *Endodontidae*). Bait cannot be applied within 20 m of any tree known to harbor endangered Hawaiian tree snails (*Achatinella* spp.). Report any evidence of suspected poisoning of Hawaiian snails to the Pesticides Branch of the Hawaii Department of Agriculture, phone: (808) 973-9401.

7.4 A Test of the Long Term Efficacy (1 year +) of St. Gabriel's Moss Killer (SGMK) to Prevent *Sphagnum palustre* Regrowth

7.4.1 Introduction

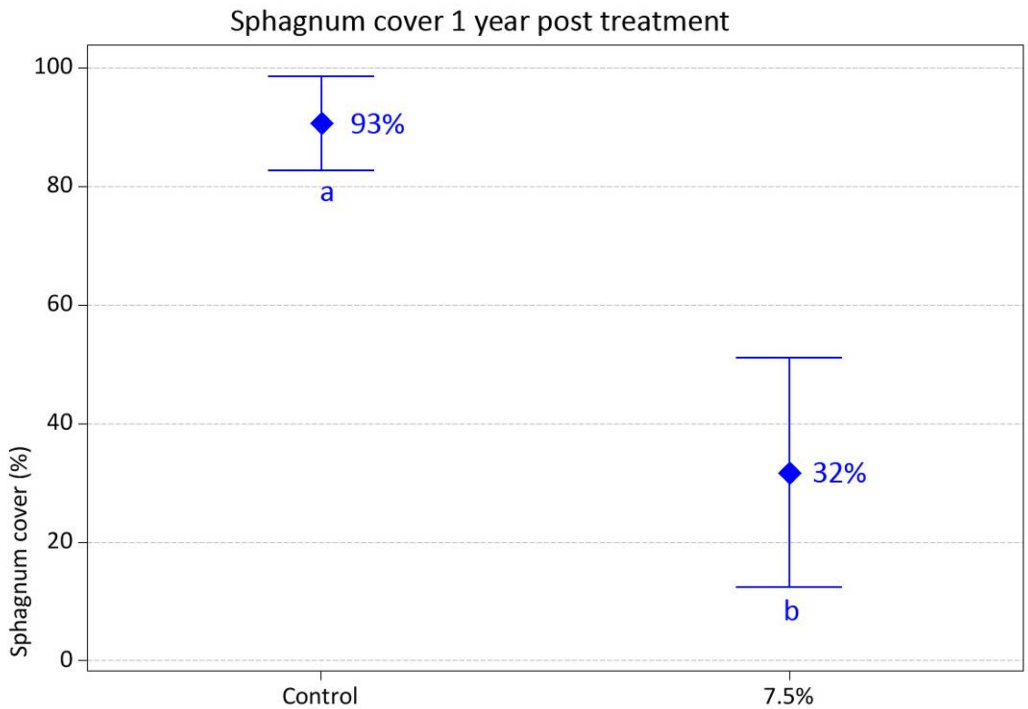
The following research was presented as a poster at the 2010 Hawaii Conservation Conference (Honolulu Convention Center, Honolulu HI) under the title: Efforts to Eradicate Invasive *Sphagnum* Moss from a Hawaiian Bog[18]. Data from this poster has been used to develop a *Sphagnum* control plan for Ka'ala Management Unit (Appendix 1-4, this document).

7.4.2 Results

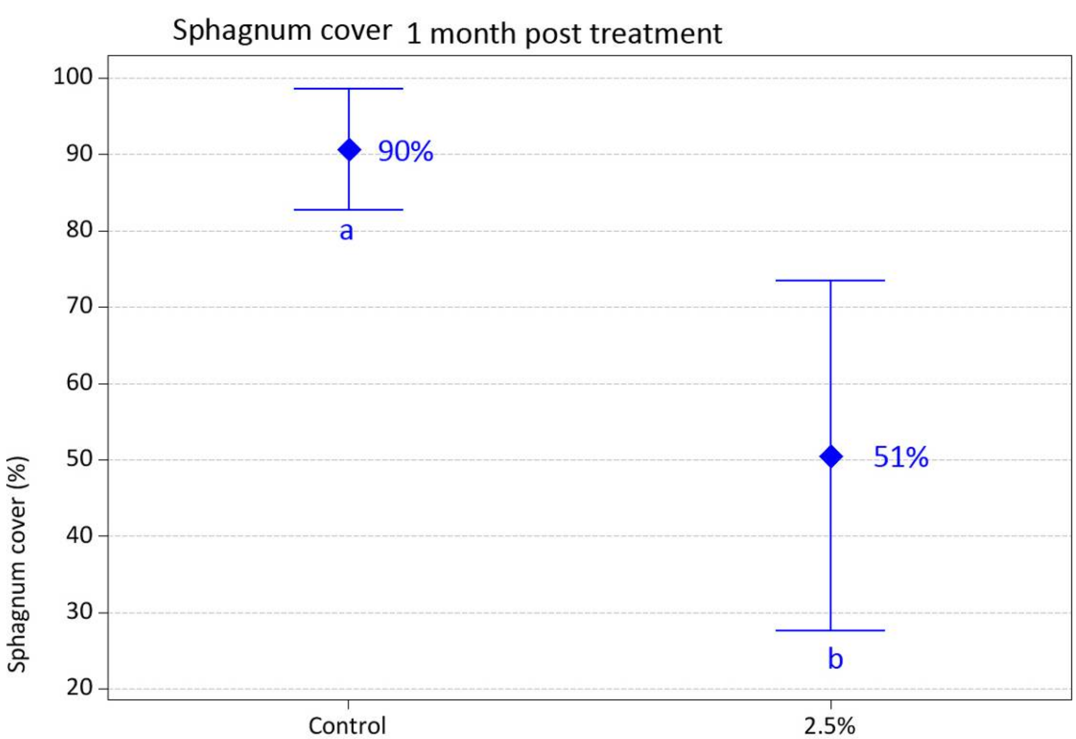


Sphagnum survival over 1.5 years by treatment (10% and 20% concentration of SGMK, manual removal of moss vs. a control group). Average *Sphagnum* survival given above error bars. Significant differences between groups indicated by letters (*e.g.*no difference between all three groups marked 'b', only between the 'a' and 'b' groups.)

[18] Joe, S. Poster Presentation. Efforts to Eradicate Invasive *Sphagnum* Moss from a Hawaiian Bog. Contributions to the 18th Annual Hawai'i Conservation Conference. Pacific Ecosystem Management and Restoration: Applying Traditional and Western Knowledge Systems. August 4-6, 2010. Convention Center, Honolulu, HI. http://manoa.hawaii.edu/hpicesu/DPW/HCC-2010/sphagnumpdf.pdf Accessed October 13, 2010



Sphagnum survival after 1 year at 7.5% SGMK. Average *Sphagnum* survival given adjacent error bars. Significant difference between groups indicated by letters.



Sphagnum survival at 2.5% SGMK concentration. Average survival given adjacent error bars. Significant difference between groups indicated by letters.

7.4.3 Discussion

Although all *Sphagnum* removal methods significantly reduced cover relative to the control (see the three figures above). *Sphagnum* showed signs of recovery after 1 year in the 10% treatment group, which at six months was identical to the manual and 20% treatment. These latter two treatments, however, have persisted in suppressing *Sphagnum* over 1.5 years. Disadvantages to manual and 20% SGMK treatment, though not significant, include reductions in native plant species (Joe *et al*. 2009[19]). Additionally, manual removal contributes to the spread of moss via contaminated equipment and footwear. Results from the 7.5 and 2.5% treatments were not 100% effective, however the former treatment did succeed in a 2/3 reduction in moss cover which persisted for one year. It is likely the 2.5% treatment will recover in a few months and therefore should be avoided. Our recommendation is to proceed with either two discreet treatments of the 7.5% concentration or with a single treatment of 10% or above.

7.5 FINAL REPORT: SURVEY OF INVASIVE ANT SPECIES WITHIN MAKUA AND OAHU IMPLEMENTATION PLAN MANAGEMENT UNITS, OAHU, HAWAII 2004-2009

7.5.1 Introduction

OANRP conducted a thorough survey of ants in all Management Units with native endangered *Achatinella* species using a protocol developed by S. M. Plentovich, PhD (University of Hawaii at Manoa Zoology) and P. D. Krushelnycky, PhD (University of Hawaii at Manoa Plant Environmental Pest Program) (see Appendix 6-1 this document). Management implications and analysis of these findings appear in a final report by Dr. Sheldon Plentovich (see Appendix 6-2, this document) but highlights and excerpts from this document appear here. Recommendations made at the end of this section include plans to be carried out by the RS in year 2010-2011.

7.5.2 Highlights

Twenty species of ants were found from sea level to 1112.8m. *Solenopsis papuana* was the most commonly sampled species in forest settings while *Anoplolepis gracilipes* and *Pheidole megacephala* appear to be confined to isolated sites disturbed by humans. *Anoplolepis gracilipes* was first sampled in January 2008 at the Nike Greenhouse. Multiple site visits suggest that the *A. gracilipes* infestation is confined to a relatively small (<1 acre) area within and around the greenhouse. *Pheidole megacephala* was found on at least three occasions in 2008 at Ohikilolo above 880 m (2890 ft).
The presence of *A. gracilipes* and *P. megacephala* at high elevations in or near some of the last intact native forest is troubling. Although we do not have experimental evidence, observations indicate that some invasive ant species might cause declines in tree snails via depredation of adults, eggs, and juveniles.

There is significant overlap between endangered snail populations and *S. papuana*. It is possible that, although *S. papuana* does coexist with tree snails, the species may still have some negative effects. Regardless, there is currently no feasible way to eradicate *S. papuana* at this time.
Preventing new ant invasions into relatively intact habitat in Hawaii and specifically, within the Makua and Oahu Implementation plan management units, is vital for the future of those native communities. This can be accomplished with careful monitoring of sensitive sites and adjacent areas where

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[19] Joe, S., L. Tanaka, S. Ching-Harbin, J. Beachy and K. Wong. Poster Presentation. Smothered in Sphagnum: Managing Moss at Ka‘ala. Contributions to the 17th Annual Hawai‘i Conservation Conference. July 28-30, 2009. Convention Center, Honolulu, HI.. Convention Center, Honolulu, HI. http://manoa.hawaii.edu/hpicesu/DPW/HCC-2009/sphagnum.pdf. Accessed October 13, 2010

introductions are likely to occur. Sites requiring special attention may include, but are not limited to camping areas, trails, fence lines, helipads, and roads. Many harmful invasive ant species, such as *P. megacephala* and *A. gracilipes* primarily reproduce via budding (i.e., mated females walk rather than fly to nearby areas to found colonies) vs. mated flights. In these cases it is relatively easy to identify areas of encroachment by invasive ants into native forest.

7.5.3 Recommendations

1) Map the boundaries of the *A. gracilipes* infestation at the Nike Site. This can be accomplished by either setting a grid of bait cards or, if ant numbers are high enough, by having 3 people walk the boundary of the infestation; the inside person staying within the infestation, the outside person staying outside the infestation and the middle person recording waypoints along the boundary.

2) Attempt to eradicate *A. gracilipes* from Nike Greenhouse site.
Bait preference trials to begin in October 2010 with assistance from HDOA staff

3) Identify areas of encroachment by *P. megacephala* into native forest. Control using hydramethylnon suspended in a corn-grit matrix (*e.g.*, AMDRO®) if warranted. Apply according to label specifications.

4) Use bait cards to conduct yearly monitoring of sensitive areas so that any new infestations can be identified and addressed. Ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads. Areas undergoing construction of fences or other structures should be carefully monitored for new introductions. Activities including the transfer of soil, such as out-planting, should also be carefully monitored. Careful monitoring will increase chances of early detection, and early detection is the key to successful eradication or control.

5) Conduct additional surveys of high elevation sites in the Koolau Mountains.

6) Protect the Mount Kaala boardwalk area from invasion by ants.
Our data indicate that invasive ants have penetrated almost all areas with the exception of the highest elevation sites with intact native communities, such as the boardwalk area of Mount Kaala. Although ants were found at the gated entryway to the bog, none were found along the boardwalk. Every effort should be made to keep ants from penetrating this habitat.

7.6 RAT – KAHANAHAIKI: LARGE SCALE TRAPPING GRID

7.6.1 Introduction

In May 2009, OANRP initiated a large scale kill trapping grid for rat (*Rattus* sp.) control over an area of 65 acres (26 ha) at the Kahanahaiki MU (see map below). The control grid follows the New Zealand Department of Conservation's current best practices for kill trapping rats. Wooden rat trap boxes and tracking tunnel monitoring equipment were purchased from New Zealand in 2009 to facilitate this method of control (see photos below). The large scale trapping grid was established as a pilot study with a goal of reducing rat activity within the MU to a level that would benefit the endangered plants, tree snails and overall forest health. This approach moved away from our traditional rat control method of using small scale bait station grids centered around individual plants and/or small groupings of plant and/or around individual snail trees to a landscape level that would benefit the native ecosystem as a whole.

The grid encompasses 11 endangered plant species, including both wild and reintroduced populations, and a large population of endangered *Achatinella mustelina* (Oahu tree snail). The focal endangered taxa that have continued to be monitored closely are *Cyanea superba* subsp. *superba* and *Achatinella* *mustelina*. The additional monitoring of seedlings, seed fall, arthropod composition and abundance, slug, and *Euglandina rosea* populations has continued through the reporting year. The Pahole Natural Area Reserve (NAR) has continued to serve as a comparison "control" site (outside the trapping grid) where rats remain at pre-trapping levels.

The overall purpose of this study is to assess the effects of rat removal on the following groups:

a. Slugs (*Limax maximus, Veronicella cubensis, Deroceras leave, Meghimatium striatum)*
b. Predatory snails (*Euglandina rosea*)
c. Arthropods (multiple species)
d. *Cyanea superba* subsp. *superba* (via fruit predation)
e. Seedling plots (multiple species)
f. Seed rain buckets (*Diospyros* sp. and *Psidium cattleianum*)
g. *Achatinella mustelina*

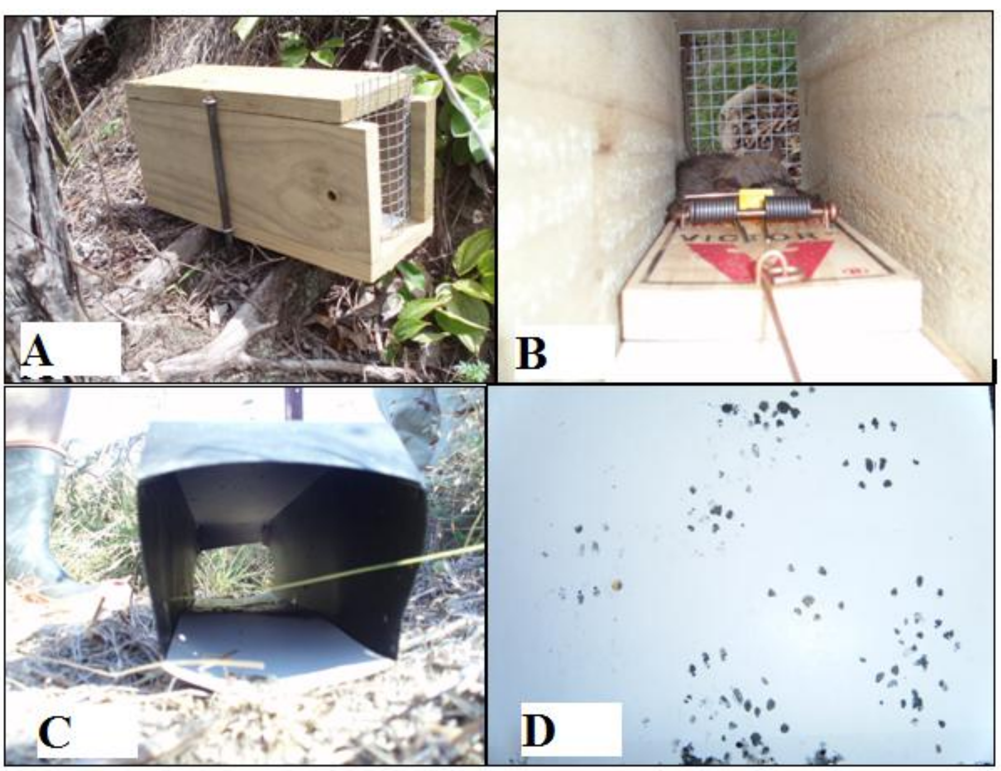
Since rat diets may include all of the above groups, it is expected that their numbers will increase with rat removal. The experiment is on-going. Changes in plant and animal groups as rodent populations are suppressed over longer time periods are anticipated. Data collection for all groups which may be impacted by rats was collected over one year in both areas.

Management and monitoring actions by site

Management & Monitoring Actions	**Kahanahaiki**	**Pahole**
Rat Control	Yes	No
Rat Tracking Tunnel Monitoring	Yes	Yes
Slug Monitoring	Yes	Yes
Euglandina rosea Monitoring	Yes	Yes
Arthropod Monitoring	Yes	Yes
Cyanea superba subsp. *superba* Fruit Predation Monitoring	Yes	Yes
Seedling Plot Monitoring	Yes	Yes
Seed Rain Bucket Monitoring	Yes	No
Oahu Tree Snail (*Achatinella mustelina*) Monitoring	Yes	No

Kahanahaiki large scale trapping grid with trap, tracking tunnel locations, and sampling locations.

Map removed to
protect rare resources



(A) Wooden rat trap box deployed. (B) Wooden rat trap box with Victor rat trap.
(C) Plastic tracking tunnel with inked tracking card. (D) Tracking card with rat tracks.

7.6.2 Methods and Results

Please refer to chapter 6.6 of the 2009 Status Report For the Makua and Oahu Implementation Plans for a full description of methods used. (http://manoa.hawaii.edu/hpicesu/DPW/2009_OIP/007.pdf). Methods are paraphrased here to better understand results.

7.6.2.1 Rat Control (Kahanahaiki MU)

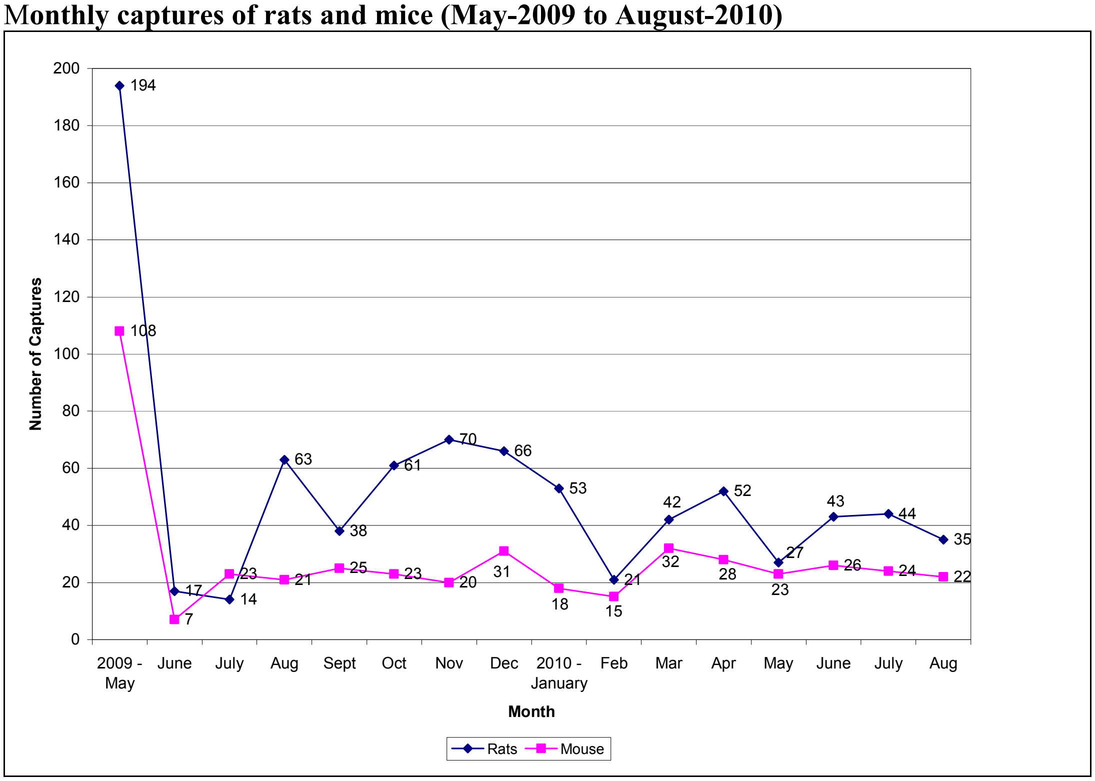
Study design

The grid was initially established in May 2009 with 402 traps and later expanded to 480 traps. The perimeter consists of 234 traps spaced at 12.5 meters apart. The interior contains 246 traps established on transects and existing trails (14 trap lines) at a spacing of 25 meters between traps. Traps were checked daily for approximately the first two weeks, then on a weekly basis for eight weeks, then two three week intervals, with the current checking interval bi-weekly.

Results

The trapping grid has been checked 49 times over a 16 month period (May 2009-August 2010) with a total of 840 rats and 444 mice trapped (See figure below). Approximately, a quarter of the total rats captured occurred in the first month (May 2009) of trapping. On average, 43 rats were captured per month after the initial knockdown occurred, with approximately 17 rats captured per grid check.

Monthly captures of rats and mice (May-2009 to August-2010)



Slug Interference

Over the past 16 months that the trapping grid has been in operation, invasive slugs continue to be a major problem in consuming bait placed on rat traps. Slugs are able to consume a quarter sized glob of peanut butter in one night, consume a half of macadamia nut in three nights, and a ¾" square chuck of coconut within a week. A variety of baits have been used in an effort to find a bait that is less susceptible to slug consumption, weathers well and is still attractive to rats. Baits that have been used include: peanut butter, coconut chunks, macadamia nuts, flavored wax coils, chocolate chips, Ferafeed® (non-toxic pre-feed bait from Connovation Ltd., New Zealand), sponges with food grade flavor concentrates, and peanut butter flavored rodent chew tab census tag wax. Slugs were able to consume all baits except the wax coils and sponges, both of these bait types had few captures. Slugs were not deterred from consuming rock salted peanut butter and Ferafeed®. In many instances, slugs would consume the salted baits and die on the trap. In an effort to keep slugs from consuming bait, some trap boxes were elevated 6 inches above the ground on rebar with 2 inches of copper tape. Slugs were able to breech the copper tape within a few days.

Rat trap with no bait, consumed by slugs (Left photo). *Limax maximus* consuming peanut butter (Right photo).

7.6.2.2 Tracking Tunnel Monitoring (Kahanahaiki MU)

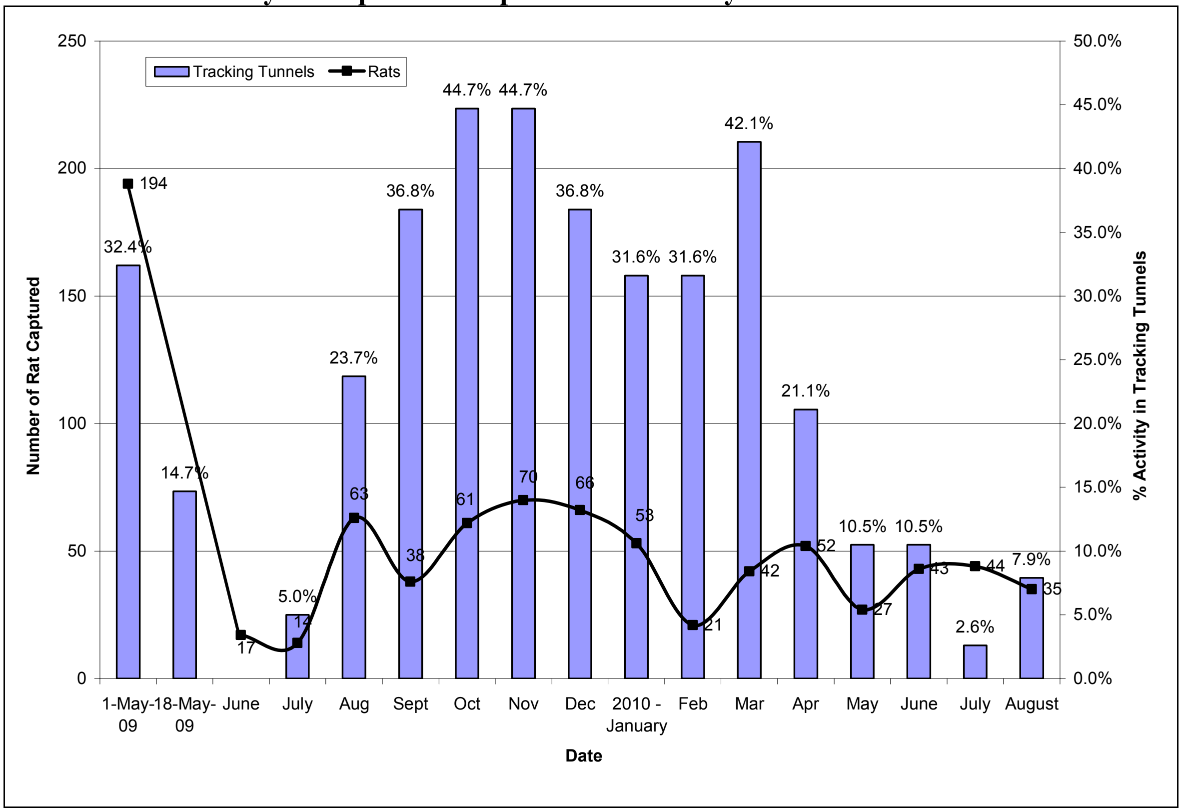
Study design

A total of 38 tracking tunnels have been run at the Kahanahaiki MU 16 times over a 16 month period (01 May – 21 August 2010) (See figure below). During each tracking tunnel session, tunnels are baited and run for one night. The initial running of tracking tunnels occurred four days before the start of the trapping grid, with tunnels being run approximately monthly thereafter.

Results

Tracking results have been variable with the peak in rat activity occurring in October and November 2009. The lowest level of rat activity detected occurred in July of 2009 and 2010. Mouse activity tracked similarly to rat activity over the same time period. The high rat activity occurring in the fall and winter appears to have been tracking the natural cycle of the rat population outside of the grid. The perimeter to the interior of the grid is approximately 125 meters which allows for incursion of rats in a short period of time. We don't have rat activity levels prior to the start of rat control, so the continued monthly running of tracking tunnels will give us a better understanding of rat activity within the grid.

Kahanahaiki monthly rat captures and percent rat activity

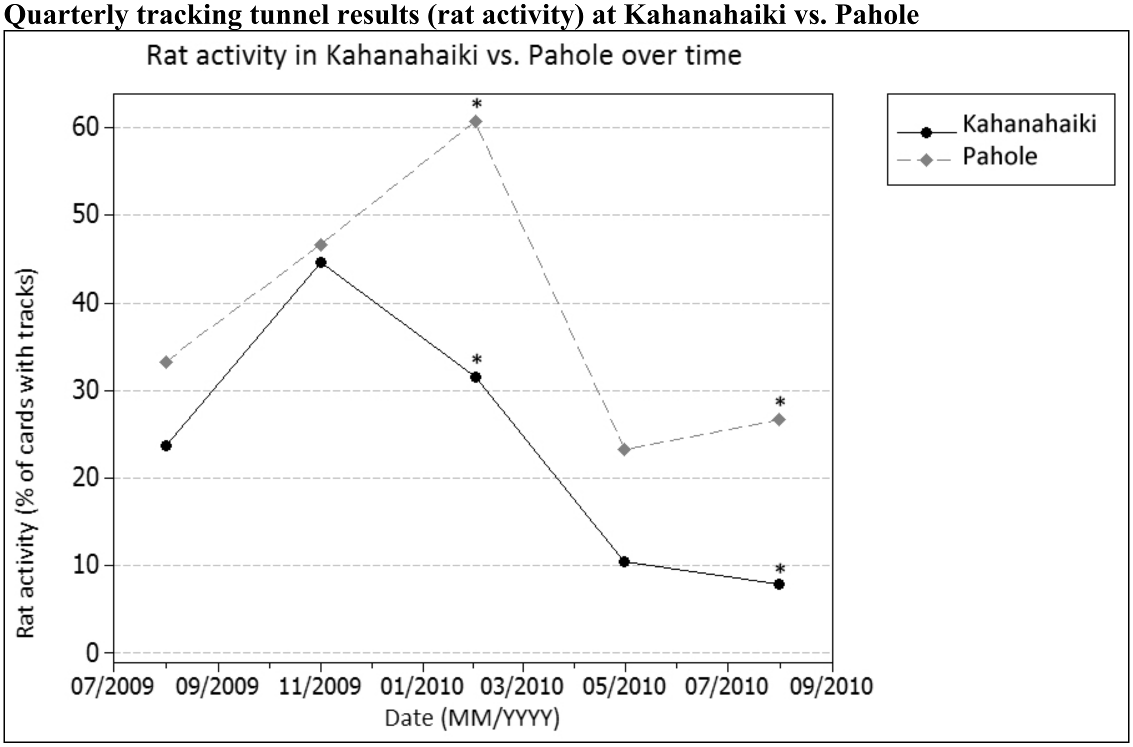


7.6.2.3 Tracking Tunnel Monitoring – Kahanahaiki vs. Pahole

Starting on Day 106 (18 August 2009) tracking tunnels were simultaneously run quarterly at both the Kahanahaiki MU (38 tracking tunnels) and the Pahole NAR (30 tracking tunnels; See map below) to compare the two sites (Management vs. Control). Rat activity did not differ significantly between sites three out of the five time periods sampled (see graph below), though it was consistently higher outside of the trapping grid. There were significant differences in rat activity between sites in February and August of 2010. Another year of data collect will help in determining trends in rat activity for both sites. Some of this data was presented by S. Mosher at the 2010 Hawaii Conservation Conference (HCC 2010) in Honolulu, HI in a talk titled: Controlling Invasive Rats (*Rattus* spp.) with a Large Scale Trapping Grid for Endangered Species Conservation on Oahu Hawaii (http://manoa.hawaii.edu/hpicesu/DPW/HCC-2010/default.htm.

Location of tracking tunnels at Kahanahaiki MU and Pahole NAR

Quarterly tracking tunnel results (rat activity) at Kahanahaiki vs. Pahole



* = significant difference between groups <0.05 (Chi-Square analysis).

7.6.2.4 Slug Monitoring (Kahanahaiki MU & Pahole NAR)

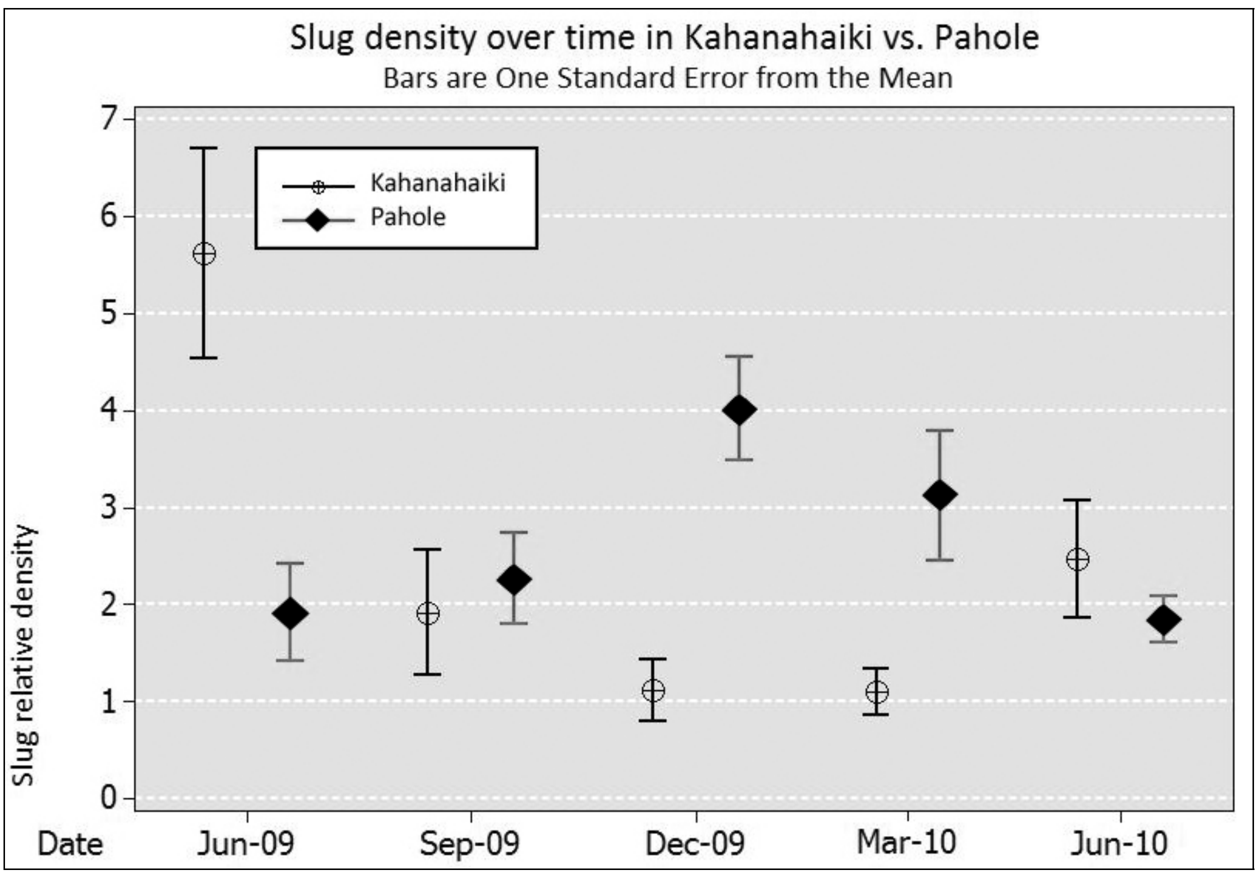
Study design

Slugs found in beer baits left out for one week were used to estimate slug numbers. Forty 8 ounce jars were deployed at 25 meter intervals along a 400 meter transect in the Kahanahaiki gulch bottom and in the main drainage of the Pahole NAR (Gulch 2). Once a quarter (in March, June, Sept. and December) traps were baited with 5 ounces of Guinness beer and the number and species of slugs caught recorded.

Results

Data from April 2009 extending through June 2010 shows no correlation between rat activity and relative slug density in either site (Pearson's correlation r^2=13%; P=0.39). High variability in slug numbers over time and between sites was observed.

The graph below shows the relative slug density (mean number of slugs per beer trap) by site over time. No clear patterns are evident. Slug numbers fluctuate between sites and do not track one another seasonally. In Pahole slug numbers peak in December while in Kahanahiki the highest density of slugs is observed in June (both years). In September 2009, and June 2010 slug numbers at both sites were the same. The inconsistent numbers of slugs over time and between sites might be due to microhabitat (soil moisture or leaf litter).



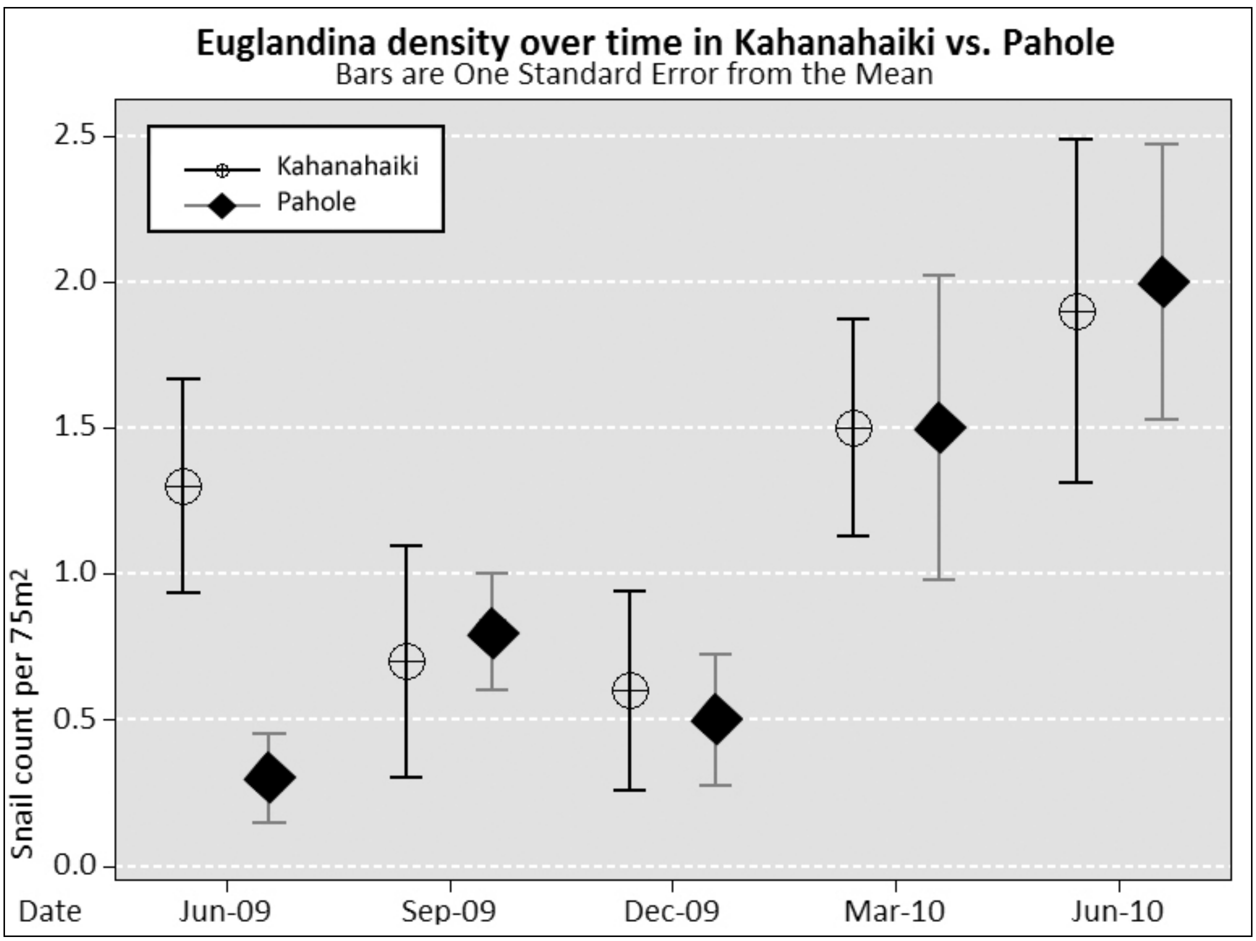
7.6.2.5 Euglandina Monitoring (Kahanahaiki MU & Pahole NAR)

Study design

Euglandina were sampled using timed searches (one person hour) at 10 discrete points along the 400 meter transect established for slug sampling. Each of the ten points marked the center of a 75 m^2 plots along which three people searched for *Euglandina* over 20 minutes (total time equal to one person hour per plot). Live *Euglandina* were counted, shell length recorded (mm) and left in place so as to not artificially control populations via manual removal. *Euglandina* shells were scored for damage (rat damaged or whole) and destroyed so as to not be re-counted at a later time.

Results

Seasonal variation in *Euglandina* over time was fairly consistent between sites despite differences in rat control effort (see graph below). As with slugs, no correlation between rat activity and predatory snails (*Euglandina)* was evident (Pearson's correlation r^2=16.7%; P=0.31). With one exception (June 2009) numbers of *Euglandina* were the same at both sites. This exception may have occurred because of a 4 day (rather than 1 day) interval in sampling between sites. Our failure to detect a relationship between rat activity and either *Euglandina* or slugs, however, suffers from a low number of sampling points over time (5 times per site).



7.6.2.6 Arthropod Composition and Abundance Sampling (Kahanahaiki MU & Pahole NAR)

Arthropod response to rat trapping was summarized in a poster presentation at the 2010 Hawaii Conservation Conference. The text and figures are provided here, however, the poster may be viewed on-line at: http://manoa.hawaii.edu/hpicesu/DPW/HCC-2010/Rat_arthropod_poster.pdf. Below is a condensed version of the poster.

