2014 Status Report for the Makua and Oahu Implementation Plans

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Prepared by:
Oahu Army Natural Resources Program
Pacific Cooperative Studies Unit
Schofield Barracks, HI 96857

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LIST OF CONTRIBUTORS

Daniel Adamski	Natural Resource Management Specialist, PCSU
Michelle Akamine	Monitoring Program Specialist, PCSU
Makanani Akiona	Natural Resource Management Technician, PCSU
Jane Beachy	Ecosystem Restoration Program Manager, PCSU
Tyler Bogardus	Small Vertebrate Pest Stabilization Specialist, PCSU
Matthew Burt	Elepaio Stabilization/Ungulate Program Manager , PCSU
Vincent Costello	Rare Snail Conservation Specialist, PCSU
Jessica Hawkins	Natural Resource Management Technician, PCSU
Celeste Hanley	Environmental Outreach Specialist, PCSU
Scott Heintzman	Natural Resource Management Specialist, PCSU
Stephanie Joe	Natural Resource Research Specialist, PCSU
Roy Kam	Natural Resource Database Specialist, PCSU
Kapua Kawelo	Biologist, Department of Public Works (DPW) U.S. Army Garrison Hawaii
Matthew Keir	Rare Plant Program Manager, PCSU
Eli Kimmerle	Natural Resource Management Technician, PCSU
Kelly Cloward	Natural Resource Management Technician, PCSU
Linda Koch	Natural Resource GIS Specialist, PCSU
Julia Gustine Lee	Senior Ecosystem Restoration Specialist, PCSU
Kala Lindsey-Asing	Natural Resource Management Specialist, PCSU
Karl Magnacca	Entomological Program Specialist, PCSU
Michelle Mansker	Natural Resource Manager, DPW, U.S. Army Garrison Hawaii
Taylor Marsh	Ecosystem Restoration Specialist, PCSU
Kahale Pali	Natural Resource Management Coordinator, PCSU
Kaleohone Roback	Natural Resource Management Technician, PCSU
Jobriath Rohrer	Senior Natural Resource Management Coordinator, PCSU
Daniel Sailer	Senior Natural Resource Management Coordinator, PCSU
Clifford Smith	Natural Resource Operations Manager, PCSU
Jonathan Sprague	Natural Resource Operations Expeditor, PCSU
Philip Taylor	Natural Resource Avian Conservation Specialist, PCSU
Jamie Tanino	Rare Invertebrate Conservation Technician, PCSU
Jenna Tomasa	Natural Resource Management Technician, PCSU
Michael Walker	Natural Resource Management Coordinator, PCSU
William Weaver	Natural Resource Management Coordinator, PCSU
Lauren Weisenberger	Propagule Management Specialist, PCSU
Kimberly Welch	Environmental Outreach Specialist, PCSU
Bert Wong	Natural Resource Management Coordinator, PCSU

*Cover photo Kahuli tree snail (*Achatinella mustelina)*, Ekahanui Gulch, Waianae Mountains, Oahu.

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EXECUTIVE SUMMARY

The Oahu Army Natural Resources Program (OANRP) has 60 personnel on staff, comprised of support staff, a fence crew, three resource management crews, and a nursery/seed bank management crew. Most of these staff are employed via a Cooperative Agreement funded by the Army through the Pacific International Center for High Technology Research (PICHTR) and administered by the Research Corporation of the University of Hawaii-Pacific Cooperative Studies Unit. Staff levels in Fiscal Year (FY) 2014 were similar to those in FY 2013, though there has been staff turnover, and replacement hiring is ongoing for several vacant positions. During this reporting period, OANRP hired a five-person rotating Ecosystem Restoration Crew to focus on invasive plant control and management unit restoration. For FY 2014, OANRP received a total of $6,562,500 to implement both the Makua and Oahu Implementation Plans. This included funding to increase support for the *Chromolaena odoratum* control efforts, conduct bat surveys of all Army installations on Oahu, and to continue important Implementation Plan essential research. In FY 2014, OANRP did not receive funding for OIP Tier 2 and Tier 3 projects as there was no training conducted that could impact the species at the Tier 2 and 3 levels, as specified in the 2003 Oahu Biological Opinion.

This status report (report) serves as the annual report for participating landowners, the U.S. Fish and Wildlife Service (USFWS), and the Implementation Team (IT) overseeing the Makua Implementation Plan (MIP) and Oahu Implementation Plan (OIP). The period covered in this report is October 1, 2013 to September 30, 2014 and covers Year 10 of the MIP and Year 7 of the OIP. Hawaiian diacriticals are not used in this document except in some appendices in order to simplify formatting. Please refer to Appendix ES-1, *Spelling of Hawaiian Names*.

OANRP completes thousands of actions each year to implement the MIP and OIP (IPs); the results of those myriad activities are summarized in this report. The report presents summary tables analyzing changes to population units of plants and snails over the last year and since the IPs were completed, as well as updates on new projects and technologies. More detailed information for all IP taxa is available via the program database supplied on CD (See Appendix ES-2 for a tutorial of how to use this database).

OANRP just completed implementing the tenth year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the seventh year of the OIP (finalized in 2008). The MIP Addendum 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 Evolutionarily Significant Unit (ESU). The original Makua Biological Opinion (BO) in 2007 and amended BO in 2008, both issued by the USFWS, require that the Army provide threat control for all Oahu Elepaio (*Chasiempis ibidis*) pairs in the Makua Action Area, stabilize 28 plant taxa and *Achatinella mustelina*, and take significant precautions to control the threat and spread of fire as a result of the 2007 Waialua fire that destroyed individuals and habitat of *Hibiscus brackenridgei* subsp. *mokuleianus*. The OIP outlines stabilization measures for 23 additional plant taxa, the Oahu Elepaio, and six extant Koolau *Achatinella* species. Since the OIP was finalized, two additional species were added requiring stabilization, *Drosophila montgomeryi* and *D. substenoptera*. Of the OIP plants, management activities are conducted with eleven taxa that are present in the Schofield Barracks West Range Action Area and in the Kahuku Training Area. In 2014, OANRP did not receive funding to support the remaining 12 OIP plant taxa and the six Koolau *Achatinella* species because of the lack of Army training impacts to these taxa.

The Army has contracted the Center for Environmental Management of Military lands based at Colorado State University to prepare an updated biological assessment for the Army to enter into formal consultation for Oahu training ranges (not including Makua Military Reservation). This document will analyze the potential impacts from Army training on the twenty plant taxa newly listed in August 2012. A Biological Opinion from the USFWS is anticipated by calendar year 2016. Management or

stabilization requirements will be determined through the consultation process and outlined in the Biological Opinion to be issued upon completion of this process.

Infrastructure

The new seed laboratory and OIP office building were completed in November 2012. With the addition of these buildings, OANRP field crews are able to function from one baseyard, improving daily communications between field crews and program managers. OANRP outreach and purchasing staff are at the East Range office for ease of access by volunteers and vendors. In addition, OANRP fencing program staff are also at East Range.

Landowner/Agency Communications

OANRP continues to operate under a 20-year license agreement with Kamehameha Schools (KS) (expiring November 2030), a license agreement with Hawaii Reserves, Inc. (expiring March 2017) and a four-year license agreement with the Honolulu Board of Water Supply (expiring November 2014). The U.S. Army Garrison, Hawaii (USAG-HI) is working with the Honolulu Board of Water Supply on a renewal. In addition, the Army is working to renew an expired right of entry permit with Dole Food Company for *Hibiscus brackenridgei* subsp. *mokuleianus* surveys and monitoring. The Army also continues to work cooperatively under an MOU with the U.S. Navy for work in Lualualei Naval Magazine. Also, the Army is in the process of renewing an annual right of entry permit to protect Oahu Elepaio on Gill and Olson property at Palehua.

In July 2011, an MOU was signed between the Army and the State of Hawaii (State), Department of Land and Natural Resources (DLNR). Currently, the Army holds six State of Hawaii permits, including a Natural Area Reserves Special Use Permit, a Threatened and Endangered Plant Species Permit, an Invertebrate Permit, a Forest Reserve Access Permit, a Conservation District Use Permit, and a Protected Wildlife Permit. In the last year, the State and Army negotiated to extend the term for these permits from one year to three. The Army and the State are nearing finalization of a rental agreement for OANRP's use of the NIKE site mid-elevation greenhouse and associated facilities. A signed lease is expected before the end of this calendar year.

OANRP continues to provide support for partner agencies including the Oahu Invasive Species Committee, Oahu Plant Extinction Prevention Program, Oahu Snail Extinction Prevention Program (OSEPP) and the Koolau and Waianae Mountains Watershed Partnerships. The Army is also an official member of the Koolau Mountains Watershed Partnership, the Waianae Mountains Watershed Partnership, the Coordinating Group on Alien Pest Species, the Hawaii Rare Plant Restoration Grouop, the Pacific Island Climate Change Cooperative and the Hawaii Conservation Alliance.

Management Unit Protection

The OANRP fencing program completed construction of the Kamaili (1,160 m) and Huliwai (140 m) MU fences this year. They have almost completed construction of the northern section of the Helemano to Poamoho (1,200/1,700 m) MU fence. In addition, the OANRP fence crew completed repair work and added fence skirting to a section of the Makua perimeter fence (900 m) opposite Kapuna gulch, Pahole Natural Area Reserve. Additionally, fence skirting was added to the base of the perimeter chainlink fence along the Makua Military Reservation installation boundary (1,385 m). In addition, a section of the Manuwai fence (200m) which had been open and tied into natural barrier was closed as it was not keeping out ungulates. Also, OANRP contracted the construction of the Keaau Subunit II (895 m) MU, protecting *Hibiscus brackenridgei* subsp. *mokuleianus*, and the replacement of a portion of the Makua perimeter fence along Ohikilolo Ridge (3,278 m).

OANRP will be transitioning management focuses to conduct more intensive MU weed control and restoration, while bringing the greater fence construction schedule to a close. Thus, OANRP will no longer staff an in-house fencing crew as of January 2015. Instead, ungulate and fence specialist positions will be developed with a focus on fence monitoring and maintenance. For more details about OANRP ungulate control see Chapter 1.

In total this year, OANRP spent 7,600 hours controlling weeds across 286.5 ha. Incipient Control Area (ICA) efforts accounted for 196.5 ha of this total. Staff spent 1,754 hours on ICA management and conducted 389 visits to 157 ICAs. Weed Control Area (WCA) efforts covered 90 ha. OANRP conducted control in WCAs for a total of 5,847 hours over 526 visits at 154 WCAs. See Chapter 1 for a comparison to last year's control figures. Ecosystem Restoration Management Unit Plans (ERMUPs) were revised this year for the following three MUs: Palikea, Opaeula Lower I, and Opaeula (Appendicies 1-1-1, 1-1-2, and 1-1-3).

OANRP has completed a total of 21 ERMUPs for the highest priority and largest MUs. OANRP submitted 31 introduced plant samples to the Oahu Early Detection Program at Bishop Museum. Of these, three were new island records, one was a new state record, two were new naturalization records and one was a range extension

During this reporting period, a Washrack Utilization Policy to Control Invasive Species (Appendix ES-3) was drafted and signed by the Commanding General. This policy ensures that units wash their vehicles when moving between training areas. It is very positive to have the highest level of support in preventing the spread of invasive species between islands and training ranges. In addition, a Landscaping with Native Plants policy was signed by the Garrision Commander requiring all new landscaping to be with native plants or non-invasive introduced plant species (Appendix ES-4). Sources for native plants must be exhausted first before selecting a non-invasive introduced plant from a list of approved species developed by OANRP. Planting with natives has a secondary benefit of aiding to minimize invasive species introductions via landscaping.

Rodent Control Program

OANRP rat control operations continue to expand the use of the Goodnature® automatic traps in areas where access if difficult and in order to reduce labor associated with re-baiting snap traps. Automatic traps are re-baited every 4 to 6 weeks and this interval is adjusted based on observed bait persistence differences between sites. To lengthen automatic trap re-baiting intervals, OANRP has begun using more persistent baits such as peanut butter infused with preservatives and peanut butter flavored beeswax. Victor and Ka Mate snap traps are also employed at various sites. OANRP control rodents using in-house staff and via contract. Currently, rodent control around Oahu Elepaio is conducted via contract and this is the last option on the current contract. A new five year contract must be solicited. OANRP plan to incorporate automatic traps into the new contract. In order to maintain a successful rodent control program, it is important to have a variety of tools available traps and rodenticide are valuable tools. Unfortunately, OANRP is no longer able to use Ramik® mini bars as a rodenticide because of new label requirements that are not possible to meet at OANRP field sites. Over this reporting period, OANRP plan to research novel alternative rodenticides and application methods and may consider supporting the research required to label a new bait for conservation use. OANRP are currently supporting two rodent control research projects by outside researchers. The first is a comparison of Ka Mate and Victor traps. The second involves testing rat control efficacy of covered versus uncovered traps placed in trees. This project also helps to address the potential non-target bird mortality associated with placing rat traps in trees. For more details about the OANRP rodent control program see Chapter 6.

Vegetation Monitoring

During this reporting period, OANRP re-monitored priority MU level plant community health monitoring plots for the Palikea and Makaha I MUs. An analysis of the Palikea MU data is included as Appendix 1-1-3. Makaha data analysis is underway and will be included in next year's report. In addition, OANRP installed monitoring plots within the 15 acre Makaha II MU. This year, OANRP supported two research projects related to vegetation monitoring. The first project was an analysis of vegetation response to pig removal in the Koolau Mountains, using satelite imagery to examine the change in Normalized Difference Vegetation Index (Appendix ES-5). The second project involves comparing satellite imagery, aerial imagery and gigapan robotic technology (Gigapan) for collecting vegetation monitoring data in Makaha (Appendix ES-6). OANRP continue to use Gigapan to monitor fountain grass and strawberry guava control efforts.

Fire

On October 16, 2014, a large fire started at the north side of the Schofield Barracks Impact Area caused by an explosive ordnance detonation/disposal. In total, the fire burned approximately 470 acres, of this 243 acres were Army property and 226 acres Dole Food Company land. This fire was declared out on November 5, 2014. The western edge of the fire was approximately 1.2 kilometers from the nearest population of *Hibiscus brackenridgei* subsp. *mokuleianus*. In order to prevent recurrence, the Army constructed a berm around the ordnance disposal site. The OANRP fire report, which summarizes the fire's progression and OANRP involvement, is included as Appendix ES-7.

In May 2014 a fire ignited above the Schofield firebreak road. It was caused by a UXO detonation in support of the May 2014 prescribed burn. The fire was extinguished within 15 minutes of ignition and no endangered species or critical habitat was impacted. In addition, artillery rounds ignited vegetation above the Schofield Barracks firebreak road two times during this reporting period, in July and September, 2014. A total of 0.62 acres of unoccupied Oahu Elepaio critical habitat was burned. The total Oahu Elepaio critical habitat that the Army is allowed to adversely modify per year is 3.7 acres. Letters reporting these fire incidents to the USFWS are included as Appendix ES-8.

Lastly, OANRP supported fire control efforts at Palehua in order to protect Oahu Elepaio. OANRP's contract helicopter flew a total of 15hours in this cooperative fire response effort. In addition, at least 24 hours of staff time were contributed to the effort, managing helicopter operations. None of the Elepaio territories being managed by OANRP were affected by the fire.

Rare Plant Conservation

The Executive Summary tables on the following pages for the MIP and OIP plant taxa include current status (with totals not including seedlings), last year's population numbers, and the number of plants in the original IPs for comparison for each population unit. Genetic storage and ungulate protection status is also summarized for each PU. The number of PUs that have reached numeric stabilization goals are included. Genetic storage of at least 50 seeds each from 50 individuals, or at least three clones each in propagation from 50 individuals, is required for each PU. If there are fewer than 50 founders for a PU, genetic storage is required from all available founders. For example, if there are at least 50 seeds from five individuals, or at least three clones in propagation from five individuals, then the "% Completed of Genetic Storage Requirement" listed in the tables is 10%. Genetic storage for reintroduced populations is not required because those populations originate from other populations with their own genetic storage requirement. PUs with population sizes of zero and a genetic storage requirement of "n/a (reintroduction)" denote reintroductions that are planned but have yet to be conducted. The number of seeds in genetic storage approximates the number of viable seeds initially received for stored collections. Viability rates for most collections were estimated or calculated at the time of storage. For untested collections, seed viability was averaged from other collections within the same PU or taxon.

As of the end of this reporting period, 44 of 100 MIP PUs (44%) and 10 of 32 (31%) PUs for OIP Tier 1 plant species are at or above the stabilization goal for minimum number of mature plants.

Presented in Chapter 2 of this report are new 5-year plans for *Eugenia koolauensis*, *Euphorbia herbstii*, *Sanicula mariversa* and *Tetramolopium filiforme*. These four species were selected for a variety of reasons including, new reintroduction initiatives, outplanting challenges and genetic storage strategy development. During this reporting period, OANRP outplanted a grand total of 1,787 individuals of MIP and OIP taxa. Specifically, 888 individuals of seven Makua taxa, 713 individuals of five OIP taxa and 186 individuals of four taxa shared between both IPs were outplanted. In the last year, OANRP made 649 observations at in situ sites of IP taxa and 289 observations at outplanting sites.