Title: Patterns of Arthropod Diversity in Natural Areas Undergoing Rodent Management on Oahu

Author: P.D. Krushelnycky, Ph.D Plant Environmental Protection Sciences, University of Hawaii at Manoa

Above: native arthropods collected as part of this project.

Overview

Arthropods constitute a majority of the biodiversity in most terrestrial ecosystems. In addition, these animals often play important roles in ecosystem processes such as decomposition, soil turnover and pollination, and form critical links in food webs. Obtaining basic measures of the status and trends of native and invasive arthropod diversity should therefore be a fundamental component of any natural area management program.

The Oahu Army Natural Resource Program (OANRP) is implementing or planning rat removal operations in three areas in the Waianae Mountains. In conjunction with these efforts, I am conducting standardized, quantitative arthropod sampling before and after rat removal in two of these areas (Kahanahaiki and Palikea), as well as in adjacent control sites where rats will not be immediately removed, to estimate the impacts of rats on arthropod populations. This sampling will also serve as an arthropod inventory, providing important information on the biodiversity of these management areas.

Study design

I report here some preliminary results from a pair of sites in the northern Waianae Mountains: Kahanahaiki Valley, where a rat snapping grid has been implemented beginning in May 2009, and the adjacent Pahole Natural Area Reserve, where little or no rat management is currently being conducted.

Arthropod sampling was conducted at both sites in May/June 2009 (immediately prior to rat trapping), December 2009, and May/June 2010. Standardized sampling at each site included 16 pitfall traps, plus vegetation beating on 8 individuals of four plant species: *Charpentiera tomentosa*, *Pipturus albidus*, *Pisonia umbellifera* and *Psidium cattleianum*.

Does rat trapping result in recovery of arthropods?

Stomach contents from rats and mice caught at Kahanahaiki commonly include remains of caterpillars (immature Lepidoptera), beetles (Coleoptera) and spiders (Araneae), among other groups (A. Shiels unpub. data). But does this predation suppress arthropod populations?
I compared samples collected in May/June 2009, prior to rat trapping, with those collected in May/June 2010, to see if beetle, spider or caterpillar populations recovered at Kahanahaiki (where rats were trapped) relative to Pahole (where rats were not trapped). These samples included a total of 2149 specimens belonging to 87 species or morphospecies (in these three orders).

Early results suggest that neither native nor adventive beetle abundances on the trees sampled increased at Kahanahaiki relative to Pahole (Figure 1, top). This appeared to be true for changes in beetle richness as well (Figure 2, top). In contrast, changes in spider abundances and richness tended to increase at Kahanahaiki relative to Pahole, although the differences between trends at these two sites were not statistically significant (Figs. 1 and 2, middle panels). The strongest evidence for potential recovery after rat trapping involved caterpillars, which increased significantly more in both abundance and richness at Kahanahaiki relative to Pahole (Figs. 1 and 2, bottom panels).

While not definitive at this point, these results indicate that continued sampling is warranted, to track possible further arthropod community changes as rodent populations are suppressed over longer time periods. Replication at additional sites, such as Palikea, will help clarify whether these changes are likely to be due to rodent removal.

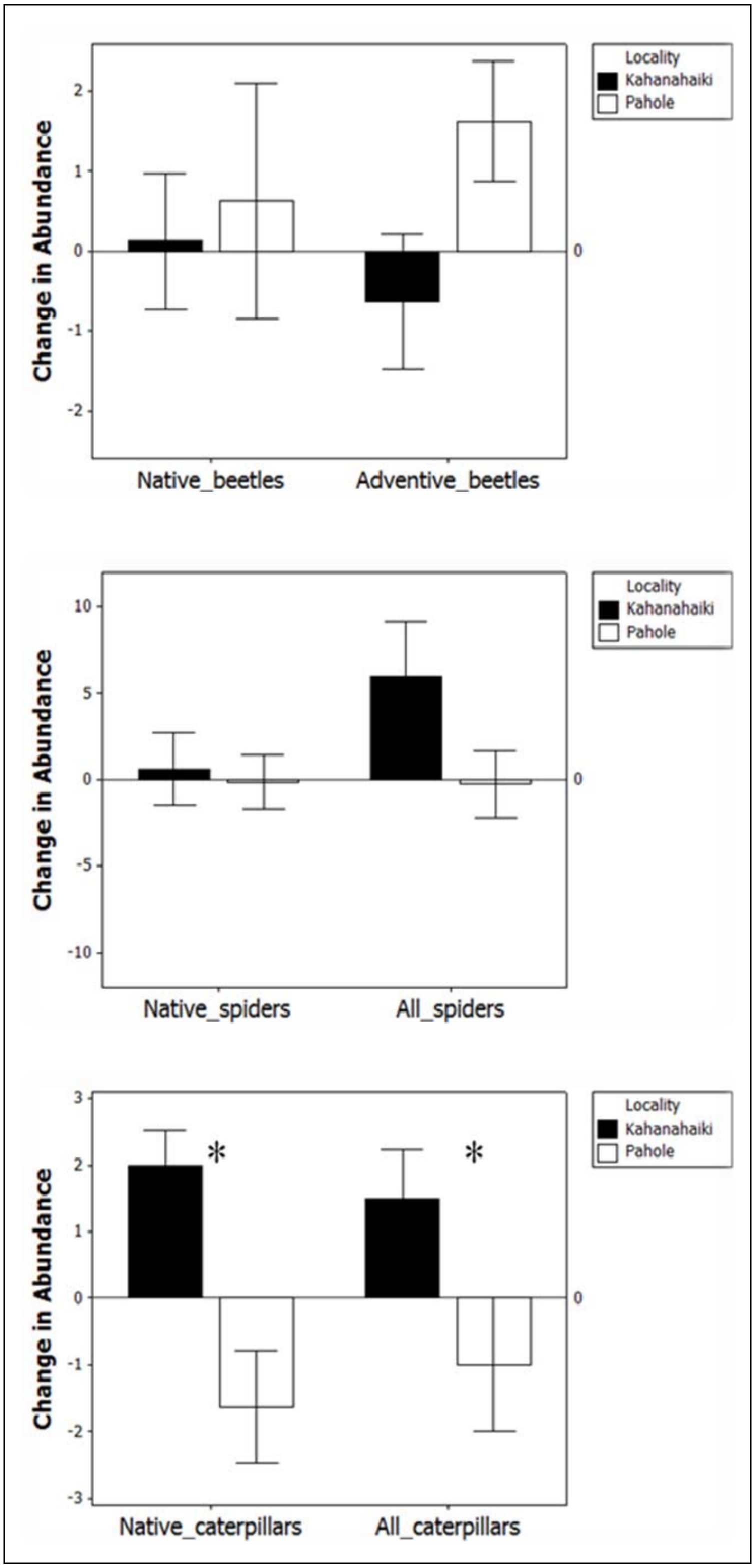


Figure 1. Changes in abundances in three arthropod orders from vegetation beating samples collected in May/June 2010 relative to those collected in May/June 2009 at Kahanahaiki and Pahole. Starred comparisons are significantly different (Mann-Whitney U test).

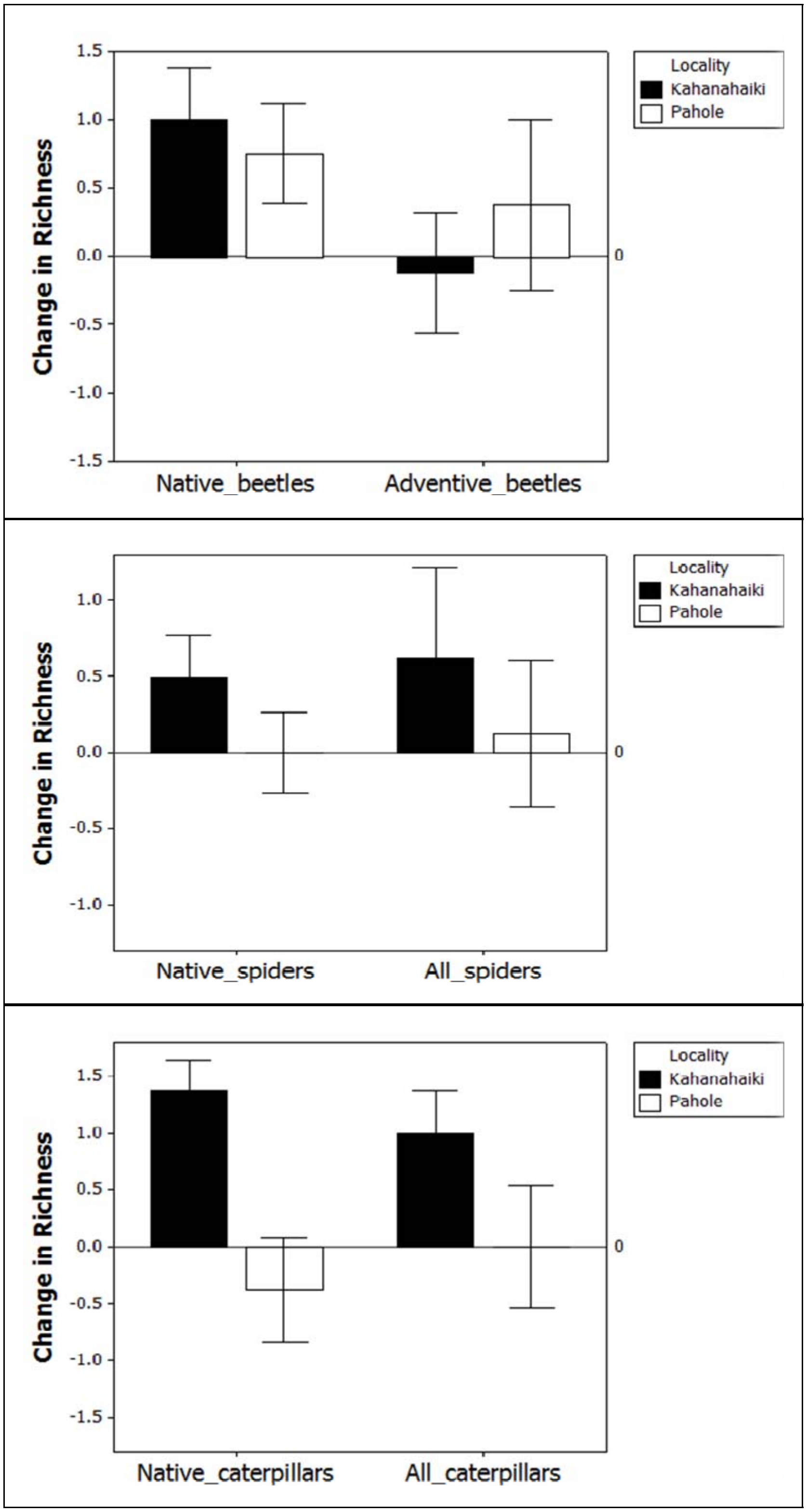


Figure 2. Changes in richness in three arthropod orders from vegetation beating samples collected in May/June 2010 relative to those collected in May/June 2009 at Kahanahaiki and Pahole. Starred comparisons are significantly different (Mann-Whitney U test).

Patterns in arthropod diversity

Native arthropods made up a much larger proportion of samples collected on four focal plant species, compared to those collected with pitfall traps, in terms of both richness and especially abundance (Figure 3). Perhaps somewhat surprisingly, the abundance and diversity of native arthropods was similar or higher on strawberry guava (*P. cattleianum*) relative to the three native tree species. However, this result applies only to three arthropod orders (Araneae, Coleoptera, Lepidoptera), and could change substantially when orders containing abundant and host-specific plant feeders (such as Hemiptera) are included.

The extensive sampling at the Palikea site (not shown) will also provide excellent information on relationships between plant community composition and patterns in diversity of native and introduced arthropods. These collections have already resulted in the discovery of at least one new endemic carabid beetle species.

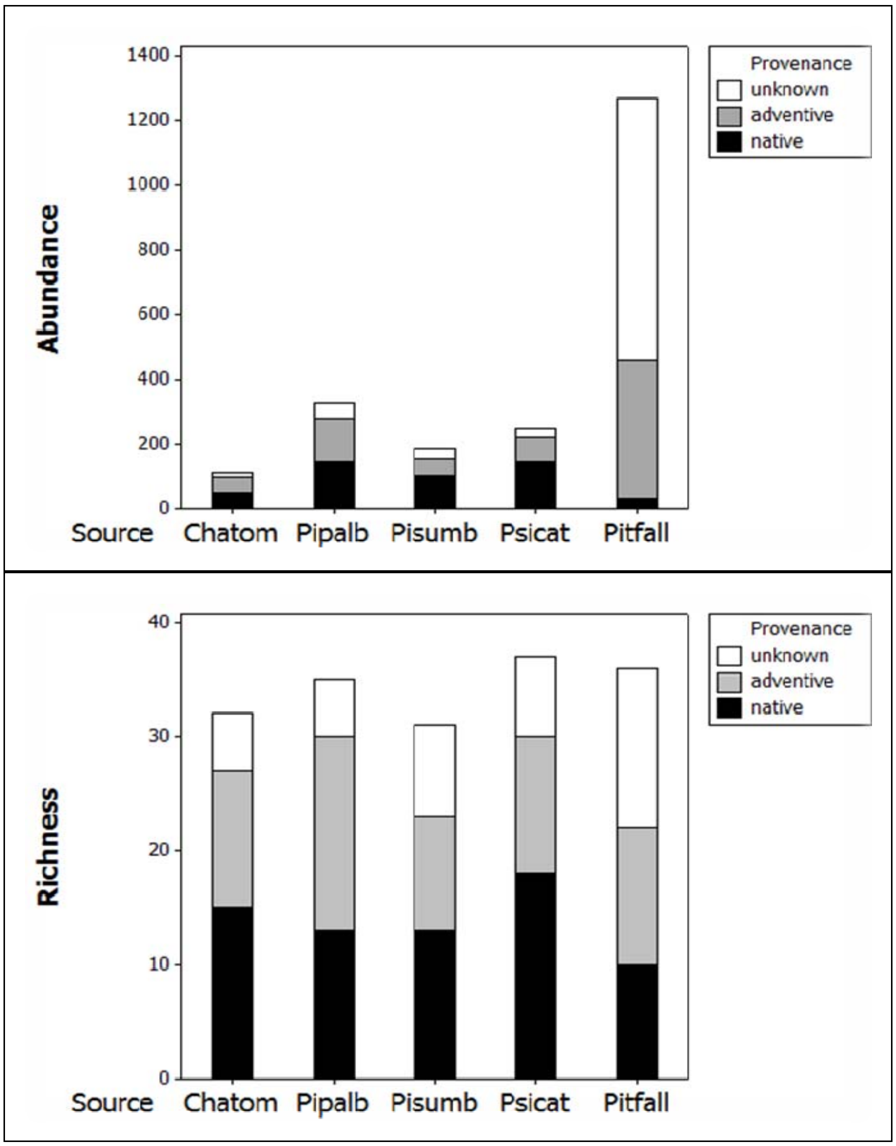


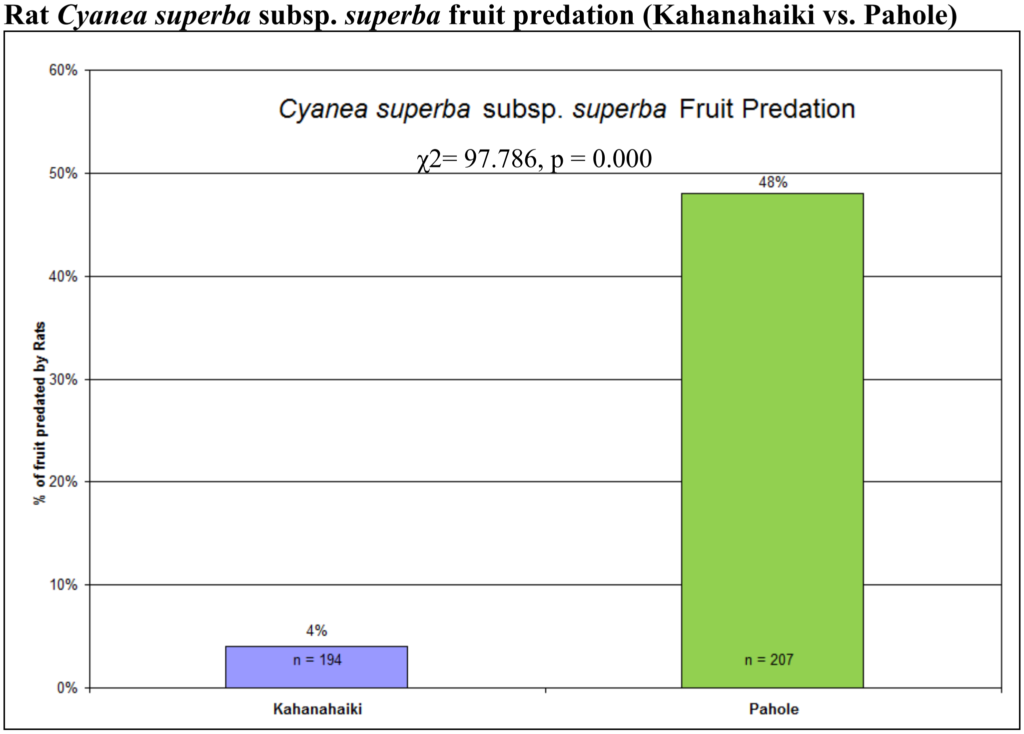
Figure 3. Patterns of abundance and richness of arthropods of native, adventive and unknown provenance on the four focal plant species sampled and in pitfall traps. Results are for Araneae, Coleoptera and Lepidoptera only (orders combined).

7.6.2.7 Cyanea superba subsp. superba Monitoring (Kahanahaiki MU & Pahole NAR)

The rat control grid was effective in reducing the amount of predation on *Cyanea superba* subsp. *superba* fruits at Kahanahaiki during the fruiting season (late-November 2009 through early-January 2010). There was a significant difference in fruit predation between sites with eight predated fruits out of 194 (4%) monitored at Kahanahaiki, as compared to 99 predated fruits out of 207 (48%) monitored at Pahole (see graph below). These data were presented as a poster at the Island Invasives: Eradication and Management Conference (Auckland NZ, February 2010) (see excerpt from poster). The poster may be viewed in full at the following URL: http://manoa.hawaii.edu/hpicesu/DPW/In_NZC/default.htm

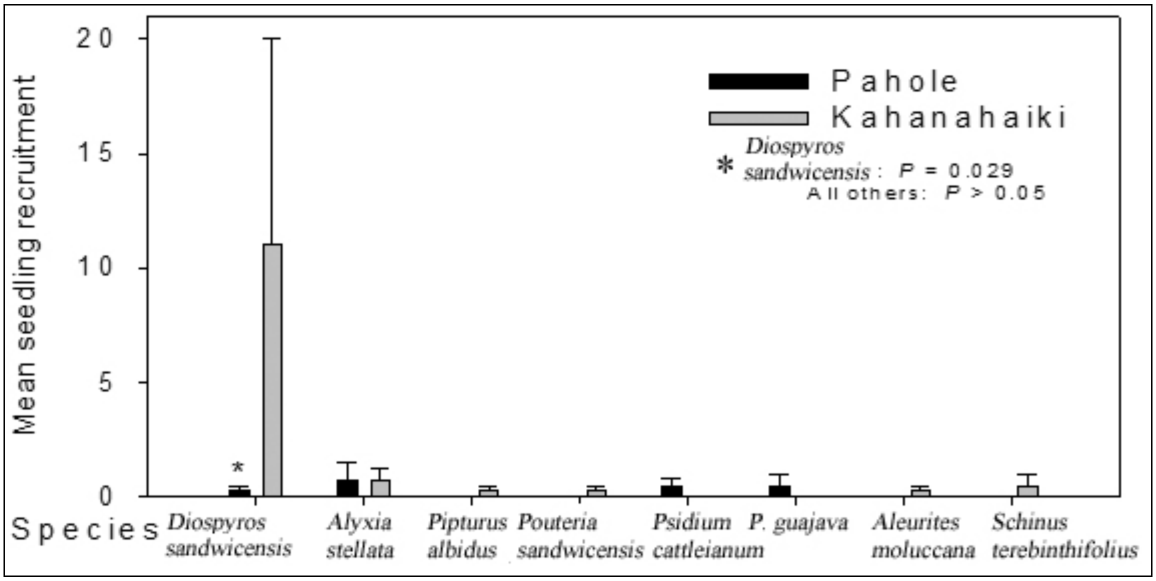

Rat climbing trunk of *Cyanea superba* subsp. *superba* (Left photo). *Cyanea superb* subsp. *superba* fruit consumed by rats (Right photo).

Rat *Cyanea superba* subsp. *superba* fruit predation (Kahanahaiki vs. Pahole)



7.6.2.8 Seedling Monitoring (Kahanahaiki MU & Pahole NAR)

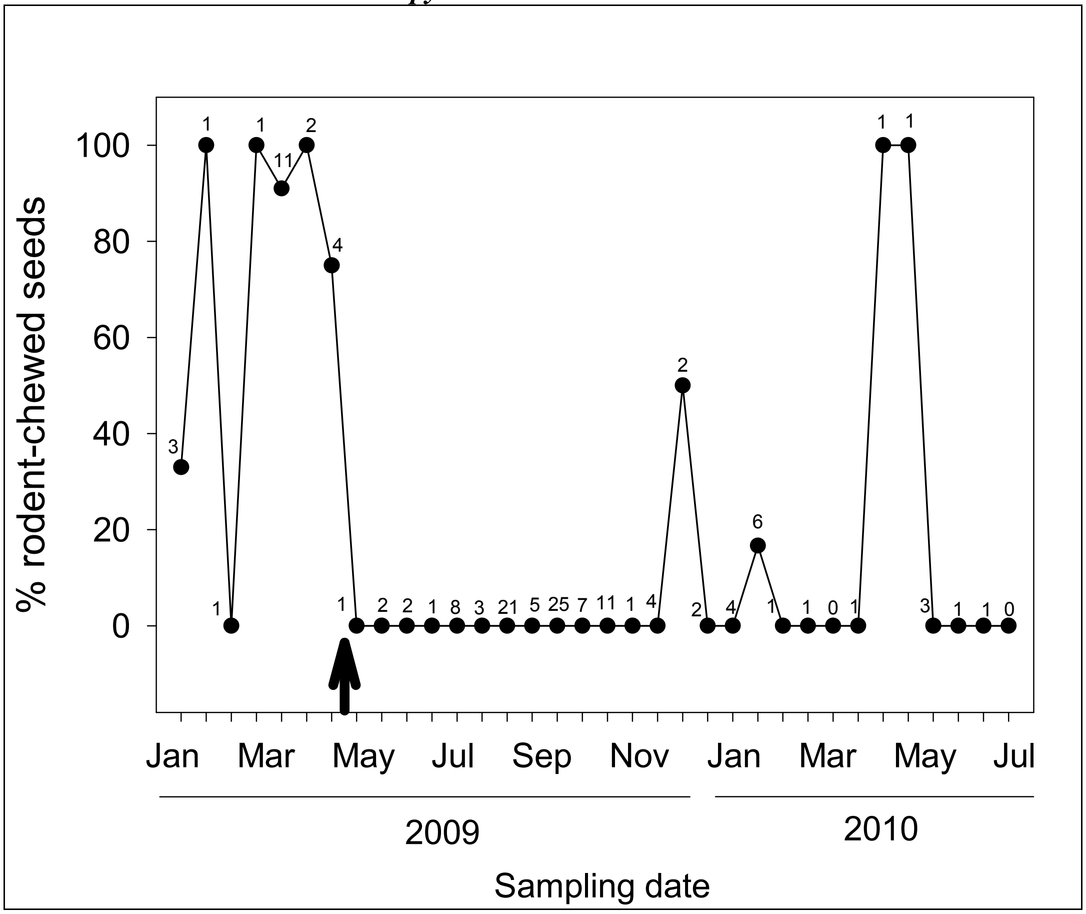
The figure below shows the mean ± SE of seedling recruitment during a 6 month period (August 2009-February 2010) at the Kahanahaiki and Pahole where rodents were not manipulated. Seedlings for four native and four introduced plant species were monitored (see figure below). Only seedling plots (32 per site) with *Diospyros sandwicensis* (lama) overstory within 15 meters of the plots were included for calculations at both sites. There was only a significant difference in seedling recruitment for *Diospyros* at Kahanahaiki vs. Pahole (Mann-Whitney U test; See figure below).



7.6.2.9 Seed Monitoring (Kahanahaiki MU only)

The figure below shows the percentage of rodent-chewed lama seeds recovered from seed rain buckets during each two week sampling period at Kahanahaiki (January 2009-July 2010). The numbers above data points indicate the total number of lama seeds collected from buckets. Trapping started in May 2009 with seven months of no chewed lama seeds until December 2009. During the peak in lama seed production there was no seed predation detected. Lama seed predation has remained low during the running of the trapping grid.

Seed rain bucket results for *Diospyros sandwicensis* from Kahanahaiki



7.6.2.10 Achatinella mustelina Monitoring (Kahanahaiki MU only)

A total of 212 *Achatinella mustelina* were counted during the August 2009 census of the Maile Flats area of the Kahanahaiki MU (for more information see MIP 2009 Snail section; http://manoa.hawaii.edu/hpicesu/DPW/2009_OIP/005.pdf). This count was an increase from the 157 snails counted in the summer of 2004. A census of this area will be conducted every three years. If necessary this interval will be reduced to annually. Two ground shell plots were monitored quarterly (April 2009-April 2010) in the Maile Flats area of the trapping grid with no detections of rat predated shells, however two live *Euglandina rosea* were found.

7.6.3 Summary

- The number of rat captures continues towards a downward trend from the initiation of the trapping grid.
- Tracking tunnel activity was high in the interior locations of the trapping grid when distances from the perimeter to the interior were less than 100m during the fall and winter months.
- The tracking tunnels appear to be potentially tracking the natural cycle of rat activity outside of the grid because to the short distance across the management unit.

- Data collected on slug and *Euglandina rosea* numbers suggests that rat reduction does not cause increases in these highly invasive species.

- There was a detectable increase of native caterpillars and spiders at Kahanahaiki vs. Pahole.

- The rat control grid was effective in reducing the amount of predation on *Cyanea superba* subsp. *superba* fruits at Kahanahaiki (Year 1).

- There was a significant difference in lama seedling recruitment between Kahanahaiki and Pahole.

- Rat predation on lama seeds was greatly reduced while running the trapping grid.

- Continued data collection of annual tree snail counts, seedling plots, arthropods and *Cyanea superba* subsp. *superba* fruit predation will give us a better understanding of what rat activity thresholds must be met to maintain and increase rare and common native species.

- Bait consumption by invasive slugs poses a hurdle that still needs to be overcome. Alternative baits are currently being pursued (wax baits and scented lures).

- All monitoring components will be continued through August 2011.

- Trapping grid effort: grid set up ~230 people hours; trapping checks (49 visits) ~915 people hours from May 2009 to August 2010; Tracking Tunnel efforts at Kahanahaiki (once a month) has taken ~245 people hours and Pahole (once a quarter) ~35 people hours.

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APPENDIX 1 EXECUTIVE SUMMARY APPENDICES

Appendix 1 contains supplemental information for the Executive Summary. Contents of Appendix 1 include:

- Appendix ES-1: Spelling of Hawaiian Names
- Appendix ES-2: July 2010 Makua Valley Fire Report
- Appendix ES-3: Determining Physical Dormancy in Hard-Seeded IP Species
- Appendix ES-4: Re-Collection Intervals for Seed Collections of IP Species for Maintaining Genetic Storage Representation
- Appendix ES-5: Oahu Army Natural Resource Program Research Proposal, M. Euaparadorn

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APPENDIX ES-1: SPELLING OF HAWAIIAN NAMES

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Spelling of Hawaiian Names

Place Name	Hawaiian Spelling
Aiea	‘Aiea
Aihualama	‘Aihualama
Aimuu	‘Aimu‘u
Alaiheihe	Alaiheihe
Alau	Alau
Ekahanui	‘Ēkahanui
Halawa	Hālawa
Haleakala	Haleakalā
Haleauau	Hale‘au‘au
Halona	Hālona
Hanaimoa	Hānaimoa
Hawaii	Hawai‘i
Hawaii loa	Hawai‘iloa
Helemano/Halemano	Helemano/Halemano
Honolulu	Honolulu
Honouliuli	Honouliuli
Hoolehua	Ho'olehua
Huliwai	Huliwai
Ihiihi	‘Ihi‘ihi
Kaaikukai	Ka‘aikūka‘i
Kaala	Ka‘ala
Kaawa	Ka‘awa
Kaena	Ka‘ena
Kahaluu	Kahalu‘u
Kahana	Kahana
Kahanahaiki	Kahanahāiki
Kahuku	Kahuku
Kaimuhole	Kaimuhole
Kaipapau	Kaipāpa‘u
Kaiwikoele	Kaiwikō‘ele
Kalauao	Kalauao
Kaleleliki	Kaleleiki
Kalena	Kalena
Kaluaa	Kalua‘ā
Kaluakauila	Kaluakauila
Kaluanui	Kaluanui
Kamaileunu	Kamaileunu
Kamaili	Kamā‘ili
Kamananui	Kamananui
Kapakahi	Kapakahi
Kapuna	Kapuna
Kauai	Kaua‘i
Kauhiuhi	Kauhiuhi
Kaukonahua	Kaukonahua
Kaumoku Nui	Kaumoku Nui

Place Name	Hawaiian Spelling
Kaunala	Kaunala
Kawaihapai	Kawaihāpai
Kawaiiki	Kawaiiki
Kawailoa	Kawailoa
Kawainui	Kawainui
Kawaipapa	Kawaipapa
Kawaiu	Kawaiū
Kahawainui	Kahawainui
Keaau	Kea‘au
Kealia	Keālia
Keawapilau	Keawapilau
Keawaula	Keawa‘ula
Kihakapu	Kihakapu
Kipapa	Kīpapa
Koiahi	Ko‘iahi
Koloa	Koloa
Konahuanui	Konahuanui
Koolau	Ko‘olau
Kuaokala	Kuaokalā
Kumaipo	Kūmaipō
Lahaina	Lahaina
Laie	Lā‘ie
Lanai	Lāna‘i
Lualualei	Lualualei
Lulumahu	Lulumahu
Maakua	Ma‘akua
Makaha	Mākaha
Makaleha	Makaleha
Makaua	Makaua
Makiki	Makiki
Makua	Mākua
Malaekahana	Mālaekahana
Manana	Mānana
Manini	Manini
Manoa	Mānoa
Manuwai	Manuwai
Maui	Maui
Mauna Kapu	Mauna Kapu
Maunaloa	Maunaloa
Maunauna	Maunauna
Maunawili	Maunawili
Mikilua	Mikilua
Moanalua	Moanalua
Mohiakea	Mohiākea
Mokuleia	Mokulē'ia

Spelling of Hawaiian Names

Place Name	Hawaiian Spelling
Molokai	Molokaʻi
Nanakuli	Nānākuli
Napepeiauolelo	Nāpepeiaoʻōlelo
Niu	Niu
Nuuanu	Nuʻuanu
Oahu	Oʻahu
Ohiaai	ʻŌhiʻaʻai
Ohikilolo	ʻŌhikilolo
Oio	ʻŌʻio
Opaeula	ʻŌpaeʻula
Paalaa Uka	Paʻalaʻa Uka
Pahipahialua	Pahipahiʻālua
Pahoa	Pāhoa
Pahole	Pahole
Palawai	Pālāwai
Palehua	Pālehua
Palikea	Palikea
Papali	Papali
Peahinaia	Peʻahināiʻa
Pohakea	Pōhākea
Puaakanoa	unknown
Pualii	Pualiʻi
Puhawai	Pūhāwai
Pukele	Pūkele
Pulee	Puleʻe
Punaluu	Punalu'u
Punapohaku	Punapōhaku
Puu Hapapa	Puʻu Hāpapa
Puu Kailio	Puʻu Kaʻīlio
Puu Kanehoa	Puʻu Kānehoa
Puu Kaua	Puʻu Kaua
Puu Kawiwi	Puʻu Kawiwi
Puu Kumakalii	Puʻu Kūmakaliʻi
Puu Pane	Puʻu Pane
Puu Pauao	Pu'u Pauao
Puukaaumakua	Puʻukaʻaumakua
Puukainapuaa	Puʻukaʻinapuaʻa
Puu Kamaohanui	Unknown
Puukanehoa	Puʻukānehoa
Puukaua	Puʻukaua
Puukeahiakahoe	PuʻukeahiaKahoe
Puulu	Pūʻulu
Puuokona	PuʻuoKona
Puupane	Puʻupane
Waahila	Waʻahila

Place Name	Hawaiian Spelling
Wahiawa	Wahiawā
Waialae Nui	Waiʻalae Nui
Waialua	Waialua
Waianae	Wai'anae
Waianae Kai	Waiʻanae Kai
Waiawa	Waiawa
Waieli	Waiʻeli
Waihee	Waiheʻe
Waikakalaua	Waikakalaua
Waikane	Waikāne
Wailupe	Wailupe
Waimalu	Waimalu
Waimano	Waimano
Waimea	Waimea
Wiliwilinui	Wiliwilinui

Spelling of Hawaiian Names

Plant Name	Hawaiian Spelling
mao hau hele	ma'o hau hele
alahee	alahe‘e
akoko	‘akoko
ohia lehua	‘ōhi‘a lehua
lama	lama
hoawa	hō‘awa
hao	hao
alaa	āla'a
wiliwili	wiliwili
lonomea	lonomea
mehamehame	mehamehame
koa	koa
naio	naio
aalii	‘a‘ali'i
iliee	‘ilie‘e
maile	maile
ieie	‘ie‘ie
mamane	māmane
hame	hame
olapa	‘ōlapa
pilo	pilo
alani	alani

Name	Hawaiian Spelling
Kanepaiki	Kanepāiki
Paki	Pākī
mahele	mahele
elepaio	‘elepaio
Kamehameha	Kamehameha
Kaneaki	Kāne‘ākī

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APPENDIX ES-2: JULY 2010 MAKUA VALLEY FIRE REPORT

IMPC-HI-PWA 29 July 2010

MEMORANDUM FOR RECORD

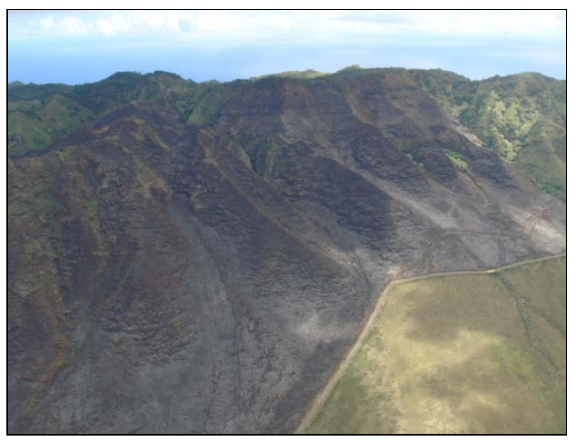
SUBJECT: North Makua Fire July 24-25, 2010

1. Summary

Impacts to Natural Resources:

The total area burned in this fire was 486 acres. Overall the impacts to natural resources, management units and State Forest Reserve lands were minimized by the incredible helicopter water support and coordinated ground control efforts. Partners at DLNR were very pleased that the fire only impacted 20 acres of land within the Kuaokala Forest Reserve. The fire burned six kilometers of the forest edge within the Kaluakauila Management Unit. Three endangered plant taxa were impacted in the fire. Approximately 50 endangered *Chamaesyce celastroides* var. *kaenana,* 16 *Nototrichium humile* and 90 *Melanthera tenuifolia* were burned. For a complete list of plant species observed on burn surveys including common native plants and introduced species see Table 1 at the end of this document.

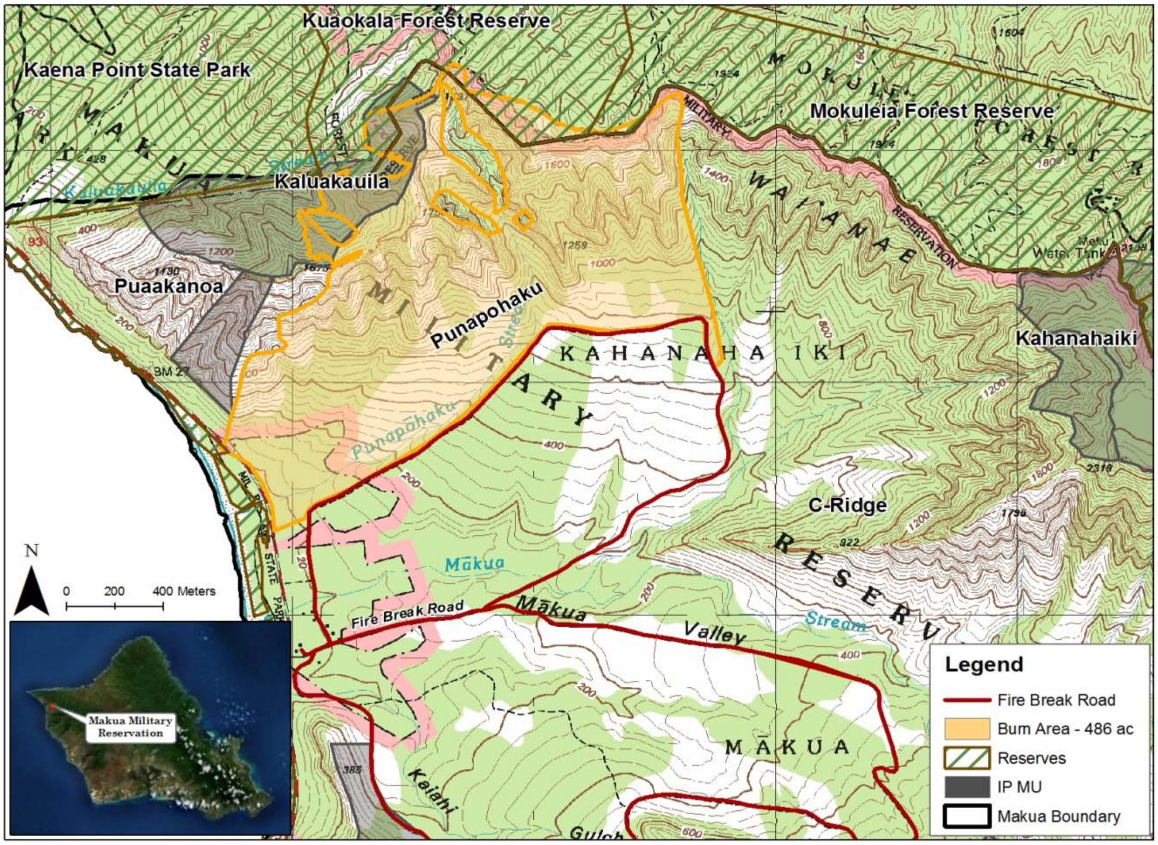
Aerial View of fire extent looking West



Aerial View of fire extent looking northwest

Cost Summary

NRS responded to this fire for a total of 110 hours costing $2,750. The Oahu Army Natural Resource Program (OANRP) contracted Airborne Aviation helicopter support for a total of 10.5 hours which cost $8,925. Overall, the cost of the Natural Resource Program response to this fire was $11,675.



2. Overview of Natural Resource Involvement in Fire Response

a. <u>Saturday July 24, 2010:</u>

The fire started at approximately 1410 hrs, July 24th inside the range fence between the range control building and Ukanipo Heiau. The exact ignition point is unknown. Army Wildland Fire (AWF) was notified at approximately 1420 and on scene at 1507 (as reported by range control). AWF did not notify Natural Resource Staff (NRS) as they were waiting for their Fire Management Officer to conduct a visual assessment first. NRS supervisors were told of fire by staff living nearby.

In the evening of the 24th, after a briefing with AWF and the State of Hawaii, Department of Land and Natural Resources (DLNR), two NRS conducted a reconnaissance by driving from Makua along the coast, up the Yokohama access road and along the Kuaokala Forest Reserve Dirt Road. These staff then returned to the NRS west baseyard to prepare fire gear for the response operation on Sunday morning. At this point, the fire had burned most of the acreage to be impacted by the fire in all (See Fire Extent map below). As OANRP have observed in the past, the south exposure of Puaakanoa ridge burns rapidly due to the steep terrain and preheating of upslope fuels. These conditions facilitate rapid fire spread and a fire which is impossible to stop mid-slope. When OANRP reported to Makua at 2000 hrs, these steep slopes had already burned. The eastern flank and the northern flank of the fire were the only two places still actively burning. At this point, the most important flanks to stop to minimize endangered resource impacts were the eastern flank and the portion of the western flank adjacent to the forest in the Kaluakauila Management Unit. Six total NRS were contacted and available to the fire on Sunday.

Personnel	Time	Total	Hourly Rate	Cost for Day
JR, SM	19:00-0100	12 hours	$25.00	$300.00

b. Sunday, July 25, 2010:

On the 25th, NRS reported to Makua at 0600 hrs, received a safety brief from Range Officer and conducted an aerial reconnaissance with AWF and DLNR. A briefing was held to determine how best to utilize fire fighting resources available on scene. For the rest of the day, one NRS member was involved at the Incident Command (IC) assisting with directing helicopter water drop operations, coordinating with field crews and taking weather readings. Five other NRS were working with AWF conducting mop up activities along the northeast edge of the fire. Also on the 25th, one staff member reported to the NRS west baseyard to assist with safety communication, to coordinate refueling operations with Wheeler Airfield, and for any additional coordination or gear support. Mop up operations on the ground were overseen by AWF in close coordination with DLNR employees. The Army crew of AWF and NRS worked the northern edge of the fire from west to east and the DLNR crew worked from east to west. AWF continued mop up operations for the remainder of the week, approximately till Friday July 30, 2010.

Personnel	Time	Total	Hourly Rate	Cost for Day
JR, DKS, KK, MW, WW, VC, MM	0430-1830	98	$25.00	$2450.00

c. Helicopter Support

Adequate helicopter support was critical to successfully extinguishing a large scale fire for the first time in recent decades. Six helicopters were flying water drops all day on Sunday. Paradise helicopters had two helicopters on site, one MD 500 and a Bell 206 both paid for out of the AWF budget. Evergreen Helicopters (Medivac service contract) flew one Bell 412 helicopter. The Honolulu Fire Department flew one MD 500. Natural Resources contracted Airborne Aviation to fly one MD 500. Also, one U.S. Marine UH 50 helicopter flew. The cost of the natural resource program's contributions to helicopter support on the fire is the table below.

Natural Resource Helicopter Costs

Company	Helicopter	Hourly Rate	Hours	Cost
Airborne	MD 500	$850	10.5 (2.5 hrs transport 24th, 8 hrs 25th)	$8,925

3. Natural Resource Impact Summaries by Area

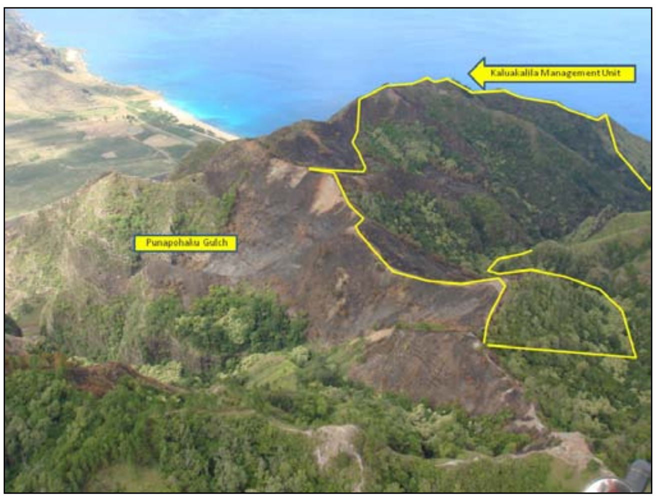
a. Kaluakauila

The Kaluakauila Management Unit is a fenced dry forest within which stabilization efforts from the Makua and Oahu Implementation Plans are conducted. Native dry forests are extremely susceptible to wildfire impact particularly since the invasive Guinnea grass, *Panicum maximum* has invaded. Each time fires burn into the Kaluakauila management unit, the grassy bowls within the fence burn intensely and carry fire to the forest perimeter. This causes the forest perimeter to recede with each successive fire, ultimately reducing the number of acres of native dry forest remaining within this management unit.

Within Kaluakauila, ~90 individuals of *Melanthera tenuifolia*, an endangered plant taxa were burned. The spot where this taxa burned is indicated on the aerial photo below.

Population of *Melanthera tenuifolia* that burned

Burned Kaluakauila Forest Edge



Kaluakauila Management Unit and Punapohaku Gulch Damage

Bobea sandwicensis

In addition, the fire burned to within 10 meters of the endangered *Euphorbia haeleeleana*. Beyond these impacts to endangered species, three *Bobea sandwicensis*, a rare but not federally listed plant were singed. It is not clear if these trees will recover. The photo above shows one singed *Bobea sandwicensis*.

Map removed to protect rare resources

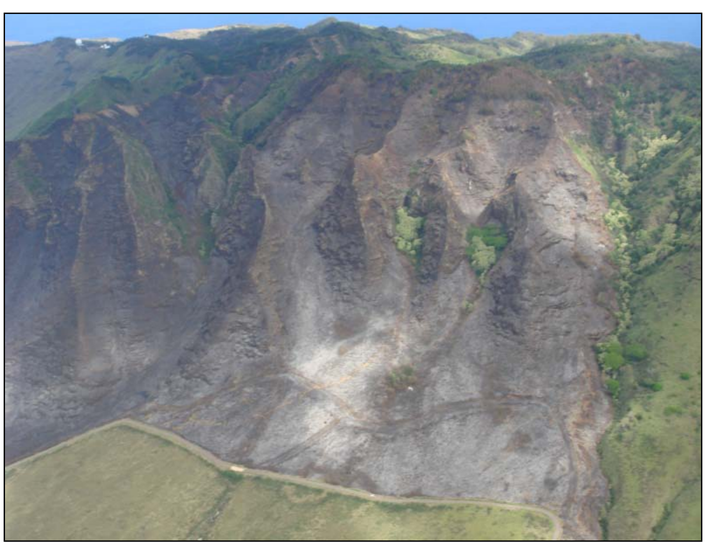
b. Kuaokala Forest Reserve

This Reserve lies to the north of Makua Military Reservation and largely composed of introduced tree plantings such as pines and *Eucalyptus* (See photo below). No endangered resources were threatened within the Kuaokala Forest Reserve. Nonetheless, the Reserve itself is of value to the State as a recreation and watershed area. Because of persistent helicopter water drops and the work of ground crews, the area within the Reserve that burned totaled only ~20 acres.

Makua/Kuaokala Forest Reserve northern fire boundary

c. Punapohaku Area

Below is a photo of fire impacts within Punapohaku Gulch. A total of approximately 50 *Chamaesyce celastroides* var. *kaenana* burned at two separate locations (population reference codes MMR-F and MMR-C). Also, ~ 16 *Nototrichium humile* (population reference code MMR-G), another endangered plant were burned. A map of the fire's impact on the Punapohaku area is included below.



Punapohaku area

4. Lessons Learned
    - An observed limitation of the Evergreen Bell 412 is that the bucket is suspended only about 30' below the belly which increases the influence of the downdraft of the main rotor on the water delivery. At times this compromised the accuracy of water drops.

    - Call to coordinate Wheeler refueling as soon as need is identified. Call was made Sunday AM could have occurred Saturday PM. Call James Ware (Chief Aviation, Wheeler Army Airfield) at 286-2613. No staff available on ADONSA, Federal holidays and weekends. Chief Aviation needs notice to coordinate for re-fueling staff.

    - No personnel in Wheeler Tower to direct air traffic on weekends, ADONSA days and Federal holidays. Make pilots aware before sending them in for fuel. Only authorization necessary to land comes from James Ware, Chief Aviation.

Table 1 is a partial list of native and alien plant species which burned observed during post fire assessment surveys on July 28, 2010.

Native Plant Species	**Alien Plant Species**
Alyxia stellata	*Acacia mearnsii*
Carex meyenii	*Adiantum hispidulum*
Pleomele forbesii	*Ageratina adenophora*
Reynoldsia sandwicensis	*Ageratina riparia*
Dodonaea viscosa	*Aleurites mollucana*
Bobea sandwicensis	*Andropogon virginicus*
Sapindus oahuensis	*Asclepias physocarpa*
Nestigis sandwicensis	*Blechnum appendiculatum*
Bidens torta	*Conyza bonariensis*
Psydrax odoratum	*Cordyline fruticosa*
Metrosideros polymorpha	*Grevillea robusta*
Syzigium sandwicensis	*Hyptis pectinata*
Microlepia strigosa	*Lantana camara*
Sphenomeris chinensis	*Leucaena leucocephala*
Sida fallax	*Melinus minutiflora*
Pouteria sandwicensis	*Melinus repens*
Peperomia tetraphylla	*Neonotonia wightii*
Dianella sandwicensis	*Panicum maximum*
Osteomeles anthyllidifolia	*Pinus luchuensis*
Artemesia australis	*Pittyrogramma austroamericana*
Leptecophylla tameiameiae	*Pluchea carolinensis*
Chamaesyce celastroides var. kaenana	*Psidium cattlelianum*
Santalum freycinetianum	*Psidium guajava*
Diospyros sandwicensis	*Rivinia humilis*
Santalum ellipticum	*Schinus terebinthifolius*
Nototrichium humile	
Melanthera tenuifolia	
Peperomia blanda	
Waltheria indica	

Kapua Kawelo
Biologist
DPW Environmental

APPENDIX ES-3: DETERMINING PHYSICAL DORMANCY IN HARD-SEEDED IP SPECIES

Introduction

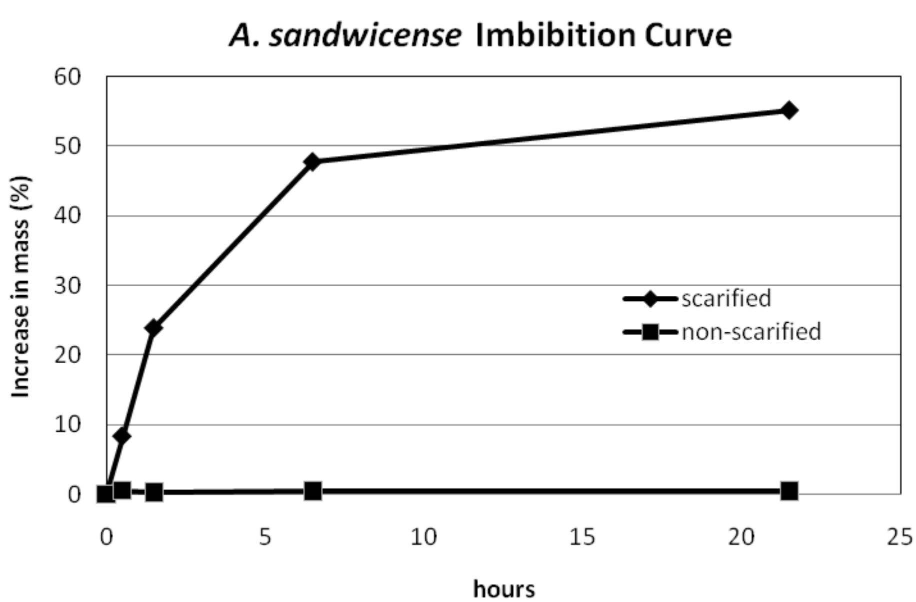
Seeds with physical dormancy have water-impermeable seed coats that require scarification for germination (Baskin & Baskin 1998). Physical dormancy is suspected in three hard-seed species; *Abutilon sandwicense*, *Gouania vitifolia* and *Hibiscus brackenridgei* subsp. *mokuleianus*. Previous germination assays show that seeds will germinate after they are mechanically scarified. In order to confirm physical dormancy, seed imbibition curves were generated for two of the three species (*A. sandwicense* and *G. vitifolia*). Imbibition curves will determine if seed coats are truly water-impermeable, and consequently will need to become permeable (break dormancy) in order to germinate.

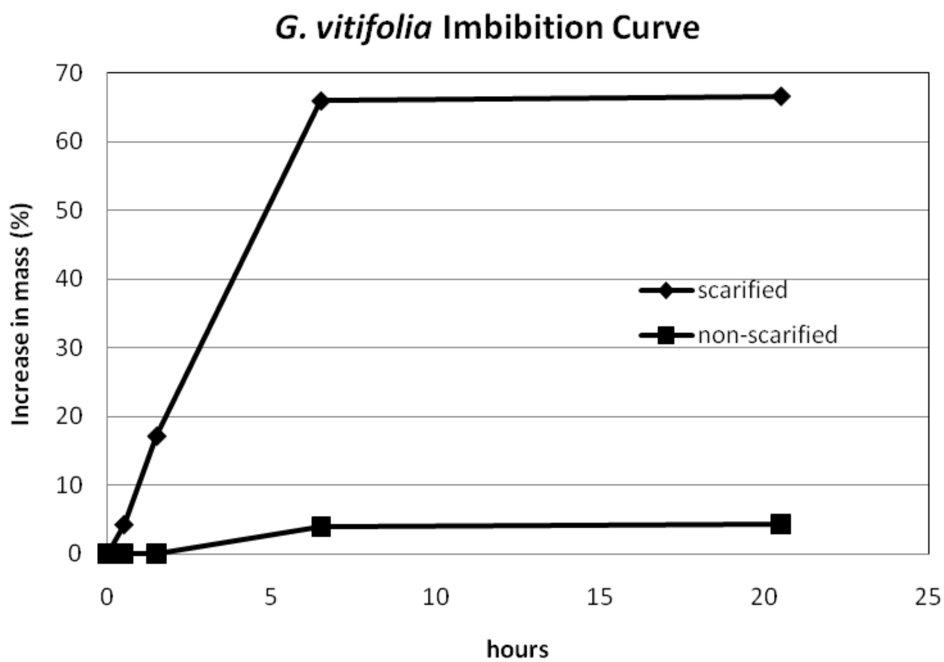
Methods

To determine if seeds have physical dormancy (water-impermeable seed coats) a simple imbibition test is done. Twenty fresh seeds of each species were obtained, ten seeds were mechanically scarified and ten seeds were left untreated (non-scarified). Both the scarified and non- scarified seeds were weighed and then both were placed into water. The seeds were taken out of the water and weighed at different time intervals throughout the day as they soaked. The data was then used to generate imbibition curves for each species. If seed weight increases, water is being absorbed. If water is absorbed by a non-scarified seed, it is not water-impermeable and hence, does not have physical dormancy. Increase in mass (%) was calculated by subtracting the initial mass (mg) by the final weight (mg) and dividing by the initial (mg).

Results and Discussion

Both graphs (below) show that scarification is necessary for the seeds of both species to become water-permeable, confirming suspicions of physical dormancy for *A. sandwicense* and *G. vitifolia*. For *G. vitifolia* one "non-scarified" seed had started imbibing water, but it is suspected that the seed was accidently nicked during fruit processing. These curves will be generated for *H. brackenridgei* when seeds become available for this purpose.





Baskin, C.C. & J.M. Baskin. 1998. *Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination*. Academic Press: San Diego, 666 pgs.

APPENDIX ES-4: RE-COLLECTION INTERVALS FOR SEED COLLECTIONS OF IP SPECIES FOR MAINTAINING GENETIC STORAGE REPRESENTATION

One of the main projects of the Army Seed Lab is to determine the storage potential of the seeds of all 51 species. In order to access the longevity of the genetic storage collections, some collections are set aside for research, and seed viablity is assessed over time (several times the first year, then once every five years) in different storage conditions (various temperatures and relative humidities). Eventually, a decrease in seed viability is detected. Preferred storage conditions are the conditions at which seeds maintain maximum viability over the longest period of time. Genetic storage collections are held at this preferred storage condition for each species. When a decrease in viability is detected at the preferred storage conditions, there is a loss in the ability of the collections to capture the amount of genetic variability in a plant or population that the same collection had when the fruit were initially harvested. There is ex situ selection on the collection as the seeds continue to age and die in storage, as the seeds that age the fastest are selected against. Since it is unclear what additional phenotypes could be linked to fast aging, it is necessary for OANRP to maintain viable and genetically diverse collections. This is achieved by refreshing or replacing seedbank collections with new, fresh collections. New collections can come from *in situ* sites or outplantings. Outplantings may be better sources for replacement collections for two reasons. First, they reduce the impact to the *in situ* sites. Second, outplantings represent all possible founders together at one site from single or multiple populations. Outplantings may produce novel genetic combinations (F1's, etc.) as well as potentially more fit offspring (limitations of small *in situ* population size.) OANRP has set the re-collection interval as the amount of time it takes to detect a decline in viability of no greater than 30% of the initial viability. Theoretically, once a decline is detected, a collection should undergo a quick drop in viability (C. Walters pers comm.). If no decline has been detected, the re-collection interval is set for 5 years greater than the length of time the collection has been tested and will be adjusted accordingly. The table below lists some species that have both 5 and 10 years of storage testing. Though the intervals are based on only one or two collections for each species, additional younger collections are showing similar trends in storage longevity. These numbers will continue to change as new data are available, and it is possible that intervals may have to be assigned by populations, rather than species, if difference storage longevities are observed. Lastly, there will eventually be a maximum interval established on a species by species basis. This maximum will be based on the life span of the species, the availability and quality of collections from reintroductions, and other factors, such as global climate change.

Re-Collection Interval Table (DRAFT)

Species	**Re-Collection Interval**	**Length of Time Tested (Years)**
Chamaesyce celastroides var. *kaenana*	≥5	5
Cyanea crispa	≥10	5
Cyanea grimesiana subsp. *obatae*	≥10	5
Cyanea superba subsp. *superba*	≥10	5
Cyrtandra dentata	5 to 10	5
Delissea waianaeensis	≥15	10
Dubautia herbstobatae	≥15	10
Flueggea neowawraea	5 to 10	5
Hedyotis parvula	≥10	5
Hibiscus brackenridgei subsp. *mokuleianus*	≥10	5
Lobelia gaudichaudii subsp. *koolauensis*	5 to 10	10
Melanthera tenuifolia	≥10	5
Neraudia angulata	≥10	5
Sanicula mariversa	5 to 10*	10
Schiedea kaalae	≥10	5
Schiedea nuttallii	≥10	5
Schiedea obovata	≥15	10
Schiedea trinervis	≥15	10
Tetramolopium filiforme	≥15	10
Viola chamissoniana subsp. *chamissoniana*	10	10

* Sites may vary in germination and storage longevity. Germination protocols are still not developed for all sites. Seeds at all sites, however, are not desiccation sensitive.

APPENDIX ES-5: OAHU ARMY NATURAL RESOURCE PROGRAM RESEARCH PROPOSAL, M. EUAPARADORN

Oahu Army Natural Resource Program Research Proposal

Title: Pollination biology of *Euphorbia celastroides* var. *kaenana* (Euphorbiaceae).

Submitted By: Melody Euaparadorn; Department of Botany; University of Hawaii at Manoa; 3190 Maile Way; Honolulu, HI, 96822; 808-345-2537; melody4@hawaii.edu

Type of Support Requested: Research Assistantship

Proposed Project Period: June 2010 – May 2011

Statement of Problem:

Pollinators and pollination can affect the viability of plant populations, especially those of rare plants. Although the disruption of pollination systems and loss of pollinators have been attributed to the decline of several endangered species in Hawaii, little remains known of the pollination biology of most Hawaiian plants. For the successful recovery of these endangered plant species, basic information on their breeding system must be determined and incorporated into management programs.

Plant pollination systems of rare plants may be especially sensitive to the effects of habitat fragmentation. Reduction of habitat can reduce plant and pollinator relative abundance and pollinator species richness, resulting in reduced pollination services. These reduced plant populations are more likely to suffer from inbreeding depression as self-fertilization occurs from pollinators visiting a higher proportion of flowers on individual plants.

The endemic Hawaiian plant *Euphorbia celastroides* var. *kaenana* (Euphorbiaceae) is known only from fragmented populations on the island of Oahu on the northwestern end of the Waianae Mountains and a single collected specimen from the southeastern portion of the Koolau Mountains. With the decline of populations of *E. celastroides* var. *kaenana*, the species was listed as endangered in 1991. The major objective of this study is to investigate the pollination and reproductive biology of *E. celastroides* var. *kaenana,* as little is known of its breeding system, to provide vital information for the recovery of this species.

Procedures/Methods:

Study Sites - It is proposed that this study be conducted at populations of *E. celastroides* var. *kaenana* occurring within Kaena Point NAR, Kaena Point State Park, and Makua Military Reservation. The Kaena Point NAR and the Makua Military Reservation populations will be categorized as larger, contiguous populations, while the populations at Kaena Point State Park will be considered smaller, isolated populations (Table 1).

Table 1. Proposed populations units of *E. celastroides* var. *kaenana* to be included in study.

Land Ownership	Population Unit	Total No. of Individuals	Population Size Category
Kaena Point NAR	Kaena Point	375-525	Larger, Continuous
Kaena Point State Park	East of Alau	26	Smaller, Isolated
Kaena Point State Park	Kaewaulu (population C & D)	20	Smaller, Isolated
Makua Military Reservation	Lower Ohikilolo	118	Larger, Continuous

Note on floral terminology – The flower of *E. celastroides* var. *kaenana* is known as a cyathium. Each cyathium is an inflorescence of several male (staminate) flowers and one central female (pistillate) flower.

Selection and manipulation of plants – When randomly selecting plants to be manipulated, individuals with a low number of flowers will be excluded. For each individual that is selected, manipulation of flowers will be limited to less than 20% of the flowers produced in the season.

Objective 1: Determine the phenology of *E. celastroides* var. *kaenana* by measuring cyathia and fruit production monthly.

- *Purpose* – A basic understanding of phenology will be pertinent for future research and management of *E. celastroides* var. *kaenana.*
- *Methods* – Total number of buds, cyathia, and fruit will be counted on ten randomly selected individual plants monthly.

Objective 2: Determine if *E. celastroides* var. *kaenana* is self-compatible or an obligate out-crosser.

- *Purpose* – If *E. celastroides* var. *kaenana* is found to be self-incompatible and requires cross-pollination for seed production, it will stress the importance of managing for both the protection of the pollinators and a genetically diverse population of *E. celastroides* var. *kaenana.*

In the outcross treatments, seed set will also be compared between cyathia cross-pollinated with a near versus a far plant donor. In general, when pollen and seeds are dispersed a short distance, neighboring plants are generally more closely related to each other than distantly separated plants. As a result, these closely related individuals are more likely to cross-pollinate leading to inbreeding depression.

- *Methods* – One hundred and twenty randomly selected buds from ten flowering individual plants will be bagged with a fine mesh and randomly assigned to one of four treatments: (1) no manipulation (autogamy) – no hand pollination of cyathium, (2) induced self-pollination (geitonogamy) – cyathium hand pollinated with pollen of the same plant donor, (3) near donor cross-pollination (xenogamy) – cyathium hand pollinated with a mixed pollen load from neighboring plant donors, and (4) far donor cross-pollination (xenogamy) – cyathium hand pollinated with a mixed pollen load from distant plant donors.

  Cyathia in Treatment (3) and (4) will be emasculated before stigmas are receptive to avoid self-fertilization. Pollen from these emasculated anthers will be used to pollinate other cyathia upon anthesis. After approximately 1 month, fruits will be collected to compare total number of fruit and seeds set between treatments.

Objective 3: Determine if seed set in *E. celastroides* var. *kaenana* is pollen limited.

- *Purpose* – This will determine whether reproductive success in *E. celastroides* var. *kaenana* is limited by insufficient deposition of pollen on stigmas.

- *Methods* – Sixty randomly selected buds from ten flowering individual plants will be randomly assigned to one of two treatments: (1) open pollination - cyathium left uncovered and no experimental manipulation, and (2) cross pollination (xenogamy) - cyathium bagged and hand pollinated with pollen from a different plant (these will be the same flowers from Treatment 4 of Objective 2). After approximately 1 month, fruits will be collected to compare total number of fruit and seeds between treatments.

Objective 4: Determine if seed set in *E. celastroides* var. *kaenana* is limited by pollen viability and/or stigma receptivity.

- *Purpose* – Reproduction in rare plant species may be limited by male and female infertility. Determining pollen viability and timing of stigma receptivity are also imperative for flower manipulation studies.

- *Methods* - A chemical test will be used to estimate the viability of pollen and receptivity of stigmas. To determine pollen viability, pollen will be collected from freshly dehisced anthers from 10 cyathia and stained with a chemical that tests for dehydrogenases as an indication of viability. Ten stigmas from 1-day, 2-day and 3-day old cyathia will be similarly tested to determine the developmental stage at which stigmas are most receptive.

Objective 5: Identify floral visitors and determine their ability to effect pollination in *E. celastroides* var. *kaenana* by quantifying visitation rates and pollen carrying load.

- *Purpose* – Identifying the floral visitor community is of general interest and important for future research and management of *E. celastroides* var. *kaenana.* To determine the effectiveness of these floral visitors to effect pollination, rates of visitation and pollen carrying load will be examined.

- *Methods* - Composition of the floral visitor community and rates of visitation will be quantified by observing insect activity at adjacent cyathia during 10 minute periods between 0900 and 1500. Cyathia will be observed from a 1-meter distance using close focusing binoculars. For each floral visitor, the identity of the visitor, whether or not it contacted the cyathium's reproductive parts, the floral resource collected, and the duration of the visit will be recorded. Observations will be conducted every two weeks during peak flowering periods on dry days with sunny weather and moderate wind speeds.

  To examine the extent to which various taxon are capable of transporting *E. celastroides* var. *kaenana* pollen, insects observed foraging on cyathia will be collected and examined for presence of pollen. A representative of 10 individuals from each taxon will be collected.

  A reference collection of the floral visitors of *E. celastroides* var. *kaenana* will be compiled and housed at the Bishop Museum. Species level identifications will be made using keys and museum collections.

Objective 6: Determine if smaller, isolated populations of *E. celastroides* var. *kaenana* receive fewer visits by floral visitors compared to the larger, more contiguous populations.

- *Purpose* – In plants that rely on insects as pollinators, small plant populations in fragmented habitats will tend to have lower seed set due to a reduction in pollinator abundance and richness. For future management and conservation of *E. celastroides* var. *kaenana*, it is important to determine if floral visitation rate and seed set is reduced in smaller, isolated populations compared to larger, continuous populations.

- *Methods* - Rates of visitation by floral visitors (Objective 5) will be compared between the smaller and larger populations of *E. celastroides* var. *kaenana.*

Objective 7: Determine if seed set and seed viability in *E. celastroides* var. *kaenana* reduces with population size as an indicator of the effects of inbreeding depression.

- *Purpose* – Studies have shown that plant populations become inbred at greater rates in smaller than larger populations. A typical symptom of inbreeding depression is a reduction in seed set and seed viability.

- *Methods* - Seed set and seed viability (Objective 3, Treatment 1) will be compared between plants of the smaller and larger populations of *E. celastroides* var. *kaenana*. Seed mass and chemical testing with Tetrazolium chloride (TTC) will be used to assess seed viability.

Objective 8: Determine if experimentally reducing inbreeding levels in both small and large populations affects seed set and seed viability in *E. celastroides* var. *kaenana*.

- *Purpose* – Seed set and viability have been shown to be reduced in smaller populations, because of reduction in pollinator visitation rates, an increase in the likelihood of crossing with close relatives, and a lack of vigor of seeds produced. If seed set is increased in the smaller populations when cyathia are cross-pollinated with cyathia of the larger populations, it will provide further support that seed set in the smaller population is affected by population size.

- *Methods* - Seed set and seed viability will be compared between cyathia hand pollinated with pollen from the same population and cyathia hand pollinated with pollen from a different population in both small and large populations. Hand pollination trials will be conducted in a greenhouse with propagated plants originating from both the small and large populations. Seed mass and chemical testing with Tetrazolium chloride (TTC) will be used to assess seed viability.

Objective 9: Identify whether ant floral visitation reduces seed set and seed viability in *E. celastroides* var. *kaenana* at the Kaena population unit.

- *Purpose* – From preliminary floral observations, ants have been observed to be the dominant floral visitor of *E. celastroides* var. *kaenana*. In general, ants are regarded as poor pollinators, because pollen does not readily adhere to their bodies and antibiotics secreted by ants to combat fungal growth reduces the viability of pollen. Ants may also limit seed set and viability in plant populations by both diminishing the amount of available nectar and aggressively deterring pollinators at flowers.

- *Methods* - Seed set and seed viability will be compared between the following cyathia manipulations: 1) cyathia excluded from ants allowing access to only flying insects; 2) cyathia excluded from flying insects allowing access to only ants; 3) cyathia excluded from both ants and flying insects; 4) cyathia open to all visitation.

To exclude only ants from a cyathium, Vaseline will be applied to the base of a branch to function as a trapping adhesive. To exclude flying insects while still allowing access by ants, mosquito netting will be draped over a cyathium and secured. An entire cyathium will be bagged to eliminate both ants and flying insects. Seed mass and chemical testing with Tetrazolium chloride (TTC) will be used to assess seed viability. Thirty flowers will be used in each treatment from 10 different individual plants.

Table 2. Research objectives to be conducted per Population Unit of *E. celastroides* var. *kaenana* from June 1, 2010 through May 31, 2011.

		Population Unit			
Obj . #	**Methods**	**Kaena Point**	**East of Alau**	**Keawaulu**	**Lower Ohikilolo**
1	Monitor phenology. Count total number of buds, cyathia, and fruit monthly.	✓			
2	Test for self-compatibility. Four treatments: (1) no manipulation, (2) induced self-pollination – cyathium hand pollinated with pollen of the same plant, (3) near donor cross pollination – cyathium hand pollinated with pollen from a near donor, and (4) far donor cross pollination – cyathium hand pollinated with pollen from a far donor.	✓			
3	Test for pollen limitation. Two treatments: (1) open pollination - cyathium left uncovered and no experimental manipulation, and (2) cross pollination - cyathium bagged and hand pollinated with pollen from a different plant (*these will be the same flowers from Treatment 4 of Objective 2*).	✓	✓	✓	✓
4	Chemical test of pollen viability and stigma receptivity. Pollen from freshly dehisced anthers, and 1-, 2-, and 3-day old stigmas will be tested.	✓			
5	Quantify insect visitation rate and pollen carrying load. Visits by insects will be recorded in 10 min. intervals. Thirty individuals of each visitor taxon will be collected and examined for presence of pollen.	✓	✓	✓	✓

Table 2 (*continued*). Research objectives to be conducted per Population Unit of *E. celastroides* var. *kaenana* from June 1, 2010 through May 31, 2011.

		Population Unit			
Obj. #	**Methods**	**Kaena Point**	**East of Alau**	**Keawaulu**	**Lower Ohikilolo**
6	Test if plant population size affects visitation rates. Rates of visitation by floral visitors (Objective 5) will be compared between the smaller and larger plant populations.	✓	✓	✓	✓
7	Test for the presence of inbreeding depression. Seed set and seed viability will be compared between the smaller and larger plant populations. *These will be the same flowers and fruit from Treatment 1 of Objective 3*.	✓	✓	✓	✓
8	Experimentally reduce inbreeding levels. Seed set and seed viability will be compared between cyathia hand pollinated with pollen from the same population and cyathia hand pollinated with pollen from a different population in both small and large populations. *To be conducted in the greenhouse with propagated plants.*				
9	Test whether ant visitation reduces seed set and seed viability. Seed set and seed viability will be compared between: 1) cyathia excluded from ants allowing access to only flying insects; 2) cyathia excluded from flying insects allowing access to only ants; 3) cyathia excluded from both ants and flying insects; 4) cyathia open to all visitation.	✓			

Table 3. Summation of total number cyathia to be manipulated and fruits to be collected of *E. celastroides* var. *kaenana* per research objective from June 1, 2010 through May 31, 2011.

Obj. #	Methods	# of plants	Total # of cyathia	Removal and/or damage of cyathia	Collect fruits*
1	Monitor phenology. Count total number of buds, cyathia, and fruit monthly.	10	n/a	no	no
2	Test for self-compatibility. Four treatments: (1) no manipulation, (2) induced self-pollination – cyathium hand pollinated with pollen of the same plant, (3) near donor cross pollination – cyathium hand pollinated with pollen from a near donor, and (4) far donor cross pollination – cyathium hand pollinated with pollen from a far donor.	10	120 (30/ treatment)	no	yes
3	Test for pollen limitation. Two treatments: (1) open pollination - cyathium left uncovered and no experimental manipulation, and (2) cross pollination - cyathium bagged and hand pollinated with pollen from a different plant (*these will be the same flowers from Treatment 4 of Objective 2*).	10	60 (30/ treatment)	no	yes
4	Chemical test of pollen viability and stigma receptivity. Pollen from freshly dehisced anthers, and 1-, 2-, and 3-day old stigmas will be tested.	10	40	yes	no
5	Quantify insect visitation rate and pollen carrying load. Visits by insects will be recorded in 10 min. intervals. Thirty individuals of each visitor taxon will be collected and examined for presence of pollen.	10	n/a	no	no

* Any seeds not tested with TTC will be properly stored at the OANRP facilities.

Table 3 (*continued*). Sum Summation of total number cyathia to be manipulated and fruits to be collected of *E. celastroides* var. *kaenana* per research objective from June 1, 2010 through May 31, 2011.

Obj. #	Methods	# of plants	Total # of flowers	Removal and/or damage of flowers	Collect fruit*
6	Test if plant population size affects visitation rates. Rates of visitation by floral visitors (Objective 5) will be compared between the smaller and larger plant populations.	10	n/a	no	no
7	Test for the presence of inbreeding depression. Seed set and seed viability will be compared between the smaller and larger plant populations. *These will be the same flowers and fruit from Treatment 1 of Objective 3*.	*same as Objective. 3, Treatment 1*	*same as Objective. 3, Treatment 1*	no	yes
8	Experimentally reduce inbreeding levels. Seed set and seed viability will be compared between cyathia hand pollinated with pollen from the same population and cyathia hand pollinated with pollen from a different population in both small and large populations. *To be conducted in the greenhouse with propagated plants.*	n/a	n/a	n/a	n/a
9	Test whether ant visitation reduces seed set and seed viability. Seed set and seed viability will be compared between: 1) cyathia excluded from ants allowing access to only flying insects; 2) cyathia excluded from flying insects allowing access to only ants; 3) cyathia excluded from both ants and flying insects; 4) cyathia open to all visitation.	10	120 (30/ treatment)	no	yes

* Any seeds not tested with TTC will be properly stored at the OANRP facilities.

Table 4. Total number of cyathia to be manipulated and fruits to be collected per Population Unit of *E. celastroides* var. *kaenana* from June 1, 2010 through May 31, 2011.

Population Unit	Total # of cyathia to be manipulated	Total # of fruit to be collected
Kaena Point	340	300
East of Alau	60	60
Keawaulu	60	60
Lower Ohikilolo	60	60
Grand Total	**520**	**480**

Anticipated Results and Products:

Results from this research will provide a valuable understanding of the pollination and reproductive biology of *E. celastroides* var. *kaenana*. Identification of potentially reproductive and ecological limiting factors will help facilitate the design of management strategies that will contribute to the recovery of this species.

A reference collection of the floral visitors of *E. celastroides* var. *kaenana* will be compiled and housed at the Bishop Museum. Species level identifications will be made using keys and museum collections.

A summary of results will be made available through a technical report, at least one peer reviewed journal, and a presentation at the Hawaii Conservation Conference.

Semester Timeline:

Summer 2010 (June-August 2010) – Monitor phenology, conduct flower visitor observations, hand pollination experiments, and floral visitor exclusion experiments.

Fall 2010 (September–December 2010) – Monitor phenology, conduct flower visitor observations, hand pollination experiments, floral visitor exclusion experiments, collect and test seeds, and insect pollen washing.

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APPENDIX 2 CHAPTER 1 APPENDICES

Appendix 2 contains supplemental information for Chapter 1. Contents of Appendix 2 include:

- Appendix 1-1: Environmental Outreach 2010
- Appendix 1-2: Target Species Form
- Appendix 1-3: Determining Soil Seed Bank Persistence for Incipient Weed Species
- Appendix 1-4: Sphagnum Control Plan for Kaala MU
- Appendix 1-5: Summer 2010 *Psidium cattleianum* Control at Kahanahaiki Clearcut and Chipper Project
- Appendix 1-6: How to Chipper
- Appendix 1-7: *Bidens torta* Seed Sow Trials at Kahanahaiki MU
- Appendix 1-8: Standard Operating Procedures for Herbicide Ballistic Technology Operations: Ground and Aerial Herbicide Application

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APPENDIX 1-1: ENVIRONMENTAL OUTREACH 2010

OUTREACH PHOTOS:

Volunteers remove the incipient weed, *Crocosmia* x *crocosmiiflora,* from the Kaala summit.

Volunteers weed invasives in West Makaleha.

Life scouts construct a water catchment and plant common natives at KTA.

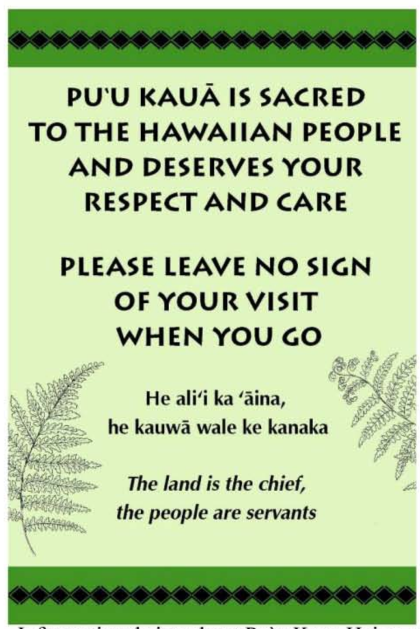
One of the OANRP's dedicated volunteers helps with seed processing and seedling care at the baseyard.

The OANRP educational display and activity at the Honolulu Zoo's 2010 "Endangered Species Day" celebration for the public.

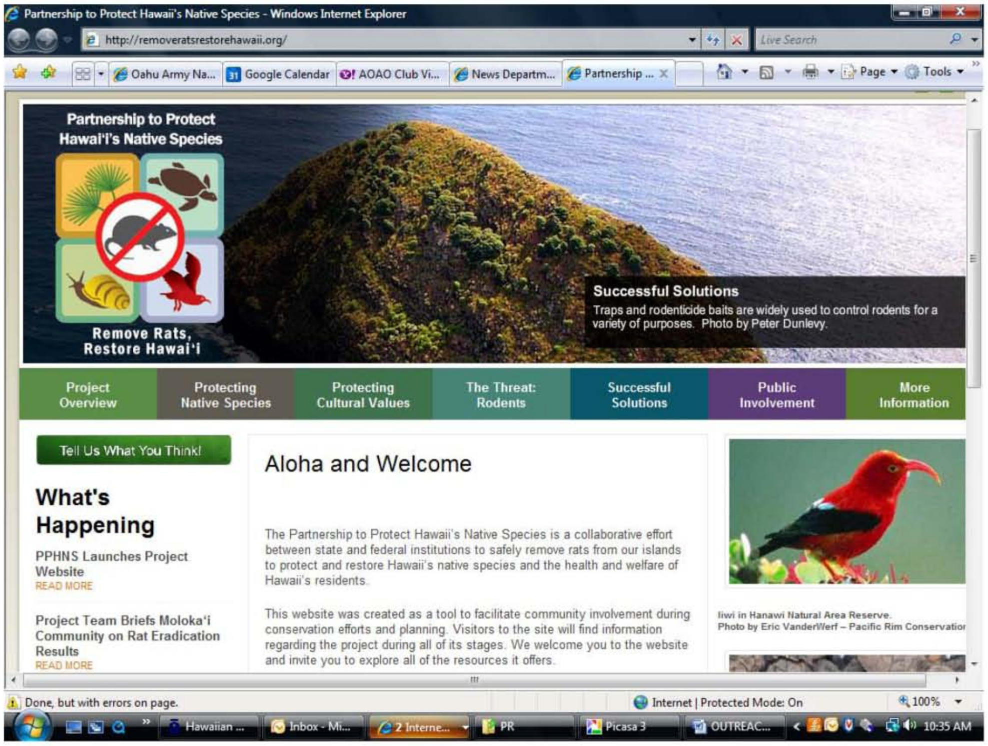
EDUCATIONAL MATERIALS:

A large, three-panel sign – one of several displays slated for an up-coming interpretive area in Makua Valley.