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 45 of 101

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Alectryon macrococcus var. macrococcus	50											
		Central Kaluaa to Central Waieli	9	4	5	0	16	53	0%	0%	No	
		Kahanahaiki to Keawapilau	5	3	2	0	5	8	0%	100%	No	
		Makaha	37	37	0	0	43	75	3%	100%	No	
		Makua	16	16	0	0	18	15	6%	0%	No	
		Alectryon macrococcus var. macrococcus Total:	67	60	7	0	82	151				0 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	257	168	89	0	210	20	60%	100%	Yes	
		Kahanahaiki and Pahole	465	327	138	128	419	276	12%	100%	Yes	
		Makaha and Waianae Kai	17	10	7	5	12	12	39%	50%	No	
		Cenchrus agrimonioides var. agrimonioides Total:	739	505	234	133	641	308				2 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	164	115	49	0	187	0	67%	100%	Yes	
		North branch of South Ekahanui	165	72	93	0	204	5	100%	100%	No	
		Pahole to West Makaleha	116	64	52	0	117	46	54%	100%	No	
		Palikea (South Palawai)	147	113	34	12	161	63	57%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	592	364	228	12	669	114				2 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	141	26	115	1	140	66	72%	100%	No	
		Makaha and Waianae Kai	52	15	37	0	59	4	31%	100%	No	
		Pahole	131	55	76	67	114	114	100%	100%	No	
		Cyanea longiflora Total:	324	96	228	68	313	184				0 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	304	50	254	139	372	152	100%	100%	Yes	
		Makaha	197	27	170	0	202	0	N/A	100%	No	
		Manuwai	173	0	173	0	101	0	N/A	100%	No	
		Pahole to Kapuna	200	102	98	36	410	170	N/A	100%	Yes	
		Cyanea superba subsp. superba Total:	874	179	695	175	1085	322				2 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 45 of 101

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	123	34	89	98	239	97	48%	100%	No	
		Kawaiiki (Koolaus)	84	5	79	0	84	50	0%	0%	No	
		Opaeula (Koolaus)	125	23	102	0	125	26	2%	35%	No	
		Pahole to West Makaleha	1273	603	670	281	1206	300	98%	96%	Yes	
		Cyrtandra dentata Total:	1605	665	940	379	1654	473				1 of 4
Delissea waianaeensis	100											
		Ekahanui	195	168	27	0	277	58	100%	100%	Yes	
		Kahanahaiki to Keawapilau	280	253	27	0	309	34	87%	100%	Yes	
		Kaluaa	720	590	130	68	760	44	78%	100%	Yes	
		Manuwai	197	112	85	0	198	0	N/A	100%	Yes	
		Delissea waianaeensis Total:	1392	1123	269	68	1544	136				4 of 4
Dubautia herbstobatae	50											
		Makaha	29	28	1	0	29	0	48%	0%	No	
		Ohikilolo Makai	91	89	2	0	91	700	0%	100%	Yes	
		Ohikilolo Mauka	424	415	9	0	424	1300	0%	100%	Yes	
		Dubautia herbstobatae Total:	544	532	12	0	544	2000				2 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	23	21	2	0	31	26	71%	0%	No	
		Kaena	1475	579	896	0	1475	300	100%	0%	Yes	
		Makua	127	125	2	0	127	40	100%	100%	Yes	
		Puaakanoa	181	149	32	1	148	157	46%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1806	874	932	1	1781	523				3 of 4
Euphorbia herbstii	25											
		Kaluaa	0	0	0	0	0	0	N/A	100%	No	
		Kapuna to Pahole	92	43	49	9	93	170	24%	100%	Yes	
		Makaha	35	4	31	0	67	0	N/A	100%	No	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Euphorbia herbstii Total:	127	47	80	9	160	170				1 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 45 of 101

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Flueggea neowawraea	50											
		Kahanahaiki to Kapuna	127	6	121	0	124	32	43%	100%	No	
		Makaha	61	10	51	0	63	4	55%	40%	No	
		Manuwai	29	0	29	0	9	0	N/A	100%	No	
		Ohikilolo	1	1	0	0	1	3	100%	100%	No	
		Flueggea neowawraea Total:	218	17	201	0	197	39				0 of 4
Gouania vitifolia	50											
		Keaau	55	55	0	0	55	0	56%	0%	Yes	
		Makaha (Future Introduction)	0	0	0	0	0	0	N/A	100%	No	
		Manuwai (Future Introduction)	0	0	0	0	0	0	N/A	100%	No	
		Gouania vitifolia Total:	55	55	0	0	55	0				1 of 3
Hesperomannia oahuensis	75											
		Haleauau	1	1	0	0	1	0	100%	100%	No	
		Makaha	27	3	24	0	27	13	0%	100%	No	
		Pahole NAR	50	2	48	0	56	8	N/A	100%	No	
		Pualii	65	1	64	0	73	0	N/A	100%	No	
		Hesperomannia oahuensis Total:	143	7	136	0	157	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	8	6	2	0	10	4	93%	0%	No	
		Keaau	27	1	26	0	3	0	19%	100%	No	
		Makua	99	89	10	0	45	7	67%	100%	Yes	
		Manuwai	198	173	25	0	104	0	N/A	100%	Yes	
		Hibiscus brackenridgei subsp. mokuleianus Total:	332	269	63	0	162	11				2 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	158	70	88	2	186	60	70%	94%	Yes	
		Central Makaleha and West Branch of East Makaleha	36	23	13	8	34	47	60%	0%	No	
		Kahanahaiki to Pahole	278	147	131	23	278	161	96%	100%	Yes	
		Kadua degeneri subsp. degeneri Total:	472	240	232	33	498	268				2 of 3

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 45 of 101

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Kadua parvula	50											
		Halona	121	93	28	19	132	64	100%	0%	Yes	
		Ohikilolo	257	100	157	5	257	66	100%	100%	Yes	
		To be determined (Ekahanui?)	0	0	0	0	0	0	N/A		No	
		Kadua parvula Total:	378	193	185	24	389	130				2 of 3
Melanthera tenuifolia	50											
		Kamaileunu and Waianae Kai	1061	815	246	274	1061	880	0%	0%	Yes	
		Mt. Kaala NAR	70	70	0	0	70	250	0%	100%	Yes	
		Ohikilolo	1117	1109	8	0	1117	2009	12%	100%	Yes	
		Melanthera tenuifolia Total:	2248	1994	254	274	2248	3139				3 of 3
Neraudia angulata	100											
		Kaluakauila	134	65	69	0	134	0	N/A	100%	No	
		Makua	126	120	6	0	133	29	40%	100%	Yes	
		Manuwai	88	88	0	0	57	12	100%	100%	No	
		Waianae Kai Mauka	19	16	3	0	65	46	56%	100%	No	
		Neraudia angulata Total:	367	289	78	0	389	87				1 of 4
Nototrichium humile	25											
		Kaluakauila	159	132	27	0	233	200	2%	100%	Yes	
		Makua (south side)	53	50	3	0	53	138	0%	100%	Yes	
		Manuwai	119	119	0	0	0	0	N/A	100%	Yes	
		Waianae Kai	270	216	54	0	259	200	4%	88%	Yes	
		Nototrichium humile Total:	601	517	84	0	545	538				4 of 4
Phyllostegia kaalaensis	50											
		Keawapilau to Kapuna	0	0	0	0	0	0	100%	100%	No	
		Makaha	1	0	1	0	7	0	N/A	100%	No	
		Manuwai	5	0	5	0	48	0	N/A	100%	No	
		Pahole	0	0	0	0	0	10	100%	100%	No	
		Phyllostegia kaalaensis Total:	6	0	6	0	55	10				0 of 4
Plantago princeps var. princeps	50											
		Ekahanui	204	46	158	0	127	33	100%	100%	No	
		Halona	11	10	1	0	72	50	100%	0%	No	
		North Mohiakea	51	39	12	0	51	30	38%	100%	No	
		Ohikilolo	0	0	0	0	0	14	60%	100%	No	
		Plantago princeps var. princeps Total:	266	95	171	0	250	127				0 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 45 of 101

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Pritchardia kaalae	25											
		Makaleha to Manuwai	136	123	13	0	117	141	2%	2%	Yes	
		Ohikilolo	1675	85	1590	0	1676	473	0%	100%	Yes	
		Ohikilolo East and West Makaleha	334	4	330	0	334	75	N/A	100%	No	
		Pritchardia kaalae Total:	2145	212	1933	0	2127	689				2 of 3
Sanicula mariversa	100											
		Kamaileunu	361	1	360	14	128	26	100%	100%	No	
		Keaau	43	0	43	0	27	141	2%	100%	No	
		Ohikilolo	30	0	30	200	39	162	74%	100%	No	
		Sanicula mariversa Total:	434	1	433	214	194	329				0 of 3
Schiedea kaalae	50											
		Kaluaa and Waieli	206	198	8	0	206	55	100%	100%	Yes	
		Maakua (Koolaus)	10	10	0	0	10	4	40%	0%	No	
		Pahole	132	106	26	200	74	3	100%	100%	Yes	
		South Ekahanui	428	160	268	12	427	85	85%	100%	Yes	
		Schiedea kaalae Total:	776	474	302	212	717	147				3 of 4
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	226	113	113	58	179	65	98%	100%	Yes	
		Kapuna-Keawapilau Ridge	113	98	15	0	69	4	50%	100%	Yes	
		Makaha	57	57	0	0	79	0	N/A	100%	Yes	
		Schiedea nuttallii Total:	396	268	128	58	327	69				3 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	1961	232	1729	2729	1961	90	100%	100%	Yes	
		Keawapilau to West Makaleha	1419	72	1347	2160	1306	36	100%	96%	No	
		Makaha	226	104	122	0	0	0	N/A	100%	Yes	
		Schiedea obovata Total:	3606	408	3198	4889	3267	126				2 of 3
Tetramolopium filiforme	50											
		Kalena	117	24	93	0	117	0	8%	100%	No	
		Ohikilolo	3858	2394	1464	20	3143	2500	12%	100%	Yes	
		Puhawai	85	10	75	3	38	12	80%	0%	No	
		Waianae Kai	38	30	8	1	38	22	0%	0%	No	
		Tetramolopium filiforme Total:	4098	2458	1640	24	3336	2534				1 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 45 of 101

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Viola chamissoniana subsp. chamissoniana	50											
		Halona	44	41	3	0	44	3	7%	0%	No	
		Makaha	79	68	11	0	71	50	0%	100%	Yes	
		Ohikilolo	411	386	25	1	411	0	0%	100%	Yes	
		Puu Kumakalii	44	44	0	0	44	20	23%	0%	No	
Viola chamissoniana subsp. chamissoniana Total:			578	539	39	1	570	73				2 of 4

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 11 of 31

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Abutilon sandwicense	50											
		Ekahanui and Huliwai	146	18	128	0	59	44	12%	100%	No	
		Kaawa to Puulu	105	27	78	0	100	124	0%	41%	No	
		Kahanahaiki	29	13	16	0	32	0	100%	100%	No	
		Makaha Makai	120	65	55	0	70	100	88%	63%	Yes	
		Abutilon sandwicense Total:	400	123	277	0	261	268				1 of 4
Cyanea acuminata	50											
		Helemano-Punaluu Summit Ridge to North Kaukonahua	375	189	186	1	72	72	8%	0%	Yes	
		Kaluanui and Maakua	221	113	108	50	221	0	0%	0%	Yes	
		Makaleha to Mohiakea	228	158	70	0	154	118	0%	48%	Yes	
		Cyanea acuminata Total:	824	460	364	51	447	190				3 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	125	113	12	0	114	76	0%	85%	Yes	
		Opaeula to Helemano	24	22	2	0	27	13	0%	59%	No	
		Poamoho	36	18	18	0	27	12	0%	0%	No	
		Cyanea koolauensis Total:	185	153	32	0	168	101				1 of 3
Eugenia koolauensis	50											
		Kaunala	62	23	39	31	131	141	4%	100%	No	
		Olio	12	7	5	0	21	74	20%	100%	No	
		Pahipahialua	28	22	6	141	57	291	17%	100%	No	
		Eugenia koolauensis Total:	102	52	50	172	209	506				0 of 3
Gardenia mannii	50											
		Haleauau	2	2	0	0	2	2	100%	100%	No	
		Helemano and Poamoho	8	8	0	0	8	18	25%	0%	No	
		Lower Peahinaia	10	9	1	0	11	46	0%	67%	No	
		Gardenia mannii Total:	20	19	1	0	21	66				0 of 3
Hesperomannia swezeyi	25											
		Kamananui to Kaluanui	246	134	112	45	245	99	0%	4%	Yes	
		Kaukonahua	128	65	63	52	128	127	0%	0%	Yes	
		Lower Opaeula	27	18	9	0	27	24	0%	0%	No	
		Hesperomannia swezeyi Total:	401	217	184	97	400	250				2 of 3

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 11 of 31

= Ungulate Threat to Taxon within Population Unit

No Shading = Absence of Ungulate threat to Taxon within Population Unit

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2013	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Labordia cyrtandrae	50											
		East Makaleha to North Mohiakea	340	271	69	0	344	100	16%	87%	Yes	
		Koloa	123	23	100	0	124	0	N/A	100%	No	
		Labordia cyrtandrae Total:	463	294	169	0	468	100				1 of 2
Phyllostegia hirsuta	100											
		Haleauau to Mohiakea	132	91	41	0	85	18	67%	89%	No	
		Koloa	129	25	104	4	5	0	18%	92%	No	
		Puu Palikea	204	101	103	0	0	0	N/A	100%	Yes	
		Phyllostegia hirsuta Total:	465	217	248	4	90	18				1 of 3
Phyllostegia mollis	100											
		Ekahanui	76	76	0	0	160	35	100%	100%	No	
		Kaluaa	191	132	59	0	72	49	100%	100%	Yes	
		Pualii	33	33	0	0	95	0	100%	100%	No	
		Phyllostegia mollis Total:	300	241	59	0	327	84				1 of 3
Schiedea trinervis	50											
		Kalena to East Makaleha	622	352	270	333	620	376	100%	91%	Yes	
		Schiedea trinervis Total:	622	352	270	333	620	376				1 of 1
Stenogyne kanehoana	100											
		Haleauau	0	0	0	0	0	1	100%	0%	No	
		Kaluaa	222	28	194	0	220	79	100%	100%	No	
		Makaha	156	0	156	0	0	0	N/A	100%	No	
		Stenogyne kanehoana Total:	378	28	350	0	220	80				0 of 3

Rare Snail Conservation

During this reporting period, OANRP continued to maintain the Kahanahaiki and Puu Hapapa predator exclosures and cooperate with OSEPP to maintain the Puu Palikea exclosure. In addition, OANRP and SEPP completed construction of the Poamoho predator exclosure which is the first built in a wet forest environment. The SEPP program will proceed with translocations into the exclosure over the course of the next year and has taken over maintenance of the fence. Vast improvements on design and construction technique were made during the course of this project that will inform other predator exclosure projects planned for wet and windy environments. OANRP and partners continue to monitor population trends for *Achatinella mustelina* within the Kahanahaiki and Puu Hapapa predator exclosures using timed count monitoring. During this reporting period, OANRP's ecosystem restoration program planted *Achatinella* host plant taxa to increase vegetation cover within the three Waianae predator exclosures, a total of 411 host plants for *Achatinella* were outplanted.

This year in Chapter 3, OANRP presents a detailed short- to medium-term field management plan for each of the field sites designated as 'manage for stability'. The predator conditions at wild sites and the limitations of terrain present incredible challenges for *A. mustelina* stabilization. The biological basis used in preparation of the original Biological Opinions, the IPs and the MIP Addendum are completely changed and require review. At the time of the BO preparation, Jackson's chameleons were not a known threat, the exclosure designs were considered adequate and captive propagation was considered successful. The Army has beared the additional responsibility of adapting to this changing basis by conducting unanticipated research in order to move toward stabilization.

In 2013, ten new adult *A. mustelina* snails from four ESUs were removed to the University of Hawaii tree snail lab for short term offsite representation (see RCUH 2012). Unfortunately, these snails had high mortality in the lab and were not able to be returned to the wild for fear that they may carry a lab pathogen. SEPP and the USFWS are working in collaboration with the lab to determine the cause of recent declines. In the meantime, OANRP does not plan to collect any wild snails for lab rearing.

Table 4 below presents the status summary for the Waianae *A. mustelina* in the MIP. This year, there is no OIP snail table as all Koolau snail taxa are Tier 2 or 3. The goal of all populations in both IPs is 300 total snails across all age classes in each ESU. Populations of *A. mustelina* in the MIP have been genetically assigned to one of six ESUs. Similar to last year, 5 of the 8 managed field populations have over 300 snails. ESU-E total snail numbers declined to less than 300 but the snails observed in ESU-C increased to more than 300. Also of note, are the 2013 total snails compared to the 2014 total for ESU-D1 which has changed from 993 to 380. This is not a population decline. Last year's total number of snails was an actual count of the existing number of snails, the number of reintroduced lab snails combined with the number translocated in the predator exclosure from the surrounding areas. This year's number was acquired via a timed count monitoring. This methodology has in the past detected ~20-25% of the actual number of snails known within the exclosure.

Table 4. Makua Implementation Plan –Executive Summary – Snails

Achatinella mustelina Evolutionary Significant Unit (ESU)	Population	2014 Snails				# Snails in 2013	# Snails in 2003 MIP	# of Snails at University of Hawaii Lab	% of Snails in Population Protected from Ungulates	% of Snails in Population Protected from from Rats	Is Population at Goal?	Overall Populations at Goal for Species
		# Adult	# Sub-adult	# Juvenile	Total 2014							
ESU A	Kahanahaiki/ Pahole	94	57	28	179	199	105	4	100%	100%	No	*5 of 8*
ESU B	B1: Ohikilolo	264	133	60	457	384	300	0	100%	93%	Yes	
	B2: East Makaleha	224	68	15	307	476	40	8	0%	100%	Yes	
ESU C	Lower Kaala NAR/ Schofield Barracks West Range	235	128	29	392	191	50	8	100%	100%	Yes	
ESU D	D1: North Kaluaa to Schofield Barracks South Range	215	143	22	380	993	86	0	100%	100%	Yes	
	D2: Makaha	153	48	9	210	188	17	2	100%	66%	No	
ESU E	Ekahanui	128	37	6	171	356	12	17	100%	94%	No	
ESU F	Puu Palikea	249	104	77	430	472	40	0	94%	100%	Yes	
Totals					**2,526**	**3,259**	**650**	**39**				***5 of 8***

Rare Vertebrate Management

In 2014, OANRP controlled rats to protect 81 pairs of Oahu Elepaio (*Chasiempis ibidis*). The BO requires the protection of 75 pairs, therefore, OANRP met this requirement. The documented fledgings from managed pairs this year numbered 62. There were mixed results with rodent control in 2014; in Moanalua the number of rats caught substantially decreased, whereas in Ekahanui the number dramatically increased. OANRP will continue to adapt rodent control approaches in order to maximize protection. Access to Schofield West Range was reduced to, at most, one visit per month during the 2014 breeding season. OANRP plan to install automatic traps for the 2015 breeding season to compensate for this access limitation. The total required access dates were met during the calendar year but were not distributed ideally for Elepaio management. For more information, see the Rare Vertebrate Management Chapter 4.

During this reporting period, nene geese (*Branta sandvicensis*) were observed for the first time at an Oahu Army Training Area. A family of nene that successfully nested at the James Campbell National Wildlife Refuge (NWR) have been flying around the island foraging at different sites. Satelite collar data suggests that they have been focusing foraging activities around Central Oahu and the James Campbell NWR. For more information, see the Rare Vertebrate Management Chapter 4.

Acoustic monitoring for the Opeapea (*Lasiurus cinereus semotus)* was conducted over 301 nights from 2010 to 2013 on Oahu Army Installations. In summary, bats were detected at all Oahu Training Areas with the highest detection rates being found at Schofield Barracks West Range. Foraging behavior was documented from Kahuku Training Area, Dillingham Military Reservation, Makua Military Reservation and Schofield Barracks (both East and West Ranges). Bat detection in general is much lower than data collected on Hawaii, Maui and Kauai. For more information, see the Rare Vertebrate Management Chapter 4.