Informational sign describing *Sphagnum* efforts at Kaala.

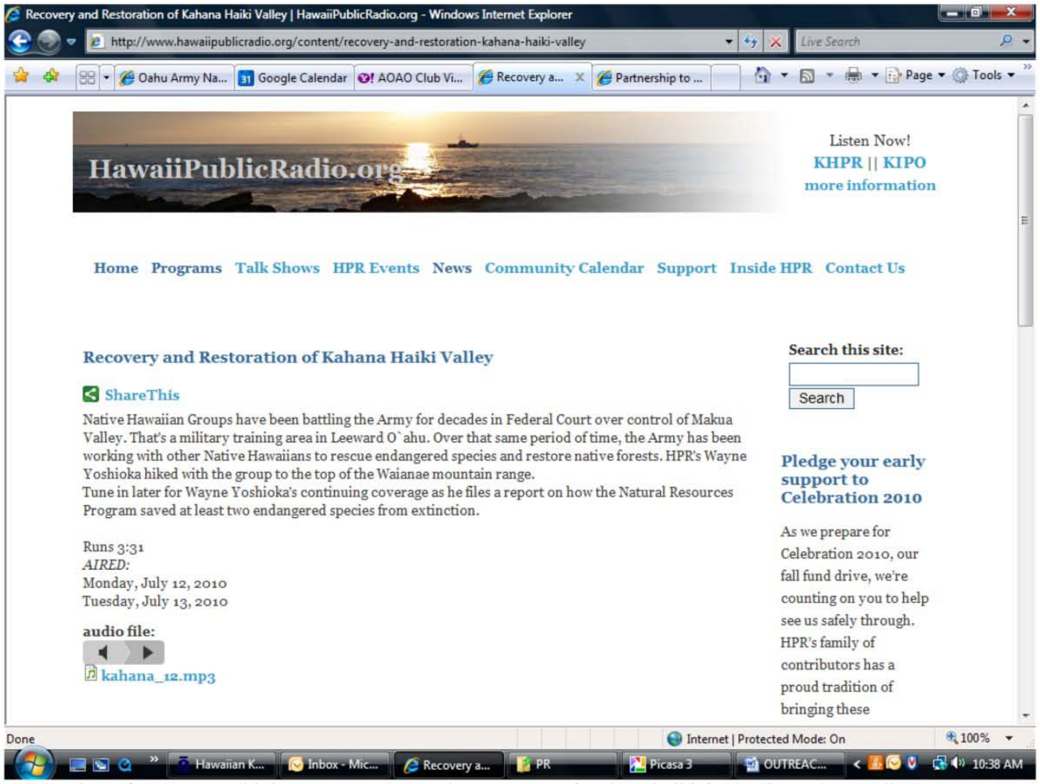


Informational sign about Pu`u Kaua Heiau, control requesting visitors to respect this important cultural site.



Screen-shot from the "Partnership to Protect Hawaii's Native Species" website's homepage.

PUBLIC RELATIONS:



Screenshot of Wayne Yoshioka's HPR story on the recovery of Kahanahaiki forest (in Makua Valley) by the OANRP.

Department of Defense
Legacy Resource Management Program

Natural Selections

Volume 5, Issue 11 November 2009

Legacy Program Update

The Legacy Program to meet with DoD decision makers: The Legacy Program will present the results of the FY 2010 proposals review meeting to senior DoD decision makers the week of November 16. We expect to begin making selection announcements by the end of December.

Legacy Project Highlight of the Month

Legacy Project 07-364: Intensive Plant Conservation Training Workshop

The six-day workshops focused on 17 different topics, including rare and imperiled plants, plant protection and legislation, how to measure success, and how to inventory and monitor imperiled plants. Nearly 40 experienced botanists from academia, agencies and non-governmental organizations helped to develop the workshop. These botanists also worked collaboratively to put together take-home resource materials for attendees.

Workshop participants complete an exercise in monitoring.
Photo: Center for Plant Conservation

The workshop instructors are among the top plant conservation practitioners in the country. They provided

See Legacy, page 3

In The News

Endangered *Cyanea superba* Responds Positively to the Strategic Management Efforts of the Army Garrison Hawaii's Natural Resources Program

By Kim Welch[1] and Michelle Mansker[2]

[1] Environmental Outreach Specialist, Research Corporation of the University of Hawaii
[2] Natural Resources Section Chief, U.S. Army Garrison Hawaii, Directorate of Public Works, Environmental Division Oahu Army Natural Resources Program

The rough crunching sounds of spiked hiking shoes mixed with morning bird calls, as a crew of field technicians from the Army Garrison Hawaii's Natural Resources Program (NRP) made their way into the native forest at the back of Makua Valley, Oahu. The crew walked at a brisk pace, anxious to get in position to receive a delivery of precious air cargo that had taken years to prepare. Today, 29 endangered Cyanea *superba* plants would be re-introdu their origin.

See Str

Inside This Issue

Strategic management, continued from page 1

Since 1998, when less than 10 wild *Cyanea superba* remained on the planet, NRP staff has taken proactive measures to improve the plant's chances for survival. The remaining wild plants were closely monitored, year after year. Although they would produce flowers and fruit, the lack of new seedlings on the forest floor did not bode well for the future of wild *Cyanea superba* in Hawaii. Recognizing this sure path to extinction, NRP intervened.

Fences were built to keep pigs and goats from damaging the Cyanea's fragile roots and seedlings. Invasive weeds were kept in check. Slug deterrents were put in place to keep these non-native plant predators from nibbling up precious Cyanea seedlings. Rat-traps and rat bait stations were put in place to keep rodents from decimating the Cyanea fruit. And if the NRP staff could get to the plants before the rats, they would collect fruit and bring the seeds back to the seed lab.

Cyanea superba seedlings discovered growing in the wild beneath plants that had been re-introduced into Kahanahaiki by NRP staff.

Helicopter delivers a plant box filled with endangered plants to a remote native forest where NRP staff re-introduce them to the wild.

The precious seeds were placed in petri dishes and grown in incubators. Form there, seedlings were moved into the nurseries where they were nurtured and monitored until they reached a full meter in height, a process that normally takes up to three years. Unfortunately, during these ten years of intensive management, the last remaining *Cyanea superba* went extinct in the wild. But NRP anticipated this sad day and the Cyanea seedlings that were growing in NRP nurseries would soon fill the void in the native forest of Makua. To date, over 250 *Cyanea superba* plants have been grown and returned to Makua by NRP staff and this week's delivery would raise the number by an additional 29 plants.

This week the endangered Cyanea were loaded into a plant box designed for transport by helicopter to the remote out-planting site. Matt Keir, NRP Rare Plant Manager, guided the incoming helicopter to the nearby landing zone on the rim of Makua. The plant box was hooked up to a cable and within minutes it was airborne beneath the helicopter and carried into the Makua forest. The awaiting field crew in the forest unloaded each plant and packed them on their backs into shady gulches for planting.

Did You Know?

With a whopping 317 threatened and endangered species, Hawaii is often referred to as the endangered species capitol of the world. There are more listed endangered species per square mile on these islands than any other place on the planet! Thirty percent of these endangered plants and animals can be found on Army lands.

"Endangered *Cyanea superba* responds positively to the strategic management efforts of the Army Garrison Hawaii's natural resources program" article in Natural Selections publication, November 2009.

Oahu Army Natural Resources Program looks back on a year of challenges, innovation, firsts

by Candace Russo

Acronyms and Abbreviations	
OANRP	Oahu Army Natural Resources Program

Some might think conservationists get excited about strange things — a snail clinging to a leaf, a single flower bud, a new rat-trap design. Moreover, trekking through mud, mosquitoes and oppressive heat while searching for that snail or checking that trap may not appeal to the masses.

Yet, the passion, dedication and hard work of a field conservationist are rivaled by few other professions. This conviction enables the 55 staff members of the Oahu Army Natural Resources Program, part of U.S. Army Garrison Hawaii, to overcome challenges, create innovative solutions and celebrate firsts.

Since 1995, the OANRP staff has managed endangered species on Army lands, which are home to almost 80 percent of the total endangered species found on the island of Oahu, including plants, tree snails and forest birds. To accomplish this, OANRP staff ventures to the mountain ranges of Oahu on an almost daily basis to control threats such as invasive weeds, pigs, goats and rats.

OANRP staff also monitors endangered species' health, surveys species ranges and, in the case of 53 managed plant species, facilitates collection of seeds and stems used to grow new plants. These plant seedlings are cared for in nurseries, in order to store genetic material and to reintroduce them back into the wild.

For the OANRP, 2009's planting activities stopped almost before they started when a halt was called to all endangered plant reintroductions after the discovery of nonnative, alien snails on many of the plants in the nurseries. Because one of the alien species found was a carnivorous snail, the very last thing staff wanted to do was inadvertently introduce any of these alien snails into the forest where so much hard work is put into protecting endangered tree snails.

Solving this snail dilemma involved several months of experimentation and communication with other horticulturists to determine the most efficient and effective way to eradicate these alien snails. After hot water treatments, different pesticide recipes and loads of salt, the problem was solved.

Currently, the legs of all nursery benches sit in containers filled with salt, a natural snail deterrent, and an effective pesticide drench is used when needed.

The rest of the solution to the nursery snail problem is found stuffed in the refrigerator at the OANRP base yard: bags and bags of lettuce. Common romaine lettuce is an effective snail attractant. Several pieces of lettuce are placed on the soil surface of every plant and covered with a small plastic pot to retain moisture.

These "lettuce baits" are checked weekly for the presence of snails, a process that can be accomplished much quicker than the original method, which included examining the entire surface of the plant, the pot and the soil inside the pot. If a plant is found to be "snail-free" for eight weeks, it is cleared for planting into the wild.

This situation speaks to the importance of a clean nursery environment and highlights the dedication of OANRP horticulturists to protect these endangered species.

Following the nursery snail challenge, spirits were drastically lifted when several field crews returned from work trips with news of "firsts."

In the spring, a new endangered snail population was discovered high in Oahu's Koolau mountain range. After torrential winter rains, several endangered Hawaiian coots were found in an ephemeral wetland at Dillingham Military Reservation in northwestern Oahu. In the summer, a new endangered hibiscus population and a new

(continued from previous page)

the engineer team hustled out more than 350 designs and specifications, scopes of work and estimates for the design package. Within six industrious months, it finished overall master plans for the expansions of three large brigade or division forward operating bases, five battalion forward operating bases and five company outposts, the design for which eventually became the theater design standard.

Also on the district's frontier were the continued support to manage the construction of $100 million in forward operating site facilities for the U.S. Army Europe-led Task Force-East initiative in Romania and Bulgaria, and another $100 million in projects requested by Israel to help it maintain its qualitative military edge over other countries in the region.

The district delivered all this to the delight of its strategic partners, proving

(continued from previous page)

establishment of the largest rat-trap-grid in Hawaii. Because rats munch on everything from endangered tree snails to bird eggs and endangered fruits, the rat is one of the largest threats to the endangered species managed by the OANRP.

In cooperation with government conservation workers from New Zealand, 400 specially designed rat traps were built and installed in a grid-formation — a trap every 12 meters — at a forest site in western Oahu. This rat-trap grid dovetails with other research and rat control efforts occurring in the same forest as part of the OANRP's management activities.

Possibly the most exciting "first" came in the form of evidence of endangered plant management success. One of the plants managed by the OANRP, a type of lobelia called *Cyanea superba*, was extinct in the wild, the last known plant having died in the mid-1990s.

Prior to this event, OANRP staff collected fruit and grew seedlings of *C. superba* in its nurseries and reintroduced these seedlings into the forest.

From these reintroduced plants, more than 200 mature plants developed, and in 2009, the very first wild-produced — created and growing on their own — seedlings were discovered. Hundreds of these new seedlings carpeted the forest floor beneath the reintroduced plants. OANRP staff is working to control slugs around these seedlings and continues to monitor the seedlings with high hopes that they will become the next generation of *C. superba*.

Following this good news, OANRP staff witnessed the first-ever flowering of a reintroduced endangered loulu palm tree. Not only does this signify the beginning of a new generation of loulu palms, it also provides critical information to Hawaiian conservationists about the timing of flower production in reintroduced palms, thus helping the success of future reintroductions.

Perhaps fitting for the past year of exciting events, the OANRP was also awarded the *Military Conservation Partner Award* by the U.S. Fish and Wildlife Service. The OANRP celebrated the award by hosting an open house to thank all the people involved, including cooperating agencies, organizations and numerous volunteers whose support continually helps make the program a success. Guests toured the new Natural Resources base yard and native plant interpretive garden at Schofield Barracks, Hawaii, while sharing the latest developments in endangered species conservation on Oahu.

Seemingly simple, this rat-trap is specially designed to increase the effectiveness of a standard snap-trap in the forest. The traps are used to control rats, one of the largest threats to endangered plants, tree snails and birds on Oahu. Photo courtesy of OANRP

The ultimate goal when out-planting endangered plants in the wild is to have them reproduce on their own, so these wild-born seedlings of out-planted Cyanea superba, an extinct plant reintroduced into the wild by OANRP conservationists, are a welcome sight. Photo courtesy of OANRP

Discussions about seedling discoveries and rat traps elicited excitement for all — the sign of true conservationists.

POCs are Candace Russo, 808-656-7641, candace.r.russo@us.army.mil; and Aiko Brum, chief, Internal Communications, U.S. Army Garrison Hawaii Public Affairs, 808-656-3155, aiko.brum@us.army.mil.

Candace Russo is an environmental outreach specialist, OANRP.

Look us up on the WEB

For an electronic copy of the

Public Works Digest,

go to:

http://www.imcom.army.mil/hq/

Click on 'News' tab

And then on 'Public Works Digest'

"Oahu Army Natural Resources Program looks back on a year of challenges, innovations, firsts" article in the Public Works Digest publication, Nov/Dec 2009.

EMP
Ecosystem Management Program Bulletin
Volume 50 Summer 2010

Mauka Matchmakers

By Dan Adamski

DEEP IN THE O'ahu wet forest, along gulch bottoms and steep slopes, hides the endangered Kāmakahala, scientifically known as *Labordia cyrtandrae*. These shrubs are endemic to O'ahu and were once known throughout the Ko'olau Mountains and at Ka'ala in the Wai'anae Mountains. Today across the entire world, only one plant in the Ko'olaus and a mere 72 others on the slopes of Ka'ala survive in the wild.

There are many threats to the survival of these few remaining wild plants including: habitat degradation from weed encroachment, wild pig and goat predation, and the loss of pollinators.

The O'ahu Army Natural Resources Program (OANRP) works to neutralize these threats in a number of ways. Staff and volunteer groups spend much of their time killing invasive weeds such as strawberry guava, kahili ginger, Christmas berry and blackberry. Additionally, OANRP staff constructs fences to exclude wild pigs and goats, allowing regeneration of native habitat.

Male flowers ready for pollen collection, *above*; and a female flower, just pollinated, *below*. (Photos by OANRP staff)

For Kāmakahala, male and female flowers are found on separate plants. Because very few individual plants remain, it is rare to find both a male and female plant in close proximity to one another.

Additionally, its natural pollinator is unknown. Uncertainty surrounds whether Kāmakahala is pollinated by a bird or an insect, if the pollinator is even still present in the wild, and if enough blooming flowers are available to attract it.

These factors make natural pollination difficult. In order to protect this endangered species, OANRP staff steps in as "matchmakers," helping the Kāmakahala produce fruit and seeds that may one day return to the slopes of Ka'ala.

The Kāmakahala flowers from May through June, during which time the plants are closely monitored by OANRP staff. As the male flowers open, the staff collects pollen. This gathered pollen is then stored in a thermos to ensure freshness and carried to female plants, where the matchmaking begins. Using a small paintbrush, the pollen from the male plants is transferred to the flowers on the female plants in a process known as "hand-pollination."

Kāmakahala growing on steep slopes in the wet forest of Ka'ala. (Photo by OANRP staff)

Inside this issue:

Sample of an EMP Bulletin from the Summer edition, 2010.

APPENDIX 1-2: TARGET SPECIES FORM

Target Species Form

DATA ENTRY (initial, date) GIS: Database: Filed:

Observers ____________________

Date found ____________________

Target species ____________________

MU ____________________

Found in which WCA/ICA/none: ____________________

GPS **YES/NO** ____________________

Directions to area: ____________________

Sketch map:

\# Plants/Status ____________________

Mature: ____________________

Immature: ____________________

Seedlings: ____________________

Resprouts: ____________________

Control Performed **YES/NO** ____________________

Comments ____________________

Management Recommendation ____________________

Research Needed/done ____________________

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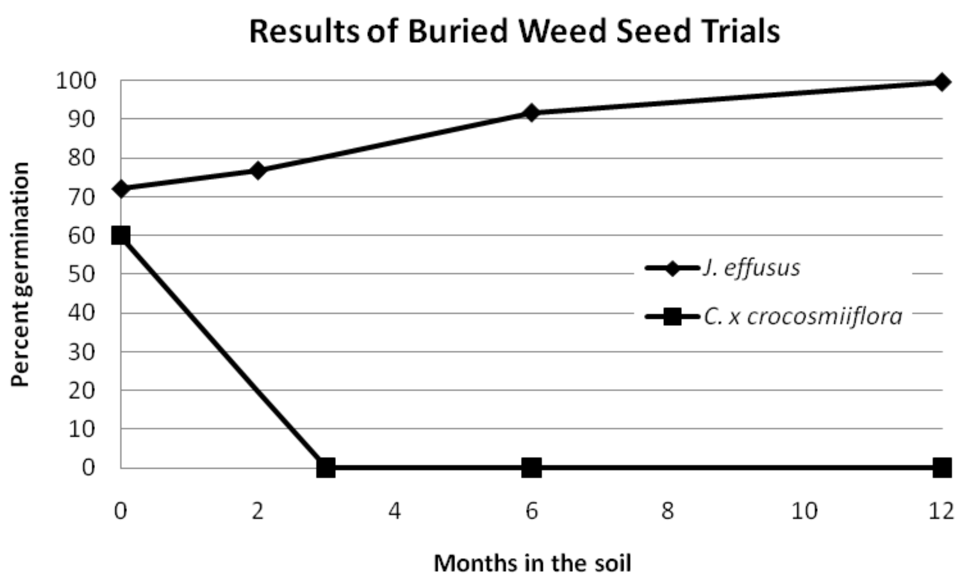
APPENDIX 1-3: DETERMINING SOIL SEED BANK PERSISTENCE FOR INCIPIENT WEED SPECIES

For many of the invasive weed species on Oahu there are gaps in basic biological information that would assist with management strategies. OANRP would like to incorporate seed biology into their ecosystem management program. In order to determine how often a site should be inspected for regeneration after removal of an incipient weed species, it would be beneficial to know whether or not a species can form a persistent soil seed bank and for how long. For two incipient weed species, *Juncus effusus* L. (Juncaceae) and *Crocosmia* x *crocosmiiflora* (Lemoine) N.E.Br. (Iridaceae), buried seed sow trials were conducted to determine their soil seed banking potential. Seeds of these species were buried in the soil in cloth packets at the field sites from which they were collected. *J. effuses* was collected and buried at Kaala and *C.* x *crocosmiiflora* was collected and buried at Palikea. Initial viability assessments were also conducted. The seed packets were retrieved after certain intervals of time and the viability of the seeds were assessed and compared to the initial viability. Trials for both of these species are still ongoing, but the first year of data is presented below. Based on definitions identified in Thompson & Grime (1979), it appears that *C.* x *crocosmiiflora* does not have the potential to form even a transient seedbank (< 1 year). All seeds were dead after only three months in the soil. Conversely, germination rates of *J. effusus* increased after a year in the soil. Since seeds remain viable after one year, this species forms a persistent seedbank. Seeds will continue to be retrieved once a year for four more years. Preliminary results suggest that sites where *C.* x *crocosmiiflora* has been removed should be re-visited once within the following year for regeneration prior to declaring the area free of this incipient. For *J. effusus*, it is likely that regeneration will continue for years following removal of mature plants. Sites will likely need to be re-visited for at least several years after clearing for recruitment. Additional incipient weed species for which soil persistence is not known may be added to this project in the future.



Thompson, K. & J.P. Grime. 1979. Seasonal variation in the seed banks of herbaceous species in ten contrasting habitats. *Journal of Applied Ecology* 67: 893-921.

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APPENDIX 1-4: SPHAGNUM CONTROL PLAN FOR KAALA MU

Sphagnum Control Plan for Kaʻala MU

Date: Oct. 12, 2010

Background and Goals

Goal:

1. Eradicate all *Sphagnum palustre* (sphagnum) from the Army half of the MU (south and east of the boardwalk).
2. In collaboration with the State, eradicate all sphagnum from the boardwalk corridor (buffer of 1-2m on either side of the boardwalk, 4m max total)
3. Provide assistance to the State in treating sphagnum on the NARS half of the MU, as requested.

General Sphagnum Information:
The high level of expertise required for bryophyte identification has meant that invasive mosses have been given little attention in Hawaii. Sphagnum, a bog moss, was purposely introduced to the Kaala Natural Area Reserve (NAR) on Oahu in the 1960's (Hoe 1973) from Hamakua, Hawaii, where it is thought to be indigenous (Hotchkiss *et al.* 2002). Though sphagnum on Oahu cannot produce spores, it does spread vegetatively and an eightfold increase in the size of the core infestation has been observed over the last 12 years. In early 2009, OARNP estimated that sphagnum occupied an area of 1.25 ha (3ac). This is a very rough estimate, as OARNP did not measure the perimeter of the infestation, but observed that it did not appear to extend beyond 30m of the boardwalk on the Army side, and assumed that sphagnum acreage on the State side of the boardwalk mirrored that seen on the Army side.

Sphagnum impacts in Hawaii are not well documented; nonetheless, bryologists consider it a threat to endemic bryophytes and speculate it may prevent regeneration of native species, such as the endemic tree *Metrosideros polymorpha* (Waite 2007). Results of a formal Weed Risk Assessment following the model developed by Daehler and Denslow (2007) demonstrate sphagnum is “likely to be invasive in Hawaii and on other Pacific Islands” (Clifford and Chimera 2009). Elsewhere, sphagnum species are known to strongly modify their habitat. Sphagnum has morphological attributes which favor the formation of highly-saturated, heat-retaining, nutrient-poor, acidic soils (aka, bog soils). These conditions enhance their growth at the expense of vascular plant growth (van Breeman 1995).

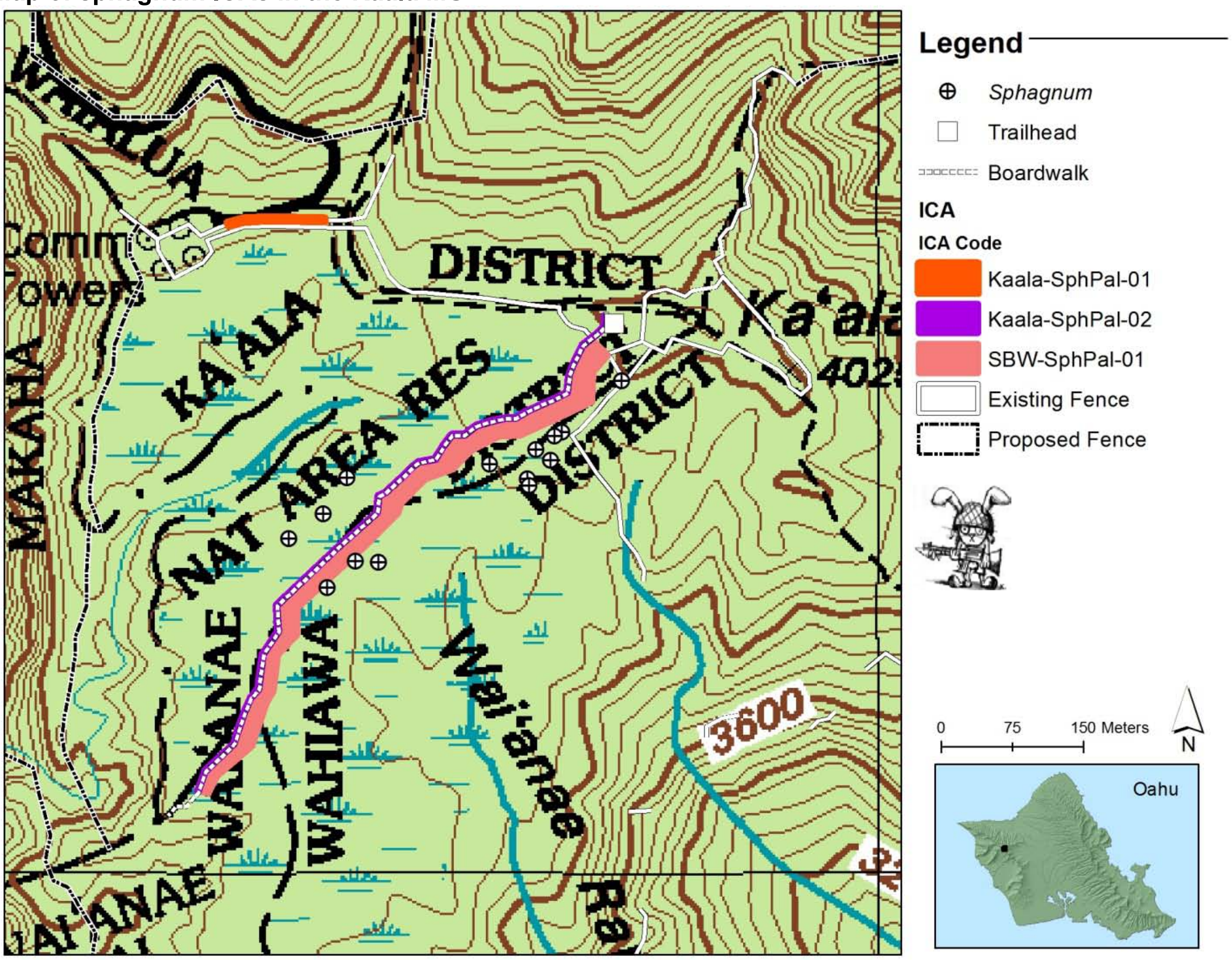
The presence of sphagnum along the boardwalk at Kaala complicates other weed control efforts. It can be spread vegetatively, via bits of moss clinging to footwear and field gear. OANRP staff avoid walking through sphagnum while conducting Weed Control Area (WCA) sweeps for *Hedychium gardnerianum* (kahili ginger). This has hampered kahili ginger control efforts on both the Army and State sides of the boardwalk. Trials conducted by OANRP in 2009 (Joe *et al.* 2009) suggest that sphagnum can be effectively controlled with St. Gabriel’s moss killer (St. Gabriel Laboratories; Orange, VA). This non-toxic product contains clove oil as its active ingredient and was chosen for testing after its recommendation to OANRP by the Pesticides branch of the Hawaii Dept. of Agriculture (HDOA) (L. Kobashigawa 2008). Trials begun in 2008 (still ongoing) indicate that sphagnum is highly susceptible to St. Gabriel’s moss killer, and there appear to be few non-target effects. St. Gabriel’s appears to be the most efficient method of controlling sphagnum, compared to manual control, physical control, and other chemical control (prohibitive restrictions on other chemical products). Sphagnum control will reduce the potential for staff and volunteers to act as vectors for this weed, and will allow for more efficient and effective WCA sweeps.

Strategy:
The basic strategy to control sphagnum at Kaala is straightforward. We will focus efforts on the Army side of the boardwalk, and work to eradicate all sphagnum from this area, starting first with the boardwalk corridor. Much of the boardwalk corridor has already been sprayed, and efforts will now expand beyond the boardwalk. We estimate the size of the infestation on the Army side of the boardwalk to be around 1.5 acres, but more accurate maps/estimates are needed. Accurate maps will aid in further strategy planning. Initial treatment will require a large effort, but given the results of trials with St. Gabriel’s, we hope to see good control. Follow-up will be conducted to treat areas missed and any re-growth. Since it does not produce spores, once all green plants are dead, it is unlikely to return. Given that extensive trials have already been conducted by the OANRP

Research Specialist, detailed monitoring work is not required. However, photopoints will be installed as a low effort method to track change over time.

In addition to working on the Army portions of the MU, we will also assist the State in controlling sphagnum on the western portion of the MU. So far, they have asked for our assistance in controlling a satellite population on the radio tower road, and have requested that we spray the boardwalk corridor on the state side. At the radio tower site, we handpulled and bagged all the sphagnum we could, then sprayed the area with St. Gabriel's. This was effective and follow-up monitoring/control will be done. We have not begun control on the State side of the boardwalk corridor; we plan to start in the 2010-2011 report year.

Map of sphagnum ICAs in the Kaala MU



Action IDs:

Record all time spent controlling sphagnum using the action IDs in the table below. There are 3 sphagnum ICAs at Kaala.

- SBW-SphPal-01 = all sphagnum on Army side of boardwalk
- Kaala-SphPal-01 = sphagnum along the Radio Tower Road
- Kaala-SphPal-02 = sphagnum along the boardwalk corridor, on the State side.

Action ID	Category	Category Priority	ICA	Location	Action Comments
5522	W	W1	SBW-SphPal-01	boardwalk	Survey extent of Sphpal infestation on Army side of boardwalk. Create GIS map of infestation area, and any satellites.
5523	W	W1	SBW-SphPal-01	boardwalk	Install and take photopoints in the Sphpal infestation.
5559	W	W1	SBW-SphPal-01	boardwalk	Install management trails running roughly perpendicular to the boardwalk, 140°, every 5m, across the length and width of the infestation.
5339	O	W1	SBW-SphPal-01	boardwalk	Control Sphpal along boardwalk, on Army side of MU. Spray with St. Gabriel's moss killer. Exercise care to prevent the spread of Sphpal via footwear or gear. Do NOT spray any flagged plots, unless cleared by Research Specialist.
5524	W	W1	Kaala -SphPal-02	boardwalk	Control Sphpal along boardwalk, on State side of MU. Control only in boardwalk corridor, (1-2m from boardwalk). Spray with St. Gabriel's moss killer. Exercise care to prevent the spread of Sphpal via footwear or gear.
4794	O	W1	Kaala-SphPal-01	Radio Tower Road	Monitor/control sphagnum along radio tower road. Communicate with State about work at this site. Utilize handpulling and St. Gabriel's moss killer for control.

Treatment Protocol

Gear checklist:
- Enough sprayers for the work crew. For volunteer groups, 1.5gal or 3gal sprayers are appropriate. Staff may choose to use 5gal sprayers. Inspect sprayers for contamination and for leaks. Bring spare parts and repair tools. Sprayers should be clean and free of pesticide residue, as there are many native species within the sphagnum infestation area, and non-target impact should be eliminated. Use gear dedicated to St. Gabriel's.
- Spare herbicide (St. Gabriel's), Turf Mark and water.
- Graduated cylinder or other measuring tool, funnels
- Buckets and water filters.
- Secondary containment to avoid surface water contamination.
- Spill clean-up supplies and watertight bags and containers as needed.
- Equipment clean-up bins and simple green
- Hip chain and spare line
- Compasses
- GPS unit and spare batteries
- Spare pairs of nitrile gloves and safety glasses
- Pink, blue, and orange flagging for marking new sphagnum populations
- PPE (nitrile gloves, eye protection, long sleeve shirts), Rain Gear

Sanitation Practices:
One careless person could do a lot of harm to the bog by casually strolling around with sphagnum contaminated shoes. Teach all volunteers and staff how to clean their sphagnum contaminated footwear and gear. Emphasize the importance of not spreading sphagnum during the workday brief.

1. Whenever possible, do not place gear or packs (especially items with fabric) onto sphagnum beds. Cloth items are more difficult to clean than metal or plastic items. Hang packs in trees.
2. Do not walk from a sphagnum contaminated area into an uncontaminated area. Operations shall be run such that once a group works in a sphagnum area, they do not enter uncontaminated areas.
3. Sphagnum lines the boardwalk. Avoid stepping on the sphagnum as much as possible. Check footwear for bits of sphagnum before stepping off the boardwalk into uncontaminated areas.
4. Check each other's shoes and gear for bits of sphagnum. It results in more thorough cleaning.
5. Before leaving Kaala, shake all excess sphagnum off of shoes. Hose off shoes thoroughly at the baseyards, where sphagnum is unlikely to grow, and where staff can monitor wash off areas regularly for weeds.
6. Wipe off all equipment (bottom of backpack or pump sprayers).
7. Do not take sphagnum home for personal use.

Mixing and Use of Herbicide:
The application rate for St. Gabriel's is a liter of solution applied to a square meter of sphagnum. The solution is prepared by diluting 100mL of concentrate to a liter in water and adding10mL of blue Turf Mark. This is a 10% solution or 100mL of concentrate applied per square meter. To mix 20L (approximately five gallons, the volume of a large backpack sprayer) add 2000mL to 18L. The St. Gabriel's concentrate should be shaken well prior to mixing, and the solution must be agitated during spraying.

The St. Gabriel's concentrate is itself a mixture of ingredients. The label details the proportions and the user should become familiar with the label before using the product. The main active ingredient is oil of clove and it has a strong smell. Handle it with care. Please see Safety Precautions, below, for more information. Required PPE includes: protective eyewear, long-sleeved shirt and long pants, waterproof gloves, and shoes with socks.

Spray Logistics:
Use a copy of the last weed form to orient you for your day's work. In general, work from the western end of the boardwalk, at one extreme end of the ICA, back along the boardwalk to the trailhead. The infestation is less dense in the west, and more dense in the east. By working from west to east, the potential for spreading sphagnum to uncontaminated or already treated areas is reduced. Use the transects installed through the infestation in SBW-SphPal-01 to guide volunteers and staff in applying the correct volume to the correct area. This is critical, as a certain volume over a certain area is necessary to deliver the correct amount of active ingredient to the sphagnum. The transects are 5m apart. A 1.5gal (5.7L) sprayer will cover a band 5m long by 1m wide, a 3gal (11L) sprayer will cover a band 5m long by 2m wide, and a 5gal (19L) sprayer will cover a band 5m long by 4m wide. Spray in bands parallel to the boardwalk until the edge of the infestation is reached. Working in this measured manner will also help to track the % cover of sphagnum across the treated area (see Data Tracking, below).

St. Gabriel's does not translocate well; thorough coverage of moss is required for thorough control. Applicators should seek to maximize coverage by clearing leaf litter from moss.

Small satellite populations should be treated separately by personnel with clean footwear so that small sphagnum propagules are not spread into uncontaminated areas.

Volunteer Considerations
When conducting sphagnum sprays (as described above) with volunteer groups, special considerations apply. Limit groups to 5 or fewer volunteers. Only invite experienced volunteers, those with abilities you trust, on sphagnum control trips. Volunteers must be to follow direction well, be diligent in sanitation inspections, and be careful when handling herbicides. The pre-work briefing should emphasize the following:

- Sanitation concerns outlined above.
- Reduce trampling of native vegetation when walking off the boardwalk.
- Safe St. Gabriel's handling.
- Avoid spraying of native plants.
- Proper rate of spray.
- Demonstrate proper spray technique to the group to achieve good coverage.

With volunteer groups working directly along the boardwalk, group size does not need to be so limited, but the pre-work briefing should emphasize the same points.

Mapping and Orienting Methods:
Staff/volunteers should be assigned to specific transects at the beginning of the work day. Each person should keep track of his/her area sprayed and quantity sprayed. If the infestation is particularly wide, multiple people may be assigned to the same transects. When the edge of the infestation is reached, all personnel should walk make sure that they do not walk in the uncontaminated area. At the end of the day, the entire area sprayed should be marked with a GPS.

Herbicide Application Methods:
Spray the St.Gabriel's solution (with Turf Mark dye) liberally on the surface of the moss. The 10% solution should be applied to the moss at the rate of 1L per square meter. Clear away dead leaves or debris prior to spraying, to ensure complete coverage. Use a coarse adjustment of the spray nozzle. Move the wand slowly

over the treatment area, ensuring that the application rate of 1L of solution per $1m^2$ is met. Trials indicate that this herbicide is somewhat selective, and has a greater effect on moss than native trees and shrubs. St. Gabriel's can burn leaves of native plants, although these effects are not fatal. Exercise care when spraying and avoid drenching native flora wherever possible. The blue Turf Mark dye will indicate where the herbicide has been applied.

On the left, sphagnum treated with St. Gabriel's (blue). On the right, untreated sphagnum.

Water Resources

Because the application rate is a liter of solution per square meter of sphagnum, a lot of solution must be mixed and transported to the application area. For example, a 5gal (20L) sprayer holds only enough solution to treat a rectangular area two meters wide by ten meters long. A worker would need to make frequent trips back to a water source to refill a tank sprayer. Herbicide should be mixed at designated staging areas near water resources. Always mix using secondary containment and do not contaminate surface water. Have spill clean-up supplies available for use in the event of an accidental spill. The following are options for efficient staging of water/mixing stations:

1. Water may be driven up to the Kaala parking site, and mixing and sprayer filling conducted in the parking area or LZ. Army Wildland Fire may be able to assist with this.
2. Water may be pumped from the parking site to a tank placed at some distance out on the boardwalk, closer to the treatment area. This might be accomplished using the pump and hoses from the power herbicide sprayer set-up. This gear must be cleaned thoroughly before being used at Kaala; ideally, only non-pesticide contaminated hoses would be used, but this may not be feasible. Water can then be pumped into sprayers with the gas-powered pump. If a tank is elevated a meter or more, then gravity feed from the drain assembly becomes feasible.
3. A raised, semi-permanent catchment could be set-up at the boardwalk trailhead, just inside the gate in an open grassy area on the Army side, eliminating the need to drive water up the Kaala Road.
4. Staff may mix a full 125-gallon tank of solution for dispensing into sprayers. The solution can be mixed in the tank and dispensed with the pump into the sprayers. If a full tank is mixed, it must be properly agitated to maintain a uniform concentration of solution. A tank of this size would treat $470m^2$ of sphagnum. Mixed solution should be used within 3 days of mixing.
5. While there is some surface water available, there are concerns that water from either of the two known sites could contain weed seeds (*Juncus effusus, Rubus argutus*). Surface water should not be used at the current time.

Whenever the power pump and hoses are used they must be tended and operated by experienced staff. Each of the above options has benefits and potential problems. The project coordinator needs to judge which alternative best fits the project's goals and available resources. Manual methods are more labor intensive but rely less upon heavy equipment. On the other hand power equipment can reduce labor needs but the use of pumps tanks and hoses can also be more prone to failure and technical difficulty.

Satellite Populations:
Sphagnum spreads vegetatively from small pieces stuck on shoes. To prevent the expansion of the sphagnum zone do not walk into uncontaminated areas while doing sphagnum sweeps. When possible, avoid walking from a sphagnum infested area, across a native area, to treat adjacent satellite clumps of moss. Use a directed stream to reach the satellite, if reachable. Otherwise, a separate operation to treat satellite clumps can be undertaken at a later date by personnel with clean boots.

Mark and report new sphagnum:
If you find any new small satellite populations of sphagnum, please flag them well with triple blue and pink and orange flagging and GPS for future treatment.

Data Tracking:
Although sphagnum is treated as an ICA on the Army side of Kaala, the infestation is large enough to make GPS tracking of area treated necessary. Always GPS the area treated. Record the boardwalk stations where sweeps started and ended on the Weed Control Effort Form (WCEF), and fill out the WCEF completely.

For ICAs, the WCEF asks for the number of mature, immature, and seedling individuals treated. This does not make sense with sphagnum, which spreads vegetatively and does not have individual plants. The purpose of tracking the number of individuals treated is to show whether numbers are increasing or decreasing with control, aka, to track success. So, instead, as a substitute for numbers of plants, record the coverage of sphagnum in each meter squared treated. Use the following coverage categories:

- 100% live sphagnum (1x1m)
- 50% or more live sphagnum (1mx50cm)
- 25% or more live sphagnum (50cmx50cm)
- 1% or more live sphagnum (2cmx 50cm, or 25cmx4cm, or 10cmx10cm)
- 0% live sphagnum

Use whichever category is closest to what you see. Note that a 5 gallon sprayer holds 19 liters, so spraying one full tank will cover about 20m², and require 20 coverage estimates. Don't worry about getting too exact; this is just a way to track sphagnum death at a macro-scale. Record this information in the comments portion of the WCEF. For all initial control work, sphagnum cover will likely be 100% across all areas.

Example of recording coverage, during initial control:

> Comments:
> Spraying went well today, all volunteers took their time to soak their designated areas and get all active ingredient on the defined area of sphagnum. We sprayed 40 gal, or 160L, and gpsed the area we sprayed. All of this area was completely covered in sphagnum.
>
> 100% live sphagnum = 160m²

Example of recording coverage, during follow-up control:

> Comments:
> All of area we sprayed today had very little live sphagnum. Looks like previous spray very effective, except between transects 17 and 18, where LA found a patch of sphagnum that was covered by fallen leaves, looks like didn't get sprayed last time. GPSed area treated, estimated it was about 300m², based on transects.
>
> We estimate ~
> 25% or more live sphagnum = 1m²
> 1% or more live sphagnum =290m²
> 0% live sphagnum = 9m²

Safety Precautions

Personal Protective Equipment (PPE): The St. Gabriel's Label does not specify any required PPE. However, the MSDS does state that the following PPE be worn during mixing and application: long sleeve shirt, long pants, shoes plus socks, gloves (neoprene, nitrile, or oil/solvent resistant), and eye protection.

General Precautions: Eye protection is required to avoid eye injuries in heavy brush. Blackberry(*Rubus argutus*) thickets are difficult to work in without thick protective clothing. Give first aid as needed to prevent scratches and wounds from later infections. Glove liners like leather or cotton gloves can be worn under chemical resistant gloves if desired. Any damaged nitrile gloves should be replaced immediately to avoid chemical exposure. Any chemical should be handled with caution. Reduce worker's exposure by spraying well away from your eyes and face and by setting the spray droplet size to avoid fine airborne mists. When spraying with a backpack in a sweep formation, stagger staff so that each is ahead or behind of his/her neighbor and not in a straight line, within range of accidental overspray from a neighbor.

Chemical Safety:
The Material Safety Data Sheet is available in a binder in the truck for any worker or volunteer to see. You can see in the MSDS and Label what the signs and symptoms of acute exposure are and what first aid measures should be. Clove oil and other ingredients are present in this herbicide. Although they are not usually considered hazardous to humans, they are concentrated, so avoid contact and handle carefully. This product is corrosive, and may cause eye damage. St. Gabriel's is harmful when ingested or absorbed through the skin. Report any exposure to the field supervisor. Consult the MSDS and Label for information about first aid and accidental spills. Wash off skin with lots of soap and water. Flush eyes with water for 15min and consult a doctor.

Snares and Pigs:
We are actively snaring and trapping along the blue transect. Have folks watch out for the snares and not trip them (marked with orange flagging) on the blue transect. No snares are near the boardwalk or near the sphagnum infestation. In the unlikely event a pig is seen, stay well away from it.

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APPENDIX 1-5: SUMMER 2010 *PSIDIUM CATTLEIANUM* CONTROL AT KAHANAHAIKI: CLEARCUT AND CHIPPER PROJECT

Summer 2010 *Psidium cattleianum* Control at Kahanahaiki: Clearcut and Chipper Project

Background

Site Description:
Maile Flats encompasses the southern end of the Kahanahaiki exclosure. Located at the head of the Kahanahaiki sub-valley within Makua Valley, Maile Flats has gentle topography. The area slopes from south to north, from the top-most part of C-ridge to waterfalls dividing the Flats from Kahanahaiki gulch proper. There are two small, north-south running gulches in Maile Flats, which become increasing shallow to the south, until they are small depressions. The southern end of Maile Flats has large patches of native-dominated, diverse, mesic forest. The northern end of Maile Flats is more weedy, with large stands of dense *P. cattleianum* monocultures in the area between the two gulches. Other major canopy weeds include *Schinus terebinthifolius* and *Grevillea robusta*. *Schinus terebinthifolius* is abundant along the fencelines dividing Maile Flats from Pahole on the east and Makua on the west. The Maile Flats area is divided into six Weed Control Areas (WCAs). The boundaries of these WCAs are delineated by fences and three access trails; the orange trail runs north/south, and bisects Maile Flats. The pink and blue trails run east/west, cutting the area into six similarly shaped parts. There are several rare plant sites in Maile Flats; most are reintroductions. At the northern tip of Maile Flats is a wild *Cenchrus agrimonioides* var. *agrimonioides* site, and on the west fenceline is a large *C. agrimonioides* reintroduction. Additional *C. agrimonioides* have been found on trails, likely dispersed accidentally by staff or perhaps Erckel's francolins (*Francolinus erckelli*). In the western gulch, there is a *Cyanea superba* subsp. *superba* reintroduction; in the eastern gulch are reintroductions of *Schiedea nuttalii* and *Schiedea obovata*. There is a large population of *Achatinella mustelina* in Maile Flats. Snail abundance is highest on the eastern and western perimeters of Maile Flats, but snails have been seen across all of the southern Flats.

***Psidium cattleianum*:**
P. cattleianum is the dominant weed in Kahanahaiki. It forms dense monocultures, grows quickly, has allelopathic properties, has delicious bird-dispersed fruit, and forms deep shade (PIER, 2010). Few native species thrive in *P. cattleianum* stands, and it is not appropriate habitat for rare taxa. Seeds remain viable in the soil for less than three months (Uowolo and Denslow, 2008). *P. cattleianum* is susceptible to triclopyr (Garlon 4). Staff have observed good incidence of control on *P. cattleianum* when treating lone trees or small stands. Basal bark, girdle, or cut stump applications of Garlon are all effective, although basal bark treatment is less effective on trees over 3" in diameter. Staff also observed poor control when some – but not all – *P. cattleianum* trees in large clonal stands were treated.

Weed Control:
Much weed control has been done in Maile Flats. Staff efforts focused on sweeping the southern, native portion of the area for all weeds, while volunteer trips focused on *P. cattleianum* stands in the middle of Maile Flats. Until now, southern Maile Flats has been a low priority for control, due to the *P. cattleianum* monocultures found there and low numbers of rare taxa. Vegetation monitoring of the entire Kahanahaiki exclosure in 2009 demonstrated that alien vegetation cover in the canopy was 53.4%, close to the MIP goal of 50% or less alien vegetation cover. To reach the MIP goal, weed control efforts had to be expanded into the weedier portions of the fence, such as northern Maile Flats.

Generally, OANRP prefers to reduce the amount of canopy weed cover removed at any one time so as to avoid changing light levels drastically. Large light changes can be harmful to delicate rare taxa and can promote invasion by weedy pioneers. However, given that selective *P. cattleianum* removal resulted in poor kill in monocultures, staff determined that a new strategy was needed. Trials were conducted to establish the most effective method of controlling *P. cattleianum* monocultures and watch the response of native and alien plants to the creation of light gaps in Kahanahaiki.

***P. cattleianum* Monoculture Control Trials:**
In 2002, staff installed a series of plots in Maile Flats to test control methods on *P. cattleianum* monocultures. Each plot was 20x20m, and received a different treatment, detailed in the table below.

Large Monoculture *P. cattleianum* Control Plot Description

Plot	Date Installed	Treatment
Clearcut	5/9/2002	All non-natives cut down and treated with Garlon 4. Only natives left standing.
Selective Clearcut	10/21/2002	Some non-native trees selected and treated with basal application of Garlon 4. Remaining non-native trees all cut down.
Basal	4/13/2002	All non-natives left standing and treated with a basal bark application of Garlon 4.
Selective Basal	4/13/2002	All non-natives left standing. Most treated with a basal bark application of Garlon, but some selected to remain untreated and provide a canopy.
Stripes	8/20/2002	Narrow rows of native and weedy trees alternating with wider rows of clearcut non-native trees.
Koa Canopy/ Clearcut	4/8/2002	All non-natives cut down and treated with Garlon 4. Only natives left standing
Chipper	3/6/2003	All non-natives cut down and treated with Garlon 4. Slash chipped up and left in piles.

All plots received some type of follow up weed control, but no common reintroductions were installed. No quantitative data was taken, photopoints were used, and detailed observations were taken on the following variables:

- *P. cattleianum* trees present in area.
- *P. cattleianum* seedlings
- Other weeds
- Light level
- *A. koa* seedlings
- Other native seedlings
- Native trees in area
- Overall impression

The plots were monitored for several years, with the last reading in 2007. The most effective plots were those in which all of the *P. cattleianum* was treated at one time: the Basal, Clearcut, Koa Canopy and Chipper plots. Light gaps were created in these plots, and this had a positive effect on native recruitment and health of existing native trees in the area. The one downfall of the plots using clearcutting is that huge amounts of slash were created; piles took up a large amount of the cleared area. The Chipper Plot showed that chippers could be effective in eliminating slash piles. While the Basal plot did not initially result in a large pile of slash, as trees died they fell (itself a hazard) and created a tangle of trunks which was difficult to walk through and work in and presented a safety hazard.

Large Monoculture *P. cattleianum* Control Plot Results

Plot	Results
Clearcut	Effective control of *P. cattleianum*, and few seedlings. Huge amount of *A. koa* germination/root suckers. Variety of other native species also colonizing area. Existing natives flushing. Other weeds also colonizing area, but not aggressively. Very effective.

Selective Clearcut	Effective control of *P. cattleianum*, some seedling beds. Very few *A. koa* seedlings, other native seedlings, or other weeds. Not a great treatment for fostering native growth.
Basal	Effective control of *P. cattleianum*, few seedlings. Good persistence/flushing of existing natives. Some *A. koa* germination, but not as dramatic as clearcut plot. Overall good control and good native regeneration.
Selective Basal	Very poor control. Could barely tell any control had been done at all. Very few native seedlings.
Stripes	Frustrating to track where control occurred and didn't occur. Control relatively effective, but little native regeneration. Very tedious to implement.
Koa Canopy/ Clearcut	Effective control of *P. cattleianum*. Good persistence/flushing of existing natives, but little recruitment of new native plants or weeds. Overall, control was very good, and site chosen as a potential *C. agrimonioides* outplanting location.
Chipper	Effective control of *P. cattleianum*, but hard to treat all stumps during course of initial control work and saw fair amount of re-sprouts. Slow invasion of other weed species, but eventually alien grass established aggressively. *Nephrolepis multiflora* appeared to preferentially colonize mulch pile. Moderate native recruitment, including koa. Site very hot, with a westerly aspect, not ideal for native germination. Existing natives flushed dramatically, thriving.

The Clearcut Plot and Basal Plots had particularly dramatic results, as is shown in these photopoints.

Post-Control: 2002

Post-Control: 2010

Clearcut Plot

Post-Control: 2002 Post-Control: 2010

Basal Plot

OANRP decided to pursue these two control techniques, and have implemented the basal control technique for *P. cattleianum* monocultures across Kahanahaiki. While staff and volunteer efforts in the central part of Maile Flats were effective at removing *P. cattleianum* stands using the basal technique, progress has been slow. Small 5x5m or 10x10m areas are cleared at a time. OANRP realized that without a large commitment of resources towards removing monocultures, it would be very difficult to make a major impact.

OANRP pursued clearcutting in Kahanahaiki, but determined that a more sturdy and rugged chipper was needed to make chipping of slash efficient. The chipper rented for the Chipper Plot was small, and all downed trees had to be bucked into small pieces prior to chipping. This added significantly to labor time. A sturdier chipper was purchased in February 2009.

Original chipper used in Chipper Plot

Chipper purchased by OANRP in 2009

Summer 2010 Clearcut and Chipper Project

Goal:

In Maile Flats, significantly reduce *P. cattleianum* cover and replace it with native species cover.

Strategy:

1. Cut down and chip as much *P. cattleianum* as possible, focusing effort in Maile Flats, at a location identified as having a very high density of *P. cattleianum*. Replicate the methods of the 2002 test plots on a larger scale.
2. Foster natural regeneration of common native species.
3. Supplement natural common native species recruitment as needed.
4. Conduct follow-up weed control to prevent invasion by other weeds.

Site Description:

The area chosen for chipper work is located in the core of the southern Maile Flats *P. cattleianum* stands, where the pink and orange trails meet. *P. cattleianum* stands run along the pink trail, from gulch to gulch, and spread north along the orange trail, again from gulch to gulch. While there are pockets of native forest, perhaps 5x5m^2, in the area, as well as scattered lone native trees, *P. cattleianum* dominates both the understory and the canopy. In some areas, *P. cattleianum* roots form a thick mat at the soil surface. Most of the *P. cattleianum* trees are less than 10cm in diameter, although very large individuals (25cm diameter or more) are also common. There are four WCAs in the control area, Kahanahaiki-07, -08, -09, and -10.

Maile Flats *P. cattleianum* Chipper Project Area:

Timeline:

6/01/10:	Chipper flown into Kahanahaiki. Control work commences.
6/01/10 through 7/28/10:	Monocultures cut and chipped. Photopoints installed and occasionally retaken
8/02/10 through 8/12/10:	Follow-up control
8/02/10:	*Achatinella mustelina* found in Kahanahaiki-10. 1 snail on a native tree in the chipper area. 1 empty shell, still fresh and shiny, under the chipper.
8/02/10:	Control work of large tree halts, due to snail discovery, and due to ripe *P. cattleianum* fruit seen in greater numbers on trees.
8/18/10:	Perimeter of cleared, chipped area mapped with GPS. Locations of mulch piles mapped as well.

Summary of Weed Control Effort:
The control area falls into several WCAs. Total effort (staff and volunteer time) to complete initial control is summarized in the table below. No follow-up control trips are included. Note that field hours only account for time spent weeding and running the chipper; logistical time spent planning trips, packing gear, hiking, driving, and conducting most gear maintenance is not included. Also, as several WCAs may have been weeded in one day, the totals do not sum all WCA data, but have been filtered to reflect this.

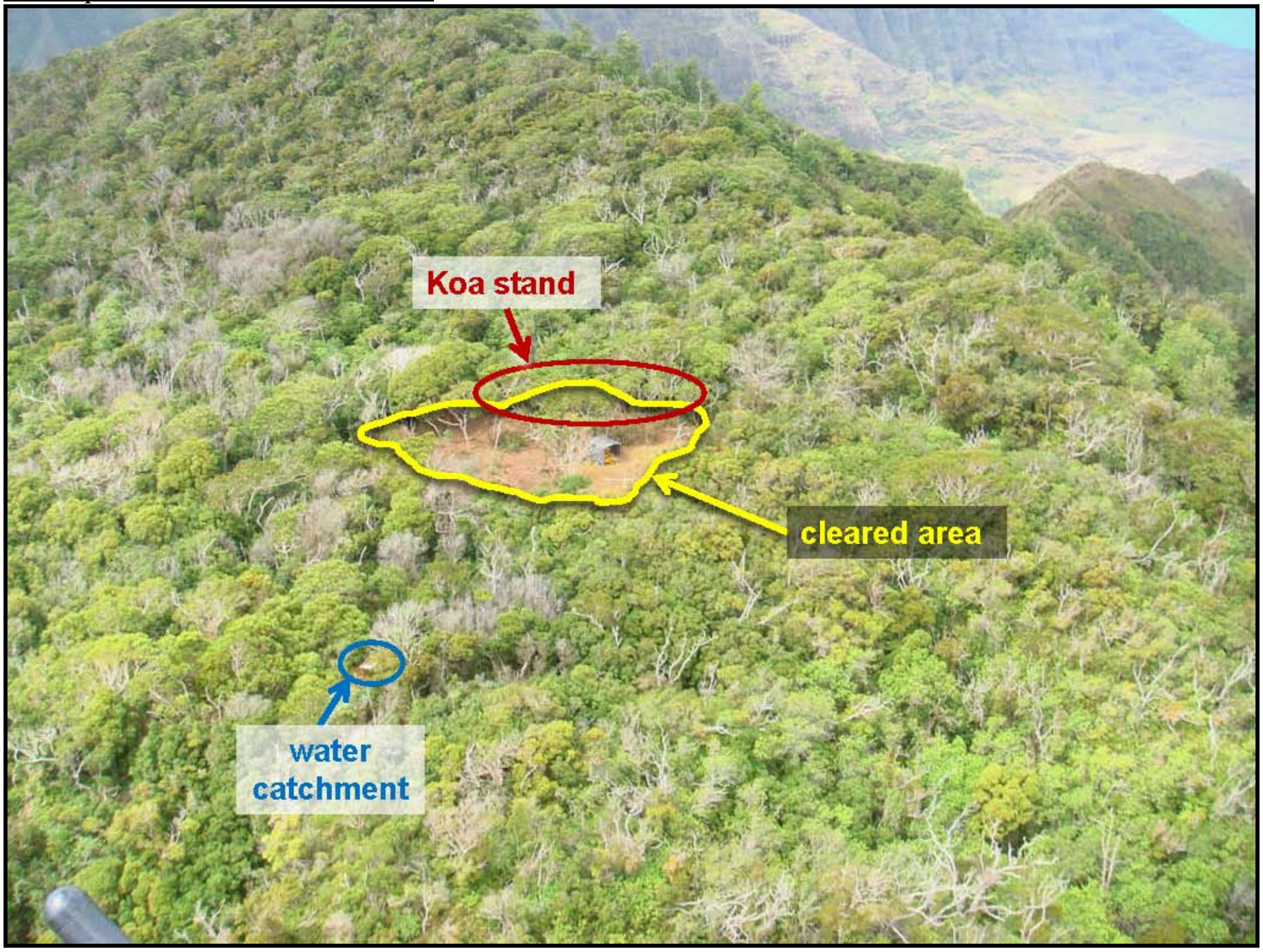
Initial Control Effort Summary:

WCA	# of visits	person hours
Kahanahaiki-07	1	7
Kahanahaiki-08	5	93.5
Kahanahaiki-09	11	756
Kahanahaiki-10	4	104
Total	**20**	**932.5**

In addition to initial control, staff visited the site three times in August to conduct follow-up control, including spraying grass and treating small *P. cattleianum*. Staff time and effort spent on this project has been significant. All field teams assisted in this project.

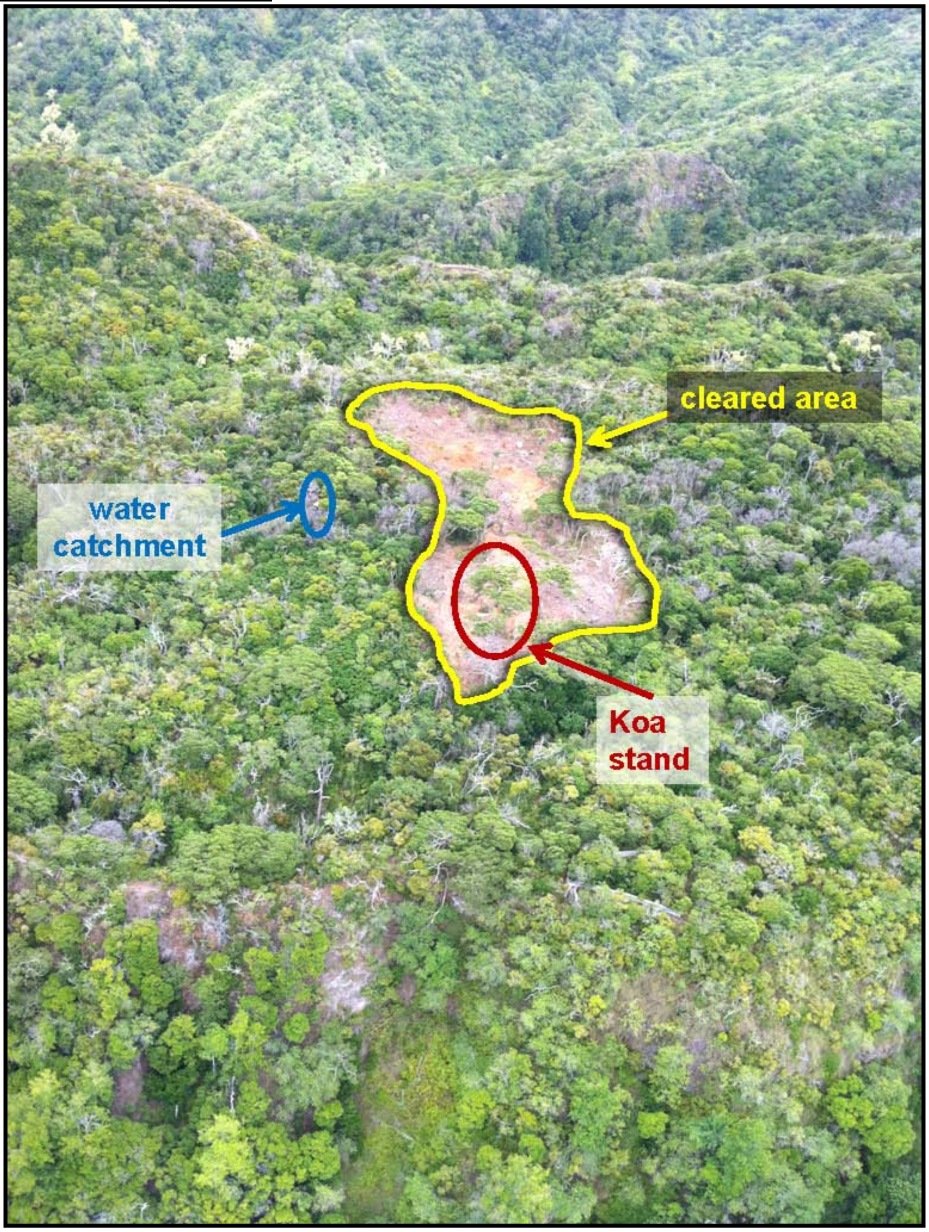
Staff cleared 0.89 acres; the control area is outlined on the Chipper Project Area map above. This is approximately 3% of the acreage of Maile Flats. However, only a small portion of Maile Flats is appropriate for this type of aggressive control. The site is now easily seen from the air.

Aerial photo of control area, 6/17/10:



This was taken after five control trips. The angle of view is towards the south.

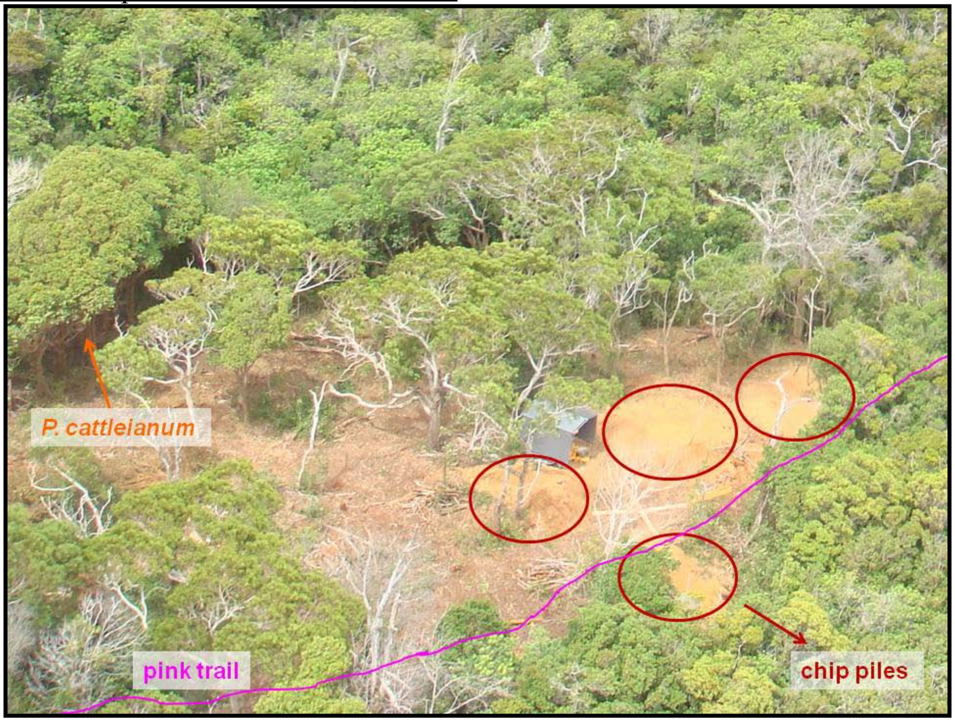
Aerial photo of control area, 8/16/10:



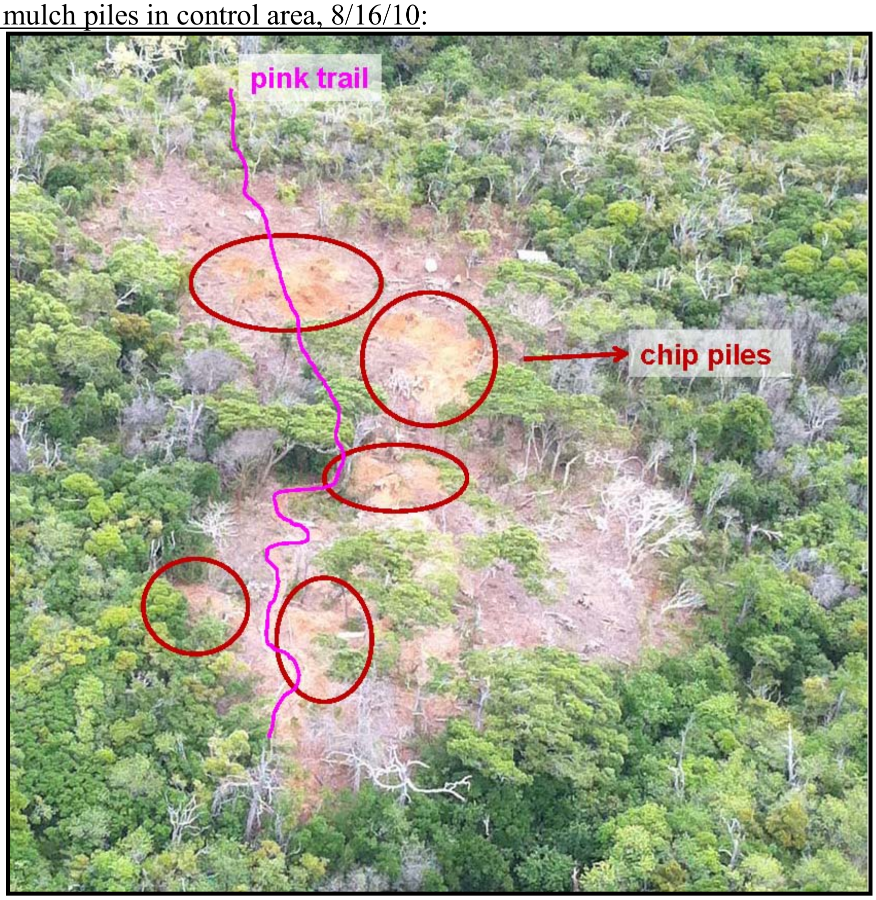
This was taken after initial control was completed for the summer. The angle of view is towards the east. Note the positions of the water catchment and a particular stand of koa trees in both photos. Also note that many large koa trees are visible in the cleared area, and that they provide a fair amount of cover. Less visible are smaller native trees which were also uncovered, particularly *Pouteria sandwicensis* and *Psydrax odoratum*.

Large mulch piles dot the control area. Staff were concerned that these could potentially catch fire, as this has happened at urban gardens in Hawaii in the past. Therefore, staff limited the size of any one mulch pile. Some thought was given as to whether it was better to spread out the mulch in a thin layer across the control area, or leave it piles. Eventually, it was decided that leaving it in discrete piles would keep more ground open for recruitment of *A. koa*. The mulch piles may also end up suppressing some weeds while favoring others. In the Chipper Plot from the original control trials, *Nephrolepis multiflora* only colonized mulch piles. However, this taxon is not limited to mulch piles elsewhere in Kahanahaiki.

Aerial photo of mulch piles in control area, 6/17/10:



Aerial photo of mulch piles in control area, 8/16/10:



Monitoring:
Given that other plots have been installed in the past to look at the effects of clearcutting *P. cattleianum*, it was decided to only use photopoints to track change in the control area. However, a MU vegetation monitoring transect does cut across the control area, and data from the transect could be analyzed to get more in depth information about vegetation cover changes.

Photopoints were installed across the control area. Some were part of the original 2002 plots, and some are new. Each phtpoint is marked by a PVC pole with a metal tag. At each pole, photos were taken to the north (0°), east (90°), south (180°), and west (270°), using a compass. These photos show the dramatic change which has already taken place in the control area; see below. Photopoints will be re-taken at regular intervals over the coming years. Also, staff will observe the height and size of the mulch piles, to get some general information on how quickly they decompose.

Pre-Clearing: 6/01/10 Post-Clearing: 7/01/10


Photopoint PC01, bearing 90°


Photopoint PC01, bearing 180°

Pre-Clearing: 6/01/10 Post-Clearing: 7/01/10


Photopoint PC02, bearing 180°


Photopoint PC02, bearing 270°

Next Steps:

OANRP must determine whether or not to conduct more clearcut/chipping in Maile Flats. In September, staff will conduct a site visit to Maile Flats and scope out any remaining stands of *P. cattleianum* which are big enough to merit the use of the chipper. If any are found, staff will decide whether the chipper can be moved to those sites on the ground (without harming native vegetation), or whether aerial assistance is required. Moving the chipper requires the use of a Huey helicopter; this is extremely expensive, as the Huey is $2,950/hour (with tax) and is stationed on Maui, requiring OANRP to pay ferry time (45min one way). Staff will also conduct required servicing of the chipper.

Follow-up weed control and regular monitoring of the control area is vital. Actions are detailed in the table below. Note that all actions will take place in each of the WCAs in the chipper control area. Actions with an asterisk may be conducted with the help of the outreach program.

Chipper Project Area Actions:

Action	MIP Year 7 Oct 2010-Sept 2011				MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept 2013				MIP Year 10 Oct 2013-Sept 2014				MIP Year 11 Oct 2014-Sept 2015			
	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Scope Maile Flats for additional chipper work. Make a decision on whether chipper work continues.	X																			
*Control Psicat monocultures using chainsaw/chipper method. Target large stands where can operate and pull chipper. Chipper not appropriate for small (less than 5x5m) stands, and most effective in large stands. Control all appropriate stands once. Control at least 3 months after peak fruiting.						X	X			X	X									
Take photopoints in chipper area quarterly for the first year, then every 6 months. If need to install additional photopoints, do so prior to chipper destruction. Note height/size of mulch piles at the same time.	X	X	X	X		X		X		X		X		X		X		X		X
Control weedy grasses across chipper control area quarterly, or as needed	X	X	X	X	X	X	X	X												
*Sweep chipper control area for woody weeds every 6 months, or as needed. Target Psicat, Monhib. Spray Psicat seedling beds.	X		X		X		X		X		X		X		X		X		X	
*Conduct BidTor seed sows across chipper control area.	X	X			X	X			X	X										
Evaluate need for common native reintroductions after the 2010 winter; dependant on level of natural recruitment, esp. of koa.		X	X	X																
*Install/monitor seed sow trials of Nessan (snail habitat)		X		X		X		X												
*Install /monitor seed sow trials of Myrles (snail habitat)		X		X		X		X												
*Install/monitor seed sow trials of Pissan (snail habitat)		X		X		X		X												
*Reintroduce snail habitat trees, if not recruiting on own. Transplant or outplant.									X	X			X	X			X	X		

Efficacy Evaluation

The level of effort required to control this area with the clearcut/chipper technique is high. In part, this is due to the density of weeds. Also, it is due to the technique: chainsawing trees, hauling slash to the chipper and mulching the slash requires more time than killing trees in place. The 2002 plots indicated that the most effective techniques for controlling *P. cattleianum* monocultures are clearcutting and basaling all plants at one time. Comparing these two techniques can't be done without taking into account the amount of follow-up required and the response of the native vegetation community. Both require follow-up. Clearcutting appeared to promote the growth of native pioneer species. Basal application is faster, but regeneration of native species happened more slowly in the plots, and fallen slash can become a safety and efficiency hazard later.

Each technique has its merits. The basal technique is better suited to forest with more of a mix of alien and native components. The clearcut technique is effective in areas with dense monocultures and nearby sources of native pioneer taxa.

In the coming year, as vegetation responses to the project occur, we will evaluate the efficacy of the clearcut/chipper technique by considering the following logistical and biological variables:

- Staff time for initial knockdown
- Staff time for follow-up
- Utility of volunteers
- Utility of temporary hire crews
- Transportation costs, including moving the chipper
- Gear costs
- Overall feasibility (how much of a hassle is it to plan?)
- Native vegetation cover response
- Alien vegetation cover response
- Changes in alien species diversity
- Evaluating habitat for rare taxa

If it is determined to be efficient, additional clearcut/chipper projects will be planned. If not, the basal technique will be applied to dense monocultures, and alternative uses for the chipper will be sought.

<u>Citations:</u>

Uowolo, Amanda L. and Denslow, Julie S. 2008. Characteristics of the *Psidium cattleianum* (Myrtaceae) Seed Bank in Hawaiian Lowland Wet Forests. *Pacific Science* vol. 62 no. 1:129-135

US Forest Service, Pacific Island Ecosystems at Risk (PIER). Hawaii Weed Risk Assessment for *Psidium cattleianum*. Daehler, C. ed. Online resource at http://www.hear.org/pier, accessed 6 Oct 2010.

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APPENDIX 1-6: HOW TO CHIPPER

HOW TO CHIPPER

Selecting a Chipper Project

Using a chipper as part of a weed control project can be very effective in getting rid of slash piles. However, using a chipper can be expensive in terms of helicopter time, gear, and personnel. All potential chipper projects and work sites should be thoroughly evaluated.

What makes an appropriate chipper project/site?

- **Weed action priority:** Is weed control in this area a weed priority 1 or 2? Will this project assist in meeting MIP alien vegetation cover goals?

- **Rare taxa considerations:** The stabilization plans for all T&E species for which the Army is required to manage, were developed pursuant to the 2003, 2007, and 2008 Oahu and Makua Biological Opinions. The USFWS determined that as a result of the Army's beneficial actions for the species, any negative impacts were far outweighed. In addition, by adopting the following listed taxa avoidance protocol, OANRP will further reduce the chances of impacts to listed species.

- **Light gap considerations:** Will the creation of a light gap increase weed, slug, arthropod, or other threat levels for rare taxa? This is difficult to know with certainty. Effects will likely vary widely by site, season, and habitat. The response of all threats to light gap creation should be observed over the course of a clearcut/chipper project. To be consistent with the MIP, threats/threat changes (such as the creation of a light gap) within 50m of rare taxa will be considered to have some type of effect on taxa, unless staff evaluation deems otherwise. Thus, additional planning is required if the chipper project area is within 50m of rare taxa. If there are specific concerns about a rare taxon and associated threat, for example, *Cyanea grimesiana* and slugs, these concerns should be addressed prior to the start of the project. For weed control threats, assume follow-up control is planned.

- **Proximity to rare plants:** Is the project site within 50m of a rare plant? Will the project change light levels at the rare plant site? Is a change in light level advised? Usually, drastic changes in light level are avoided, as sudden environmental perturbances can negatively affect rare plants. There are some exceptions, particularly *Hibiscus brackenridgii* subsp. *mokuleianus*.

- **Proximity to rare snails:** Is the project area within 50m of a rare snail site? Are snails known historically from the area? Are there recent records of snails in the area? Is the target weed used by snails? This should be considered prior to chipping operations. If there is a history of snails in the area, night surveys shall be conducted prior to bringing the chipper on-site. If snails are found, the project should be reevaluated. Options to be considered should include, moving chipping operations away from the snail area, leaving a 10m berth around any snail trees, moving snails off target weeds into native trees, conducting additional night surveys.

- **Targeted weed taxa:** Is the architecture of the targeted weed such that it will require extra bucking prior to chipping, or will it feed easily? Is the species allelopathic or clonal? Are there any aspects of the species' biology which favor (or discourage) drastic removal? Are the seeds viable over a long period? Do seeds respond/germinate in open areas?

- **Size of weed infestation:** If heli support is required to move the chipper to the work site, the targeted area should require at least 5-8 days of work to clear and chip, to justify the cost ($2,950/hour, with tax). The infestation should be as dense as possible; moving the chipper around lots of native plants is not easy and makes chipper operations less efficient.

- **Geography and topography:** The chipper weighs 2850 lbs. Work sites should be large and flat enough to allow for the chipper to be moved. On level ground, it can be moved pretty easily using straps, come-alongs, and able-bodied staff. Any kind of slope makes it much more difficult to move the chipper. In addition, the chipper cannot be operated on ascending/descending slopes greater than 25° or on side slopes greater than 17°. On any slope, no matter how slight, the chipper must be strongly secured, so as to prevent any movement during operation.

- **Expected response post-chipping:** Have trials been done to see how the area responds to the creation of large light gaps? Do native species germinate? Do weedy species germinate? Is there a way to time operations to reduce the growth of weeds?

- **Level of follow-up required:** Is intensive follow-up necessary? What weedy species are expected to invade? Is grass control required? How important is timing to follow-up weeding? Can volunteer groups be used? Should common native plantings be part of the equation?

- **Fire:** Is the focus of the project reducing overall woody fuel load? Chipping slash promotes decomposition and reduces above ground woody biomass.

- **Chips and slash:** How much slash will be created at the site? How much area will the slash cover? How long does it take for chips to decompose as opposed to whole trees? Is fast decomposition desired or not needed?

Psidium cattleianum considerations

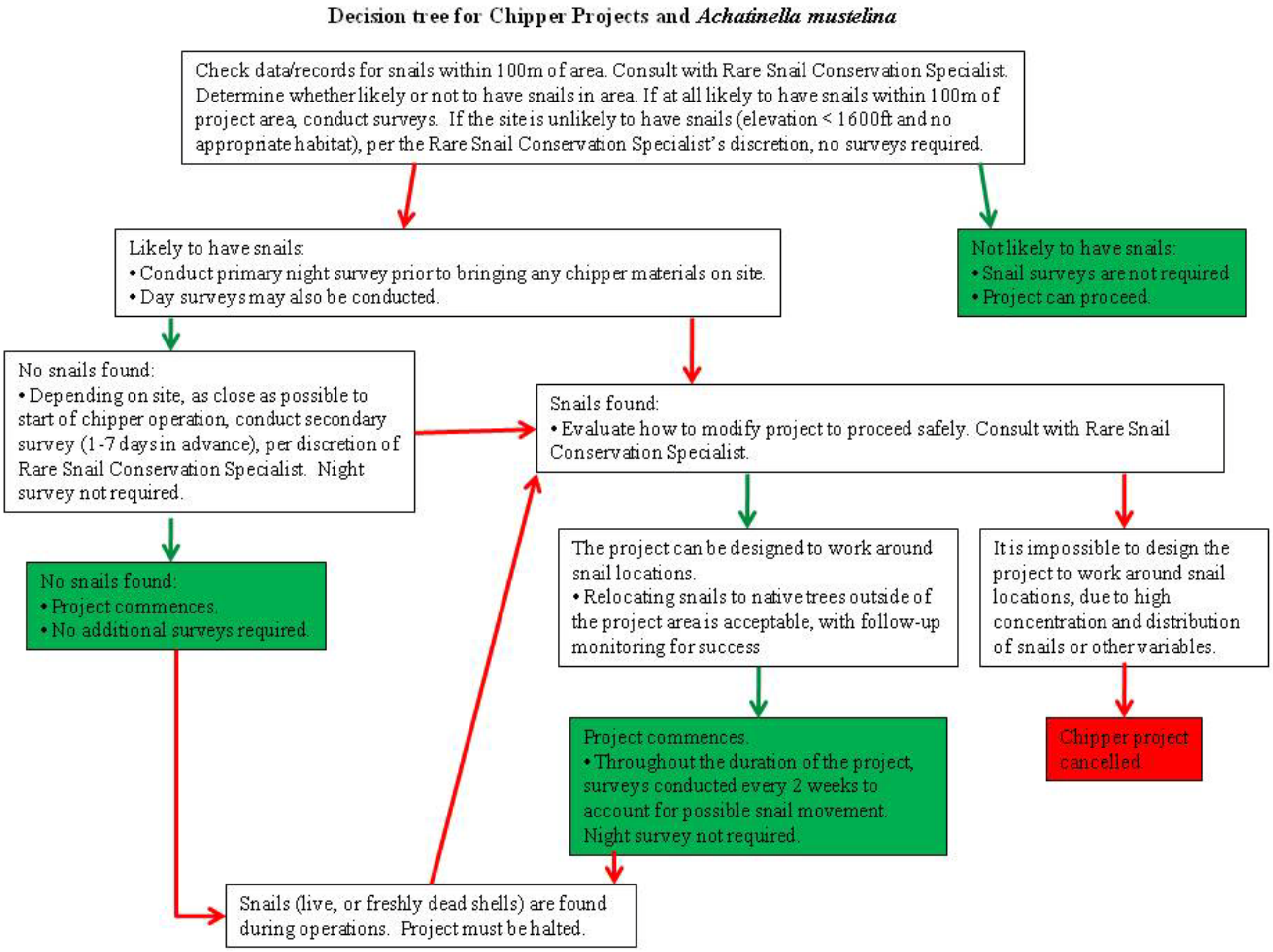
Psidium cattleianum forms dense monocultures and severely reduces biodiversity. Since multiple trees may actually be connected underground, treating the plants in just part of a dense monoculture often results in low overall mortality. Treating all of a monoculture at once often results in more effective kill. This is not the case for more widely scattered *P. cattleianum*, which tend to be separate plants.