Insect Mangement

During this reporting period, OANRP continued to emphasize surveys for additional populations of the two target *Drosophila* taxa known from Schofield Barracks, *D. montgomeryi* and *D. substenoptera;* new populations were also found. In addition, OANRP continued to survey within training areas in order to establish a comprehensive baseline for endangered insects to use in the upcoming Section 7 Consultation with the USFWS. Also, OANRP focused efforts on regular monitoring of known *Drosophila* populations in order to track fluctuations and attempt to determine abundance patterns. The number of *Drosophila* observed at baits differed dramatically by month and site, and results are summarized in Chapter 5. Additionally, seeds and cuttings were collected and put into propagation from *Drosophila* host plant taxa in preparation for outplanting in the coming year. Three sites per taxon were selected to be designated as 'manage for stability' sites. Also included in Chapter 5 are management plans for *D. montgomeryi* and *D. substenoptera*. These plans include background information on taxon, an overview of extant populations, a summary of management history and recommendations and three year action plan tables which summarize goals for host plant restoration, weed control, threat assessments and monitoring frequency.

Other projects that OANRP has undertaken during this reporting period include invasive insect control and detection work. Namely, OANRP has deployed and monitored coconut rhinoceros beetle (CRB) traps in collaboration with the United States and the State of Hawaii Department of Agriculture and the U.S. Navy at Schofield Barracks. In addition, OANRP responded to the detection of adult CRB at Ft. Shafter by addressing all mulch and greenwaste accumulation points. OANRP have also been involved with the little fire ant (LFA) reponse effort on Oahu. OANRP conducted surveys of new landscaping, the PX landscaping shop and other potential sources of introduction identified on post to prevent

establishment of LFA at Schofield Barracks. OANRP also checked the horticultural vendors used to supply greenhouse materials for LFA to eliminate this possible avenue of introduction. In addition, OANRP have assisted with LFA surveys in the neighboring community of Mililani (Chapter7).

Research

During this reporting period, OANRP funded numerous research projects related to management of MIP and OIP taxa. The OANRP Research Specialist concluded Sluggo application trials to determine if the reapplication interval could be extended beyond the current one month interval and still achieve resource protection. In addition, the Research Specialist tested three herbicides on large patches of *Blechnum appendiculatum* to identify the most suitable option. Preliminary results of this trial are presented in Chapter 1.

For tree snail management, OANRP continued to fund the captive *Achatinella* propagation program at the University of Hawaii (UH) Tree Snail Laboratory (Lab). Results of this work are included in Appendix ES-9. The UH Lab also conducted Jackson's chameleon (*Chamaeleo jacksonii*) and introduced bird stomach content analyses. In addition, OANRP funded a molecular systematic assessment of *Achatinella mustelina* diet using snail feces and host plant leaves. A summary of research results obtained during this reporting period are included as Appendix ES-10.

In support of the rare plant program, OANRP funded Dr. Janice Uchida to identify the fungal pathogen affecting rare *Phyllostegia* spp. in the greenhouse and in the wild. This project also includes fungicide screening for an effective treatement. A summary of findings is included as Appendix ES-11. OANRP are also supporting a population viability analysis for three IP rare plant taxa using demographic modeling. The project proposal for this work and a summary of work conducted during this reporting period are included as Appendix ES-12. In house, OANRP inititated seed sowing trials with *Delissea waianaensis* in order to determine the effect of slugs on seedlings and to identify suitable microsites and methodology for seed sowing. In addition, OANRP funded the National Center for Genetic Resource Preservation to conduct research with dessication-sensitive seeds of IP taxa. Lastly, OANRP continue to conduct ground-breaking in-house research on pollination biology, fruit collection, seed viability, germination and storage.

Research funded by OANRP in support of the Ecosystem Management Program included the work of Dr. Paul Krushelnycky, who is studying the impacts of rodents on native arthropods. His research is conducted at two sites within the Waianae Mountains where OANRP maintains large-scale snap trap rat control grids. For an update on the fourth year of this research refer to Appendix ES-13.

TABLE OF CONTENTS

Chapter 6: Rodent Management

Chapter 7: Invertebrate Control Program

Appendices:

Appendix for Chapter 4

Appendix 4-1 Hawaiian Hoary Bat Seasonal Acoustic Monitoring Study on Oahu Army Installations

**Starred appendices are printed at the end of chapter 7. All other appendices are included in electronic format on a CD enclosed with this document. Also, they can be found online through the PCSU website. http://manoa.hawaii.edu/hpicesu/dpw_mit.htm*

CHAPTER 1: ECOSYSTEM MANAGEMENT

Notable projects from the 2013-2014 reporting year are discussed in the Project Highlights section of this chapter. This reporting year covers 12 months, from 1 October 2013 through 30 September 2014.

Threat control efforts are summarized for each Management Unit (MU) or non-MU land division. Ungulate control, outreach program, and weed control data is presented with minimal discussion. For full explanations of project prioritization and field techniques, please refer to the 2007 Status Report for the Makua and Oahu Implementation Plans (MIP and OIP; http://manoa.hawaii.edu/hpicesu/DPW/2007_YER/default.htm).

Ecosystem Restoration Management Unit Plans (ERMUP) have been written for the following MUs:

Report Year	ERMUP
2008-2009	Ekahanui, Helemano, Kaala, Kahanahaiki, Kaluakauila, Ohikilolo (Lower Makua), Ohikilolo (Upper), Palikea
2009-2010	Kaena, Kahuku Training Area, Lower Ohikilolo, Makaha, Pahole, Upper Kapuna
2010-2011	Kaluaa and Waieli, Manuwai, Koloa
2011-2012	Waimano; revised Ohikilolo (Makua)
2012-2013	Puaakanoa; draft only of Opaeula Lower I, Opaeula

Please refer to the relevant Status Reports for the MIP and OIP for copies of these plans, or view them online at http://manoa.hawaii.edu/hpicesu/dpw_ermp.htm. Each ERMUP details all relevant threat control in each MU for the five years immediately following its finalization. The ERMUPs are working documents; OANRP modifies them as needed and can provide the most current versions on request. They will not be included in Status Reports until they need to be rewritten to cover another five years. This year, the Palikea MU ERMUP was revised, and the Opaeula Lower I and Opaeula ERMUPs were finalized; they are included as Appendix 1-1-1 and Appendix 1-1-2.

1.1 UNGULATE CONTROL PROGRAM

The Oahu Army Natural Resources Program (OANRP) is ending the fence construction phase of its management program and focusing more energy on invasive plant control and vegetation restoration. It is redirecting the focus from construction of new fences to maintaining existing fence units. OANRP is also assessing the feasibility of transferring management of some Manage for Stability populations into these completed fences rather than building additional enclosures. Since Army training has not been shown to directly impact the Tier 1 for rarity, Tier 2 or 3 species from the 2003 Oahu Biological Opinion, the program is focusing its work on the OIP Tier 1 species that Army training directly impacts. This significantly reduces the number of fences left to build.

As a result of the refocus of efforts, as of 31 December 2014, OANRP will no longer staff an in-house fencing crew. Rather, OANRP will focus on working within partnerships to contract fence construction projects together. These opportunistic partnerships will allow all parties to share the costs rather than one program absorbing all of it. OANRP will be hiring two ungulate management technicians whose responsibilities will be fence monitoring/maintenance and ungulate control.

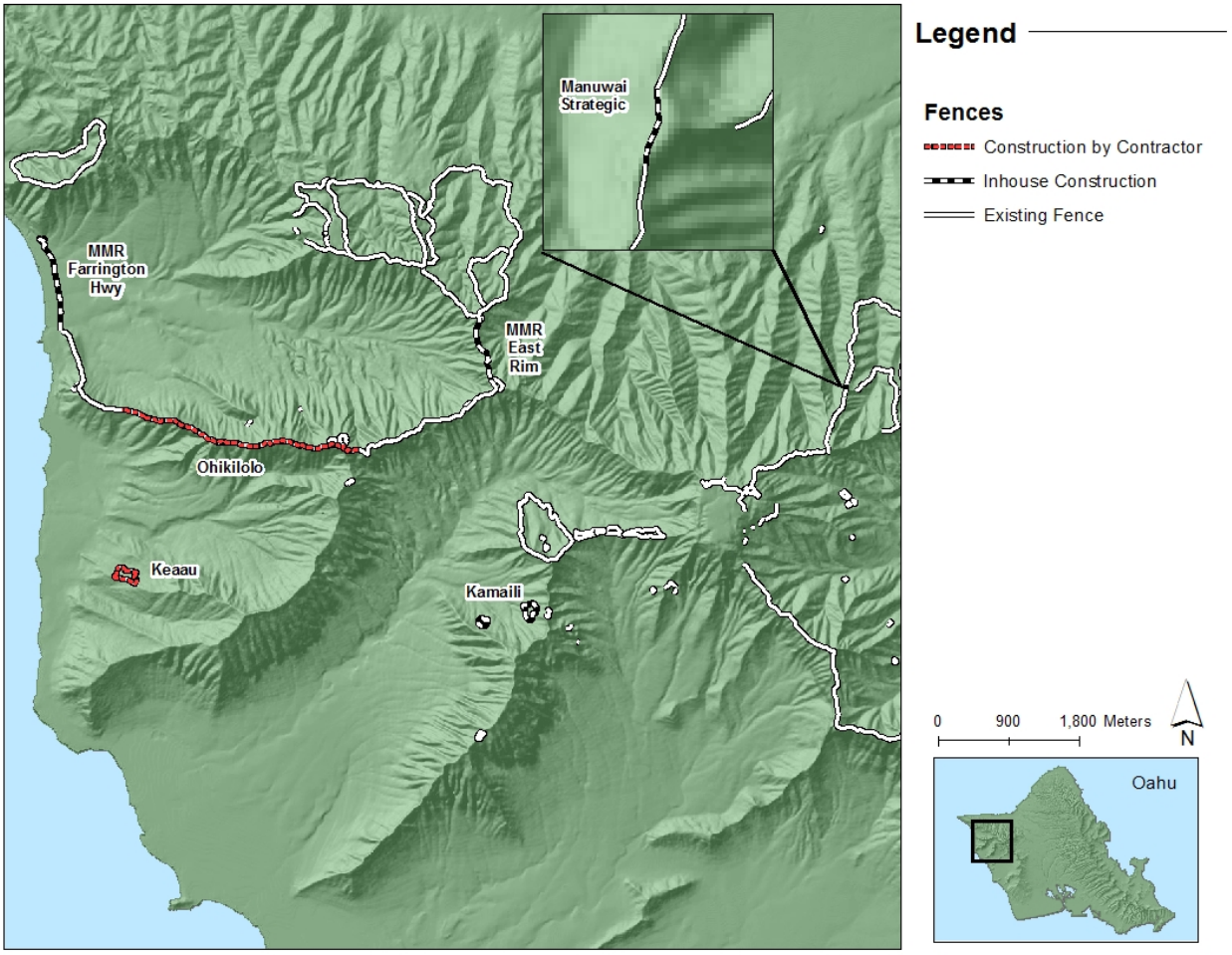

Figure 1.1 Map of fence construction in Northern Waianae's

Summary

- The OANRP in-house fence crew completed construction of the Kamaili (1,160 m) and Huliwai (140 m) MU fences. These fences are ungulate free. The fence crew was also able to complete repair work/skirting on the Makua East rim section of fence (900 m), Farrington Highway chainlink fence at Makua (1385 m), Manuwai strategic section (200m) and almost complete construction of the North line at Poamoho (1200 out of 1700 m) MU fences.

- OANRP contracted the construction of the Keaau Subunit II (895 m) fence and replacement of a portion of the Ohikilolo perimeter fence on the south rim of MMR (3278 m). Both of the fences are complete and the Keaau Subunit II fence is ungulate free.

- All totaled, during the last reporting year about 3,600 meters of new fencing was built, enclosing approximately 17 acres, and about 5600 m of fencing was replaced/repaired. Only three fully enclosed units were completed and all of them were small. Most of the linear distance of fence completed was portions surrounding Makua Military Reservation (MMR) in preparation for the enclosure and subsequent eradication of the feral pigs in the valley. When MMR is fully enclosed a total of 4,856 acres will be protected.

- The Waianae Kai (Mauka Nerang) fence is continuously damaged by rock falls. OANRP is assessing the cost/benefit to maintaining management at this site. Management of the *Neraudia angulata* may be moved to a more suitable MU with less risk of continuous fence damage (e.g Kamaili).

- Pig eradication efforts continued in the Lihue MU. Since the Army has gone back to full time training at Schofield Barracks West Range, OANRP has had reduced access to complete the eradication (56 days in this reporting period). A total of 13 pigs were removed this year bringing the total to 533 pigs removed. Pig sign in all portions of the unit has been dramatically reduced but not eliminated. There are still little pockets of animal activity being found but not over the entire unit. Efforts are focused on increasing coverage in these areas where sign is found and making sure all snares are well set all throughout the unit. OANRP is exploring the use of Forward Looking Infra-Red (FLIR) attached to military Shadow unmanned aircraft as a means to detect and measure the population of feral pigs left within the unit. The hope is that this technology will help identify areas to focus efforts in order to achieve eradication.

- Using existing funds, OANRP is proposing to finish the Northern rim of Makua Valley, replace sections of the Opaeula/Helemano line and construct a Waianae Kai section of Kaala through contracts by the end of the next reporting period. The in-house fence crew will complete the north line of Poamoho, close off a strategic section at Ekahanui and help with the Opaeula/Helemano fence when possible.

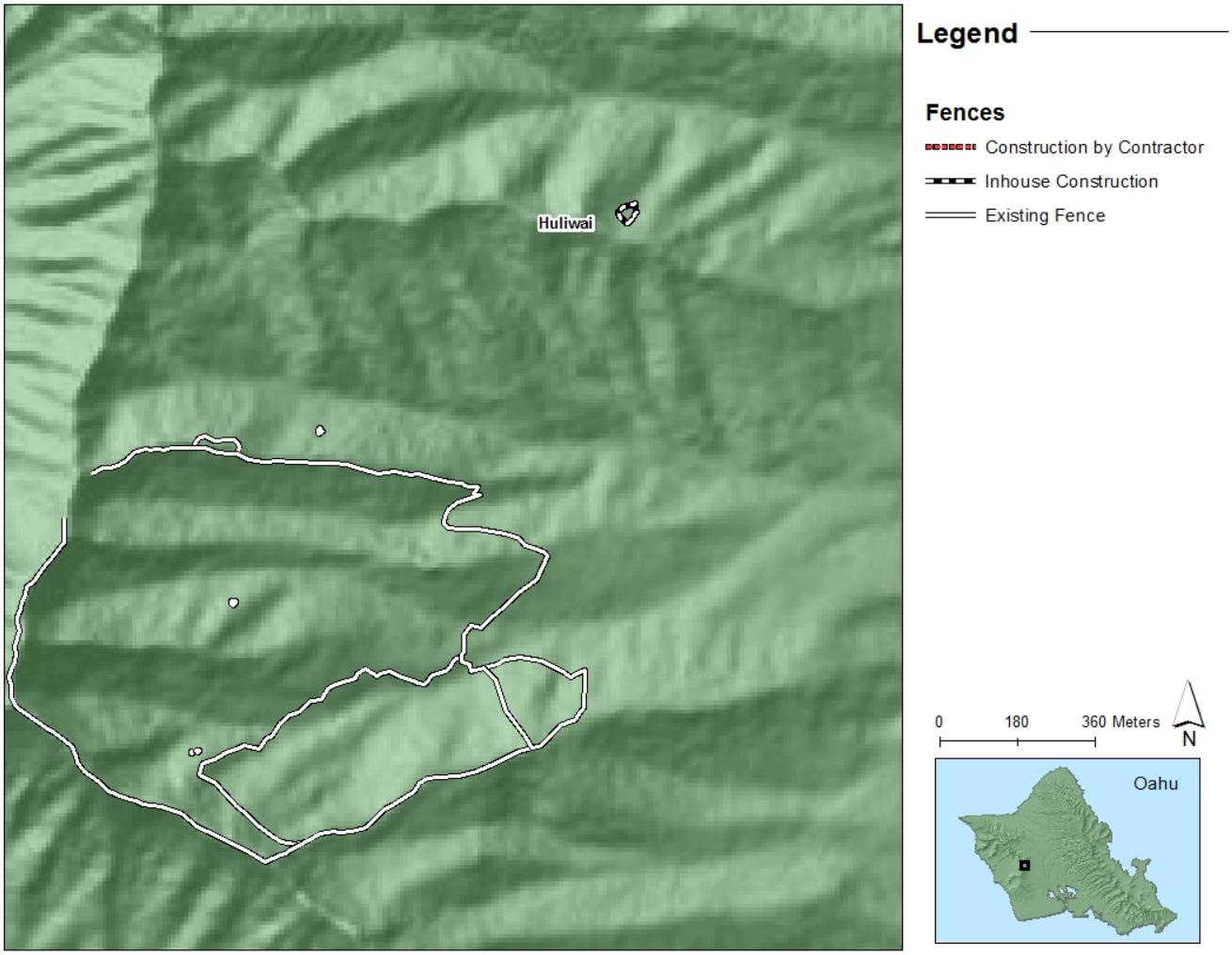

Figure 1.2 Map of Huliwai fence

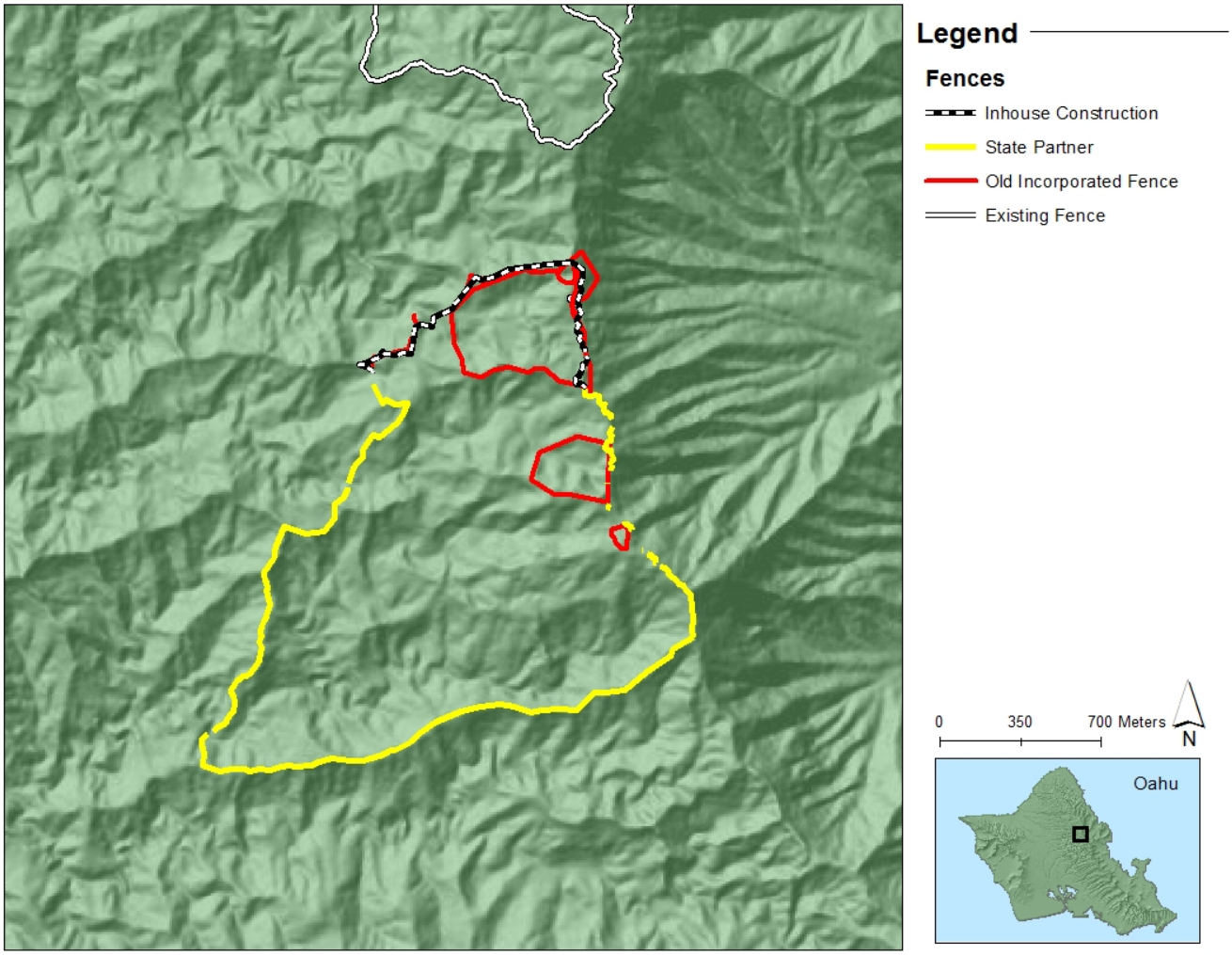

Figure 1.3 Map of Poamoho fence

OIP/MIP Management Unit Status

The MU status table below shows the current status of all proposed and completed fence units by MU. Shaded boxes identify where ungulate management or compliance documentations and authorizations are needed. The table identifies whether or not the fence is complete, ungulate free, identifies how many acres are protected versus how many were proposed in the Implementation plan, and the year the fence was or is expected for completion. Fences for which a Conservation District Use Permit (CDUP), Cultural 106, MOU, ROE or RA, or a License agreement has been acquired are checked in the appropriate box. The number of Manage for Stability Population Units protected is also identified for each fence. The table also contains notes which give the highlights and status from each fence and lists the current threats to each fence unit.

MIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
ARMY LEASED AND MANAGED LANDS													
Kahanahaiki	Kahanahaiki I	Yes	Yes	64/64	1998					7	0	Complete and ungulate free	None
	Kahanahaiki II	Yes	Yes	30/30	2013		X			6	0	Fence is complete and ungulate free	None
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002					3	0	Complete. Fence is in need of some repair but still pig-free.	None
Opaeula Lower	Opaeula Lower	Yes	Yes	26/26	2011	X	X		X	2		Fence is complete and ungulate free.	None
Ohikilolo	Ohikilolo	Partial	No	3/574	2002 2014		X			10	0	Ohikilolo ridge fence is complete. A 3.27 kilometer section of fence, from the cabin to the saddle makai, was replaced in 2014. Six PU fences are also complete and ungulate free. Since July 2006, 20 goats have been able to breach the fence. All have been removed. The Northern Makua rim section is slated for construction in 2015.	Pig/Goat
Ohikilolo Lower	Ohikilolo Lower	Yes	Yes	70/70	2000					2	0	This strategic fence is complete. A portion of the fence was repaired after rock-falls.	Goat
Puu Kumakalii	Puu Kumakalii	No	-	-	-	-	-	-	-	2	0	None needed but is partially included within the Lihue fence. Any potential goat issues will be dealt with as they arise.	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES													
East Makaleha	East Makaleha	No	No	0/231	Canceled	X	X			7	3	High priority fenceline for Waianae Mountains Watershed Partnership. OANRP may construct PU sized fences for PUs that could not be managed within existing MU fences.	
	West of East Makaleha	No	No	0/3	TBD	X				1	0	A PU fence has been proposed but is being deferred for now. A partnership fencing effort with the Snail Extinction Prevention Program may be a possibility. Permission from Oahu Branch required.	Pigs and Goats
Ekahanui	Ekahanui I	Yes	Yes	44/44	2001	X				6	3	Complete and ungulate free.	None
	Ekahanui II	Yes	Yes	165/159	2009	X	X			5	1	Complete and ungulate free. The completed fence is several acres larger than the original proposed MU fence	None
Haili to Kealia	Haili to Kealia	No	-	-	-	X	-	-	-	1	0	As per DOFAW staff 'no fence needed'	None
Kaena	Kaena	Partial	-	-	-	X	-	-	-	1	0	There is a predator proof fence installed by State but it does not protect all of the plants	None
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999	X		X		4	3	Completed by TNCH. The completed fence is several acres larger than the original proposed MU fence.	None
	Kaluaa/Waieli II	Yes	Yes	25/17	2006	X		X		3	3	Completed by TNCH. The completed fence is several acres larger than the original proposed MU fence.	None
	Kaluaa/Waieli III	Yes	Yes	43/11	2010	X	X	X		1	0	Completed and ungulate free	None

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
Keaau	Keaau II	Yes	Yes	8/33	2014	X	X	X		1	0	Complete and ungulate free. DLNR requested OANRP reduce the size of original proposed MU fence.	None
	Keaau III	No	No	0/33	Cancelled	X	X	X		1	0	Fence not to be built until after further consultation	
Keaau/Makaha	Keaau/Makaha	Yes	Yes	1/3	2009	X	X			1	0	Complete and ungulate free. The completed fence is smaller than the original proposed due to the terrain limitations.	None
Manuwai	Manuwai I	Yes	Yes	166/166	2011	X	X	X		8	1	Complete and ungulate free. Closed strategic section out of concern for possible ungulate breach.	None
Napepeiauolelo	Napepeiauolelo	Yes	Yes	1/1	2009	X	X	X		1	1	Complete and ungulate free	None
Pahole	Pahole	Yes	Yes	215/215	1998	X				16	0	Complete and ungulate free	None
Palikea	Palikea I	Yes	Yes	23/21	2008	X		X		4	0	Complete and ungulate free.	None
Kapuna Upper	Kapuna I/II	Yes	Yes	32/182	2007	X		X		1	0	Complete and ungulate free.	None
	Kapuna III	Yes	Yes	56/182	2007	X		X		5	0	Complete and ungulate free.	None
	Kapuna IV	Yes	Yes	342/224	2007	X		X		8	0	Complete and NAR staff believes it is ungulate free.	None
Waianae Kai	Slot Gulch	Yes	Yes	9/9	2010	X	X	X		2	0	Complete and ungulate free.	None
	Gouvit	Yes	Yes	1/1	2008	X		X		1		Complete and ungulate free	None
	NerAng Mauka	Yes	Yes	1/1	2011	X	X	X		2		Complete. Fence is continuously damaged by rock falls. OANRP is assessing the cost/benefit to maintaining management at this site. Management may be able to be moved to a suitable MU with less risk of continuous fence damage.	None
West Makaleha	West Makaleha	Partial	No	7/93	Canceled	X	X	X		7	0	The *Schiedea obovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free. OANRP will not construct larger unit because of the degraded nature of the forest and PU effort relocation.	
BOARD OF WATER SUPPLY													
Kamaileunu	Kamaileunu	Yes	Yes	5/2	2008	X	X		X	1	0	Both of the *Sanicula mariversa* PU fences at Kamaileunu and Kawiwi are completed and ungulate free.	None
	Kamaileunu and Waianae Kai	No	No	0/1	Canceled	X			X	1	0	This fence will not be constructed due to the terrain and safety concerns for staff.	
Makaha	Makaha I	Yes	Yes	85/96	2007					10	1	Complete and ungulate free.	None
	Makaha II	Yes	Yes	66/66	2013	X	X		X	4		Complete and ungulate free	None
DOLE FOOD COMPANY, INC.													
Alaiheihe and Kaimuhole	Alaiheihe and Kaimuhole	No	No	0/100	Canceled	X				4	0	Landowner is unwilling to allow fences built so this fence will not be constructed.	

OIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
ARMY LEASED AND MANAGED LANDS															
Kaala-Army	Kaala	Partial	No	183/183	2008		X			2	3			Strategic fences complete. Three pigs were caught in 2014, the first since 2010. A line has been scoped for the Waianae Kai side and 106 surveys complete. OANRP is pursuing construction of this fence.	Pig
Kaunala	Kaunala	Yes	Yes	5/5	2006		X				1			Complete and ungulate free.	None
Kawaiiki I/II	Kawaiiki I/II	No	No	0/11	Canceled	X			X			2		There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	
Kawailoa	Kawailoa	No	No	0/7	Canceled	X	X		X		1			Army training does not impact this tier 1 species	
Lihue	Lihue	Yes	No	1800/980	2012		X			4	7			Completed. Encompasses six PU fences and original three proposed units. A total of 533 pigs have been removed. There are very few pigs left in unit.	Pig
Poamoho	Poamoho Lower	No	No	0/156	Cancelled	X	X		X		1			Species management be relocated to Poamoho Rain Follows the Forest fence.	
	Poamoho Upper	No	No	0/60	Canceled	X	X		X			2		There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	
Opaeula Lower II	Opaeula Lower II	No	No	0/24	Canceled	X			X		1			Army training does not impact this tier 1 species	
Oio	Oio	Yes	Yes	4/4	2006	X					1			Complete and ungulate free.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	273/273	2001/ 2007						1			Complete. Portions of fence need replacement. Significant rust along sections exposed to direct winds. OANRP will request funding to accomplish this.	None
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006	X					1			Complete and ungulate free.	None
South Kaukonahua	South Kaukonahua I	No	No	0/95	TBD		X				3	3	1	Postponed pending completion of Section 7 consultation in 2015. The Tier 1 taxa *Hesperomannia arborescens* occurs within this MU.	Pig
	South Kaukonahua II	No	No	0/.5	Canceled		X					2		There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES															
Huliwai	Huliwai	Yes	Yes	.3/1	2014	X		X			1			Complete and ungulate free.	None
Ekahanui	Ekahanui III	Yes	Yes	8/8	2010	X	X				1			Complete and ungulate free.	None

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
Kaipapau	Kaipapau	No	No	0/273	Canceled	X					4	1		OANRP has shifted PU efforts from Kaipapau to other existing MUs.	Pig
Kaleleiki	Kaleleiki	Yes	Yes	2/2	1998	X					1			Completed by DLNR. May need to expand existing fence.	None
Manana	Manana	No	No	0/19	Canceled	X	X				1			OANRP is managing Labordia cyrtandrae within the Koloa MU as the wild plant found at Manana died.	Pig
Manuwai	Manuwai II	Yes	Yes	138/138	2011	X	X			1	1			Complete and ungulate free. The Lihue and Manuwai II unit share a strategic boundary and the ungulate free status is subject to pig traffic that although not highly probable, is possible could breach the unit	Pig
North Kaukonahua	North Kaukonahua	No	No	0/31	Canceled	X	X	X			3	1		OANRP is partnering with the State to build a larger unit encompassing large amounts of suitable habitat.	Pig
Poamoho	Poamoho Lower II	No	No	0/5	2014	X	X	X			1	4		OANRP is partnering with the State to build a larger unit encompassing this unit. OANRP is almost completed with construction of the North line.	Pig
	Poamoho Pond	No	No	0/18	2014	X	X	X				1	1	There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	Pig
	Kaukonahua-Punaluu	No	No	0/2	2014	X	X	X				1		There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	Pig
Wailupe	Wailupe	No	No	0/22	--	X						1		There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	Pig
Waimano	Waimano	Yes	Yes	4/4	2011	X	X				1			Complete and ungulate free.	None
North Pualii	North Pualii	Yes	Yes	20/20	2006	X				2	1			Completed by TNCH and ungulate free.	None
	BOARD OF WATER SUPPLY														
Kamaili	Kamaili	Yes	Yes	9/7	2014	X	X		X		1			Complete and ungulate free.	None
	HAWAII RESERVES INC.														
Koloa	Koloa	Yes	Yes	177/160	2012	X	X		X		4	2		Complete and ungulate free.	None
	KAMEHAMEHA SCHOOLS														
Waiawa	Waiawa I	No	No	0/136	Canceled	X			X		2	1	1	Army training does not impact these tier 1, 2 and 3 taxa.	Pig
	Waiawa II	No	No	0/136	Canceled	X			X		2	1		Army training does not impact these tier 1, 2 and 3 taxa	Pig
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION															
North Halawa	North Halawa	Yes	No	.5/4	Canceled	X					1			Complete. Management Actions for *Cyanea st.johnii* have fallen off of OANRP's list.	Pig
KUALOA RANCH INC.															

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
Kahana	Kahana	Yes	No	1/23	Canceled	X						1		There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	Pig
U. S. FISH AND WILDLIFE SERVICE															
Kipapa	Kipapa	No	No	0/4	Canceled	X							1	There are no tier 1 taxa therefore it will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	Pig

1.2 ENVIRONMENTAL OUTREACH

The OANRP outreach program is tasked with:

- conducting outreach to the military (including troops, their families and civilian contractors);
- conducting outreach to local communities about natural resource management;
- educating local communities and students about Hawaii's natural resources and careers in natural resource management;
- running an active volunteer program which assists staff in meeting IP goals, particularly by conducting field actions.

Highlights from the 2014 reporting year are discussed below. See Appendix 1-2 for photos and examples of outreach materials and articles.

Volunteers

During the reporting period the OANRP outreach program developed additional volunteer based projects at appropriate sites within OIP and MIP management areas and simultaneously phased out volunteer projects at Kahuku Training Area due to shifts in management strategies. Projects at the two OANRP baseyards continue to receive support from a few of the program's most dedicated volunteers.

The greatest volunteer effort focused on controlling a variety of incipient and invasive weeds at the Kaala MU. A large portion of volunteer time has also been spent within the Kahanahaiki "chipper site" controlling emerging weedy seedlings and saplings as follow up to the initial clear cut control effort from previous years.

The table below compares volunteer participation with OANRP for this year with that of previous years, distinguishing between volunteer efforts spent in the field and around the OANRP baseyards.

Report Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Work Site**	Total Volunteer Trips	Total Baseyard Volunteer Hours***
2014	4,421.5	1,133.75	78	490.75
2013	3,767.5	957	69	569.5
2012	4,302.5	1,261.5	78	602.5
2011	4,194	1,231	76	618
2010	3,415	1,299	58	885

****** Includes driving time to and from trailhead, safety briefing, hiking time to and from work site, and gear cleaning time at end of day*
*** Includes actual time spent weeding, planting or monitoring*
****Includes propagule processing, nursery maintenance and baseyard landscaping and maintenance*

The number of volunteer trips in FY2014 increased from FY2013, and volunteer weeding goals continue to be met. In addition, outreach staff successfully balanced this increase in volunteer trips with monthly troop and community outreach engagements.

The table below summarizes volunteer service trips by location.

Volunteer service for FY 2014

Management Unit	Projects	Total

		Number of Field Days
Kahanahaiki	Invasive weed control	22
	Trail maintenance	2
	Water catchment construction	1
Kaala	*Sphagnum* moss control	9
	Other incipient weed control	9
	Invasive weed control	6
Makaha	Invasive weed control	7
	Waianae High School Field Day	2
Palikea	Incipient weed control	3
	Invasive weed control	4
West Makaleha	Invasive weed control	4
Kaluaa	Invasive weed control	2
	Rare plant reintroduction	1
Pahipahialua	Invasive weed control	3
Ekahanui	Invasive weed control	2
Makua	Invasive weed control	1

The following bulleted list highlights additional volunteer coordination conducted by OANRP outreach staff.

- Maintained a volunteer database of 1,833 total volunteers and communicated regularly with active volunteers;
- Served as guest presenters at the Department of Land and Natural Resources Volunteer Leadership Training Workshop, providing insight on OANRP's use of iVolunteer (an online sign-up service), and volunteer recruitment, safety, project coordination and appreciation;
- Solicited feedback from volunteers using online evaluation form to provide post-service trip comments and suggestions. Feedback is used to help outreach staff refine and improve service trip opportunities. Samples of feedback can be found in Appendix 1-2.

Internships and Temporary Staff

Outreach staff developed internships at OANRP and with cooperating agencies. Staff coordinated the first day of orientation and various training for all interns. Internship opportunities provide valuable natural resource management training for the next generation of conservationists and give participants the opportunity to experience terrestrial field work. Bulleted points below highlight outreach staff efforts with the interns and temporary staff.

- Hosted three teams of HYCC members, providing hands-on natural resource training for 20 youth. Together, HYCC members contributed a total of 800 volunteer hours in June and July.
- Evaluated and scored 17 applicants, interviewed 11 applicants and awarded four individuals with three-month, paid OANRP summer internships. Interns were placed with field and horticulture crews to gain valuable career skills and experience in the field of natural resource management.
- Evaluated and scored three applicants, interviewed two applicants, and awarded one individual with a three-month, Pacific Internship Program for Exploring Science (PIPES) internship with OANRP. Intern was placed with our natural resource fence crew.
- Hosted a 10-month AmeriCorps intern with OANRP. Intern worked with all of the natural resource field crews.

See Appendix 1-2 for photos of interns and temporary staff.

Educational Materials

Outreach staff developed new educational materials in various media focused on natural resource issues specific to MIP and OIP species and their habitats. These contributions are summarized by category in the bulleted list below.

- Outreach Exhibits and Activities:
  - Got Tracks?
    - PURPOSE: Inform Hawaii Conservation Conference participants about tracking tunnels and how OANRP is using them to monitor predator activity trends in MUs
- Signage:
  - Have you spotted nene geese?
    - PURPOSE: Inform post staff and residents about what to do if they spot endangered nene on Wheeler Army Airfield or Schofield Barracks
  - Please Close Gate
    - PURPOSE: Post on ungulate fences to remind any individuals to close the gate upon exiting or entering the fenced area
  - Area Closed to Training (posted at East Range wash rack sediement disposal site)
    - PURPOSE: Inform soldiers that the wash rack sediment disposal site, located at East Range, is closed to training in order to prevent the spread of invasive weeds.
  - No Mowing
    - PURPOSE: Prevent *Chromolaena odorata* spread via mowing at Schofield Barracks West Range
  - Administrative Signs
    - Truck decals with program name and logo for all PICHTR trucks
    - Office signs denoting program office entrance, hours and contacts if staff is not around
  - Bioretention Area
    - PURPOSE: Identify the bioretation area at OANRP's West base and prevent introduction of pesticides or rinsate into the area

- Brochures & Flyers:
  - Oahu Army Natural Resources Program
    - Revised existing brochure containing general program overview, updating with current information, photos and text
- Other:
  - Developed script and coordinated filming for OANRP video, to provide a comprehensive overview on OANRP and the Army's natural resource management actions for the general public and military community

Troop Education

Outreach staff conducted presentations for Army troops, contractors and other active duty military personnel, highlighting the relationship between training activities and natural resources on Army training lands. Additionally, staff coordinated volunteer opportunities for a recovering soldier through the

Wounded Warrior Program. Unfortunately, the soldier's numerous medical appointments greatly impacted his availability to volunteer on a regular basis.