Seedlings tend to germinate in light gaps, rather than under dense *P. cattleianum* shade. Opening up the canopy can trigger germination and result in carpets of quick-growing *P. cattleianum* seedlings. These seedling beds often necessitate backpack spraying of herbicide, and more intensive follow-up. Most *P. cattleianum* seeds in the soil are no longer viable after 3.5 months. Timing large scale weed control 3 months after peak fruiting may reduce the amount of follow up weed control required (Uowolo and Denslow, 2008). *P. cattleianum* stands typically have a large fruiting event in summer, and a smaller one in winter. The size of fruiting events can vary from year to year.

P. cattleianum seedling bed

High germination

Achatinella mustelina considerations



Where to next?

Helicopter considerations: Where we take the chipper and how often it is moved depends in large part on how expensive it is to move. Determine if there are cheaper options, such as using Evergreen, military helicopters, or adding the Huey onto our AMD contract.

Potential projects:

- **Kahanahaiki:** scope out the rest of Maile Flats to identify where, if anywhere, has large enough stands of *P. cattleianum* to justify continued chipper operation. Survey more in WCAs #7 and #10. Determine if any location in the Maile gulch region is large and flat enough.
- **Makaha:** project options include *P. cattleianum* removal and *Coffea arabica* removal. More site scoping is needed to identify potential work sites. Rare taxa issues are important. *Coffea arabica* biology must be studied to determine if there are any special considerations for seed germination, creation of light gaps, etc prior to the commencement of any clearcut project.
- **Kaena East of Alau:** there is a stand of woody trees (kiawe, klu) near the Kaena East of Alau *Chaemaesyce celastroides* var. *kaenana* population. This site is accessible by vehicle. Removing these trees would greatly reduce the fuels in the area; fires have burned within 100m of the *C.*

celastroides twice in recent years. Need to get permission from the State. Not sure how quickly we want to do this.

- **Firebreaks:** determine locations of other future fire breaks. Chipper can be used to mulch cut material on the breaks and speed decomposition of flammable organic material. Possible fire breaks include Puaakanoa and Keaau.
- **Kaunala:** there is a large stand of *P. cattleianum* and *Casuarina equisetifolia* in the Kaunala fence. It lies on a gradual ridge between the 2 main patches of *Eugenia koolauensis*. The area has been surveyed thoroughly, and there are no *E. koolauensis* plants in the nearby area. It would be a good site in terms of weed target, infestation size, topography, lack of rare species. However, need to think about how much of this can be done with volunteers, effort for only 1 rare taxon, and follow-up needed. Could be good project stewardship type area.
- **Pahole NAR:** There may be places in the NAR where the NARS Biologist is interested in using a chipper, particularly the restoration site on the ridge between Gulches 1 and 2. However, a project in the NAR would need to be done under State direction, with some State follow-up.
- ***Flueggea neowawraea* outplanting sties:** the current reintroduction strategy for *F. neowawraea* is to clear large light gaps in gulch bottoms, and then plant into these moist, sunny microclimates. The chipper could be used to mulch cut slash and increase the size of the areas for outplanting. Considerations include cost of flying chipper to the reintroduction sites, and degree of slope at the sites.

Before Heading into the Field:

Safety: All staff who will be working with the chipper (feeding the hopper) need to READ THE SOP AND WATCH THE SAFETY VIDEO!!!!! This cannot be emphasized enough.

PPE: Ear pro, eye pro, helmet, no loose anything to get caught in branches, no watches or earrings. Footwear is a little more tricky; the SOP only says 'safety footwear'. Whenever possible, use boots rather than tabis, particularly on gentle terrain. The chipper operator mostly stays in one small area, so spikes aren't critical. There are lots of big branches and logs to lift, things fall, things twist as they get pulled into the chipper, there are lots of opportunities to drop things on feet. So, wear boots unless it really isn't possible.

Chipper Specific Gear : The chipper comes with a lot of its own stuff. Critical: the ignition key is in a lockbox on the chipper itself. There is a copy at West Base.

Must Have	Nice To Have
key	hydraulic fluid
manual and SOP	engine oil
diesel (5 gal cans), with pouring funnel	crescent wrenches/tool kit
grease and grease gun	full first aid kit (should always have pack kits)
leatherman	sledge hammer for tent stakes
tent, with tent stakes	potable water (for drinking)
tarp and line	non-potable water (for washing)
come-along	
straps x 3	
carabiners x 3	
fire extinguisher	

Other gear: Chainsaws and all accompanying gear. Handsaw, hatchet, or safety brush axe, for cutting branches that get stuck in the chipper maw. Gloves. Herbicide and all accompanying gear. PVC for photopoints. Camera and GPS.

In the Field, Taking care of Business:

When conducting weed control, you should always have a GPS. GPS the boundaries of the area you weed – this is vital for tracking our effort and having productive, efficient weeding projects.

Photopoint Monitoring: Photopoints provide a simple, fast way to monitor vegetation change over time. It is crucial to install photopoints PRIOR to any clearcutting activies, thus establishing a baseline. Photopoints should be marked with metal-tagged PVC poles. The bearing for each photo should be recorded on a photopoint form. As a rule of thumb, use cardinal directions for bearings. Photopoints should be taken at regular intervals during and after clearcut/chipping; see the Ecosystem Restoration Program Manager. An appropriate photopoint timeline is:

1. Once prior to clearing
2. Once or twice during clearing
3. Once a quarter for a year following clearing
4. Once every six months for the next 1-2 years
5. Once every 1-2 years for the next 10 years

Other monitoring techniques may be used. Monitoring questions and protocols should be developed prior to the commencement of any clearing.

Heli Transport: The chipper weighs in at a hefty 2,850lbs. It must be flown level. It is too big to be flown by a Hughes 500 or Bell Ranger. It can be flown by a Huey, Bell 412 or Blackhawk. The chipper should be rigged from 3 points, as shown in these pictures.


Running the Chipper: When operating the chipper, stand on the right side of the hopper (when facing the hopper). As the feed wheels pull in the branches and trees, it rotates them to the left, meaning they turn towards the left side of the hopper. If the operator is standing on the left, it is easy to get whacked. Note that trees being pulled in are subject to serious vibrations; occasionally dead branches break off. Also, if you are touching the tree as it is being pulled, the vibrations feel rather uncomfortable. Green material is much easier to chip than dead material. If you are chipping dead material, alternate it with green material or the feed wheels can get gummed up.

Mulch Piles: The chipper puts out a lot of mulch. Move the chute regularly, so that you make many small (3-4ft tall) mulch piles. Try to place the piles along trails or on top of weeds. The piles will get hot while they decompose; don't make them too big (6-7ft tall), or they'll get too hot, and possibly could catch fire. Don't place them at the base of native trees, which may be damaged by the heat. Consolidate the piles, as native plants, like koa, won't be able to germinate through them. Do use them for weed suppression where possible. Avoid placing them in areas where you want to move the chipper – it is impossible to summit a 3 ft mulch pile with 3 staff pushing the chipper.

Moving the Chipper: If you have a lot of people, you can probably push the chipper wherever you want. If you don't, use straps and come-alongs, and you can get the chipper wherever you need it to go. It is WAY easier to move the chipper if you clear a smooth, pungy-stick free path for it. Cut all stumps to the ground. Move debris away. Pull in a straight line towards the come-along anchor point. Raise and lower the wheel on the hitch to change the center of balance on the chipper.

Putting the Chipper to Bed: At the end of the day, cover the chipper with the tent, and stake the tent down. Grease all 10 grease points. Cover as much of the chipper as possible, particularly the engine, with another tarp and tie it in place. Move other gear under the tent.

GPS Your Work: At the end of the day, set the track feature to take a point a second, then walk the perimeter of the area weeded. Simple, and it saves your friendly weed tech time and effort in processing the data.

End of the Field Day:

Filling out forms: Fill out a WCEF at the end of the day – each WCA gets its own form, so keep track of how many WCAs you've been in. Use the form to note whether more diesel, chaisaw fuel, herbicide, or other gear is needed.

Citation:

Uowolo, Amanda L. and Denslow, Julie S. 2008. Characteristics of the *Psidium cattleianum* (Myrtaceae) Seed Bank in Hawaiian Lowland Wet Forests. *Pacific Science* vol. 62 no. 1:129-135

APPENDIX 1-7: *BIDENS TORTA* SEED SOW TRIALS AT KAHANAHAIKI MU

Bidens torta seed sow trials at Kahanahaiki MU.

INTRODUCTION

Invasive, alien plant species plague Oahu native forests and are a constant battle for natural resource managers working to protect rare species in these habitats. In the Kahanahaiki Management Unit (MU), an approximately 63-acre fenced area, the OANRP is protecting one species of native tree snail (*Achatinella mustelina*) and numerous endangered plants including *Cyanea superba* ssp. *superba*, *Cenchrus agrimonioides* var. *agrimonioides*, *Flueggea neowawraea*, and several species of *Schiedea*. Of the many protective actions employed for these rare species, invasive weed control ranks among OANRP's top priorities.

In addition to OANRP staff conducting protective actions, Kahanahaiki also provides an accessible site for education. Volunteer service trips allow the community to help restore this forest while learning about rare species found in mesic forests, their threats, and what can be done to protect them. This translates into: 1) additional labor valuable to the protection of Kahanahaiki forest; and 2) increased awareness about biodiversity, invaluable in helping to shape future generations' decisions regarding such issues.

Invasive weed management is one strategy that can be safely and easily accomplished with the help of volunteers. As a result, hundreds of volunteer hours have been spent assisting OANRP staff with projects such as removing monotypic stands of strawberry guava (*Psidium cattleianum*) from the Kahanahaiki forest. However, as is common following weed control efforts, established weed seed banks or new alien weed recruits can soon take-over the newly disturbed areas as they are exposed to sunlight (Sailer, 2006, p.72). One technique used to overcome this is to plant or sow seed of vigorous common native plants (Cabin et al., 2002) such as *Bidens* spp. (Sailer, 2006, p. 72).

A trial of this technique was conducted in Kahanahaiki forest in 2009 to gauge the efficacy of *Bidens torta* in quickly establishing a dense plant cover in both weedy and weed-free areas.

METHODS

Four questions were posed in this trial: 1) Do *B. torta* seeds grow from a simple seed sow? 2) Does pre-soaking the seeds increase the effectiveness of *B. torta* growth in a seed sow? 3) Do *B. torta* grow in areas that have not been weeded? 4) Do *B. torta* grow following a simple seed sow in different sites in Kahanahaiki? To answer these questions, four treatments were used: 1) soaked seeds, open weed-free area; 2) soaked seeds, shaded, weedy area (not grass); 3) unsoaked seeds, open weed-free area; 4) unsoaked seeds, shaded, weedy area (not grass).

Seeds from *B. torta* were collected in the fall of 2008, divided into 40 packets with approximately 500 seeds per packet (determined by mass), and stored at 4^{o} C until the trials began in January 2009. "Soaked seed" treatments were placed in deionized water (at room temperature) for three days; the water was changed each morning, for a total of two water changes during the soaking period. In the afternoon of day three, seeds were strained from the water, placed in paper packets and stored back at 4^{o} C until they were sown, the following day.

Locations for weedy treatments were selected if they had approximately 50% or more total weed cover, and weed-free areas were selected if they had approximately 15% or less total plant cover (i.e. at least ~85% exposed soil). Some weed-free areas had been weeded during the previous year, while other weed-free areas had little plant growth even without being weeded.

Groupings of 20 1 x 1 m plots (five plots for each of the four treatments) were established in two different sites in Kahanahaiki forest – Black Wattle site (K-1 WCA) and upper Maile Flats site (K-10 & K-12 WCAs), for a total of 40 plots. These two sites were chosen because of differences in microhabitat. The Black Wattle site is generally exposed, with little canopy cover, drier and on a gentle slope facing southwest. Dominant overstory is young *Acacia koa* (~20 feet tall), with some sections in *P. cattleianum* monoculture (also ~20 – 30 feet tall). Dominant understory is molasses grass (*Melinis minutiflora*) and bracken fern (*Pteridium aquilinum*). The Maile Flats site is wetter and has more overstory cover with larger trees. Generally, the site has diverse native mesic forest species both in the overstory and understory, in addition to weeds such as *P. cattleianum, Rubus rosifolius, Clidemia hirta, Buddleia davidii, and Oplismenus hirtellus.* Although relatively flat, there is a slight north facing slope to the Maile Flats site.

Each plot was demarcated with pin-flags in each corner and a metal tag indicating treatment. A single packet of seeds was scattered evenly, by hand, in each plot and gently tamped into the soil. Approximately 1 – 1 ½ gallons of water was then sprayed on the surface of each plot (enough to moisten the entire m^2 area) using a backpack sprayer.

Six months after the seed sow, all plots were monitored with the help of volunteers. Percent weed cover and percent *B. torta* cover was estimated and recorded for each plot. Monitoring of these plots is on-going, with the second monitoring planned for quarter four, 2010.

RESULTS

After one monitoring period (six months), results show a greater percent cover of *B. torta* was found at the Maile Flats site, compared to the Black Wattle site (Figure 1). Since *B. torta* cover was so low at the Black Wattle site, we focused all analysis on results from the Maile Flats site.

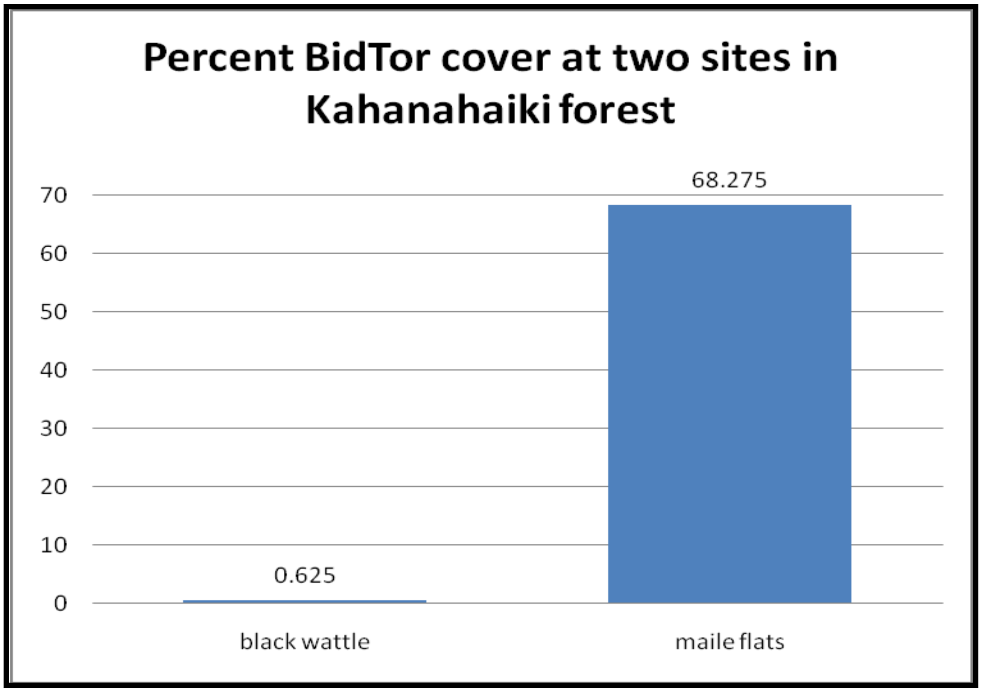


Figure 1. Average percent cover of *B. torta* in all treatments at each of the two sites in Kahanahaiki forest.

At the Maile Flats site, weed-free areas showed a greater percent *B. torta* cover than weedy areas (Figure 2). However, *B. torta* did grow in the weedy areas in Maile Flats, and in these weedy areas, the unsoaked seeds showed a significantly greater percent *B. torta* cover than soaked seeds (p = 0.03; Figure 3).

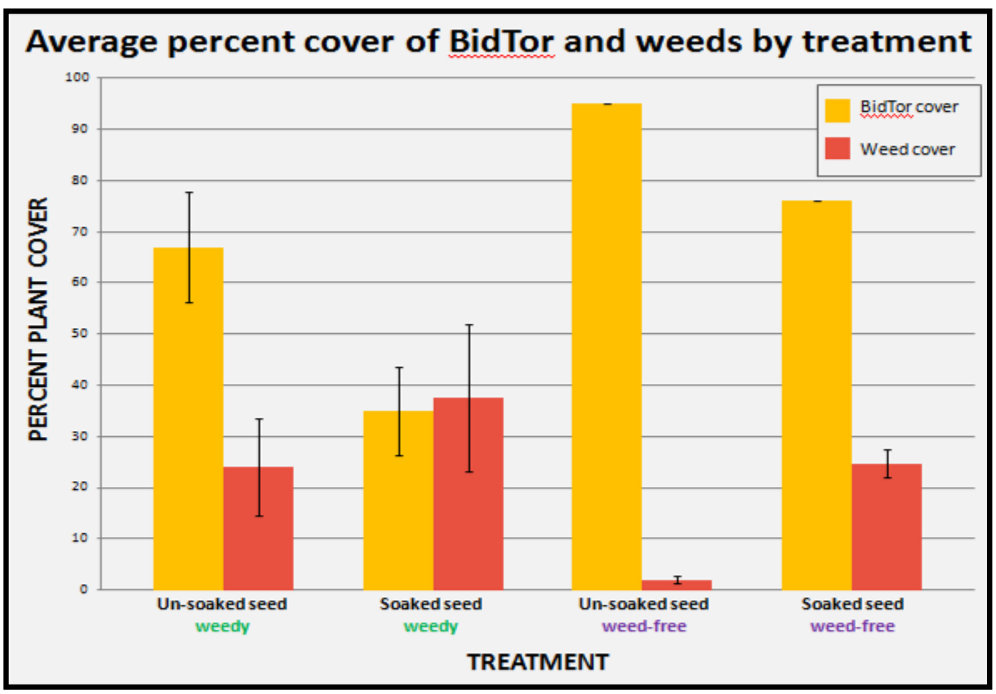


Figure 2. Average percent cover of *B. torta* in each of the four treatments at the Maile Flats site.

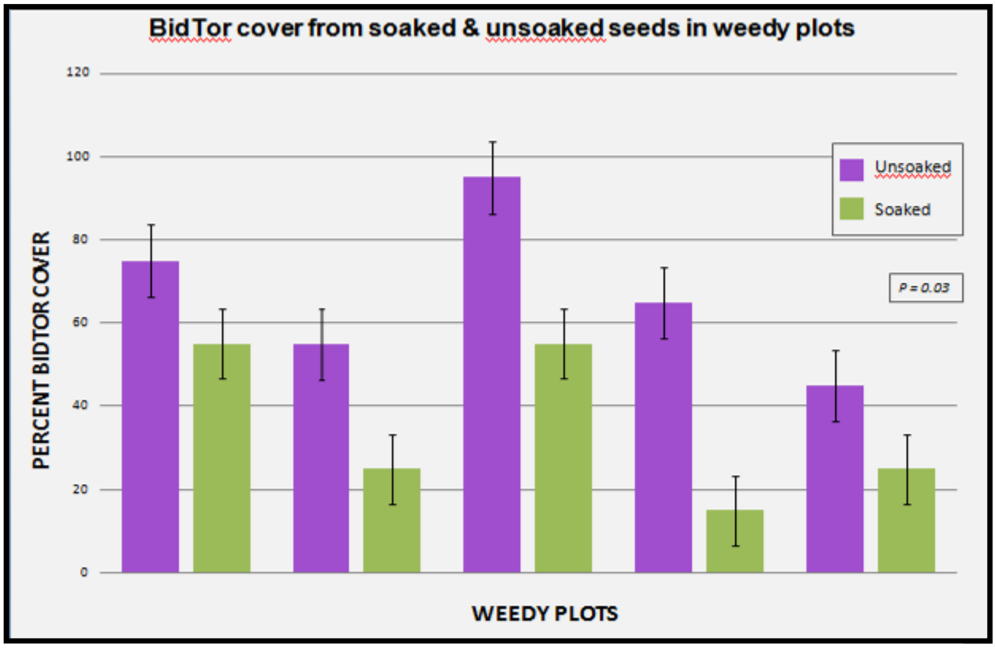


Figure 3. Average percent cover of *B. torta* from soaked and unsoaked seed treatments in five weedy plots in Maile Flats.

DISCUSSION

Referring back to our original questions, 1) Do *B. torta* seeds grow from a simple seed sow? Although the *B. torta* grew with limited success at the Black Wattle site, *B. torta* successfully grew from a simple seed sow at the Maile Flats site (Figure 4). This supports other restoration efforts that have used this technique with success (D. Sailer, *pers. comm.*, 2010).

2) Does pre-soaking the seeds increase the effectiveness of *B. torta* growth in a seed sow? Not that we observed. In fact, it was found that pre-soaking *B. torta* seeds resulted in a decrease in the percent cover of *B. torta* when compared to unsoaked seeds at the Maile Flats site. One possible explanation for this is that the pre-soaked seeds were removed from the water and placed back in paper packets and stored back at 4^{o} C until they were sown, the following day. Embryo growth could have been initiated by soaking, but the straining and storing in paper packets could have dried out the embryo, resulting in a lower success rate. If soaking is attempted in the future, seeds should be kept moist until sown.

3) Do *B. torta* grow in areas that have not been weeded? Yes; although the overall percent cover of *B. torta* was less than that recorded in weed-free areas, it still grew in the weedy plots. It is not surprising that decreased competition due to the removal of weeds prior to seed sowing would result in more seedling cover.

4) Do *B. torta* grow following a simple seed sow in different sites in Kahanahaiki? For the two sites that we examined, the Maile Flats site exceedingly outperformed the Black Wattle site. The Black Wattle site plots were observed to have little growth at all, suggesting many of the *B. torta* seeds did not germinate. Several explanations could account for this. One is the exposure and aspect of the Black Wattle site. It is exposed, has less shade and sits at a southwest aspect. In other OANRP field sites, south and west aspect slopes have been observed to be drier and weedier than north and east aspect slopes. Another possible explanation is that the Black Wattle site exhibits hydrophobic soils. Further, there may be

residual allelopathic compounds in the soil from when black wattle trees (*Acacia mearnsii*) once dominated this site. Although seedling *A. mearnsii* continue to be found at this site, all mature trees were removed by 2003. The combination of these factors likely contributed to the low germination rate of *B. torta* at this site. Historically, outplantings in Maile Flats have had a higher success rate than those at Black Wattle.

a. b. c.

Figure 4. *B. torta* growth over time: a) one month; b) three months; c) six months.

In conclusion, sowing *B. torta* seeds is a plausible method for increasing percent cover of a native plant in areas, and the method to achieve the best results is to sow seed in areas after weeding. Seeds appear to grow well without any pre-treatment, however if pre-soaking is preferred seeds should be kept moist until sown.

It is not recommended that this method for a *B. torta* seed sow be employed at the Black Wattle site due to the exposure and soil conditions; however it should be noted that previous *A. koa* outplantings have been successful at this site. Because of this, it is recommended that common native plantings be explored at Black Wattle as an alternative to seed sows.

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Cabin, R. J., S. G. Weller, D. H. Lorence, S. Cordell, L. J. Hadway, R. Montgomery, D. Goo and A. Urakami. 2002. Effects of light, alien grass, and native species additions on Hawaiian dry forest restoration. Ecological Applications 12(6): 1595-1610.

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APPENDIX 1-8: STANDARD OPERATING PROCEDURES FOR HERBICIDE BALLISTIC TECHNOLOGY OPERATIONS: GROUND AND AERIAL HERBICIDE APPLICATION

RCUH-PCSU 16 Sept 2010

SOP No. XX

Standing Operating Procedures (SOP) for

Herbicide Ballistic Technology Operations: Ground and Aerial Herbicide Application

1. PURPOSE. The purpose of this SOP is to outline safe procedures and methods to follow when conducting Herbicide Ballistic Technology (HBT) operations.

2. SCOPE. Includes procedures for field operations of HBT.

3. RESPONSIBLITIES.

a. Natural Resource Management Coordinator: Review procedures with designated Applicator and any other staff involved in HBT operations to ensure understanding and compliance. Conduct safety briefings prior to any HBT operation. Ensure staff has all appropriate certifications.

b. Applicator: Execute HBT operations in accordance with SOP. The designated Applicator shall be the only Applicator of HBT. During field operations, the Applicator will be responsible for the safe application and reloading of HBT systems.

c. Support staff: Execute HBT operations in accordance with the SOP. Provide field assistance to Applicator, under the direct supervision of the Applicator.

d. Helicopter Manager: In aerial operations, the Heli-Manager is responsible for the overall safety of the helicopter components of the HBT operation.

e. Designated Flight Follower: In aerial operations, the DFF shall flight follow the helicopter by monitoring the radio communications, and if available, through the AMD-approved Contractor or On Call vendor's Automated Flight Following. If no AFF is available, radio communication will be made between the DFF and helicopter every 15 min at minimum.

f. Failure to comply with this SOP may result in disciplinary action.

4. PROCEDURES.

a. General Considerations

(1) HBT is a method of delivering discrete amounts of herbicide to target weed species. Adapted from commercial paintball equipment, HBT systems include projectiles filled with herbicide, propellant, and a marker. HBT may be applied from the ground or aerially.

(2) Compliance with SOP No. 2 Helicopter Field Operations, SOP No. 7 Pesticide Use, and Helicopter Safety and Management Plan is required.

(3) Definition of basic HBT terms:

- **Accuracy**- A ratio of projectile hits/misses within the target area, which should be >95% during operations.
- **Applicator** - administers HBT application.
- **Dose**- A measure of herbicide volume and concentration necessary to cause a negative effect on the weed target. Dose will be administered in projectile-units per target area.
- **HBT**- An acronym for Herbicide Ballistic Technology™, which is a concept for pneumatically administering encapsulated herbicide aliquot projectiles to weed targets with long-range accuracy.
- **Hopper**- A projectile retention and delivery magazine that typically retains 150-200 units when loaded. The hopper consists of a ventral feed neck for direct gravity flow of projectiles into the marker breach, and a dorsal lid for reloading with 150-unit pods. Hopper systems can be passive or active feed, with internal battery powered agitators.
- **Marker, Pneumatic applicator** - A gas charged (CO_2 or high-pressure air) projectile delivery system consisting of a bolt and valve assembly to channel metered gas charges for directional propulsion of HBT projectiles. This document will use marker, the term used by the paintball industry.
- **Pod** - A projectile retention vessel and ammunition stockpile unit for reloading the hopper. The capacity is often comparable to the hopper so that one pod will fill the hopper. The pod usually consists of a cylindrical tube with a wide-mouth spring-loaded lid for open transfer of projectiles into the hopper. Pods are sometimes used as a unit of measure in calculating HBT application rates. Operations are determined by increments of pre-loaded pods.
- **Projectile** - A frangible 0.68 caliber bifurcated gelatin capsule with spherical dimensions and active liquid herbicidal fill components designed for lethal plant-physiological disruption. May be referred to as **unit** or **units**.
- **Propellant** - High pressure air (HPA) and CO_2 are the most common propellants with a marker. HPA is the preferred source for consistent projectile propulsion. HPA is stored in **tanks** of varying capacities ranging from 48 cubic inches to 80 cubic feet. A flexible, coiled remote line often serves as the connection between the tank and the marker. Markers operate with pressures ranging from 200-800psi in order to achieve a muzzle velocity of 300 feet per sec. Pressures are often preset by the factory and generally are not modified. May also be referred to as **air** in this document.

Tank attached directly to marker

Tank attached to marker via remote line

- **Range** - The travel distance for projectiles to reach a target with minimum threshold velocity to achieve projectile rupturing upon impact. The typical horizontal range for 0.68 caliber projectiles with an initial muzzle velocity of 300 ft per second is approximately 100 ft. The range could be extended from a helicopter platform with a downward trajectory on the target.
- **Target** - An individual or small satellite population of invasive alien plants designated for treatment.
- **Target Acquisition, TA** - In aerial operations, a pilot maneuver to position the aircraft within hazard-free airspace and to bring the Applicator's target window within range and trajectory for discharging projectiles.
- **Trajectory** - The flight path of a discharged projectile influenced by the ballistic integrity of the projectile, muzzle velocity, wind dynamics and angle relative to gravity. It is expected that the trajectory of a projectile is with a clear line of sight to the target.
- **Tank** - A pressurized vessel for retention of the gas propellant to be metered through a regulator valve. Tanks are most often manufactured out of aluminum or spun carbon fiber. Depending on the tank, standard pressure is 3000 psi, but some tanks are also designed to maintain 4500 psi. A 72 ci/3000 psi tank is enough propellant to discharge >1000 units.

b. Product Information

(1) HBT systems consist of a marker, projectiles, and propellant.

(2) Markers: a variety of marker brands may be used, including Tippmann. Once markers are purchased, specifications of markers purchased by the program shall be detailed here.

(3) Projectiles: manufactured by Nelson Paint Company, HBT projectiles are biodegradable gelatin capsules filled with herbicide. Various active ingredients and surfactants, at various mix rates may be encapsulated. Active ingredients include triclopyr and imazapyr. Only formulations covered by appropriate EPA Experimental Use Labels or Special Local Needs (SLN) 24(c) labels will be used, for example, SLN 24(c), HBT-IMAZ, by Wilbur Ellis, EPA no. 86199-MI-001.

(4) Propellant: compressed air and tanks will be approved by a certified SCUBA shop. Tanks may be made of metal or carbon fiber.

c. Certification/Training

(1) All OANRP staff involved in HBT operations must possess valid State of Hawaii Restricted Use Pesticide certification, Hazcom, and First Aid training.

(2) Applicators should be familiar with the operator's manual and manufacturer's safety guidelines for the marker and shall demonstrate proficiency in safe marker handling and accuracy in application. In the year prior to an application, the Applicator shall achieve 80% accuracy in hitting a 12" plate from 50 ft, 70% accuracy in hitting an 12" plate from 100 ft, and have fired 1000 projectiles (paint or herbicide) in the last quarter. For aerial applications, Applicators must be Crewmember certified.

d. Personal Protective Equipment (PPE).

Both Applicator and support staff shall wear all required PPE. If staff are not handling projectiles, nitrile gloves are not required. During helicopter operations, ground crew shall wear nitrile gloves when the helicopter has shut down and they are handling potentially contaminated gear. When the helicopter is operating, nomex or leather gloves shall be worn. Applicators on board the helicopter shall always wear nomex gloves. Since projectiles are encapsulated herbicide, contamination is only an issue if a projectile ruptures.

Required PPE: Ground Operations	Required PPE: Aerial Operations	Required Training
• Eye protection which covers the entire eye cavity. • Nitrile gloves, when handling projectiles • Barrel cover/ swab • Long shirt, long pants, shoes, socks	• Nomex flight suit • Nomex/leather gloves • All leather boots above the ankle • Non-synthetic garments (cotton, wool) • Flight helmets (on-board helicopter) • Hard hat with eye and hearing protection (ground crew). • Barrel cover/swab	• Hawaii Restricted Use Pesticide Applicator's license • HAZCOM • Demonstrated proficiency and safe handling of markers • First Aid • B-3, Crewmember (aerial operations only)

e. Storage

(1) Marker: Markers may be contaminated with pesticides, and shall be clearly labeled as such. They shall be stored in a sturdy, ventilated, locked storage locker in the pesticide storage area at West Base. Access to the locker will be limited.

(2) Propellant and Tanks: only compressed air shall be used, as compressed CO_2 may contain propane. Compressed air tanks shall be secured in a locked storage area at West Base. All tanks should be kept out of direct sun. Caustic cleaners/strippers should never be used on tanks. Tanks will not be overfilled or modified. Tanks will be maintained and filled by professionally trained personnel at a certified scuba shop or equivalent. This includes annual visual and computerized inspection (VIP) for cracks, pitting, or other deformation, and hydrostatic treatment every five years. All tanks will be depressurized prior to long term (six month or more) storage. Inspection logs shall be maintained for all tanks.

(3) Projectiles: manufacturer's recommendations will be followed for storage and handling. Projectiles shall be stored in the pesticide storage area in the sump at West Base. They should be kept cool and dry, in an insulated container. Desiccant may be used to minimize moisture. Heat and moisture can compromise the gelatin skin of the projectiles, causing them to rupture in the barrel of the marker. This can contaminate both the marker and the Applicator with pesticides. Projectiles do not retain integrity indefinitely. Projectiles will be used in a timely manner with older stock used first.

f. Ground Transport

HBT equipment shall be secured to prevent movement during transit. In particular, compressed air tanks should be strapped or otherwise secured. Projectiles should be kept in a cooler or other insulated container; they should be clearly labeled as pesticides. Markers and other potentially contaminated equipment should be transported in a container labeled "Contaminated with Pesticides". All equipment should be protected from sun/heat. HBT equipment should not be left unattended in the back of a truck.

g. Basic Handling and Operation Guidelines

(1) Prior to conducting an HBT operation, all staff shall be briefed by the NRMC as to goal, target weed species, location of refilling stations, application zones, and safety.

(2) Inspect all equipment prior to operations. Never use a damaged or out of date tank. Ensure that the marker is functioning properly. Inspect projectiles and ensure that gelatin skins are not broken or leaking. Do not alter/modify equipment without assistance from a qualified professional.

(3) Always exercise care when connecting and disconnecting tank to marker.

(4) Always assume a marker has projectiles and is pressurized. Projectiles can be in the barrel, even if the hopper has been emptied. Likewise, even when the propellant is detached, a small residual air charge often remains in the valve until manually depressurized.

(5) Never look down the barrel of a marker.

(6) Always keep the trigger safety on until just before firing. Communicate to support staff when the trigger safety is switched on or off. Use a trigger guard where feasible.

(7) Always use a barrel blocking device when carrying a marker. Remove just before firing, and replace promptly. Barrel blocking devices shut off the barrel, ensuring that if a marker is accidentally fired, no projectiles will be deployed.

(8) Never point a marker at another person. HBT is not paintball and is not a game. Being hit with a projectile can be painful, particularly from close range. Being hit in the eye can result in loss of vision. Also, projectiles are filled with herbicide, not non-toxic paintball filler. Keep markers pointed at the ground.

(9) If a projectile ruptures and staff are contaminated with herbicide, it should be washed off with soap and water as quickly as possible.

(10) HBT projectiles may be applied in a variety of ways. They may be shot at the trunk of trees or at the crown, at the apical meristem of Australian tree fern (*Sphaeropteris cooperi)*, or at the core of shrubs. Different target species respond best to different HBT treatments. Always apply the most effective treatment known.

h. Ground Operations

1. Ground-based operations may involve several Applicators and support staff. All personnel in the area of an HBT operation should have good communication with each other. If staff are beyond easy talking distance, radio contact is required. All staff should be aware of the locations of all other staff. Rino GPS units may be used to track staff locations. See pre-ground operation pre-flight checklist, attached as appendix.

2. Staff must ensure that they are not pointing the marker at other personnel. Once a target has been identified and the Applicator is in place, s/he shall communicate to all nearby personnel, notifying them that s/he is going to turn the safety off and begin discharging. Nearby personnel must respond before the Applicator can continue. At the conclusion of discharging, the Applicator shall again communicate with nearby personnel, notifying them that the safety is on. These strict communication rules may be relaxed if staff are in different gulches or otherwise protected by terrain, are over 500m apart, and notify each other if crossing into a new location. The Applicator shall consider prevailing wind conditions when determining whether or not to proceed with an application, as herbicide drift is also a hazard to nearby staff.

3. Reloading. Depending on the operation, staff may set-up and use a designated reloading station, or may reload from their firing locations. In either case, the same safety precautions apply.
    a. Ensure the safety is on and the barrel blocking device is on.

b. Projectiles: open the hopper, insert pod. As the pod is pressed down onto the mouth of the hopper, it will automatically open and release all projectiles. Ensure the pod is empty. Remove pod and close hopper.

c. Propellant:

- IMPORTANT Close tank by unscrewing valve pin (opposite thread rotation)
- Depressurize marker connection with slide check release (pull back slide check)

- Disconnect marker and decompress bolt (or electronically power off)
- Depressurize remote line (push slide check forward). Warning! If valve pin is still screwed in, the tank will depressurize at 1000 psi, whipping the remote line hazardously.
- Connect marker to new tank
- Pressurize remote line by opening tank with pin valve screwed in and slide check pulled back
- Compress bolt and pressurize marker (push in slide check)

4. At the conclusion of operations for the day, disassemble the marker system.
   - Ensure that the marker safety is on and barrel blocking device is on.
   - Bolt decompressed (or electronically powered off)
   - All tanks closed (valve pins unscrewed)
   - All remote lines depressurized and secured to the connected tank
   - Disconnect marker from the remote line
   - Check hopper for remaining projectiles
   - Empty projectiles from hopper to pod

i. Aerial Operations

(1) Flight mission planning: Missions shall be planned based on target priorities and overall weed control objectives. Plans will include contingencies should weather in the original area not allow for HBT operations; use of the Risk Assessment form will determine the go/no-go decision for the operation. The goal for each flight mission is to SAFELY treat a maximum number of incipient weed targets with HBT. Pre-flight surveys and target maps are valuable to mission planning. The weed control area should mapped, but specific target points do not need to be mapped within the weed control area. Maps must be available to the Heli-base Manager and Designated Flight Follower.

(2) Applicator equipment and ensemble:

a. Safety First! Trials will be conducted to identify a standard, safe way to assemble an HBT marker system in a helicopter, with temporary attachments (straps, holsters, etc) to the aircraft, marker and Applicator. The Heli Manager, Applicator, and support staff will use configurations that will ensure safe and efficient HBT flight operations.

b. The basic components necessary for the Applicator to administer an HBT application include the marker with loaded projectile hopper and propellant tank reservoir. The three limiting factors in an aerial HBT flight are projectiles, propellant and helicopter fuel. Only quantities of projectiles and propellant that can be safely stored within reach of the Applicator and used during one flight should be carried during a flight; gear should be minimized to what is necessary. All personnel on a flight should be aware of the helicopter's fuel limitations and halt HBT operations to allow adequate time/fuel for the pilot to return to refuel.

c. All components of the marker system must be:

- secured inside the aircraft during flight operations with minimum potential for position shift or accidental detachment.
- reachable from the Applicator's seated position, but should not impede egress in an emergency.
- quickly and easily jettisonable, using a reliable quick-release mechanism, such as existing seat belt restraints, in case of an emergency.
- The HBT system shall be installed under the supervision of the Pilot, Heli-Manager, and Applicator at the beginning of operations, before the first application flight, with the helicopter shut down.

d. HBT in-flight gear configuration:

- The Applicator will hold the marker while in use. When the Applicator requires both hands free to load projectiles or change tanks, the marker will be secured to the helicopter or Applicator with a detachable single point sling or similar design using a load bearing nomex harness.
- The marker will either be directly threaded to the tank (<114 cubic inches) as a single unit or will be connected to a secured stationary tank with a flexible coiled high pressure remote line. The remote line should consist of a pin valve on the tank and a slide check with quick disconnect on the marker for rapid disengagement.
- The onboard projectile repository will consist of individual pods (120-150 projectiles per pod) compartmentalized within a retention device secured to the aircraft. Each pod will have a mechanically-activated spring lid to ensure contained transfer of the projectiles into the hopper.
- One example of a retention device which meets all above requirements is a milk crate, packed with padding, pods and tanks, secured in the seat next the Applicator using the existing seat belt.

e. Applicator position. Aerial operations shall use one Applicator. Configuration may vary slightly depending on the helicopter model. In a Hughes 500, the Applicator shall be positioned sitting facing forward, in the rear seat of the aircraft, directly behind the pilot, and shall have a standard 3 or 5-point seat belt which fastens with a metal-to-metal mechanism. The doors of the aircraft shall be removed.

f. In-flight Communication: The Pilot and Applicator shall have full communication during all operations. The Applicator shall have both momentary ("keyed") and locking ("hot mic") microphone activation; the Heli-Manager should ensure that the helicopter used has this capability. Whenever possible, a foot pad key should be available for the Applicator, as opposed to a hand key.

(3) Pre-flight checklist: Along with standard pre-flight checks, the Heli-Manager will also ensure that the equipment and Applicator are fully prepared. Fill out Pre-Flight Checklist in attached appendix:

- Projectile inventory is adequate for achieving operation goals.
- Projectiles are housed within a temperature-and moisture-resistant container on the ground, and enough pods are present to facilitate reloading.
- Propellant fill station on the ground is fully pressurized and adequate for achieving operation goals.
- Projectiles are visually inspected for integrity to maintain true trajectory.
- Run a full pod of projectiles through the hopper (detached) to be sure that there are no obstructions.
- On the ground, pressurize the marker and administer a series gas discharges with an empty breach.
- A spill kit is present at the staging site.
- Water and soap present for washing.
- The Pilot is briefed as to the pesticides carried aboard the helicopter, as per AMD Hazmat policy.

(4) In-flight safety: All safety procedures during helicopter flight operations as outlined in SOP no. 2 apply. Added safety procedures specific to HBT operations include:

- Always assume that the marker is pressurized and loaded.
- When holding the marker, the Applicator shall always be conscious of the locations of all personnel.
- The Applicator shall maintain continual verbal notification on the status of the marker safety being on or off.
- The Applicator shall always have the safety on, and barrel pointed down and away from other staff, the Pilot, and the helicopter. While in flight, the Applicator shall always keep the barrel pointed within the imaginary target window.

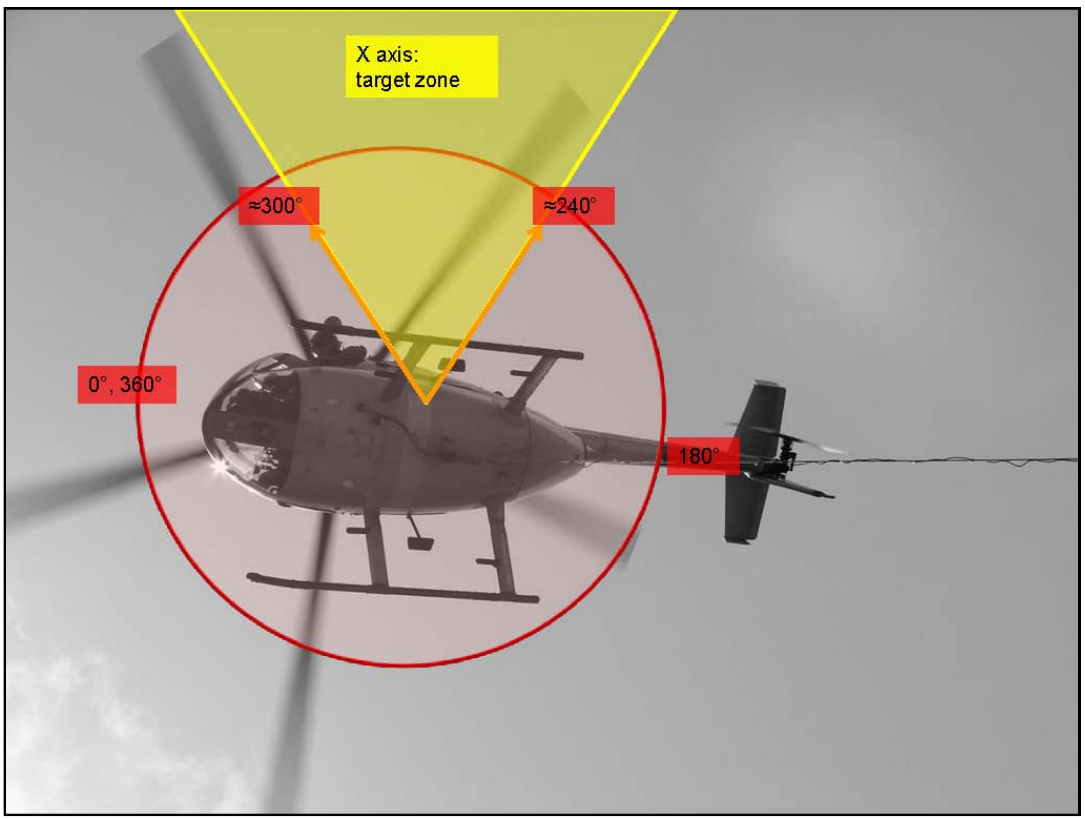
(5) In-flight HBT operation:

a. Personnel onboard during an HBT flight include the Pilot, Applicator, and data support staff (DS).
b. The DS will record pertinent data (e.g. # of targets, projectiles per target, target density in given area), track the operation with a GPS, assist in spotting target weeds, and monitor the right side/rear of the helicopter for potential obstructions.
c. Prior to takeoff, the Applicator will pressurize the marker, load the projectile hopper and maintain the system in safety mode as described above.
d. The Applicator should monitor projectile and propellant levels throughout the flight.
e. All personnel are responsible for visual target identification (TID).
f. The pilot will position the aircraft so that the Applicator can acquire the target and discharge projectiles.

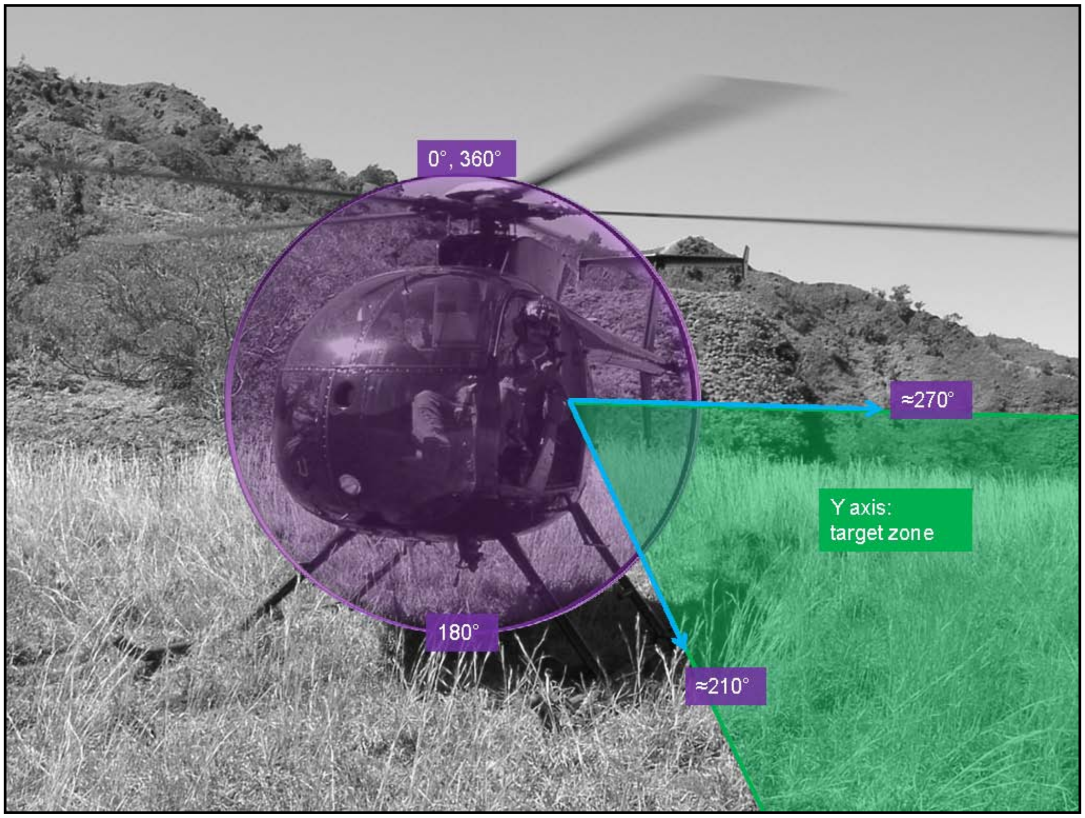
g. The following series of steps illustrates a safe and effective treatment:

- Pilot to Applicator TID announcement
- Pilot survey of surrounding airspace for hazard-free path to final target acquisition (TA) position
- Pilot maneuvers aircraft within target range and clear line of sight trajectory
- Pilot requests target validation from Applicator (TA complete upon acknowledgement)
- Applicator requests permission from the Pilot to discharge projectiles
- Once Pilot permission is granted, the Applicator takes aim and switches off the safety, notifying the Pilot that the safety has been switched off. The Applicator then discharges projectiles at the weed target.
- Upon completion, the Applicator switches the marker back to safety mode and notifies the Pilot that the target has been treated and that the safety is switched on.
- The pilot proceeds with moving into position on the next target.

Target Window:



X-axis: roughly 240°-300°, leaving ample buffer towards the pilot, and towards the tail.



Y-axis: roughly 210°-270°, or eye-level to skid.

(6) In-flight reloading: The Applicator is responsible for all in-flight reloading of projectiles and propellant. Properly installed, conveniently positioned pods and tanks allow for quick, simple, and clean reloading.

a. To reload the hopper, the Applicator will first set the marker safety on and secure it to a detachable single point sling such that both hands are free. The Applicator will open the top lid to the hopper and slide the pod over the mouth. The pod will automatically open via a spring-loaded mechanism as it closes the union with the hopper. This closed transfer system is a contingency to mitigate accidental spillage of loose projectiles within the aircraft. The empty pod will be placed back in the retention device.

b. The Applicator should change tanks when the gauge reads <1000 psi. To safely change tanks in-flight, the Applicator will notify the pilot of a tank change, then follow the sequence of steps outlined above in section h. Ground Operations, (3) Reloading, c. Propellant.

(7) Landing preparations and marker system disassembly: On all return flights back to the Heli-Base, whether to re-fuel and re-load or to conclude operations for the day, the Applicator will commence with the depressurization procedures as described above. Prior to landing the following system checks must be in place:

- Marker safety on
- Bolt decompressed (or electronically powered off)
- All tanks closed (valve pins unscrewed)
- All remote lines depressurized and secured to the connected tank

- Disconnect marker from the remote line
- Keep remaining projectiles in the hopper

(8) Ground-Based Reloading. HBT flight operations are limited by space available to store projectiles and propellant, as well as flight time between refueling. Projectile and propellant reloading should synchronize with helicopter refueling to maximize efficiency. The best approach to reloading consists of a complete swap of empty pods and tanks for full ones. Support staff can assist the Applicator with this change out.

- Empty pods and tanks may be refilled by ground support staff during flights. Both could be refilled by the time the helicopter again needs to refuel, facilitating easy reloading for the Applicator.
- Tanks can be re-filled with a cascade series of large capacity 3000 psi scuba tanks, see Appendix. Tanks shall not be re-filled in the helicopter, only on the ground.
- Projectiles should remain in their original container until needed to fill the pods for the next flight. This will minimize any damage to the projectile skins.

(9) Remove and disassemble HBT system after the final flight of the day, after the helicopter has completely shut down, with rotor stationary. Disconnect straps and holsters for each component of the marker system from the aircraft. Return projectiles to their original storage container. Tanks may be safely stored while pressurized.

j. Maintenance

Before beginning any maintenance, the Applicator shall disconnect marker from propellant, ensure that valve is depressurized, and ensure that no projectiles remain in the barrel. The Applicator is responsible for ensuring maintenance tasks are completed.

(1) Marker: follow manufacturer instructions for maintenance and inspection of marker. Visually inspect all O-rings for cracks/deformities, replace as needed, and lubricate with oil, wipe off excess. Visually inspect bolt mechanism for dirt/debris and signs of wear. Clean bolt, lubricate worn areas, and replace if damaged. Unscrew barrel and visually inspect interior and exterior for dirt and signs of wear. Clean using squeegee or barrel swab.

(2) Propellant: Visually inspect tank, ensure that O-ring has no cracks or deformities. Attach tank to marker and listen for sounds of air leaks, or use soapy water to inspect for leaks. If a flex hose is being used, ensure that the quick-disconnect mechanism is working properly. Ensure that tank has current VIP.

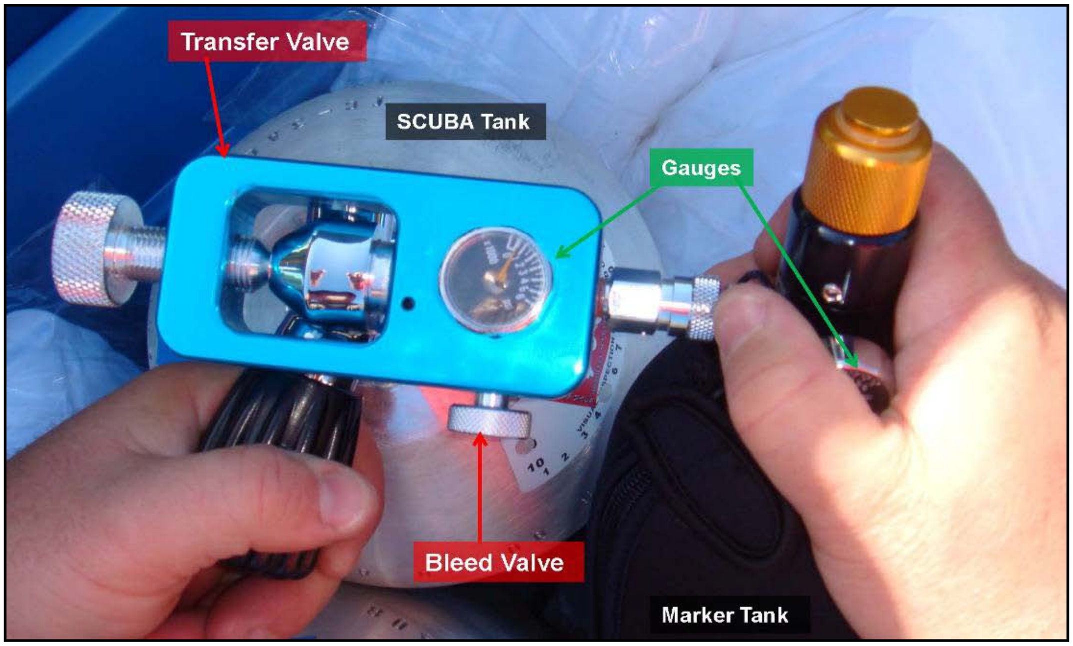
(3) Filling marker tanks from large storage SCUBA tanks: only trained personnel will fill marker tanks. Tanks will be inspected prior to filling. Eye and ear protection will be worn. See attached Appendix.

(4) All other HBT gear, such as harnesses, barrel blocking devices, hoppers, pods, etc, will be inspected for damage prior to and at the completion of each HBT operation.

HBT trial underway

Appendix: Filling Marker Tanks

1. Tanks used to fuel markers will be inspected prior to filling.
2. Ensure all valves are shut off.
3. Connect marker tank and SCUBA tank via transfer valve.



4. Ensure bleed valve is shut.
5. Open marker tank to be refilled.
6. Slowly open full SCUBA tank.
7. Listen and watch gauge to insure air transfer is occurring.
8. Close both tanks when transfer gauge and marker tank gauge read the same psi.

9. Open bleed valve to release pressure
10. Disconnect tanks.
11. If needed, boost marker tank. Follow same procedure described above on a SCUBA tank at a higher psi.

HBT Pre-flight Checklist

Date: ________________ Heli Manager: ____

List all staff involved:

NRMC	
Applicator	
Support Staff (note if ground only, or also riding in heli)	
DFF	

Review list with all involved staff. The entire right-hand column must be checked in the affirmative to proceed safely with the mission.

Standard pre-flight check conducted?		
Projectiles	Sufficient inventory?	
	Projectiles inspected for integrity? No lumps or dimples.	
	Stored in temperature and moisture resistant container at fill station?	
	Sufficient pods?	
Propellant	Sufficient volume at fill station for operation?	
	Fill stations tanks adequately pressurized?	
	Sufficient small tanks present?	
Marker System	Run full pod of projectiles to detached hopper; no obstructions.	
	Pressurize marker with an empty breach, discharge gas to ensure proper function.	
Safety and First Aid	Spill kit at fill station?	
	Water and soap for washing?	
	All pesticide PPE present?	
	All flight PPE present?	
	All staff briefed for operation?	
	Pilot briefed about operation and carrying of pesticides within helicopter?	
	Weather check conducted?	
Communication	Pacmere radios present and functional?	
	Helicopter radios present and functional?	
	Helmets fully functional?	
	In-flight communication system fully functional?	

Ensure all staff are prepared and ready to proceed.

HBT Pre-Ground Operations Checklist

Date: ________________ Trip Leader: ____

List all staff involved:

NRMC	
Applicators	
Support Staff	
Base	

Review list with all involved staff. The entire right-hand column must be checked in the affirmative to proceed safely with the mission.

Standard pre-flight check conducted?		
Projectiles	Sufficient inventory?	
	Projectiles inspected for integrity? No lumps or dimples.	
	Stored in temperature and moisture resistant container at fill station?	
	Sufficient pods?	
Propellant	Sufficient volume at fill station for operation?	
	Fill stations tanks adequately pressurized?	
	Sufficient small tanks present?	
Marker System	Run full pod of projectiles to detached hopper; no obstructions.	
	Pressurize marker with an empty breach, discharge gas to ensure proper function.	
Safety and First Aid	Spill kit at fill station?	
	Water and soap for washing?	
	All pesticide PPE present?	
	All staff briefed for operation?	
	Weather check conducted?	
Communication	Pacmere radios present and functional?	
	Talkabout radios present and functional; if needed?	
	Sufficient Rino GPS units present and functional?	

Ensure all staff are prepared and ready to proceed.

Appendix 3 Chapter 4 appendices

Appendix 3 contains supplemental information for Chapter 4. Contents of Appendix 3 include:

- Appendix 4-1: A reptilian smoking gun: first record of invasive Jackson's chameleon (*Chamaeleo jacksonii*) predation on native Hawaiian species, Holland, Montgomery and Costello, 2009
- Appendix 4-2: *Euglandina rosea* detection by dogs, February-March 2010, Hurt and Whitelaw (Working Dogs for Conservation), April 2010.
- Appendix 4-3: *Euglandina rosea* Exclosure Description

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APPENDIX 4-1: A REPTILIAN SMOKING GUN: FIRST RECORD OF INVASIVE JACKSON'S CHAMELEON (*CHAMAELEO JACKSONII*) PREDATION ON NATIVE HAWAIIAN SPECIES, HOLLAND, MONTGOMERY AND COSTELLO, 2009

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ORIGINAL PAPER

A reptilian smoking gun: first record of invasive Jackson's chameleon (*Chamaeleo jacksonii*) predation on native Hawaiian species

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Received: 29 September 2009 / Accepted: 11 December 2009

Abstract Here we report the first conclusive evidence of an introduced reptile (*Chamaeleo jacksonii*) feeding on Hawaiian taxa, including 11 snails in four endemic genera from two families, including four individuals of an endangered species (*Achatinella mustelina*), and native insects in five genera. Native Hawaiian invertebrates were discovered in the dissected stomachs of wild caught Jackson's chameleons collected from June to November 2009 on the island of Oahu. Although Jackson's chameleons were introduced to the Hawaiian Islands in the early 1970s, ecological impacts have never been documented. Of particular concern is the fact that chameleons have previously only rarely been found in native Hawaiian habitat, although 12 were recently collected in a mid-elevation native forest, an area that is not likely to be suitable for their long-term persistence, but that is adjacent to higher elevation pristine forest where endemic prey are abundant and favorable climatic conditions exist for chameleon persistence. One concern is that Jacksons's chameleons may be undergoing a range expansion into upper elevation pristine forests. If chameleons reach and establish populations in these areas, devastating impacts to the native ecosystem are possible. A thorough understanding of the impacts of chameleons on Hawaiian fauna will require additional evaluation and sampling, but dissemination of this discovery in a timely fashion is important as it provides new information regarding this threat. Monitoring and collection of chameleons is ongoing, particularly in native Hawaiian forest habitats at mid and upper elevations (600–1,300 m).

Keywords *Achatinella mustelina* · Oahu tree snails · *Auriculella* sp · Impacts of introduced predators · Conservation · Native Hawaiian insects

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Introduction

Jackson's chameleons, *Chamaeleo jacksonii* (Boulenger 1896) are native to high elevation montane habitats in Kenya and Tanzania (Necas 1999). Optimal foraging strategy studies suggest that chameleons behaviorally maximize the diversity of prey for energetic and nutritional balance (Eason 1990). In their native habitat, Jackson's chameleons prey on flying and crawling insects, centipedes, isopods, millipedes, spiders, lizards, small birds, and snails. In the early 1970s, chameleons became part of the pet trade in Hawaii. In 1972 a licensed pet shop owner in Kaneohe on the eastern side of Oahu imported several dozen chameleons from Kenya. Upon arrival of the shipment, the lizards were in poor condition, appearing dehydrated, and were placed outdoors, effectively releasing them and constituting the first and only known introduction of Jackson's chameleons in the state of Hawaii (McKeown 1996). In subsequent years, chameleons were transported within and among the islands as pets; their inter-island transport remained unrestricted until 1997. Established populations were first documented on Lanai and Kauai in the mid 1990s, and today multiple, self-sustaining and possibly increasing populations are present on all of the main islands, predominantly in wetter habitat from 100 to 1,000 m elevation, with substantial established populations on Oahu, Maui, and the island of Hawaii. Here we present the first documentation of wild Jackson's chameleons preying on native Hawaiian invertebrates.

Materials and methods

We examined stomach contents of Jacksons's chameleons captured from mid-elevation endangered tree snail habitat at Puu Kumakalii in the Schofield Barracks Forest Reserve just north of Kolekole Pass in the Waianae Mountains on the western side of the island of Oahu (Fig. 1) in June 2009. The first chance encounter occurred during a survey for rare and endangered native tree snail populations. Subsequent surveys were conducted with the goal of searching for Jackson's chameleons. Chameleons were collected by hand from native trees alongside rare native snails, transported back to Honolulu and were humanely euthanized and dissected. Gut contents were examined under a dissecting microscope.

Results

In total, 12 Jackson's chameleons were collected. The stomach of one of the chameleons (Fig. 2A) contained a single specimen of the endangered Oahu tree snail species *Achatinella mustelina* (Achatinellidae, subfamily Achatinellinae), and four individuals of another endemic Hawaiian achatinellid, *Auriculella* sp. (subfamily Auriculellinae; Fig. 2B). Another chameleon, collected during the same survey, had a single specimen of *Lamellidea* sp., another endemic achatinellid (subfamily Pacificellinae), in the stomach. During a subsequent survey in the same area, a chameleon was collected, and when dissected was found to contain two *Auriculella* sp., two *Achatinella mustelina*, and a single specimen of a native helicarionid, *Philonesia* sp. In nearly all cases in which snail remains were found, shells were intact with some traces of soft tissues remaining. The fact that shells were not crushed suggests that these snails were swallowed whole.

In addition to snails in gut contents, we identified legs, wings and other body parts of the following five native insect genera: *Banza* sp. (grasshoppers), *Hyposmocoma* sp. (case-bearing caterpillars), *Oliarus* sp. (planthoppers), *Oodemas* sp. (beetles), *Pantala* sp.

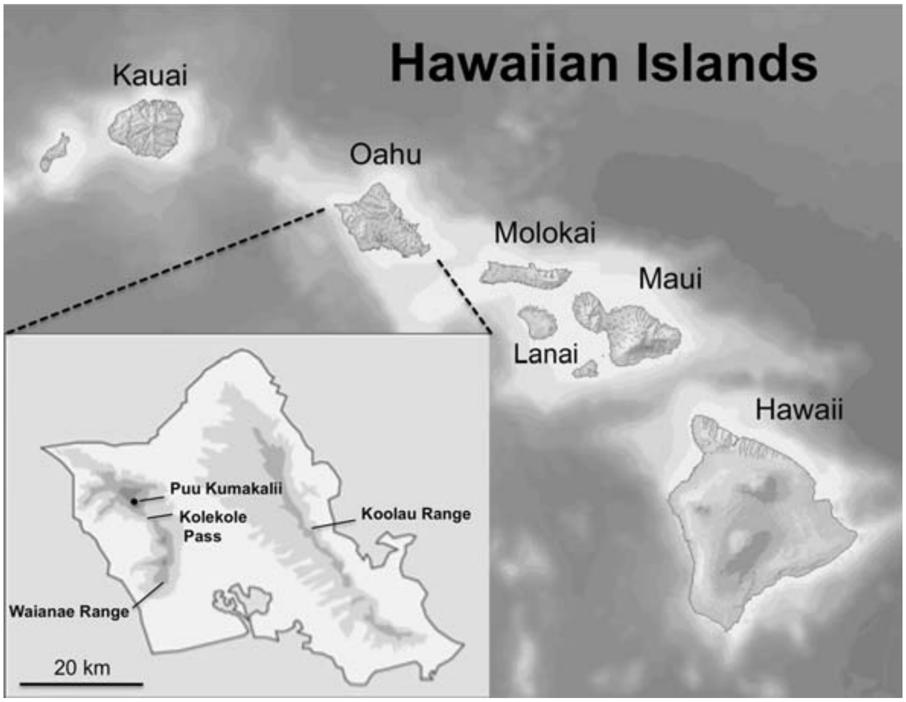

Fig. 1 Map of the Hawaiian Islands with detail of Oahu inset, showing sampling location of Jackson's chameleons. On Oahu, endangered tree snail habitat is indicated by the *darkest shading* in both Koolau and Waianae mountain ranges, representing elevations of about 900 m and higher. The elevation of the Puu Kumakalii locality is about 850 m

(dragonflies). The presence of dozens of wings of *Oliarus* indicates that planthoppers comprise a major dietary component in this area.

Discussion

Although Jackson's chameleons are classified by the State of Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife as "injurious wildlife", and export as well as inter-island transport has been prohibited since 1997 (Hawaii Administrative Rule Section 13-124-3), published studies demonstrating their impact on native Hawaiian fauna are lacking. However, this has not prevented speculation on the ecological impacts of these predators, ranging from claims that they have beneficial effects by controlling invasive pest arthropods, to theories that they are harmful by directly preying on threatened native fauna. Until now such threats remained unsubstantiated. Meanwhile no restrictions have been imposed on selling and or keeping chameleons as pets, and they can readily be found in pet stores throughout the islands. A noted local herpetologist summarized his assessment of the threat to native Hawaiian fauna as follows: "In Hawaii the versatile but low density Jackson's chameleon feeds on a wide variety of primarily introduced species of insects and other invertebrates including, but not limited to grasshoppers, crickets, flies, bees, butterflies, moths, beetles, cockroaches and spiders." He went on to state, "During hundreds of hours of field observations of this species in Hawaii, the author has seen nothing to indicate it will negatively impact endemic species of invertebrates" (McKeown 1996).

Fig. 2 (**A**) Closeup of adult male Jackson's chameleon collected in the Waianae Mountains on the Hawaiian island of Oahu, showing endemic snail shells for scale. (**B**) Hawaiian land snail shells removed from chameleon stomachs: the three smaller shells to the left are endemic *Auriculella* sp., not shown are one additional *Auriculella* sp. shell that had deteriorated further than the other three, and one minute shell of *Lamellidea* sp. ($\sim$1 mm shell length); these shells were all from the same individual. The larger shell on the right is a subadult specimen of *Achatinella mustelina*, an endangered Oahu tree snail. During a subsequent survey in the same area, a chameleon was collected and found to contain two *Auriculella* sp., two *Achatinella mustelina*, and a single specimen of a native helicarionid, *Philonesia* sp

The Oahu tree snail genus *Achatinella*, which once comprised 41 endemic species, has been listed as endangered since 1981 (USFWS 1981), and all extant species in the genus are currently categorized as Critically Endangered on the IUCN Red List (2009). At present 10 of the original 41 tree snail species are extant. Factors leading to the high extinction rate in Hawaiian tree snails include historical shell collecting, habitat degradation and loss, and predation by intentionally released, failed biocontrol species (Hadfield 1986; Holland et al. 2008). These factors coupled with the particularly slow growth, development, and fecundity of *Achatinella* spp. lead to nearly non-existent recovery potential when populations crash. Topping the list of modern day threats are invasive predators such as the rosy wolf snail (*Euglandina rosea*), rats (*Rattus exulans*, *R. norvegicus* and especially *R. rattus*), and the predatory triclad flatworm (*Platydemus manokwari*). In light of the discovery presented in this paper, an additional species should be added to this list.

Much remains to be determined in terms of making an accurate assessment of the threat posed by Jackson's chameleons in Hawaii, and further work is planned. For example, little is known about their precise range, elevation preference, reproductive season and rate, desiccation tolerance, and prey preference. Jackson's chameleons occur in lower to mid-elevation non-native forests on Oahu, and have rarely been reported from tree snail habitat, which tends to be upper elevation dominated by native flora beginning around 600 m above sea level. The observations presented provide conclusive evidence that when chameleons are present in native forest where tree snails and other endemic invertebrates occur, they pose a threat.

It is possible that due to a number of factors, such as prey availability and distribution, changing climatic conditions, recent population establishment due to pet release or escape, Jackson's chameleons are undergoing a range expansion into upper elevations. This is a concern for a variety of threatened and endangered invertebrate species, including tree snails (*Achatinella* spp.), pomace flies (*Drosophila* spp.), rare damselflies (*Megalagrion* spp.), and rare amastrid and succineid land snails, all restricted to upper elevation forests such as Mt. Kaala Natural Area Reserve adjacent to the sampling locality. Prior to this discovery, as part of an ongoing collaborative study, one author (BSH) has collected several hundred chameleons, and gut contents are being examined from populations in the Round Top/Tantalus area of the Koolau Mountains, Honolulu, on eastern Oahu (Whiting et al. in prep). Endangered Oahu tree snail species have not been observed in this region in several decades. It is conceivable that predation by Jackson's chameleons may have played a role in the local extinction of *Achatinella* spp. in this area.

Acknowledgments We thank Mike Walker and Mandy Hardman for field assistance, Joy Browning and Mike Hadfield for discussions, and Anita Manning, Timothy Pearce and Robert Cowie for helpful comments that improved this manuscript. BSH was supported by a grant from the US Army Directorate of Public Works during this study.

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APPENDIX 4-2: *EUGLANDINA ROSEA* DETECTION BY DOGS, FEBRUARY – MARCH 2010, HURT AND WHITELAW (WORKING DOGS FOR CONSERVATION), APRIL 2010

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Euglandina rosea detection by dogs, February-March 2010

Prepared by: Aimee Hurt and Alice Whitelaw (Working Dogs for Conservation)
406-529-1943/406-285-9019
For: Kapua Kawelo and Vince Costello, (Oahu Army Natural Resources Program)
April 18, 2010

Summary:
Between 20 February and 20 March 2010, Working Dogs for Conservation (WDC) continued training and fielding of two conservation detection dogs on the scent of *Euglandina rosea* in the Wai'anae Range on Oahu, Hawaii.

The purpose of this report is to summarize the training and fielding activities of 2009/2010, and provide recommendations for future use of dogs to detect *Euglandina rosea*. Accompanying this report is a spreadsheet of the training and trial results for 2010.

Summarized training activities:

Dog	2009 # rewards for Euglandina	# rewards for Euglandina in Montana between 2009 and 2010	2010 # rewards for Euglandina In Hawaii	TOTAL # rewards for Euglandina
Tia	237	35	115	387
Tsavo	201	n/a	n/a	201
Wicket	255	74	98	427

In 2009, we performed a variety of training scenarios with three dogs including: known line-ups; blind area (placed snails); blind area (wild and untouched, but previously located); piles of multiple snails to increase amount of odor; known area; blind area with wild snails; 'point of last seen' searches where the snail was once seen but has gone missing; placed snails contained in place overnight; and placed *Euglandina* in proximity to other placed non-target snails (African, and small sea snails). Finally, we performed searches in areas not yet searched visually by people in order to mimic more realistic search scenarios.

Dogs completed the 2009 season detecting snails in a training scenario and performing unprompted alerts upon locating a snail in order to inform the handler of the find. We conducted a few searches for wild snails and did find some wild snails at the rate equal to human visual searchers. However, we hoped that through repeated exposure to *Euglandina* that the dogs would become more sensitive to the scent and be able to either increase detection distances or reduce the number of times they needed to have their noses close to the snail before detecting them (termed "number of approaches"). To this end, we then continued training back in Montana and returned to Oahu in 2010.

For this 2010 season we did only a small number of known line-ups and then moved to known area and blind area searches with placed snails with two dogs. After the first few days, we started working only with wild, unhandled snails as well as doing more searches where the area had not already been scanned by people searchers. The additional objectives for this year were to increase the number of repetitions and reward opportunities, work the dogs in variable vegetation types and forest floor debris, maximize the length of time dogs could work, support nose-to-ground search behavior, and field dogs in a manner which might represent ways in which they would be fielded should dogs be used in actual searches.

We did not see a notable increase in detection distance. Because we worked with so many wild snails whose locations were unknown to the handler, we were often not able to track the number of approaches required. However, we noted improvement in search behavior, notably the ability of the dogs to keep their noses on the ground thus improving search efficiency.

Field testing 2010:
We completed the 2010 season by visiting an area (Land of 10,000 Snails) where both *Achatinella* and *Euglandina* are present and which will be the site of a new exclosure which will house *Achatinella*. Vince Costello has data on how many *Euglandina* of small (under 25mm) and large (25mm and over) have been located over how many person-hours of searching during 10 visits over the last 15 months. We searched with the dogs and then compared our results to these data from human visual searchers. We also went to an area near an existing exclosure in Kahanaha'iki where people regularly search small areas for *Euglandina* at the base of trees known to house *Achatinella*. In the Kahanaha'iki area, dog results matched that of people: finding no snails where people typically don't find snails, and finding one snail in areas where people usually find one snail.

Results from the Land of 10K Snails are as follows:

	people	Aimee/Wicket	Alice/Tia	Combined Dog
# Eugl found <25mm	119	18	6	24
# Eugl found >25mm	206	4	3	7
Total Eugl found	325	22	9	31
Hours searched	140	6.75	5.73	12.48
Avg Eugl/hour*	2.43	3.26	1.57	2.48
% small Eugl of total find**	39.5%	81.8%	66.7%	77.4%
% found "loose" as opposed to stuck on leaf/rock/root	Not recorded	72.8%	88.9%	77%
% dog found before people saw it	n/a	59%	44%	55%

*range of Eugl/hour for people: 1.4-3.78
** range of small Eugl relative to all found: 16-58.8%

We recognize that this is not a one-to-one comparison, because the searching was not conducted simultaneously and there is a much larger sample size for people than for dogs. However, when people and dogs try to search immediately following each other, the one who follows has a search that has been impacted by the one who searched before them- either the debris has been moved and the snail is more obvious for the second team, or the snail has been bumped and lost in a crack and less obvious for the second team, or has moved out of the area entirely. So we use this not as an absolute comparison, but as suggestive data.

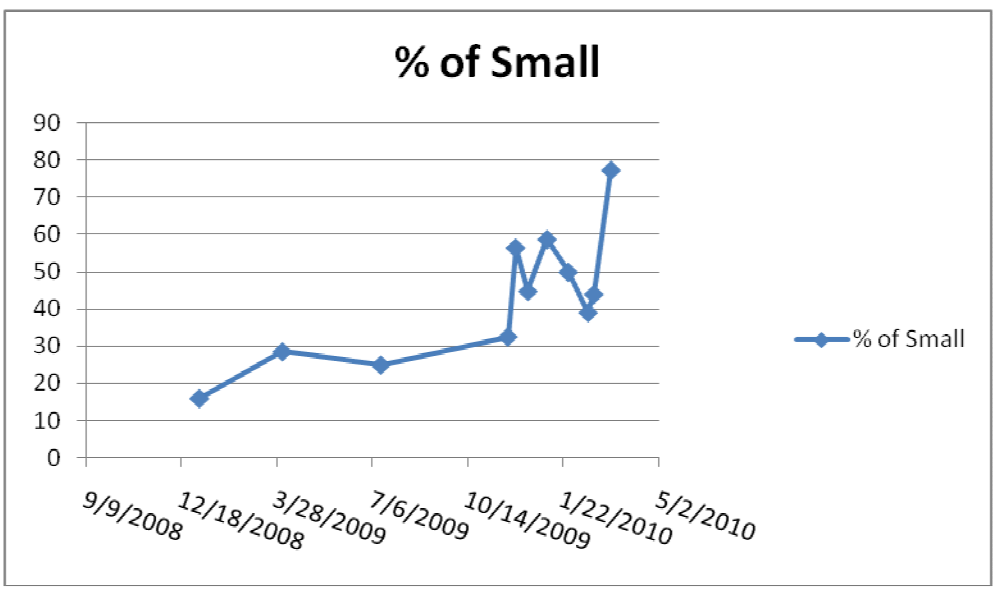
Also, our sample size in terms of number of hours searched is too small here to definitively indicate that there's a difference between the two dog teams, especially given that the teams searched different areas which had dramatically different vegetation and ground debris (e.g. recent cut of Christmas berry trees covered in logs and stick litter vs. pisonia patch, and pisonia patch vs. ieie patch). However, we wanted to present results from both teams in order to show the range of the results gathered.

“Hours searched” for dog teams include the time that the dogs are taking a break, since this is the practical deployed time. However, if we use only the actual time the dogs were searching, then dog team finds per hour would increase to 4.56 for team Aimee/Wicket or 1.96 for team Alice/Tia, or 3.3 snails per hour overall, which would exceed the per hour average for people searching visually.

Note that a “team” consists of one dog and one handler and each team is counted as one collective unit in time. Though the handler sometimes sees a snail before the dog smells it, the primary activity of the handler is to guide the dog, not comprehensively visually search for snails, and so is not considered an independent search unit.

Even though a team is one collective unit, we still track how often the dog finds the snail before the handler in order to track how each member of the team is contributing to the overall search. Over half of the time (55%), dogs detected snails before the handler saw it. This is in contrast to how it occurred in training, when only 22% of the time dogs found it before the handler saw the snail. This is likely due to a couple of reasons: 1) in training, snails used are often large and therefore more easily seen, and 2) even while doing “blind” searches in training where the handler doesn’t know where the snail is located, there is usually the expectation that a snail is there somewhere and it’s likely that the handler is visually searching harder during training than during hours of actual deployment. This is a good example of how training data is not necessarily representative of actual search data.

The most notable result is likely the percentage of snails less than 25mm found by dogs relative to people (77.4% and 39.5%, respectively). It is possible, even likely, that *Euglandina* demographics are changing in this area due to regular and frequent visits by searchers. It’s logical that the larger snails, which are more visually obvious than small snails, are becoming less abundant while more small snails persist. By graphing the percentage of small snails collected, we see that over the last few months the number of small snails found is trending upwards. However, even in this context, the final diamond represents the dog team finds and clearly stands out as a high number of small snails found.



It’s worth noting that ¾ of the snails located by dog teams were “loose”, as opposed to fixed on leaves or other objects. This could potentially be improved upon by additional training, or at the least, could be used to inform handlers of where they need to be looking as they supplement the dog's olfactory search for snails.

Overall, in all field tests we found that dog teams either matched or exceeded measures of human visual searchers.