Event	Description	Number of presentations	Number of People Served
Range Brief Presentation: "Environmental Requirements"	A 20-minute brief on natural resource considerations on training lands.	20	1,998
Environmental Compliance Officer (ECO) training presentation: "Protecting Natural Resources"	A one-hour presentation for the ECO training courses held at Schofield Barracks.	11	285
Training Area Presentation: "Protecting Natural Resources in Makua"	A 15-minute presentation on natural resource considerations at Makua Military Reservation (MMR).	3	165
Total number of people served:			**2,448**

Outreach Events

Outreach staff disseminated information on natural resources specific to Army training lands at local schools, community events and conferences. These activities are summarized in the table below. See Appendix 1-2 for photos.

- Total number of outreach activities = 22
- Total number of people served (approximated) = 1,598

Outreach activities for FY 2014

Event	Estimated Number of People Served	Audience
Joint Spouses Conference	32	military
UH NREM Internship Class Presentation	25	undergraduate students
Leilehua High School Career Fair	38	high school students
Windward Community College Botany 130 Presentation	17	undergraduate students
Makua Tour and Interpretive Hike	22	general public
Mililani Uka Aina in Schools Presentation	75	elementary students and families
Invasive Species Awareness Day Exhibit	20	conservation community
HPU Environmental Studies Presentation	12	undergraduate students
BYU Presentation	20	undergraduate students
Live and Learn Community Event	75	military

Event	Estimated Number of People Served	Audience
Key Project Community Center Booth	75	Kaneohe community
Kahanahaiki MU Educational Hike	12	government employees (national)
Schofield Barracks Fun Fest	100	military
Schofield Earth Day	100	military
Fort Shafter Earth Day	100	military
Windward Community College Botany 130 Presentation	18	undergraduate students
DLNR Volunteer Leadership Training	30	conservation community
Hawai'i Conservation Conference	700	conservation community
Kahuku HS Science Fair Prep Presentation	22	high school students
UH Botany Pau Hana Talk	21	graduate students
Makua's Natural Resources Presentation	25	Waianae community members
HTMC Trail Clearing Support	19	Hiking club
Leeward Community College	40	Hawaiian Studies Program
Total number of people served	**1,598**	

Contributions to Conferences

OANRP staff contribute to outreach by presenting research findings at various conferences throughout the Pacific. This reporting year, four staff presented at the 2014 International Conference on Island Evolution, Ecology and Conservation, and five staff presented at the 2014 Hawaii Conservation Conference, held at the Hawaii Convention Center. These and other presentations are listed in the table below.

Presentation Title	Format	Presenter	Venue	Date
Growth and ecological impacts of an invasive bryophyte in Hawaii: the strange tale of *Sphagnum palustre*	Poster	D. Beilman, Stephanie Joe* (OANRP), O. Schubert and M. McCain	International Conference on Island Evolution, Ecology and Conservation	07-July-14
Balancing conservation needs of different taxa sharing the same space	Oral	Karl Magnacca	International Conference on Island Evolution, Ecology and Conservation	07-July-14
Seed storage behavior of the native Hawaiian flora	Oral	Lauren Weisenberger*, T. Kroessig, M. Chau and Matthew Keir*	International Conference on Island Evolution, Ecology and Conservation	07-July-14
Achieving optimal slug control in forest settings	Poster	Stephanie Joe*, Kelly Cloward*, Jessica Hawkins* and Brian Yannutz*	Hawaii Conservation Conference	15-July-14
Utilizing Partnerships to Improve Island-Wide Early Detection of Invasive Plants on Oahu	Poster	D. Frolich, A. Lau, Jane Beachy* and C. Imada	Hawaii Conservation Conference	15-July-14
Rapid radiation and host plant conservation in the Hawaiian picture-wing *Drosophila*	Oral	Karl Magnacca	Entomolgical Soceity of America Meeting	12-Nov-13

Presentation Title	Format	Presenter	Venue	Date
Insect conservation on the Hawaiian Islands: Strategies and recommendations for land managers	Oral	Medeirso, M.J., Eiben, J.A., Haines, W.P., Kaholoaa, R., King, Cynthia B. A., Krushelnycky, P., Rubinoff, D., Karl Magnacca*	Entomolgical Soceity of America Meeting	12-Nov-13
Natural Resources Management in Hawaii	Oral	Matthew Keir	Florida Rare Plant Task Force Meeting	10-Apr-14
**Denotes OANRP staff for co-authored presentations.*				

Outreach staff supported the Nahululeihiwakuipapa Program (emerging professionals group) at the 2014 Hawaii Conservation Conference as members of the planning committee, which met on a monthly basis throughout the FY. Results of this planning included the following features at the conference:

- Nahululeihiwakuipapa Workshop: Trending Conservation - Building a Social Media Strategy that Informs and Activates, a session targeting youth interested in conservation careers

- Mentorship Program: an opportunity for attendees to connect with seasoned professionals attending the conference

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 1-2 for examples). The table below is a summary of all media featuring OANRP in 2014.

Media coverage of OANRP activities in FY 2014

Title	Publication	Date	Format
Army, HI partner to protect watersheds	Hawaii Army Weekly http://www.army.mil/article/117567/Army__Hawaii_partner_to_protect_watersheds/	27-Dec-13	Article
Army aids watershed protection in Koolaus	Honolulu Star Advertiser http://www.staradvertiser.com/s?action=login&f=y&id=235530281&id=235530281	12-Dec-13	News story
Army, state partner to protect Oahu's watersheds	Hawaii Reporter http://www.hawaiireporter.com/army-state-partner-to-protect-oahus-watersheds/123	10-Dec-13	News story
'Species Awareness' is March 3-9	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2014/02/28/species-awareness-is-march-3-9/	28-Feb-14	Article
Army joins State, Nation in spotlighting invasive species	Public Affairs Office, U.S. Army Garrison, Hawaii	3-Mar-14	Media release
Alien Species: USAG-HI native plantings prevent spread	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2014/03/07/alien-species-usag-hi-native-plantings-prevent-spread/	7-Mar-14	Article

Title	Publication	Date	Format
Army joins national and state control efforts	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2014/03/07/army-joins-national-and-state-control-efforts/	7-Mar-14	Article
OANRP manager named 'Oahu MVP'	Hawaii Army Weekly http://www.army.mil/article/121669/OANRP_manager_named__Oahu_MVP_/	7-Mar-14	Article
OANRP Investigates the Utility of Automatic Rat Traps	Public Works Digest http://www.imcom.army.mil/About/Publications/PublicWorksDigest.aspx	April/May/June 2014	Article
State bird touches down at Wheeler	Hawaii Army Weekly http://www.army.mil/article/132496/State_bird_touches_down_at_Wheeler/	25-Aug-14	Article

Ecosystem Management Program Bulletin

During this reporting period, the outreach staff edited, produced and distributed the Ecosystem Management Program (EMP) Bulletin, a quarterly newsletter highlighting achievements made by the Army Environmental Division's Conservation Branch, both on Oahu and Hawaii Island.

This year staff spent a significant amount of time overhauling the layout of the bulletin, which resulted in a temporary break in publications. Along with an updated design, the new bulletin features increased field photography, more background information on article authors and additional newsworthy highlights on the Army's natural and cultural resources programs. Volume 60, Issue 1, was released in September 2014.

The EMP is posted online at http://manoa.hawaii.edu/hpicesu/dpw_emb.htm and is also 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. A hard copy of the bulletin is also provided to the University of Hawaii at Manoa Hamilton Library.

With the release of the new look of the bulletin, staff also developed additional online presence for the bulletin at www.issuu.com/oanrp. ISSUU allows for easy online reading of the bulletin without the need to download the PDF file. Sharing and download options are available on the site as well, should these opportunities interest the reader.

Outreach Program Recognition

During the reporting period, the outreach program received the following national recognition:

- Registered and planned volunteer work day in Kahanahaiki MU for September 27, 2014 in celebration of National Public Lands Day. Received cash award totaling $4,917.42 to purchase supplies including: Nalgene transport bottles and applicator bottles, earth augers, auger bits, saws, pruners, work gloves, nitrile gloves, shovels, hand trowels, dibble bars and dry bags. An additional day in celebration of National Public Lands Day is scheduled for Saturday, November 15 for planting in the area previously weeded. Both volunteer work days are being promoted on the National Public Lands Day website.

- Nominated four OANRP volunteers for the President's Volunteer Service Award. Three volunteers were eligible for the Silver Level Award (serving 250-499 hours each within the reporting year) and one was eligible for the Gold Level Award (serving over 500 hours within the reporting year). Each awardee will receive presidential pins and certificates of appreciation.

- **2014 President's Volunteer Service Award Nominees**

Award Level	Hours per volunteer in FY2013
Gold	519.75
Silver	387
Silver	290
Silver	284.5

See Appendix 1-2 for photos and samples of outreach materials and articles.

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1.3 WEED CONTROL PROGRAM

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 should be treated as guidelines and adapted to each MU as management begins. Please see the 2010-2011 MIP and OIP Annual Report for a discussion of adaptive changes to these goals. The ERMUPs for each MU detail specific goals and monitoring expectations for each MU.

Weed Control Effort Summary

OANRP weed control efforts are divided into three primary categories: incipient control efforts, broad ecosystem control efforts, and early detection surveys. Weed control efforts are discussed for each category separately.

This year, OANRP spent 7,600 hours controlling weeds across 286.5 ha. This is a program record. These figures include both incipient and ecosystem control efforts by staff and volunteers but do not include survey efforts or travel time. The table below compares this year's effort with that of previous years. This year's increases are due in part to a continued program emphasis on weed control projects, and in part to the creation of a new Ecosystem Restoration team. This team, made up of temporary and permanent staff, began work in July and focused almost exclusively on weed control projects.

Report Year	Effort (hrs)	Area (ha)
2013-2014	7,600	286.5
2012-2013	6,967.6	267.7
2011-2012	5,860	275.7
2010-2011	5,778	259

Complementing control efforts, OANRP staff conducted early detection surveys on all primary training range roads and military landing zones (LZs), some MU access roads, and all secondary training range roads in KTA, SBE, MMR, and SBW.

Incipient Control Areas

Incipient control efforts are tracked in Incipient Control Areas (ICAs). Each ICA is drawn to include one incipient taxon; the goal of control is eradication of the taxon from the ICA. ICAs are primarily drawn in or near MUs. Those not located within or adjacent to an MU were selected for control either because they occur in an Army training range (for example, *Cenchrus setaceus* in MMR) or are particularly invasive (*Morella faya* in Kaluaa). Many ICAs are very small and can be checked in an hour or less, and in some MUs multiple small ICAs can be checked in one day. In contrast, a few ICAs, like those for *Sphagnum palustre* in Kaala or *Chromolaena odorata* in Kahuku, are quite large and require days to sweep completely. Typically, ICAs are swept repeatedly until eradication has been achieved and staff is reasonably confident there is no remaining seed bank. In the absence of data regarding seed longevity, staff does not consider a site eradicated until ten years after the last sighting. The goal of ICA efforts is to achieve local eradication of the target species. OANRP currently controls about 63 taxa in 212 ICAs.

Of the total 286.5 ha swept, ICA efforts covered 196.41 ha. Staff spent 1,753.6 hours on ICA management and conducted 389 visits to 157 ICAs. This is the greatest amount of effort, and second greatest area managed for incipient weeds by OANRP, as shown in the table below. This year, ICA work accounted for 69% of the total area controlled and 23% of total effort. This makes sense, as incipient control generally requires less time per acre than habitat restoration weed control.

Report Year	# ICAs	Visits	Effort (hrs)	Area (ha)
2013-2014	157	389	1,753.6	196.41
2012-2013	152	311	1,369.2	184.34
2011-2012	115	260	1,661	219.27
2010-2011	130	281	665.5	164

While the goals for all ICAs are the same, the rate of visitation required to achieve local eradication varies widely. Some ICAs, such as those for *Ehrharta stipoides*, must be visited at least quarterly, as this cryptic grass grows and matures very quickly. In contrast, for *Angiopteris evecta* ICAs, once initial knockdown is complete, ICAs need only be swept once every year or two, as individuals are slow to mature. In general, ICA efforts are considered successful if visits are frequent enough to detect and control plants before they mature and there is a downward trend in total numbers of plants found per visit.

Although not included in this document, specific reports that identify dates of last mature and non-mature plants found, overall effort spent, and population trend graphs are available for each ICA. These reports may be generated in the OANRP database (supplied on CD) and are recommended for review by the IT.

The ten MUs where most ICA effort was spent are highlighted in the table below. Note that effort hours do not include travel or trip preparation, or time spent surveying outside of known ICA boundaries to define infestation areas.

Alstonia macrophylla discovered on SBW

ICA Effort in MUs

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Kaala Army	7	*Anthoxanthum odoratum* *Crocosmia* x *crocosmiifolia* *Festuca arundinacea* *Juncus effusus* *Odontonema cuspidatum* *Pterolepis glomerata* *Sphagnum palustre*	35	460.85	Much of the work done at Kaala utilizes volunteers, particularly for control of *C. crososmiifolia, J. effusus*, and *S. palustre*. *Sphagnum* continued to account for the majority of time spent, although efforts are still significantly lower than 2012 (781 hrs), now that control has entered the maintenance phase. Control began on two new species this year, *P. glomerat*a and *O. cuspidatum*. The *P. glomerata* site is located along the boardwalk, and is highly concerning, as it likely was introduced via staff or hikers. The *O. cuspidatum* doesn't flower or seed at elevation, but is steadily spreading vegetatively in a localized area; this year control was conducted with volunteers.
KTA No MU	6	*Acacia mangium* *Cenchrus setaceus* *Chromolaena odorata* *Melochia umbellata* *Miscanthus floridulus* *Rhodomyrtus tomentosa*	94	413.05	All of the ICA taxa at KTA pose significant ecosystem risks and have the potential to degrade the training ranges. As one of the most heavily used ranges, KTA is a priority incipient control area. Efforts on *C. odorata* account for most of the time spent. Hours recorded here do not include hours spent by OISC, which are included in Appendix 1-3-1.
SBE No MU	8	*Buddleja madagascariensis* *Cenchrus setaceus* *Heterotheca grandiflora* *Rhodomyrtus tomentosa* *Schizachyrium condensatum* *Senecio madagascariensis* *Smilax bona-nox* *Vitex trifolia*	60	225.75	Last year, little effort was spent at this heavily used training area. Renewed prioritization of SBE accounts for the dramatic jump in effort (20 hrs in 2013). Most effort was spent on *Schizachyrium* and *Rhodomyrtus*. New ICA sites were found for several species: *Schizachyrium* (2), *Rhodomyrtus* (1), *Vitex* (1), and *Heterotheca* (1). All known *Heterotheca* sites are growing out of sand brought on to the range. The source of this sand is being investigated.
SBW No MU	1	*Chromolaena odorata*	15	158.3	*Chromolaena* control efforts expanded greatly this year. Two new ICA locations were discovered by Cultural Resources staff and reported to OANRP. Buffer surveys (ground and aerial) were conducted around both outlier spots to delimit perimeters. Both sites have been treated with pre-emergent herbicides. The majority of effort was spent on the primary infestation, and included aerial and ground surveys, regular treatment of hotspots, and roadside sprays to keep *Chromolaena* off a high-traffic road.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Kaala NAR	4	*Crocosmia* x *crocosmiifolia* *Juncus effusus* *Pterolepis glomerata* *Sphagnum palustre*	19	143.15	All the taxa on this list except *Pterolepis* are controlled with volunteers. *Pterolepis* was found at the Kaala Shelter last year; regular monitoring resulted in no additional plants found. Staff spent more time than usual controlling *Sphagnum* (90.5 hrs) on the NAR side of the boardwalk, as part of a work swap arrangement with NARS staff.
Ohikilolo Lower	1	*Cenchrus setaceus*	9	92.40	*Cenchrus* continues to be a control priority at MMR. Efforts this year included three days of aerial spraying, as well as multiple ground survey/control days. Staff noted a well-used trail to a cave which appears to be very popular with hikers. The presence of hikers sometimes hampers control operations, and also suggests a vector for the spread of *Cenchrus* to this area.
Palikea	2	*Crocosmia* x *crocosmiifolia* *Setaria palmifolia*	16	51.75	The majority of time was spent on *Crocosmia* control, done primarily by volunteers. Numbers of plants found continue to decrease across known locations. *Setaria* sites are discrete and require little time to maintain. Last year, *Angiopteris* was controlled in ICAs; strategy was changed this year due to additional locations found during vegetation monitoring. Given the wider distribution and the fact that no mature plants have ever been seen, it seems likely there is an external source population seeding in the MU, and that the old ICA locations did not best represent potential future colonizations. *Angiopteris*, like *Sphaeropteris cooperi*, will continue to be a priority target, but will be controlled in the course of regular WCA work, wherever it is found.
Kapuna Upper	2	*Angiopteris evecta* *Rubus argutus*	7	41.5	The majority of effort was spent on *Angiopteris* control. This infestation covers a large area, but recruitment and maturation of plants is slow; ICAs are swept once a year.
Kaluaa and Waieli	8	*Angiopteris evecta* *Arthrostemma ciliatum* *Casuarina equisitifolia* *Clusia rosea* *Dovyalis hebecarpa* *Ehrharta stipoides*	22	36.10	These numbers include ICA control in both Kaluaa and Waileli MU and Kaluaa No MU. Efforts appear to have been very successful, with no plants found this year at several ICAs, including *Morella*, *Clusia*, *Solanum*, *Dovyalis*, and *Arthrostemma*. However, two new ICAs were added this year, one each for

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Morella faya			*Angiopteris* and *Ehrharta*.
		Solanum capsicoides			
Manuwai	3	*Caesalpinia decapetala*	20	27.05	First found along the eastern edge of the Manuwai fence, *Pterolepis* continues to be challenging to control. Plants mature quickly and maintain small stature, making it difficult to identify and control them before they set seed. Constant effort will be needed to eradicate *Pterolepis*. Staff spent almost half of Manuwai effort controlling suspected *Caesalpinia decapetala*. Fortunately, four sites were later identified as the native *Caesalpinia bonduc*, leaving only one site requiring maintenance in future.
		Dietes iridioides			
		Pterolepis glomerata			

The table below highlights the taxa which required the most control effort in the past year.