Challenges, considerations, and lessons learned:

- Non-targets and empty shells: Aside from one training session in 2009 where dogs were exposed to sea snails and African snails in a lineup with *Euglandina*, we did not focus on training 'off' of non-target species. It appears that training with live *Euglandina* is sufficient for the dogs to learn to detect only live *Euglandina* and ignore non-targets. Dogs were observed sniffing empty *Euglandina* shells, *Achatinella* shells, and live slugs. Both dogs would alert to a freshly crushed *Euglandina* (e.g. stepped on by handler), but otherwise stayed on-target. Only one dog ever alerted to non-targets, but less than 1% of her alerts were on non-targets.
- Our assumption is that the *Euglandina* do not produce very much scent relative to the ambient environment as opposed to there being any reason inherent to the odor that makes it necessary for the dogs to be so close to the snails in order to detect them. We corroborated this assumption by showing that when piled together, thereby creating more odor, the dogs were able to find the snails from several meters away.
- Slope, ground cover, and debris all impact ease of detection. Steep slopes are challenging because the dog's feet are likely to be slipping and pushing the ground debris, and any hidden snail, down the slope. Ground cover can be varying depths and unless the handler helps move debris for the dog, snails deeper than the first inch or two will likely go undetected. Also, some leaf duff is strongly aromatic or actively decomposing and gives off strong ambient odor which masks the snail odor. Debris comprised of sticks is too heavy for the dog to effectively push aside for independent searching. Kukui nuts are likewise heavy for the dog to push out of the way, and also appear to have a tactile feel upon the dog's nose similar to that of *Euglandina*. Throughout the course of training all three dogs would sometimes spend more time in kukui debris as they needed to roll the nuts around against their noses and in early training sometimes alerted to kukui nuts. Rocky washes can be challenging because often dogs will knock a snail off of a rock with her body or tail, which then falls deep into a crevice between rocks before the dog gets a chance to smell it.
- Snails loose on the ground appeared to be more detectable than those affixed to leaves or other surfaces. It's likely that there's less odor escaping from a snail that is affixed to a surface than a snail whose fleshy parts are exposed at the shell opening as on a loose snail. Also, as leaf litter is very easy for a dog to push around with her nose, as the dog tries to pinpoint the location of a snail on a leaf she often ends up nudging the leaf away and thereby losing the scent.
- Loose snails up against a root, log, rock, or other feature seem slightly more detectable than loose snails in the middle of an opening. They are less likely to be inadvertently nudged out of the way by the dog's nose, and also they have the opportunity to "catch" scent against the feature, creating a small "pool" of accumulated scent which is helpful for detection.
- Among the dozens of targets (live animal, scat, and plants) that WDC dogs have been trained to, *Euglandina* requires the most investigation by the dogs in order for them to be fully convinced that it is the correct target before alerting. This investigation comes in the form of having to directly contact the snail and either lick it, press it with their noses, or scrape their teeth against it. This need for tactile corroboration is unprecedented in our experience. Since this obviously

presents a danger to the snail, it does suggest that using dogs to locate invasive, unwanted snails may be appropriate, but likely would not be acceptable for native snail detection.

- Team variation- just as not all humans are equally effective at visually locating *Euglandina*, neither should all dogs be expected to perform equally. Since many of the targets are found by the handlers prior to the dog finding them, individual handler variation in ability to see *Euglandina* also will come into play as well as handler aptitude to maintain detailed searching and directing the dog effectively over time. So, while we can describe which snails are seen by the handler first versus those that are found by the dog first, the overall performance capability is a product of teamwork and not the dog or handler individually.
- Handlers are primarily focusing on the dog, and while they accomplish some degree of visual searching, it is not to the same extent that a person searching alone would be looking. This is because the handler has to conduct him/herself in a way to maximize the dog's searching (e.g. a handler may point out or move a bit of debris to gain the dog access to an area, but won't likely be able to thoroughly move all of the debris without excessively distracting the dog).
- While dogs can often search for many targets simultaneously, it's unlikely that a dog searching for *Euglandina* could successfully search for another target at the same time, unless the other target was another slug or snail likely to require the same degree of detailed searching and likely to inhabit the same area. This is due to the level of detail required; therefore the dogs just won't cover enough area to look for other targets.
- We conducted both "hasty" and "detailed" searches. During hasty searches we pointed out very few targets to the dogs and moved relatively quickly through the area. During detailed searches we watched the dog's nose to ensure she sniffed each square foot of the area. Hasty searches produced very few finds and so detailed searches appear to be the best use of time. However, at the Land of 10K Snails, the areas were too large to have the dog cover every square foot in our given time. In that case, a detailed search consisted of the handler choosing to walk through some areas in favor of having the dog more heavily search other areas. This is consistent with how human visual searchers allocate their search time as well, but may not ultimately be the best deployment method for dogs. We recommend that future teams, if deployed, continue to experiment with search strategy.
- While in the Land of 10K snails, it appeared as though small snails maintained a "clumped" distribution: where we found one there were others. One effective search tactic then may be for dog teams to locate a new "clump" area, and then visual searchers come behind and comprehensively comb that area for additional snails.
- We primarily worked in morning to early afternoon. *Euglandina* detection may be susceptible to microclimate conditions given the level of detail required to locate them, and daily variation in temperature and humidity create different predictable air flow patterns. Therefore, it would be worth trying night searches.

Recommendations:

We feel these results demonstrate that dogs can be trained to detect wild *Euglandina rosea* in natural environments on Oahu. They clearly demonstrated the ability to recognize *Euglandina rosea* scent, work towards it from limited distances to pinpoint the source of the odor, ignore other odors present in the area, and communicate the location of the *Euglandina* to their handlers.

In order to detect the snails, the dogs needed to keep their noses pressed to the ground with very rapid successive sniff/exhalation cycles. Dogs were most successful at detecting snails when they could sniff them directly and might find them at a distance of up to 12 inches away. We do not believe that additional repetition or experience would increase the detection distance significantly for any dog, because the dog must consistently contend with the rather faint odor of the snail in the context of a rich background odor (pungent soil and vegetation and decaying ground debris). Additional experience for these, or any, dogs would improve is the length of time that the dog is able to search without breaks, and improved search behavior (keeping nose-to-ground throughout the search, self-targeting crevices). This results in a very detailed level of searching wherein the handler is very involved pointing out crevices and features for the dog to check as well as moving rocks and ground-covering debris out of the way so that the dog can access the area with its nose. Because of this, it takes a relatively long time for dogs to search fairly small areas. Additionally, because of this high detail and slow speed of the search, often the handler sees the snail before the dog smells it.

Therefore, we think there are some applications for which dogs may be a helpful additional tool for OANRP but because field tests did not show that dogs vastly exceeded human visual searchers we do not see the day-to-day utility of dogs being sufficient to recommend OANRP contract with WDC to establish OANRP's own *Euglandina* detection dog program. Based on our searches, we think dogs are likely to be the most valuable searching areas which are destined to become *Achatinella* exclosures and where *Euglandina* need to be systematically removed from the area, or other areas of high *Euglandina* density for which the larger snails in the population have been located and smaller *Euglandina* remain, as this is the search scenario in which the dogs appeared to have the potential to surpass human searchers. Dogs appeared to have results on par with human searchers in conducting small area searches underneath trees known to contain *Achatinella*. Though not measured directly, it does not appear that dogs would be very helpful in locating new areas of *Euglandina* infestation. This is because in order to locate new areas, a lot of ground must be covered quite quickly and the dogs do not locate *Euglandina* while moving quickly through an area or when their heads are above ground level, which is the head position of a dog walking through the forest. Also, because of the short detection distances, dogs will not be an effective tool for finding *Euglandina* in trees above the height where the dog can directly sniff the trunk or branch (and even this level of tree detection will require the dog to have repeated training with snails on trees).

Should OANRP desire to continue to employ dogs in these suggested applications, we recommend continued contracting with WDC and trying out an on-island source for detection dogs. Though we haven't personally seen the dogs of Kris Lesperance, after spending hours with her, we find her to be credible and experienced with various detection targets and is the local trainer we suggest for working with OANRP. Each option confers advantages: by continued contracting with WDC we can send our highest-performing team which would be able to engage in *Euglandina* detection with minimal (1-2 day) reminder training prior to deployment. We have a baseline determined for this team and therefore have realistic performance expectations, as well as an intimate understanding of the time and training already invested into *Euglandina* detection. By working with a local source, transport and lodging costs are greatly diminished and the dog(s) will be fully acclimated to Oahu as well as more readily available for frequent short-term deployments if needed. Perhaps the option to offer the greatest assurance to OANRP to meet short-term needs and ensuring future team availability—if future teams are required after the creation of the next planned exclosure area—would be to use both WDC and the local source for the next exclosure area, where WDC would be able to bring the calibrated team and also be available to personally share experiences with the local source.

We at WDC are thankful for the opportunity to puzzle through *Euglandina* detection with OANRP, and hope that we can continue to be of assistance as you determine if and how detection dogs have a role in your efforts to protect *Achatinella*.

APPENDIX 4-3: *EUGLANDINA ROSEA* EXCLOSURE DESCRIPTION

The following sections describe the beginning approach taken by OANRP to exclude *Euglandina rosea*. These preliminary results were presented to potential New Zealand contractors. OANRP is now in the final stages of awarding a contract to construct these barriers in two sites, at Puu Hapapa and Poamoho.

Fence design specifications: The backbone of this fence will be a rat/mouse proof fence based on patented designs from qualified and proven companies such as Pest Proof and Excluder. This fence must have all the necessary components to ensure ungulate and rat/mouse exclusion including a buried section, mesh of an appropriate size, a hood, sturdy construction and long lasting (20 year) galvanized and/or stainless steel components. Poamoho will not be within a larger panel/hog fence. Overall the fence must be at least 1.3 meters high. See pictures below, note the fences shown in photos are taller than what will be built for *E. rosea*, rats and mice.

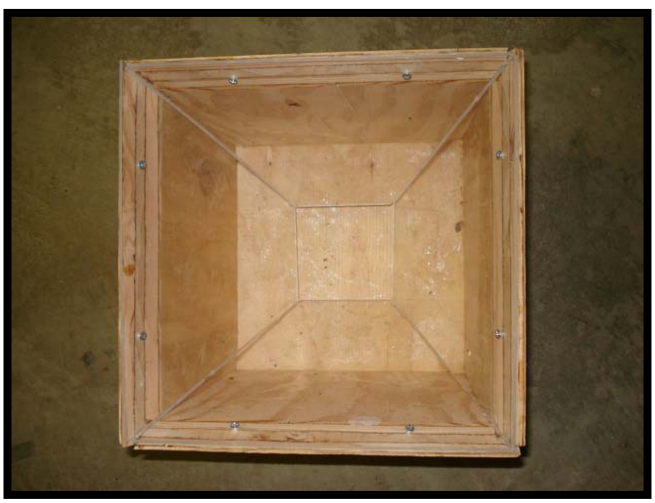
Excluder Fencing

Pest Proof Fencing

***E. rosea* barrier specifications**: The typical predator type fence shown above will be enhanced with additional barriers to exclude *E. rosea*. They will be mounted on a solid stainless, copper or synthetic panel secured to the bottom third of the rat/mouse fence. This barrier must be continuous to ensure juvenile *E. rosea* cannot penetrate it.

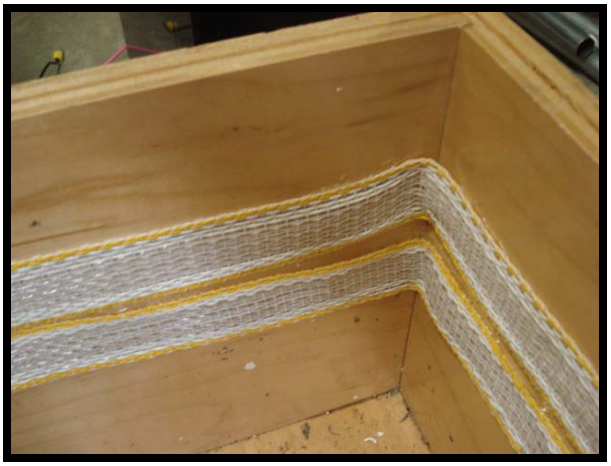
This is the first time that fencing integrating these types of barriers will be constructed. Therefore, there is not an established specification for construction. OANRP has been experimenting with these barriers for some years and has developed the guidelines below. However, OANRP does not have extensive experience in fence construction beyond ungulate type fencing. Therefore, OANRP will collaborate in finalizing the design components of this portion of the fence once the project is awarded. When bidding the project companies should include the cost of this 'design' aspect. Below OANRP describes the parameters of these barriers as developed so far. With this strategy it is the intent of OANRP to utilize the contractor's expertise to collaborate on the final design of these components.

Angle Barrier: The angle barrier is the simplest of the barriers to be installed. A smooth piece of copper or stainless flashing will be attached to the vertical wall of the fence such that it extends down at an angle of 15-20% and at its terminal edge is at least 7 cm from the wall of the fence. These specifications require a flashing of approximately 20-30 cm depending how it is secured. The picture below illustrates the angle barrier inverted to facilitate testing. Corners on the fences should likely be rounded to avoid having to join materials as seen below.



Angle box in lab

Electric Barrier: Using a low voltage barrier has proven to be an extremely efficient method to exclude *E. rosea* in laboratory tests. On small scale trials as illustrated in the picture below two sixteen-wire livestock tapes are glued in parallel to the vertical surface. In alternating sequence eight wires from each tape are then joined to the positive then negative pole of two 12 volt batteries in series for a total of 24 volts.



Livestock tapes mounted in test box

Test box with 12 volt batteries

When *E. rosea* attempt to cross these wires they are effectively deterred by the low current and low amperages encountered. There are a couple of aspects of this barrier that are still under investigation and design. First, a reduced charge encountered by the *E. rosea* at increasing distance from the battery is still under investigation. To ensure that the barrier remains effective it may have to be boosted intermittently along the length of the fence using larger diameter insulated wiring. The best mounting mechanism for the system has yet to be determined. The system must allow for easy maintenance and repair, but must not compromise the integrity of the barrier. The tape must be mounted flush or with 2-3 mm of the vertical surface and must not have any fasteners that bridge the tape allowing for a safe passage across the wire barrier. Currently OANRP has used construction adhesive to fasten the tapes; however this will not allow for maintenance and should be considered a last resort.

Photovoltaic system: To ensure batteries stay charged on site and maintain an effective barrier a simple PV system will be required.

Cut Wire Mesh Barrier: This is the most effective physical barrier that has no electric components. This barrier works by presenting a surface that does not provide adequate adhesion as *E. rosea* traverses it upside-down, thus the snail falls to the ground. The barrier must be fastened to the vertical wall in a perpendicular orientation such that the *E. rosea* must traverse it upside-down and to prevent debris from accumulating on the surface. The grates must be spaced close enough to force *E. rosea* of all sizes to pass over and not through. There are no strict parameters around the fabrication of this barrier. However, it must be constructed out of a long lasting synthetic backing and with copper or stainless components to ensure durability. Specifications are presented below. As discussed with the angle box it may be best to construct this barrier along rounded corners to ensure no gaps in presentation.

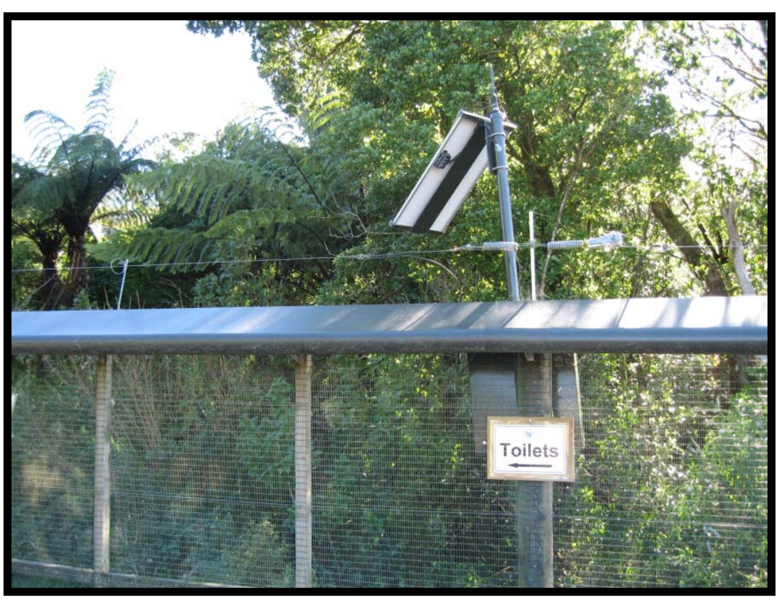
This shows the test box barrier upside-down. *E. rosea* were placed in the box and encountered this barrier as they came up the vertical sides and onto the roof of the box.

This is a close up of the barrier constructed with copper screen mesh mounted no more than 4-5 mm apart for a total width of no less than 8 cm.

This picture shows the copper screen presenting a grid of 12 rows of shredded screen.

Barrier sequencing: Currently OANRP staff are still discussing the best barrier arrangement. A hood may also be required over these systems as protection from the elements and to prevent accumulation of debris.

Site Monitoring: With so much invested in the development and construction of these fences a remote monitoring system must also be included to ensure continuous barrier integrity in remote areas. This system must be remotely accessible and updated on the following parameters. First, the system must indicate if there has been anything that has fallen across the barrier. This can be accomplished by using a grounding ring system or something comparable. See picture below.



Second, the integrity of the PV system including the condition of the batteries must be monitored. Third, a weather system to monitor basic environmental conditions to include temperature, wind speed, direction and gust velocity, humidity and rain fall must be included. These parameters can be measured by many types of commercially available weather stations.

APPENDIX 4 CHAPTER 7 APPENDICES

Appendix 4 contains supplemental information for Chapter 7. Contents of Appendix 4 include:

- Appendix 7-1: Invasive Ant Monitoring Protocol
- Appendix 7-2: Final Report: Survey of invasive ant species within Makua and Oahu Implementation plan management units, Oahu, Hawaii 2004 - 2009

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APPENDIX 7-1: INVASIVE ANT MONITORING PROTOCOL

Index cards (3 X 5 inches) containing SPAM, peanut butter and honey will be spaced along the edges of, or throughout, the area to be sampled. Each card will be placed so that it is halfway out of a ziplock "sandwich" bag. This maximizes your chances of capturing all ants present on the index card. Make sure all cards are separated by at least 15 meters. Only a small amount of each type of bait is necessary for each card. A minimum of 10 bait cards will be deployed at each site. Label each card with date, location, card # and collector name prior to placing cards in sampling areas. Target areas of increased human activity such as trails, campgrounds and picnic areas when possible. Always place cards in the shade. Deploy cards no earlier than 8:00 am in the morning and avoid sampling on rainy, blustery or cold days as both rain and low temperatures reduce ant activity. Should foraging ants be seen in the area prior to bait deployment, conditions are likely fine for sampling. Leave baits out for at least 1 hour. Pick up baits rapidly by slipping the card into its accompanying ziplock and immediately closing the ziplock. Make sure the bag is completely closed or you will have ants exploring your backpack. Place the bags in freezer for latter identification.

(With input from S. M. Plentovich and P. D. Krushelnycky (University of Hawaii at Manoa)

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APPENDIX 7-2: FINAL REPORT: SURVEY OF INVASIVE ANT SPECIES WITHIN MAKUA AND OAHU IMPLEMENTATION PLAN MANAGEMENT UNITS, OAHU, HAWAII 2004 - 2009

Final Report

Survey of invasive ant species within Makua and Oahu Implementation plan management units, Oahu, Hawaii 2004 - 2009

Completed by:

Sheldon Plentovich

Department of Zoology

University of Hawaii, Manoa

April 2010

Summary

Invasive ants have had devastating effects on biodiversity in the Hawaiian Islands, however information on new ant infestations and spread of existing populations into native communities is incomplete. Here we used bait cards to survey and identify invasive ant species on Makua and Oahu Implementation Plan Management Units on the island of Oahu. Twenty species of invasive ants were identified at 45 sites during 67 surveys conducted between 8 February 2004 and 7 October 2009. Survey sites ranged from sea level to 1220 m (4002 ft). Ants were abundant at most survey locations with the exception in some high elevation sites. Notably, the Mt Kaala boardwalk was surveyed twice and no ants were found on either occasion. As a result of nonrandom survey locations biased for upland habitat, the Papuan thief ant (*Solenopsis papuana*) was detected at more locations than any other species. The big-headed ant (*Pheidole megacephala*), yellow crazy ant (*Anoplolepis gracilipes*), and glaber ant (*Ochetellus glaber*) were also widespread. *Pheidole megacephala*, which tended to occur in the greatest numbers in areas it inhabited, compared to the other common species, and *Anoplolepis gracilipes* pose the most serious threats to intact native forests. Isolated infestations of these two species were identified and

control or eradication efforts may be warranted (see recommendations). Seventeen ant sampling locations containing five ant species (*P. megacephala*, *Plagiolepis alluaudi*, *O. glaber*, *S. papuana*, *Technomyrmex albipes*) were within a 50-m radius of known tree snail (*Achatinella* sp.) locations. There was a high degree of overlap among tree snails and *S. papuana*, possibly indicating some level of tolerance. However, other species of invasive ants were rarely surveyed in proximity to tree snail populations. These sites need to be carefully monitored as they may represent new invasions (especially in the case of *P. megacephala* along the fenceline at Ohikilolo) that could be addressed using ant control methodology. Based on the catastrophic effects ants have on many other invertebrates paired with anecdotal observations of ants negatively affecting tree snails reported here, research on the potential impacts of ants on tree snails is warranted to effectively conserve tree snails on Oahu and elsewhere.

Introduction

Ants (Hymenoptera: Formicidae) are not represented in the native fauna of the Hawaiian Islands (Wilson 1996). Since humans began to colonize the archipelago over 45 species of ants have been introduced (Nishida 1992; Krushelnycky *et al.* 2005; http://www.antweb.org/Hawai`i.jsp) and some species have had devastating effects on native ecosystems (Perkins 1913; Zimmerman 1970; Howarth 1985; Cole *et al.* 1992; Gillespie and Reimer 1993; LaPolla *et al.* 2000; Krushelnycky and Gillespie 2008). Invasive ants can reduce, extirpate and possibly cause the extinction of arthropod species (Perkins 1913; Zimmerman 1948; Solem 1967; Risch and Carroll 1982; Cole *et al.* 1992, Gillespie and Reimer 1993; LaPolla *et al.* 2000; Hill *et al.* 2003; O'Dowd *et al.* 2003; Plentovich 2010), directly and indirectly harm vertebrates (Meek 2000; Holway *et al.* 2002; Davis *et al.* 2008; Davis *et al.* 2009; Matsui *et al.* 2009; Plentovich *et al*. 2009) and alter plant communities (Bach 1991; Green *et al.* 1997; Christian 2001; Hill *et al.* 2003; O'Dowd *et al.* 2003; Handler *et al.* 2007). In some instances invasive ants can alter the overall structure and functioning of natural communities (Christian 2001; Holway *et al*. 2002; Hill *et al.* 2003; O'Dowd *et al*. 2003; Krushelnycky and Gillespie 2008).

Due to the small size and cryptic nature of many ant species, information on species distribution in the Hawaiian Islands is limited (Wilson 1996). On the main islands, there seems to be lower abundances and fewer species at higher elevations, and some areas at the highest elevations remain uninvaded (Krushelnycky *et al.* 2005). Since the majority of Hawaii's native biota is confined to high elevation areas, there is a need to identify which ant species are present in native forests, and then identify threats those species pose to native biota. Once this information is available we can determine whether control or eradication efforts are warranted.

Although there is much evidence that invasive ant species [e.g., the yellow crazy ant (*Anoplolepis gracilipes*), the big headed ant (*Pheidole megacephala*), Argentine ant (*Linepithema humile*)] harm a variety of native invertebrates (Cole *et al.* 1992; Gillespie and Reimer 1993; LaPolla *et al.* 2000), there is no experimental information on the effects of ants on endangered tree snails (*Achatinella* sp.) which can be found within the Makua and Oahu Implementation plan management units. Solem (1976) observed that tree snails were not found in areas with "swarming ants", especially *P. megacephala*. Professor Robert Cowie and Dr. Ken Hayes have reported similar observations throughout the main Hawaiian Islands (pers. comm.). Solem (1976) believed ants would not be able to penetrate the apertural barrier of adult snails. Therefore, he attributed the absence of snails in areas invaded by ants to predation of juveniles. This seems logical, however there is also an observation of ants attacking adult snails. Professor Michael Hadfield observed an unknown ant species attacking adult tree snails (*Achatinella* sp.) that were being kept in a greenhouse in Lyon Arboretum in upper Manoa Valley, Oahu. These attacks caused biologists to move the snails to a different location where access by ants could be limited (M. Hadfield pers. comm.). These anecdotal observations indicate that at least some species of ants do attack tree snails and that they may be a factor in reducing populations. It is unclear whether all invasive ant species are potentially harmful to native snail populations.

The objectives of this effort were to 1) identify potentially harmful ant species present on Makua and Oahu Implementation plan management units, 2) provide locale data that can be used to determine which species overlap with known populations of threatened and endangered species, and 3) discuss ways to monitor sites for new infestations and to limit the spread of harmful species.

Methods

Survey Methodology: Index cards (12.7cm X 7.6cm) baited with potted meat (i.e., SPAM®), peanut butter, and honey were set in 45 sites on U.S. Army lands throughout Oahu between 8 February 2004 and 7 October 2009 (Figure 1). Survey locations ranged in elevation from sea level to 1220 m (4002 ft). The number of bait cards used at survey locations ranged from one to 30, depending on time constraints. Surveys often involved setting bait cards along an elevation gradient. A global positioning system was used to record longitude, latitude and elevation at each bait card unless forest cover precluded satellite acquisition. Surveys focused on areas with known populations of threatened and endangered species. Within these sites, special emphasis was placed on locations potentially serving as points of entry for invasive ants such as helipads, fence lines, camps, and out-planting sites. Survey coordinates were imported into ArcInfo and combined with locations of existing endangered tree snail populations to assess extent of overlap of invasive ants with tree snails.

Data Analysis: Density of individuals of each of the 4 common invasive ant species was compared using a Kruskal Wallis test. A nonparametric test was chosen because data were not normally distributed. Analyses were performed using JMP version 8 (SAS Institute Inc.).

Results

Twenty species of invasive ants were identified at 45 sites during 67 surveys conducted between 8 February 2004 and 7 October 2009 (Table 1, see Appendix 1 for raw data). Sites ranged in elevation from 6 m (19.7 ft) to 1220 m (4002 ft). *Solenopsis papuana*, *P. megacephala*, *Ochetellus glaber*, *A. gracilipes* and *Plagiolepis alluaudi* were the most commonly surveyed species respectively (Table 1). *Solenopsis papuana*, also called the Papuan thief ant, occurred at more than twice as many sites as the other ant species, however sampling effort was concentrated in upper elevation sites where habitat is more suitable for this species compared to other common species (Table 1). Nineteen surveys were done in low elevation sites from sea level to 406m (0 – 1,333 ft), five in mid elevation forests from 406 to 812 m (1,333 to 2,666 ft) and forty-three in upland forests above 812m (2,666 ft). A comparison of densities of each species within invaded areas showed that, although *P. megacephala* only occurred at 12 sites, it tended to occur in the greatest numbers in areas it inhabited compared to the other 3 common species (Kruskal-Wallis Test, ChiSquare = 9.9, df = 3, P = 0.018, Table 1).

Very few areas remained uninvaded by ants. Cards with no ants were found between 396.2m (1300ft) and 1219.2 meter (4000ft). The Mount Kaala boardwalk was the only site where ants were not found in repeated surveys. It is possible that other areas such Makaha (above 2200 feet) and the Helemano Fenceline, are ant free, but additional surveys are needed to verify this.

Seventeen ant sampling locations containing five ant species (*P. megacephala*, *P. alluaudi*, *O. glaber*, *S. papuana*, *Technomyrmex albipes*) were within a 50-m radius of known snail locations. *Solenopsis papuana* occurred at nine of the 17 locations, *P. megacephala* occurred at three, *P. alluaudi* at 2 and both *T. albipes* and *O. glaber* at one, and no ants were found at one.

Discussion

Twenty species of ants were found from sea level to 1112.8m (3,651 ft). Despite the general conception that some species of ants are limited to lowland areas, we found four of the five most common species (*P. megacephala*, *O. glaber*, *A. gracilipes* and *P. alluaudi*) distributed throughout the sampling area. *Solenopsis papuana* was the most commonly sampled species, but was confined to mid and high elevation sites. Unlike *S. papuana*, in elevations above 880m (2890 ft), *A. gracilipes* and *P. megacephala* appear to be confined to isolated sites disturbed by humans. *Anoplolepis gracilipes* was first sampled in January 2008 at the Nike Greenhouse in the Waianae Mountains. Multiple site visits suggest that the *A. gracilipes* infestation is confined to a relatively small (<1 acre) area within and around the greenhouse. *Pheidole megacephala* was found on at least three occasions in 2008 at Ohikilolo above 880 m (2890 ft).

This infestation may be confined to area around the fence-line, but additional surveys are needed to identify the boundaries of the infestation.

The presence of *A. gracilipes* and *P. megacephala* at high elevations in or near some of the last intact native forest is troubling. Although we do not have experimental evidence, observations by Solem (1976) and Hadfield (per comm.) indicate that some invasive ant species might cause declines in tree snails via depredation of adults, eggs, and juveniles. Solem (1976) believed ants would not be able to penetrate the apertural barrier of adult snails and therefore ants. Therefore, he attributed the absence of snails in areas invaded by ants to predation of juveniles. Additional observations by Professor Michael Hadfield confirmed that ants also attack adult tree snails.

There is significant overlap between endangered snail populations and *S. papuana*. Gillespie and Reimer (1992) observed extensive overlap between *S. papuana* and native spiders (*Tetragnatha* sp). They found a significant inverse relationship between the abundance of S. *papuana* in an area and the diversity of native spiders. In the present study, the quality of data collected on ants and tree snails precludes a similar analysis, however, it is possible that, although *S. papuana* does coexist with tree snails, the species may still have some negative effects. Regardless, there is currently no feasible way to eradicate *S. papuana* at this time.

The extirpation of native invertebrates by invading ants tends to occur soon after invasion. A study in Australia showed that the longer *P. megacephala* was present in study sites, the lower the macro-invertebrate abundance (Hoffmann and Parr 2008). Krushelnycky and Gillespie (2008) show that endemic species are lost soon after invasion by alien ant species. Species that survive the initial invasion tend to be relatively resistant to the invader. *Solenopsis papuana* was first recorded in Hawaii in 1967 (Krushelnycky *et al.* 2005). It is possible that tree snails and other extant invertebrates are somewhat resistant to extirpation by *S. papuana*. Although negative effects may sill occur, as observed by Gillespie and Reimer (1992), extant tree snails may be less likely to be extirpated by *S. papuana* since they survived the initial invasion.

Preventing new ant invasions into relatively intact habitat in Hawaii and specifically, within the Makua and Oahu Implementation plan management units, is vital for the future of those native communities. This can be accomplished with careful monitoring of sensitive sites and adjacent areas where introductions are likely to occur. Sites requiring special attention may include, but are not limited to camping areas, trails, fence lines, helipads, and roads. Many harmful invasive ant species, such as *P. megacephala* and *A. gracilipes* primarily reproduce via budding (i.e., mated females walk rather than fly to nearby areas to found colonies) vs. mated flights. In these cases it is relatively easy to identify areas of encroachment by invasive ants into native forest.

Recommendations

1) Map the boundaries of the *A. gracilipes* infestation at the Nike Site. This can be accomplished by either setting a grid of bait cards or, if ant numbers are high enough, by having 3 people walk the boundary of the infestation; the inside person staying within the infestation, the outside person staying outside the infestation and the middle person recording waypoints along the boundary. This method has been used on Christmas Island, Indian Ocean and in Australia to successful map invasion boundaries.

2) Attempt to eradicate *A. gracilipes* from Nike Greenhouse site.

Begin by conducting a bait preference trail using a variety of ant baits with a sweet or fishmeal base. Put 1g of each product on small squares of paper/plastic side by side, and time how long it takes the ants to take the entire product. It may take half an hour for an "attractive matrix". Another option is to weigh baits before and after leaving them sitting out for some period of time. The time period could range from 2 to 24 hours depending on the situation. Regardless of the method you choose, replicate at least 5 times. In general *A. gracilipes* is attracted to products with a fishmeal matrix, however, the species is known to be fickle, therefore, preference trials are necessary to maximize chances of successful eradication. Ideally the ants will be attracted to two different products, one with fipronil and the other with hydramethylnon as active ingredients. If this is the case, alternatively broadcast the products within the invaded area at 1 to 3 month intervals. Do three broadcasts starting and ending with the fipronil-based bait product. On Christmas Island, they found that low concentrations of fipronil (0.00015%) work as well as high concentrations (eg., 0.1%). You can expect about a 99% control rate for each broadcast. Spot treatments will be necessary to achieve eradication. It may also be possible to use bait stations instead of broadcast to eradicate this species.

3) Identify areas of encroachment by *P. megacephala* into native forest. Control using hydramethylnon suspended in a corn-grit matrix (eg., AMDRO®) if warranted. Apply according to label specifications.

4) Use bait cards to conduct yearly monitoring of sensitive areas so that any new infestations can be identified and addressed.

Ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads. Areas undergoing construction of fences or other structures should be carefully monitored for new introductions. Activities including the transfer of soil, such as out-planting, should also be carefully monitored. Careful monitoring will increase chances of early detection, and early detection is the key to successful eradication or control.

5) Conduct additional surveys of high elevation sites in the Koolau Mountains.

High elevation sites in the Koolau Mountains were not well surveyed during this effort. Additional surveys are needed to identify ant species present in these areas and potential risks to resources.

6) Protect the Mount Kaala boardwalk area from invasion by ants.

Our data indicate that invasive ants have penetrated almost all areas with the exception of the highest elevation sites with intact native communities, such as the boardwalk area of Mount Kaala. Although ants were found at the gated entryway to the bog, none were found along the boardwalk. Every effort should be made to keep ants from penetrating this habitat. These efforts should include limitation of any activities, such as fence building that include disturbance. If these activities must take place, careful monitoring of invasive ants should occur and may be necessary to control some species until disturbed habitat is allowed to recover.

7) Conduct additional research on the effects of invasive ants on tree snails.

Based on the catastrophic effects ants have on many other invertebrates, research on the potential impacts of ants on tree snails is necessary to effectively conserve these species on Oahu and elsewhere. Comparison of tree snail numbers in sites where ant densities are experimentally reduced vs. unmanipulated sites could reveal negative effects of ants on tree snails. Ant species should be carefully considered, as some ant species such as *A. gracilipes* and *P. megacephala* are likely to be far more detrimental than more cryptic species that occur at lower densities such as *Cardiocondyla venustula* and *C. emeryi*.

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Table 1. Alphabetical listing of twenty species of invasive ants, number of locations surveyed, average density (± mean standard error), and elevation range of detections within Makua and Oahu Implementation plan management units, Oahu, Hawaii from 2004 to 2009.

Genus	Species	# Locations	Average Density	Elevation Range (m)	Elevation Range (ft)
Anoplolepis	gracilipes	10	18.6±16.7	18.6 – 664.9	61-2180
Camponotus	variegatus	3	3	36.5 -664.9	120 - 2180
Cardiocondyla	minutior	1	1	1064.1	3489
Cardiocondyla	venustula	6	1.17±0.17	610 – 1112.8	2000 - 3651
Cardiocondyla	wroughtoni	4	1	610 - 1063	2000 - 3489
Cardioconyla	emeryi	1	2	686.2	2250
Leptogenys	falcigera	5	NA	6.1 – 634.4	20 - 2080
Monomorium	floricola	1	21	264.1	866
Monomorium	pharaonis	1	NA	854	2080
Ochetellus	glaber	15	126.8±52.37	12.2 – 902.8	40 - 2960
Paratrechina	bourbonica	1	NA	166.8	547
Paratrechina	longicornis	4	11.0±10.0	15.2 – 555.1	50 - 1820
Paratrechina	vaga	1	12	819.9	2690

Pheidole	megacephala	12	374±107.5*	264.1 – 664.9	866-2950
Plagiolepis	alluaudi	9	17.5±5.4	80.5 – 854	264 - 2800
Solenopsis	geminata	2	NA	594.7 -610	1950 -2000
Solenopsis	papuana	31	107.2±33.0	390.4 – 1018.7	1280 - 3340
Tapinoma	melanocephala	1	1	664.9	2180
Technomyrmex	albipes	7	192.5±126.2	9.1 -677	30 - 2220
Tetramorium	simillimum	6	17.0±7.7	264.1- 899.7	866 - 2950

* = species occurs at significantly higher densities than other species (Kruskal-Wallis Test, ChiSquare = 9.9, df = 3, P = 0.018)

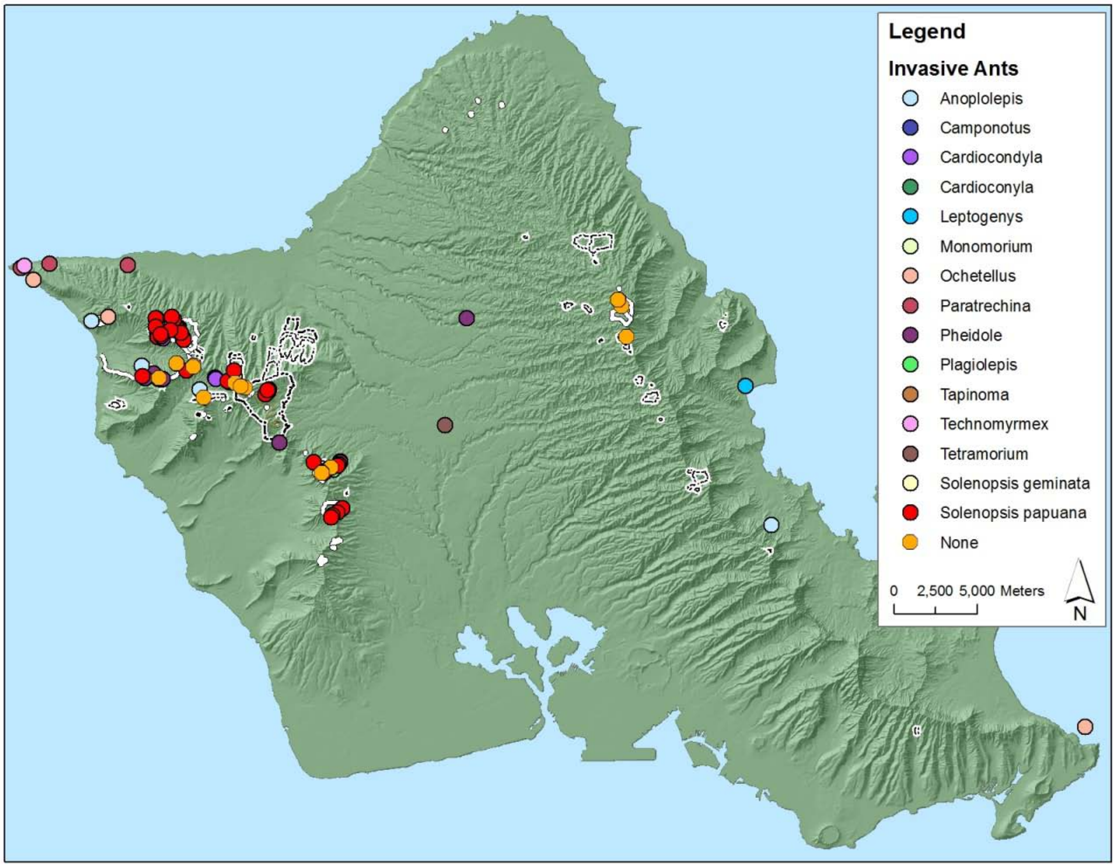

Figure 1. Distribution of ant surveys by species on the island of Oahu.

Map removed to protect rare resources

Figure 2. Location of invasive ant detections and proximity to known tree snail (*Achatinella* sp.) snail populations in the Waianae Mountains, Oahu.

Map removed to protect rare resources

Figure 3. Location of invasive ant detections and proximity to known tree snail (*Achatinella* sp.) populations in the Koolau Mountains, Oahu.