ICA Target Taxa

Taxa	2014 Effort	2013 Effort	Comments
Chromolaena odorata	418.6	396.35	Effort includes only OANRP time (OISC time in Appendix 1-3-1). Time spent conducting survey sweeps in buffer areas is not included. See discussion in section 1.3.4 below.
Sphagnum palustre	327.75	292.65	*Sphagnum* control continues to be a priority for the Outreach program, with volunteers providing the majority of field effort. The ER team began re-sweeping the infestation buffer and treating outliers at the end of the report year. While efforts focused primarily in the Kaala Army MU, over 95 hours were spent assisting State control efforts in Kaala NAR MU. Unfortunately, one new sphagnum site was found in Kaala Army MU along a transect, well away from the known infestation.
Crocosmia x *crocosmiifolia*	167.95	143.35	Volunteers conduct the majority of *Crocosmia* control at both Kaala and Palikea. Most effort is spent at Kaala, where *Crocosmia* forms dense, localized banks. Staff tested the efficacy of weed mat as a control method; most corms appeared dead after 1 year, although plants just under the edge of mat did survive. In the coming year, chemical control methods will be investigated to supplement mechanical control.
Schizachyrium condensatum	108	15	Renewed emphasis was placed on *Schizachyrium* this year. Staff discovered two new ICA sites, suggesting that this cryptic taxon is spreading across the range. Buffer surveys have begun to further delimit the infestation.
Melochia umbellata	91.75	15.75	Aerial surveys and discoveries by OISC staff sweeping for *Chromolaena* revealed scattered mature *Melochia* trees across Kaunala gulch, between previously known plant sites. It appears that *Melochia* has infested a much larger area than previously thought. Given the large area and long-lived seeds, OANRP strategy will change in the coming year, focusing on annual treatment of Kaunala gulch and keeping plants off roadways.

Taxa	2014 Effort	2013 Effort	Comments
Cenchrus setaceus	107.05	130.2	This taxon is a high priority wherever it is found. While total time spent on *C. setaceus* decreased this year, the time spent on the largest infestation (at MMR) increased. The decrease is primarily due to little time being spent at the Keaau infestation (now monitored by OISC), less time spent at the two extant KTA infestations (which appear to be under control), and the discovery that another possible KTA infestation was actually a mis-identification.
Rhodomyrtus tomentosa	77.05	1	Staff discovered a new *Rhodomyrtus* site on the Pahole fence this year. While the plant was less than a meter high, it was already flowering, although it likely had not yet set seed. Possible vectors include staff and recreational hikers. The SBE infestation accounts for almost 73 hours of effort. Plants are scattered sparsely across a large area, making for challenging conditions. One new site was found across a gulch from the primary infestation. Buffer surveys are a priority in the coming year.
Angiopteris evecta	52.55	50.93	This taxon is relatively widespread, but has been targeted for eradication in select MUs. Most effort was spent in Kapuna Upper. Initial control is complete at all known sites, and the current strategy of annual maintenance checks appears to be effective.
Juncus effusus	41.85	38	Volunteers conduct the majority of control on this species, which staff only know from Kaala. Since the seeds are long-lived, control will need to continue for years to come.
Miscanthus floridulus	31.25	14	Ground control efforts targeted accessible plants on the edge of Pahipahialua gulch. Plants often require multiple foliar glyphosate treatments, likely because they form very thick clumps which are difficult to penetrate with sprays. Aerial control will be needed in the future.
Ehrharta stipoides	28.5	17.45	Widespread in Palikea, this cryptic grass has been found at an increasing number of sites, including Kaluaa, Kahanahaiki, and Lihue. Its ability to thrive in the shade, form dense mats, and disperse easily makes it challenging to eradicate. Staff and contractors are possible dispersal vectors.
Pterolepis glomerata	23.30	16.85	This taxon is only a target in the Waianae Mountains, where it is a control priority in Kaala, Manuwai, Makaleha, Pahole, and Makaha. This year, new infestation sites were found at the Kaala boardwalk, and along the new Makaha II MU fence/Kumaipo trail. State staff also found it at another site midway along the Kumaipo-Kaala trail. While staff may be responsible for spreading *Pterolepis*, recreational hikers may also be spreading it along this popular trail.
Vitex trifolia	22	3	While this species is not a high priority, it is found in SBE, in the same area as *Rhodomyrtus*, and is controlled whenever seen. Staff noted that it aggressively resprouted from roots and cut stumps, despite application with triclopyr. Experimental treatments with imazapyr products appear to be much more effective.
Acacia mangium	20.75	9.5	In the course of *Chromolaena* work, a new *Acacia* site was discovered on KTA, and another was located to the west in Pupukea. While control efforts continue at KTA, the Pupukea population, which includes mature trees, is geographically out of OANRP's purview.

Unfortunately, new invasive weeds are found with some regularity on training ranges and in MUs. This year, new locations of *Pterolepis glomerata* and *Ehrharta stipoides* demonstrated the importance of rigorously cleaning gear between work sites, and communicating with partner agencies, contractors, and recreational users to ensure all parties are practicing basic sanitation. Likewise, new locations of *Schizachyrium condensatum* at SBE highlight the necessity of military sanitation efforts.

While the majority of ICAs require minimal amounts of effort to monitor, some require significant investment of resources. Volunteers contribute significantly to ICA control efforts at Kaala and Palikea, which enables OANRP to divert staff time to more challenging taxa and/or work sites. A good example of this is *Sphagnum palustre*, which is highly invasive, but is not located in direct proximity to IP taxa. Volunteer time allows staff to focus on *Hedychium gardnerianum*, which directly threatens rare plants and their habitat, while maintaining focus on less immediate threats, including *S. palustre, J. effusus,* and *C. crocosmiifolia*.

In the coming year, OANRP hopes to conduct more buffer surveys for select taxa, which will assist in developing control strategies and schedules. Species that will benefit from this include *Schizachyrium condensatum*, *Rhodomyrtus tomentosa*, and *Erythrina poeppigiana*. Incipient taxa on SBE, SBW, and KTA, the most heavily used ranges, will continue to be top priority. In particular, *Chromolaena odorata* control efforts are critical to mitigating the Army's impact on the training ranges. Likewise, *C. setaceus* control at MMR is important as a fire-suppression measure.

Several ICAs are considered eradicated, and others are approaching eradication. The table below highlights these locations.

ICA Eradication Status

ICA Code	Year Plants Last Seen	Eradicated?	Comments
DMR- *Cenchrus Setaceus*-01	2001	Yes	Seeds short-lived, persisting less than 1 year. Site eradicated.
MMR- *Caesalpnia decapetala* -01	2001	Yes	Seed longevity unknown, but no plants seen for 10 years, indicating site eradicated. However, the site was not checked regularly during this whole period, so it will continue to be monitored during annual road surveys through 2016.
Kaala- *Setaria palmifolia* -01	2003	Yes	Seed longevity unknown, but no plants seen for 10 years, indicating site eradicated.
MMR- *Rubus argutus* -04	2003	Yes	Seed longevity unknown, but no plants seen for 10 years, suggesting site eradicated.
SBE- *Buddleja madagasariensis* -02	2004	Yes	Seed longevity unknown, but no plants seen for 10 years, indicating site eradicated.
SBE- *Cenchrus setaceus* -01	2004	Yes	Seeds short-lived, persisting less than 1 year. Site eradicated.
KTA- *Cenchrus setaceus* -01	2005	Yes	Seeds short-lived, persisting less than 1 year. Site eradicated.
KTA- *Rhodomyrtus tomentosa* -01	2005		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2015).
MMR- *Rubus argutus* -03	2005		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2015).
MMR- *Cirsium vulgare* -02	2006		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2016).
MMR- *Syzigium jambos* -01	2006		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2016).
SBE- *Buddleja madagasariensis* -01	2006		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2016).
KTA- *Sideroxylon persimile* -01	2008		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2018). No mature plants were ever seen.

ICA Code	Year Plants Last Seen	Eradicated?	Comments
SBE- *Senecio madagascariensis* -01	2008		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2018).
Whitmore-*Tibouchina urvilleana* -01	2008		Not known to set seed, no plants have been seen since 2008, indicating the site may be eradicated. Annual monitoring will be continued until 2018.
Kaluaa- *Arthrostemma ciliatum* -01	2009		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2019).
MMR- *Fraxinus uhdei* -01	2010		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2020). Large mature tree was present, no recruitment has been seen.
PaholeNoMU- *Setaria palmifolia* -01	2010		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2020).
Central Makaleha No MU- *Verbesina encelioides* -01	2011		Plants observed growing out of gravel pile, which was then treated with pre-emergent herbicide. No plants seen since. As seed longevity is unknown, site will be monitored annually for 10 years (2021).
East Makaleha No MU- *Verbesina encelioides* -02	2011		Plants observed growing out of gravel pile, which was then treated with pre-emergent herbicide. No plants seen since. As seed longevity is unknown, site will be monitored annually for 10 years (2021).
MMR- *Cirsium vulgare* -01	2011		Seed longevity unknown, so site will be monitored annually until 10 years have passed with no sightings (2021)

Erythrina poeppigiana seedlings at SBW

Weed Control Areas

Ecosystem control efforts are tracked in Weed Control Areas (WCAs). WCAs generally track all control efforts which are not single-species based. Note that WCAs are not necessarily drawn to encompass all of a MU, although in some MUs, like Makaha and Manuwai, the entire MU has been divided into WCAs. Each WCA is prioritized and goals are set based on a variety of factors including: presence of MIP/OIP rare taxa, potential for future rare taxa reintroductions, integrity of native forest, invasive species presence, and fire threat. Different WCAs have different goals; some simply track trail and fence line vegetation maintenance. The goals and priorities for weeding in a particular WCA are detailed in the appropriate ERMUP. For some low-priority WCAs, no control may be planned for many years. WCAs drawn outside of MUs typically provide a way of tracking weed control effort at genetic storage rare plant sites or along access trails and roads. OANRP does not necessarily plan to control 100% of the acreage in a WCA every year. Some WCAs are not intended to be controlled every year, particularly those in sensitive habitats. Others, like the ones in Ohikilolo Lower which facilitate fuel break maintenance, are monitored quarterly and are swept in their entirety. Visitation rates and goals are further elucidated in the ERMUPs. Via the ERMUPs, staff hopes to more accurately show how priorities are set for different WCAs over a multi-year time period. This year, more WCA area was designated as additional fence exclosures were completed. See the 2009 Status Update for the MIP and OIP, Appendix 1-2, for information on control techniques.

In the OANRP database, specific reports can be generated which detail the amount of time spent in each WCA, the weeds controlled, the techniques used, and the rare taxa managed. These database reports, as well as the ERMUPs, provide a more detailed look into each MU and each WCA, and are recommended to the IT/USFWS for review. It can be difficult to compare effort spent between WCAs/MUs and to judge whether the effort spent was sufficient. Since goals for each site vary, estimating the effort needed for each WCA is very challenging. Staff continues to work towards creating meaningful estimates of effort needed per WCA for select sites in the coming year.

Control efforts are summarized in the MU WCA Weed Control Summary table below. The table lists all MUs where WCA control was conducted in the past year. Data from the 2013 report is included for reference. This year's data is shaded and in bold. For each year, the total actual area weeded is reported; for example, if one rare plant site of one acre was swept on three separate occasions, the area weeded is reported as one acre, not three acres. The number of separate weeding trips is recorded as number of visits, and the effort is recorded in person hours spent weeding (travel and set-up time is not included).

Native taxa begin colonizing an aggressive *Psidium cattleianum* removal site in Palikea.

MU WCA Weed Control Summary, 2013/10/01 through 2014/09/30

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Aimuu No MU	N/A	0.43	**0**	**0**	**0**	99 m^2	1	1.5	No control was conducted at this small rare plant site.
Alaiheihe No MU	N/A	9.99	**2.46**	**2**	**3.5**	0.2	1	0.5	This region includes the Lower Kaala NAR access road. Staff sprayed weeds along the road, part of the Manuwai fence, and monitored an *Ehrharta stipoides* site at the end of the road.
East Makaleha No MU	N/A	1.21	**257 m^2**	**1**	**1**	0	0	0	This area includes the very top of East Makaleha gulch, around the Kaala Radio Tower road. Grass and herbaceous weeds along the road were controlled to facilitate ICA work.
Ekahanui	87.5	77.54	**1.48**	**28**	**119.25**	3.4	17	157.5	Control efforts focused around rare species sites, particularly reintroduction zones. Low staffing levels on the Ekahanui crew may have contributed to the decline in area and effort this year.
Ekahanui No MU	N/A	10.09	**117 m^2**	**1**	**1**	118 m^2	1	1	Limited weed control is conducted outside the MU. Weed control was conducted around a Genetic Storage *Delissea waianaensis* site.
Haili to Kealia I and II	12.81	0.32	**0**	**0**	**0**	223 m^2	1	1	This area is alien-dominated, and the rare plant reintroductions have not done well. Long term goals need to be evaluated.
Haili to Kealia No MU	N/A	0.82	**0.70** *(7,002 m^2)*	**1**	**1.5**	528 m^2	1	3	This region encompasses the Kuaokala access road. Staff controlled *Sphaeropteris cooperii* along the road, and will continue to do so opportunistically.
Helemano	60.63	61.86	**0.49**	**5**	**24.5**	1.72	12	52	Helemano is a low priority MU due to the small number of Tier 1 taxa. This, combined with challenging access due to weather led to limited weed control effort in 2014. Staff targeted *Setaria palmifolia* along the fenceline, and controlled some *Psidium cattleianum* this year.
Helemano-Poamoho	257.91	29.01	**0**	**0**	**0**	222 m^2	1	5	This MU replaces the former Poamoho Upper MU. This area is low priority, due to few IP Taxa present. OANRP plan to contribute to partner-led efforts in this area in the future.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Huliwai	0.91	0.20	**0.13** *(1,331 m²)*	**1**	**4**	28 m²	1	1	This MU is centered around an *Abutilon sandwicensis* population, and weed control efforts focused around these rare plants.
Huliwai No MU	N/A	9.43	**0.41**	**1**	**6**	0	0	0	Staff conducted one IPA treatment in this area this year, targeting *Grevillea robusta* along the ridge between two rare taxa locations.
Kaala Army	49.02	51.19	**6.55**	**33**	**570**	19.1	49	542.25	*Hedychium gardnerianum* continues to be the primary weed target at Kaala. Staff focused efforts on the lower slopes of Kaala, just above the cliffs ringing the summit. In addition, staff conducting buffer sweeps for *Sphagnum* also treated *Hedychium* along the boardwalk. Grass control was conducted at the beginning of the boardwalk to facilitate ICA work.
Kaala NAR	20.03	4.30	**101 m²**	**1**	**0.25**	0	0	0	Effort in the NAR focused solely on controlling grass at the beginning of the boardwalk.
Kaena	10.06	3.06	**0.92**	**4**	**18**	1.77	5	65	Staff continue to focus weed control efforts around *Euphorbia celastroides* var. *kaenana*. Little weed regrowth was seen, allowing for a decrease in effort this year.
Kaena East of Alau	14.51	0.89	**0.27**	**3**	**47**	0.39	2	35	Weed control efforts focused on reducing fuel loads around a small population of *E. celastroides* var. *kaenana*. While some grass control was done, the majority of time was spent removing *Prosopsis pallida* and *Leucaena leucocephala*.
Kahanahaiki	37.7	41.62	**7.22**	**62**	**896.9**	2.99	52	577	There was a huge increase in both effort and area from 2013. Most of the area increase is due to IPA sweeps targeting *G. robusta* in Kahanahaiki II. These sweeps account for some of the effort increase as well. The rest of the increase is due to a combination of volunteer efforts (at the chipper site especially), staff efforts, and the new ER team efforts. Control continues to focus on rare taxa sites and general habitat improvement.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaleleiki	0.12	0.80	**338 m²**	**1**	**2**	259 m²	1	20	The *E. koolauensis* population protected in this MU has been heavily impacted by the *Puccinia* rust. Weed control efforts continue to be a low priority, until a plan for *Eugenia* is developed.
Kaluaa and Waieli	80.97	82.91	**6.37**	**42**	**436.25**	12.87	68	776.75	There was a decrease in effort and area covered from 2013. Last year, several large-scale IPA sweeps accounted for the large area swept. Fewer IPA sweeps were done in 2014, but more are planned for 2015. Control efforts continue to focus around rare plant sites and the Hapapa snail enclosure.
Kaluaa No MU	N/A	14.21	**6.45**	**6**	**48.5**	0.48	3	31.5	Limited effort is spent outside of the fenced enclosure. Trail and road maintenance account for much of the time spent in this area. In addition, one rare taxa site was weeded, and priority weed species (*Dovyalis hebecarpa*, *Mallotus phillippensis*) were targeted below the contour trail.
Kaluakauila	42.73	9.64	**1.73**	**12**	**102**	2.45	14	113.5	Control efforts focused on grass control and *L. leucocephala* control around rare taxa. The ridgeline fuelbreak was maintained.
Kamaili	2.57	3.89	**0.14**	**4**	**24**	0	0	0	Two fences were recently completed in Kamaili. Fenceline and LZ clearing accounts for most of the control effort. One trip focused around rare taxa locations.
Kapuna Upper	172.35	179.20	**1.00**	**22**	**82**	1.27	24	113.5	Control efforts continue to focus around rare taxa and reintroductions. The drop in effort may be due to low staffing on the Kapuna team.
Kaunala	1.98	1.99	**863 m²** *(0.086 ha)*	**2**	**28.5**	0.35	5	110.4	Weed control efforts in this MU were limited this year, due to the poor condition of the remaining *E. koolauensis*. Until an effective strategy to combat *Puccinia* rust is created, OANRP is hesitant to commit resources to habitat restoration. Team efforts were minimized, and no volunteer trips were held.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Keaau and Makaha	1.19	0.18	**238 m²**	**2**	**3**	0	0	0	Minimal effort is needed around this *Sanicula mariversa* site. Both woody weeds and grasses were controlled around the rare plants.
Koloa	71.54	70.80	**1.51**	**11**	**154.9**	0.36	4	2.8	This is the first year staff conducted significant weed control at Koloa. Staff controlled *A. evecta* wherever found and targeted *P. cattleianum* in select locations. In addition, more intensive weeding was conducted at a rare plant reintroduction site
KTA No MU	N/A	1.31	**0**	**0**	**0**	106 m²	2	11	Little weed control is conducted outside of MUs. Last year, staff assisted Cultural Resources in clearing around a heiau.
Lihue	710.23	714.98	**9.28**	**17**	**310.5**	0.73	7	79.5	The large increase in area and effort in 2014 is due primarily to *H. gardnerianum* control on the far western end of the MU, below the Kaala strategic fences. In addition, road/trail maintenance accounts for much of the increase in area. Rare taxa sites continue to be a control priority.
Makaha I	34.2	34.32	**2.70**	**31**	**406.5**	3.68	39	431	Control efforts at Makaha I continue to focus around rare taxa sites and native forest patches in the mauka portion of the MU, select *Coffea arabica* patches, and *Toona ciliata* landscape sweeps. Volunteer trips supplement staff efforts here.
Makaha II	26.69	5.56	**0.29**	**7**	**94**	0.41	3	26.69	Weed control expanded in Makaha II this year. The increase in effort is due to fenceline clearing, reintroduction site preparation, and rare taxa habitat sweeps. Last year, most of the area controlled was due to fenceline clearing alone, which tends to cover more area.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Manuwai	122.49	127.43	**8.18**	**19**	**184.5**	5.26	21	189.75	Much of the effort at Manuwai this year was spent on IPA sweeps targeting *T. ciliata* and *G. robusta*; these efforts account for the increase in area treated. Other weed control efforts focused around rare taxa sites and fenceline grass control
MMR No MU	N/A	15.09	**1.33** *(13,253 m²)*	**8**	**132.1**	293 m²	1	8	Weed control was conducted along the MMR fence bordering Farrington Highway to facilitate retrofitting the fence with skirting. This accounts for most of the effort and area in non-MU MMR areas this year.
Nanakuli No MU	N/A	4.00	**0**	**0**	**0**	0.71	1	12	This is the Halona ridgeline, between the Palikea and Palikea IV MUs. In the past, staff controlled *S. cooperi* here to reduce this source population and protect neighboring MUs. No work was done on this second priority project this year.
Ohikilolo	272.79	147.40	**6.04**	**25**	**295**	5.72	23	262.5	In the Ohikilolo Ridge (upper) half of this MU, control efforts continued across native dominated forest and around rare taxa, including opening new reintroduction spots. In the Lower Makua half of this MU, weed control was conducted in native dominated forest and around rare taxa sites.
Ohikilolo Lower	28.75	4.44	**4.13**	**18**	**218**	3.94	25	269	Maintaining fuel breaks around the rare taxa here continues to be labor-intensive. Most effort was spent on grass control and focused weeding directly around rare tax. Significant recruitment of *Dodonea viscosa* was observed across managed areas.
Oio	1.33	1.63	**0**	**0**	**0**	0.12	1	3	Due to the poor health of the *E. koolauensis* population at this site, OANRP is hesitant to commit resources to this site. No control was conducted.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Opaeula Lower I	10.15	6.80	**0.36**	**12**	**177.5**	0.51	16	230.6	Weed control efforts in this MU focused on *C. hirta* control at reintroduction sites and across the flat bowl in the center of the MU. See the MU plan (Appendix 1-1-1) for further discussion of plans for this area.
Pahipahialua	0.6	0.60	**0.23**	**6**	**71**	0.18	6	107	Staff efforts focused around rare taxa, and volunteer efforts continued in areas with no *E. koolauensis*. Due to the poor prognosis of *E. koolauensis* due to *Puccinia* rust damage, efforts at this MU will be limited in future.
Pahole	88.02	32.03	**3.80**	**39**	**548.25**	2.38	23	146	Weed control effort at Pahole increased in every WCA. Rare taxa sites continued to be a high priority for control. OANRP also assisted NARS staff with a large *P. cattleianum* control project on the border between Kahanahaiki and Pahole.
Pahole No MU	N/A	9.40	**4.95**	**4**	**26.5**	5.06	7	148	Staff continues to control weeds along the Pahole road and around the Nike greenhouse and LZ. Last year, the Pahole road was particularly overgrown; less time was needed to maintain it this year.
Palawai No MU	N/A	1.43	**0.21**	**3**	**12**	0	0	0	This area immediately abuts the Palikea MU. Control efforts targeted weeds along the fenceline corridor, and sweeps in the gulch to the north for *S. cooperi*. There is a large source population of *S. cooperi* here, and control efforts prevent ingress into the MU.
Palikea	9.95	10.73	**3.22**	**45**	**486.5**	3.45	51	692.95	The drop in effort is primarily due to the completion of a *P. cattleianum* removal project last year. This year, efforts focused around rare taxa sites, the snail enclosure, and careful thinning of *Cryptomeria japonica*.
Poamoho No MU	N/A	94.67	**4.60** *(46,011 m²)*	**1**	**18**	465 m²	2	30	Staff targeted select weeds for control along the Poamoho road.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Puaakanoa	10.7	1.07	**0.27**	**4**	**40**	0.69	2	24	Fire is a major threat to the MU. Weed control efforts continued to focus on fuel reduction and *L. leucocephala* control around the *E. celastroides* var. *kaenana* locations this year.
Pualii North	7.99	4.52	**0.27**	**4**	**10.25**	0.54	4	13	OANRP focused control efforts around rare taxa sites and reintroductions, including a new site, which was selected for planting *Drosophila* host trees.
SBE No MU	N/A	4.10	**547 m²**	**2**	**1.5**	0	0	0	Control efforts focus on keeping the East Baseyard free of problematic weed taxa and maintaining weed-free gear-staging areas.
SBW No MU	N/A	2.03	**1.34**	**12**	**23.5**	1.1	5	15	Control efforts focus on maintaining weed free areas at the West Baseyard, to reduce the potential for staff to act as weed vectors.
Waianae Kai	3.66	1.14	**465 m²**	**2**	**15**	207 m²	1	4	Control efforts focused around rare taxa locations and keeping the fenceline clear of weeds.
Waianae Kai Neraudia Mauka	0.53	2.59	**0.14**	**6**	**29**	0.28	6	60.5	Efforts in this degraded area focused on grass control and clearing new area for *Neraudia angulata* reintroductions. Work at this MU many not continue as the *Neraudia* MFS PU may change next year.
Waianae Kai NoMU	N/A	2.90	**0**	**0**	**0**	207 m²	1	1	This area encompasses a *Gouania vitifolia* exclosure. It is not a priority taxa; no weed control was done this year. Management of this site has been passed to OPEPP.
Waimanalo to Kaaikukai No MU	N/A	0.64	**0**	**0**	**0**	234 m²	1	28.75	This area encompasses the Palikea access trail. Last year, one volunteer trip was conducted at a native forest patch midway along the trail. This is not a priority project, and was not continued this year.

Management Unit	2014 Report Year					2013 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Waimano	3.22	4.06	**0**	**0**	**0**	0.44	4	22	OANRP did not conduct work at this MU this year, as it contains only Tier 2 and 3 taxa, which the Army is not currently managing. The State Botanist and OPEPP conduct some work at Waimano.
West Makaleha	38.04	1.34	**0.51**	**14**	**174.5**	0.31	13	171	Efforts continued to target rare taxa sites inside the exclosure. Volunteer trips focused on removing a large stand of *P. cattleianum* from the north side of the exclosure, and clearing fenceline weeds. Common native plants will be planted into the *P. cattleianum* zone in future. While *Rubus argutus* continues to be problematic to control, qualitative observation suggests native taxa are filling in the entire exclosure.
West Makaleha No MU	N/A	0.32	**932 m²**	**1**	**1**	659 m²	2	3	Control is conducted as needed to maintain the access trail. This year, trail maintenance involved grass control.
TOTAL	N/A	2164.98	**90.05**	**526**	**5,846**	83.39	532	5,620	See discussion below.

Right: volunteers hard at work. Far right: discussing strategy at Ohikilolo Lower.

This year, WCA efforts covered 90 ha, an increase from last year (83 ha). Also, staff spent 5,846 hours over 526 visits at 154 WCAs. This is the greatest amount of effort spent in the last five years, as is shown in the table below. WCA work accounted for 23% of the total area controlled and 77% of total effort. Much WCA control involves intensively working in small areas around rare taxa locations, and thus requires high inputs of time per acre.

Report Year	Effort	Visits	Area (ha)
2013-2014	5,846 hours	526	90
2012-2013	5,620 hours	532	83.4
2011-2012	4,199 hours	443	57
2010-2011	5,123 hours	409	
2009-2010	3,256 hours	353	
2008-2009	2,652 hours	267	

Increased use of new tools, the use of volunteers and interns, the hiring of a new ER crew, and an increased programmatic focus on weed control all account for this year's high numbers. As MU vegetation monitoring results have come in, it has become apparent that OANRP efforts are not sufficient to meet IP goals across MUs, although observations suggest habitat immediately around some rare taxa locations has become more native-dominated. Staff recognizes that significantly more effort and time is needed to reach IP goals (the IP covers 20 years) at all MUs and that capacity issues persist regarding the overall efficacy of weeding efforts. At the same time, alien plant control efforts must be balanced against time needed to control other threats to rare taxa.

Although weed control efforts on average increased, some MUs experienced greater increases than others, and some MUs experienced declines. The following table highlights the changes in effort and area for the twenty-one MUs where the most effort was spent. The MUs vary in size, habitat quality, and number of IP taxa present, but they include the largest and most diverse MUs where OANRP works. The table is sorted by 2014 effort. Decreases are noted in italics.

Changes in Effort and Area in Select MUs, 2013/10/01 through 2014/09/30

Management Unit	2014 Effort (hrs)	2013 Effort (hrs)	Change in Effort	% Change from 2013	2014 Area (ha)	2013 Area (ha)	Change in Area	% Change from 2013
Kahanahaiki*	896.9	577	319.9	55.4%	7.22	2.99	4.23	141.33%
Kaala Army*	570	542.25	27.75	5.1%	6.55	19.1	*-12.55*	*-65.71%*
Pahole	548.25	146	402.25	275.5%	3.80	2.38	1.42	59.61%
Palikea*	486.5	692.95	*-206.45*	*-29.8%*	3.22	3.45	*-0.23*	*-6.75%*
Kaluaa and Waieli*	436.25	776.75	*-340.5*	*-43.8%*	6.37	12.87	*-6.50*	*-50.48%*
Makaha I and II*	500.5	457.69	42.81	9.3%	2.99	4.09	*-1.10*	*-26.89%*
Lihue	310.5	79.5	231	290.6%	9.28	0.73	8.55	1170.90%
Ohikilolo	295	262.5	32.5	12.4%	6.04	5.72	0.32	5.68%
Ohikilolo Lower	218	269	*-51*	*-18.9%*	4.13	3.94	0.19	4.93%
Manuwai	184.5	189.75	*-5.25*	*-2.8%*	8.18	5.26	2.92	55.60%
Opaeula Lower I	177.5	230.6	*-53.1*	*-23.0%*	0.36	0.51	*-0.15*	*-30.38%*
West Makaleha*	174.5	171	3.5	2.0%	0.51	0.31	0.20	63.81%

Management Unit	2014 Effort (hrs)	2013 Effort (hrs)	Change in Effort	% Change from 2013	2014 Area (ha)	2013 Area (ha)	Change in Area	% Change from 2013
Koloa	154.9	2.8	152.1	5432.1%	1.51	0.36	1.15	318.92%
MMR No MU	132.1	8	124.1	1551.3%	1.33	0.03	1.30	4423.28%
Ekahanui*	119.25	157.5	*-38.25*	*-24.3%*	1.48	3.04	*-1.56*	*-51.31%*
Kaluakauila	102	113.5	*-11.5*	*-10.1%*	1.73	2.45	*-0.72*	*-29.52%*
Kapuna Upper	82	113.5	*-31.5*	*-27.7%*	1.00	1.27	*-0.27*	*-21.55%*
Pahipahialua*	71	107	*-36*	*-33.6%*	0.23	0.18	0.05	26.18%
Kaluaa No MU	48.5	31.5	17	53.9%	6.45	0.48	5.97	1244.66%
Kaena East of Alau	47	35	12	34.3%	0.27	0.39	*-0.12*	*-31.61%*
Puaakanoa	40	24	16	66.7%	0.27	0.69	*-0.42*	*-60.76%*
TOTALS	5,595.15	4,987.79	607.36	12.2%	72.90	70.24	2.66	3.79%

* = areas where volunteers contribute to control efforts

Many MUs saw increases in both effort and area controlled. The MUs which saw the most dramatic increases in effort and/or area are Pahole, Kahanahaiki, Lihue, Koloa, Manuwai, Kaluaa No MU, and MMR No MU. Kahanahaiki statistics increased due to additional weeding in the unit II fenceline, IPA sweeps, and renewed volunteer effort in the Maile Flats chipper site. Weed control increased across the board at Pahole this year, reflecting a concerted effort by teams to work here. Efforts at Koloa expanded this year from ungulate control and plant surveys to weed control sweeps. It is expected that efforts will continue to ramp up, although weather considerations may pose a challenge, since weed control cannot be conducted in the rain due to herbicide concerns. In the past, effort at Lihue has been predominantly taken up with ungulate control. As these efforts have decreased with declines in pig numbers, staff has been able to shift more attention to weed control. *Hedychium gardnerianum* is one of the worst weeds in Lihue, and control efforts have focused on it. The increase in area controlled at Manuwai is due to IPA sweeps for target canopy trees conducted by the ER crew. The increase at MMR No MU is due entirely to fenceline construction; minimal effort is expected here in future. At Kaluaa No MU, the increase is due to incidental weeding of non-ICA target species in an area just below the exclosure. This effort may continue in future, as the target weeds are important, but it will be low priority as the area is outside a fence and no goals have been set for it.

Some MUs experienced declines in both effort and area controlled. The MUs which experience the most dramatic declines in effort and/or area are Kaluaa and Waieli, Ekahanui, Puaakanoa, Kaala Army, Ohikilolo Lower, Opaeula Lower, and Pahipahialua. Last year was a banner year for Kaluaa and Waieli, with a record amount of effort spent there, in part due to IPA sweeps. While efforts have declined, it still is in the top five MUs this year. Declines at Ekahanui are due in part to low staffing levels on the crew assigned to it. Last year IPA sweeps were conducted across part of Ekahanaui. These were not needed in that area again this year. While area covered at Kaala Army decreased this year, effort did not. This reflects some of the challenging area the crew is currently working in. The decline in effort at Ohikilolo Lower can be viewed as a positive; less effort was needed to maintain fuel breaks than in past years. While statistics dropped somewhat at Opaeula Lower, it should be recognized that this MU is home only to a couple of Tier 1 IP taxa. Staff has continued aggressive *C.hirta* removal in the MU, and once a trial examining optimal revisitation interval for *C. hirta* removal is completed, these efforts can be strategically scheduled. Effort at all *Eugenia koolauensis* sites declined this year, including Pahipahialua. This was a conscious decision, as weeds may provide a physical barrier to airborne *Puccinia* rust spores,

providing plants some protection. Given the poor prognosis for *E. koolauensis*, staff decided to reallocate resources elsewhere.

Volunteer efforts contribute significantly to WCA control efforts, as is shown in the table below. While not every project or MU is well-suited to productive volunteer trips, staff is able to leverage large amounts of volunteer time for select projects. In the coming year, new volunteer work sites will be identified in other MUs, such as Pualii, and efforts at Pahipahialua will be phased out.

Volunteer Effort in Select MUs, 2013/10/01 through 2014/09/30

Management Unit	2014 Total Effort (hrs)	Volunteer Effort (hrs)	Staff Effort (hrs)	% Volunteer Effort
Kahanahaiki	896.9	399.6	497.3	44.6%
Makaha I and II	500.5	172.9	327.6	34.5%
Palikea	486.5	106.3	380.2	21.8%
Kaala Army	570	81.1	488.9	14.2%
West Makaleha	174.5	68.3	106.2	39.1%
Kaluaa and Waieli	436.2	53.9	382.4	12.4%
Pahipahialua	71	42.5	28.5	59.9%
Ekahanui	119.2	2	117.2	1.7%
TOTALS	3,254.9	926.6	2,328.3	28.5%

In the coming year, OANRP hopes to maintain and even increase weeding efforts across MUs. The new ER crew will continue to assist with this. The crew is midway through its first session. It is expected that the format of the crew will continue to change as staff solve logistical and administrative challenges, figure out the most efficient way for this group to be brought on board, and develop a better understanding of what types of projects are a good fit for the crew's capacity.

'Effort spent' and 'area controlled' are useful metrics to evaluate weed control efforts, but vegetation monitoring will show definitively whether OANRP is improving habitat on an ecosystem level at MUs.

Left: Part of the ER crew. Right: Staff conducting vegetation monitoring

1.4 Inter-Agency Invasive Plant Collaboration

Invasive species management can be incredibly daunting, as the number of weeds rarely diminishes and new species discoveries add to an ever-mounting list of challenges. Collaboration is critical in achieving progress. OANRP supports, and is supported, by a variety of partner agencies in addressing weed control issues. They include, but are not limited to:

- Board of Water Supply (BWS)
- College of Human Resources and Tropical Agriculture (CTAHR). OANRP has worked closely with Dr. James Leary of CTAHR in research on novel weed control techniques, which are discussed in section 1.1.3.6.
- Koolau Mountains Watershed Partnership (KMWP)
- Oahu Early Detection (OED). Plant samples submitted to the Bishop Museum Herbarium are identified by Museum and OED staff. Interesting finds are discussed in section 1.1.3.3.
- Oahu Invasive Species Committee (OISC). OANRP serves on the OISC steering committee. In the past year, joint projects have included *Cenchrus setaceus* and *Chromolaena odorata* control effort, both of which are discussed in section 1.1.3.4.
- Puu Ohulehule Conservancy
- State of Hawaii, Dept. of Land and Natural Resources (DLNR), Natural Area Reserve System (NARS) and Forest Reserves (FS)
- Waianae Mountains Watershed Partnership (WMWP)
- Waimea Valley

In December 2013, OANRP participated in a Weed Workshop organized by KMWP. This one day event included a discussion group on weed control techniques as well as presentations on advanced efficiency metrics. A spreadsheet of weed control techniques used by various agencies, organized by target species, was created as a resource by workshop participants. OANRP plans to collaborate on future workshops.

1.5 Vegetation Monitoring

Vegetation monitoring was conducted at the Palikea MU this year. This is the third monitoring of this MU. The project is described and analyzed in Appendix 1-3-2, "Vegetation Monitoring at Palikea MU 2014." The results of this study are being incorporated into the latest draft of the Palikea ecosystem restoration plan and will be used to modify weed control plans at this MU. Vegetation monitoring was also conducted across Makaha and Makaha II MUs at the end of this report year. Results are being analyzed and will be presented next year.

Reading vegetation monitoring plots at Palikea, June 2014

1.6 Weed Survey Updates: New Finds

Every year, new alien taxa are detected during directed surveys and incidentally during regular work. During directed surveys, lists of weeds are compiled, and staff considers distribution and invasive potential to determine whether control is warranted. Unknown species are collected and delivered to Oahu Early Detection (OED) and Bishop Museum. Support from these organizations facilitates the prompt identification of unknown species, and aids in determining whether control work is necessary. OANRP supports OED and Bishop Museum financially for identification services. The Hawaii Pacific Weed Risk Assessment (HPWRA) also provides a valuable indicator of invasive potential.

This year staff drove all roads on Army Training Ranges including side roads and new roads to detect new introductions and expansions of current infestations. The surveys in Kahuku Training Area reflect this change. Instead of surveys along the same set of delineated roads conducted annually, each survey now constitutes a region of the Range over which *all* roads are driven annually. These thorough road surveys revealed expansions of the known locations for both *Chromolaena odorata* and *Schizachyrium condensatum* on KTA and SBE respectively. As a greater emphasis was made to thoroughly survey roads used in Army training, this year some OANRP MU access road surveys were reduced to an every other year frequency; none of these reduced effort roads are used for military training. Over 150 miles of road both on and off training areas were surveyed this year.

Surveys on Army LZs were also emphasized this year. Staff gathered locations of all known Army LZs, assessed active use, and surveyed 'active' LZs.

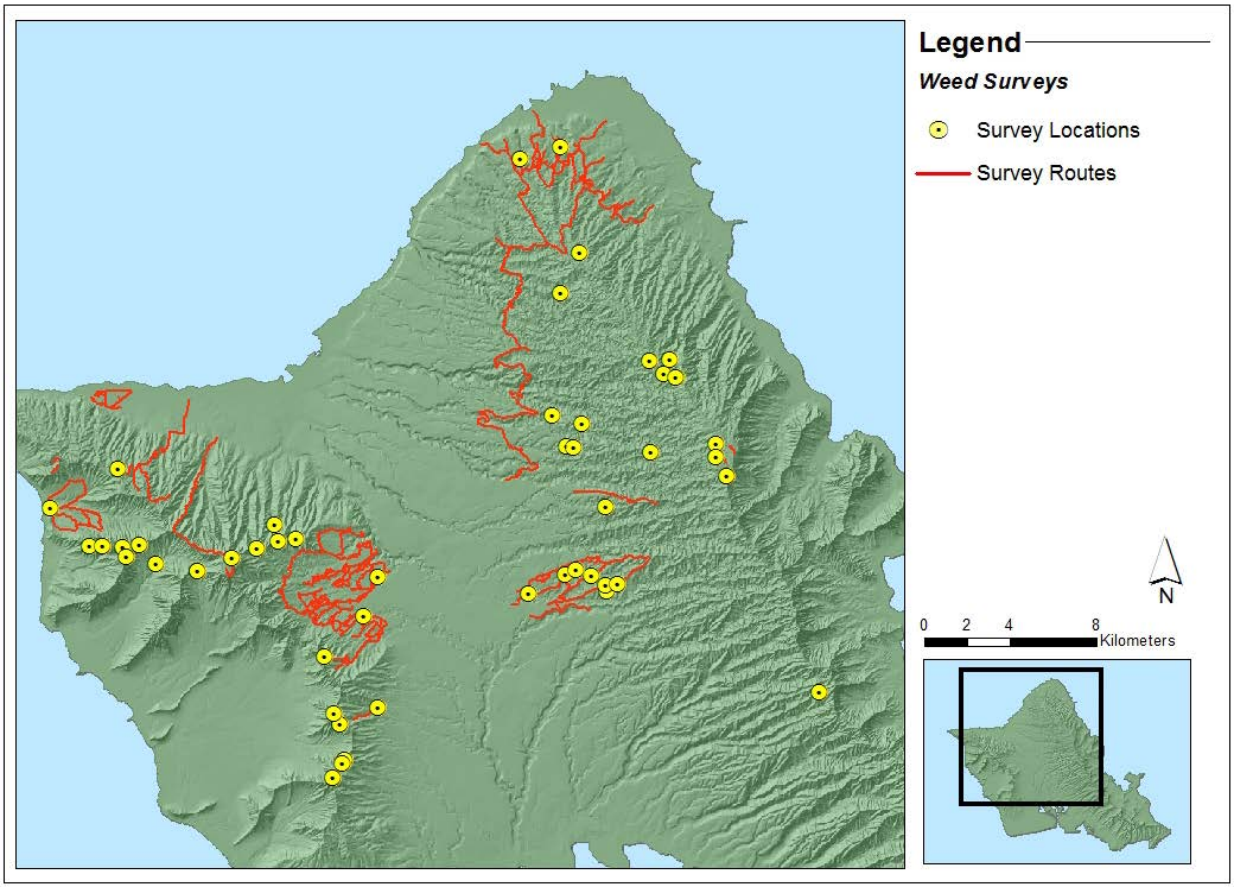
The OANRP West Baseyard was surveyed for the first time this year. A total of 133 species were identified across the 1.3 ha baseyard. While most of these weeds are common roadside and garden weeds, some, such as *Rhynchospora caduca* were most likely transported from field sites back to the baseyard on either vehicles or gear. These finds at the OANRP baseyard highlight the need to separate staging sites for gear prep and gear decontamination at the baseyard, and at other major staging areas, such as the Nike site. A newly functioning washing area with truck washing bays was installed at the West Baseyard this year and greatly improves sanitation measures.

Additional survey types are described and summarized in the table below.

Summary of Surveys Conducted

Survey Type	Description	# Surveys Conducted this Year
Road Survey	All drivable roads on Army Training Ranges surveyed; Access roads to OANRP Management Units surveyed annually or every other year.	16 road surveys
LZ Survey	All actively used Army LZs surveyed once per year. OANRP LZs surveyed if used within a quarter.	56 surveys on 45 LZs
Transect Survey	Surveys conducted annually along access trails to OANRP MUs, and along selected MU fencelines and transects inside MUs.	13 surveys along 13 transects
Camp/Other Survey	Surveys conducted at OANRP campsites and other potential locations of introduction such as washrack sediment disposal sites.	7 surveys conducted at 7 sites

Map of Surveys Conducted in 2014



The table below summarizes the results of surveys and incidental observations where new significant alien taxa were seen over the past year, and also includes noteworthy species submitted to Bishop Museum for identification.

Summary of Alien Taxa Survey Results

Survey Type	Survey Code	Significant Alien Taxa Seen	Discussion
Camp/ Other	OS-Kumaipo-01: Makaha/ Waianae Kai Saddle	*Rubus argutus, Urochloa maxima*	This survey was conducted for the first time this year to identify any significant taxa colonizing the Kumaipo burn site that might impact adjacent fenced MU. *R. argutus* was known to colonize after the burn, and has likely expanded down from the known infestation at Kaala. It will be targeted in weed control sweeps across the MU once more effective control methods are developed for this species. *U. maxima* carries fire well, and given the history of fire at this site, and the proximity to managed species, it should be targeted for control.
Camp/ Other	OS-Kaluaa-01: Hapapa Shelter	*Drymaria cordata* var. *pacifica*	This species has been problematic inside the snail enclosure. It recruits and reproduces rapidly. Control of this weed should be targeted along trails and at campsites.

Survey Type	Survey Code	Significant Alien Taxa Seen	Discussion
Road	RS-Kaala-01:	*Schefflera actinophylla*	This species is highly invasive in the Koolaus, and is noted as spreading in the Waianaes. This find documents this spread. *S. actinophylla* is a weed targeted during MU wide sweeps in Manuwai MU in Lower Kaala NAR.
Road	RS-KTA-08	*Chromolaena odorata*	The roads on this survey run throughout the core of the *C. odorata* infestation at KTA. Road and trail corridors are targets for control in this area to prevent further spread of this invasive weed.
Road	RS-KTA-10	*Chromolaena odorata, Santalum album*	This survey runs through the 'Delta' area of KTA where the eastern most outliers of *C. odorata* are found. No other plants were seen in the immediate area after initial control of the individual found. However, continuing to delimit the scale of the infestation, and control *C. odorata* in this area of the range is a priority. *S. album* is widespread in the area, but is believed to be able to hybridize with a native *Santalum* species. Locations where *album* and native *Santalum* species co-occur will be noted. No control is currently planned.
Road	RS-SBE-01	*Vitex trifolia*	This species is controlled where found on SBE, and is given ICA status. This site is separate from other known locations. However, as OANRP better assesses how taxa are naturalizing across SBE, this species may rank in lower priority in the future.
Transect	WT-Kaluaa-03: Kaluaa access trail; parking spot to MU fence	*Ardisia elliptica, Mallotus phillippensis*	*A. elliptica* is not previously known from inside the MU and its presence is worrisome. The location of this individual should be noted, and it should be targeted. *M. phillippensis* occurs throughout the MU in low numbers. Both species will be targeted for control during regular weed control sweeps.
Landing Zone	LZ-KLOA-021: Kamananui (Elephant's Foot)	*Leptospermum scoparium*	This find documents the continued spread of *L. scoparium* across the Koolau mountains. Any plants found here will be controlled. Collaboration with KMWP about control of this species is prudent.
Landing Zone	LZ-KLOA-035: Paalaa Uka (Puu Kapu)	*Falcataria moluccana, Araucaria columnaris*	*F. moluccana* is present in adjacent gulches and likely spread up to the LZ. *A. columnaris*, new to this LZ, is likely to have spread from neighboring ranch and agricultural lands along drum road. No control is planned.
Landing Zone	LZ-LKN-149: Manuwai/ Alaiheihe crest (Manuwai Camp)	*Triumfetta semitriloba*	This weed is found in patches scattered across the MU. It does prefer disturbed areas and is targeted as part of WCA work, but should also receive heavier control along fenceline corridors and at camp areas where gear is staged.
Landing Zone	LZ-SBE-172: Lower Kaukonahua (Lower 36)	*Rhodomyrtus tomentosa, Schefflera actinophylla*	The ICA for *R. tomentosa* at SBE is adjacent to this LZ. The ICA boundaries will be expanded to reflect the plants found outside of current boundaries. *S. actinophylla* is invasive in the Koolaus but is already very widespread. It will not be targeted for control.
Landing Zone	LZ-SBE-174: Lower Kaukonahua (Lower 72)	*Heterotheca grandiflora*	*H. grandiflora* was found growing out of a sand bag on this LZ. This is the third occurence of this species on SBE. All locations have sand present. OANRP is currently working with Range maintenance to locate the source of the sand. While *H. grandiflora* may not be a significantly invasive species, its spread highlights the need for improved sanitation protocols for moving materials on the range.

Survey Type	Survey Code	Significant Alien Taxa Seen	Discussion
Landing Zone	LZ-KLOA-191: Bryan's Mt. House LZ-KLOA-192: Puu Peahinaia	*Pinus luchuensis*	This species is noteworthy to pay attention to whether or not it is naturalizing. At this point it poses a low threat as an invasive in the Koolaus, but could naturalize across disturbed areas in the lowlands.
Incidental	None (Malaekahana)	*Adenanthera pavonia*	This species was noted on the Malaekahana Trail and is near the eastern boundary of KTA, but not on the Range. OED has relayed that it has been on Oahu for a long time and is not yet invasive, however is documented as invasive in other Pacific Islands. It will be documented and controlled if found in Koolau MUs.
Incidental	None (SBW)	*Alstonia macrophylla*	One immature plant surprisingly was found while doing a *C. odorata* buffer sweep across open areas on the active McCarthy Flats training range. Only two other immature individuals have been seen by OANRP, both from SBE, however it is documented to have naturalized across central Oahu and is overall widespread on Oahu. This species does score high on the Hawaii Pacific Weed Risk Assessment and all locations of its presence will be documented and controlled when found.
Incidental	None (Malaekahana)	*Blecchnum orientale*	An individual of this introduced fern was found and removed by staff along the Koolau Summit trail near the Malaekahana junction. No further control is planned, but staff will be vigilant for its presence at Koolau MUs.
Incidental	None (SBE)	*Ilex casssine*	Individuals of this ornamental plant are increasingly noted across SBE. There is a planting known from Whitmore Village, to the north, in what is now a wild area, but was an old greenhouse in the past. No control is planned, but additional sightings will be documented.
Incidental	None (KTA)	*Morella faya*	A single individual was found during ground surveys at KTA in the Delta training area. *M. faya* is a high target anywhere in the Koolaus, and in the Waianaes north of Pohakea pass. This is the only known location for this species in the Koolaus by OANRP. This site will be controlled in an ICA.
Incidental	None (Kaala)	*Pterolepis glomerata*	A single individual of this species was found within 1 meter of the Kaala boardwalk on the Army side, and accounts for the 3rd known site of this taxa at Kaala summit. An ICA also occurs along the Kaala Rd at a lower elevation. Given the invasive nature of this species in the Koolaus there is a zero tolerance for it at Kaala. ICAs are created for all new sites. This new site will be targeted for eradication.
Incidental	None (Kumaipo)	*Pterolepis glomerata*	This small patch of individuals was found in the top corner of the recently completed Makaha Subunit II fence, in the Kumaipo saddle, near the trail to the Kaala summit. It likely was transported to the site by hikers via this well-used trail. OANRP staff will work with DOFAWstaff to discuss weed spread and control strategies control along this trail.

1.7 Invasive Plant Updates

Cenchrus setaceus, Fountain Grass

Control work continued at all known *C. setaceus* locations this year, which include locations at KTA, SBE and MMR. Efforts at MMR are discussed under a separate heading below.

Cenchrus setaceus is a state listed Noxious Weed and received a HPWRA score of 26 (indicating high threat). It is quick-growing, produces large numbers of wind dispersed seed, thrives in dry, rocky areas, and is both fire-adapted and fire-promoting. While *C. setaceus* is widespread at Diamond Head, Punchbowl and Lanikai, no established populations are known from Waianae, Wahiawa, or the North Shore. If it becomes established at any of these sites, *C. setaceus* will add greatly to the risk of fire on Army training ranges. In particular, the site at MMR poses a major fire threat to the Waianae Mountains. The Waianae coast suffers from numerous fires every summer, and if *C. setaceus* were to spread from Makua to the rest of Waianae, the incidence, severity, and spread of fires could increase substantially.

The table below summarizes the status of all known *C. setaceus* sites ever found on Army training lands on Oahu. Note that of the ten sites listed, four have been extirpated, five are extant, and one was a mis-identification. This year, plants were found at only three of the ICAs, although all were monitored. This is an encouraging trend, and indicates that small, isolated *C. setaceus* sites are very eradicable. All of the sites listed below are thought to have been spread via military training, except for the sites at MMR and Keaau. Sanitation of training-related equipment, vehicles and gear is crucial to avoiding further spread. Early detection and rapid control of new introductions is critically important to achieve local eradication.

Summary of* Cenchrus setaceus *ICA Status

ICA Code	Extirpated?	Extant?	Date Plants Last Seen	Number of Plants in 2014	Comments
DMR-CenSet-01*	Yes		2001-08-30	0	Monitored in 2014 during annual road survey, which goes through site.
KTA-CenSet-01*	Yes		2005-03-29	0	Monitored in 2014 during annual road survey, which passes by site.
KTA-CenSet-02		Yes	2013-02-11	0	No plants found this year; promising trend.
KTA-CenSet-03		Yes	2014-07-24	17 imm.	Only immature plants found this year.
KTA-CenSet-04*					Mis-identification
KeaauNoMU-CenSet-03		Yes	2014-04-24	1 mat., 9 imm.	OISC manages this site. Staff controlled these plants in the course of other work.
MMR-CenSet-01*	Yes		2006-03-13	0	This site might have been an early outlier of MMR-CenSet-02, which wasn't discovered until 2011.
MMR-CenSet-02		Yes	2014-09-24	500+, mat. & imm.	Control is on-going, and includes both ground sweeps and aerial sprays.
SBE-CenSet-01*	Yes		2004-09-21	0	Monitored in 2014 during annual road survey, which passes this site.
SBE-CenSet-02		Yes	2012-08-14	0	No plants found this year; promising trend.

* notes sites where no additional action is needed in future

Control Efforts at MMR

The *C. setaceus* infestation continues to be a high priority for eradication. This year, efforts continued to focus on a combination of aerial sprays and ground-based control; 92.4 person hours were spent at MMR, which is an increase over last year (79.45 hrs). OANRP is lead on all operations on MMR, and OISC is lead on all operations off-range at Keaau.

Staff inspecting the spray rig prior to beginning aerial operations

- **Aerial Spraying Operations**: This year, 24 hours were spent conducting aerial ball spraying over the course of three days in June and July. This is less than last year (33 hours); the decline is due to a variety of factors including: faster turnaround time for the helicopter when refilling with herbicide and fuel, quicker set-up and take-down times due to a modified spray ball rig, and a later start in the year. The entire Aerial Spray Zone was treated once, with some portions treated twice. The success of aerial sprays depended in large part on the weather. Sprays were only conducted when grasses were green and growing to ensure that herbicide application was effective; amazingly, unexpected rains kept the grass lush and conditions optimal well into summer. Due to the steep nature of the terrain and highly technical flying required, extremely low winds were critical; waiting for perfect conditions was logistically difficult but crucial for a safe operation. For most of the sprays, the pilot did not need a spotter, as he had demonstrated his ability to spot the plants to staff. Staff did act as spotter on two flights, and likely will need to do so more in future, as plants become more scattered and difficult to locate. Some plants located on cliffs could not be reached either by the ball sprayer or from the ground; Herbicide Ballistic Technology options will be investigated for these remaining plants.
- **Ground Control Operations**. This year, 67.4 hours were spent conducting ground-based control, an increase over last year (46.45 hours). Staff swept the walkable portions of the infestation, particularly the makai-facing cliffs and ledges of Ohikilolo ridge, and areas difficult for the helicopter to access for aerial spraying. These ground operations greatly complemented aerial operations. Not counted here is time spent conducting weed control in the nearby rare taxa

fuel breaks. There are three breaks, two for *Euphorbia celastroides* var. *kaenana*, and one for *Hibiscus brackenridgii* subsp. *mokuleianus*. Staff spends considerable time in these breaks, sweeping them in their entirety several times a year. Three plants were found in the *Euphorbia* breaks this year.

- **Range Expansion**. No new outlier plants were discovered this year. However the threat of dispersal is high, as *C. setaceus* disperses via wind and takes advantage of natural and un-natural breaks in the *Urochloa maxima* dominated landscape. Regular buffer surveys need to be conducted to locate any new outlier plants, particularly in the areas between the various fuel breaks.
- **Dispersal Potential**. This year staff noted an increase in hikers using the area of the infestation. There is a popular trail which leads from Farrington Highway to a cave located partway up the cliff face. The trail is very well-defined, with a rope installed to assist hikers up a talus slope. It is well-publicized on the internet and appears to get a lot of traffic. The trail also leads directly through a portion of the *C. setaceus* infestation. Staff theorizes that hikers may be the vector for introducing *C. setaceus* to MMR and may spread it further around Waianae in future. 'No trespassing' signs have been installed along the highway as a deterrent, and control around the cave and trail will be prioritized to reduce the potential for further spread.

Photo from a website detailing the upper Makua cave trail. *C. setaceus* plant are found along the horizontal portion of the dotted trail, as well as on the cliffs surrounding it.

- **Keaau, Private Land**. While monitoring the Ohikilolo fence, OANRP staff discovered one mature and nine immature plants just mauka of the known Keaau infestation. This represents a range expansion of the Keaau infestation, although it is not particularly alarming, given the outlier's proximity to known plants. OANRP controlled the plants and reported the find to OISC.

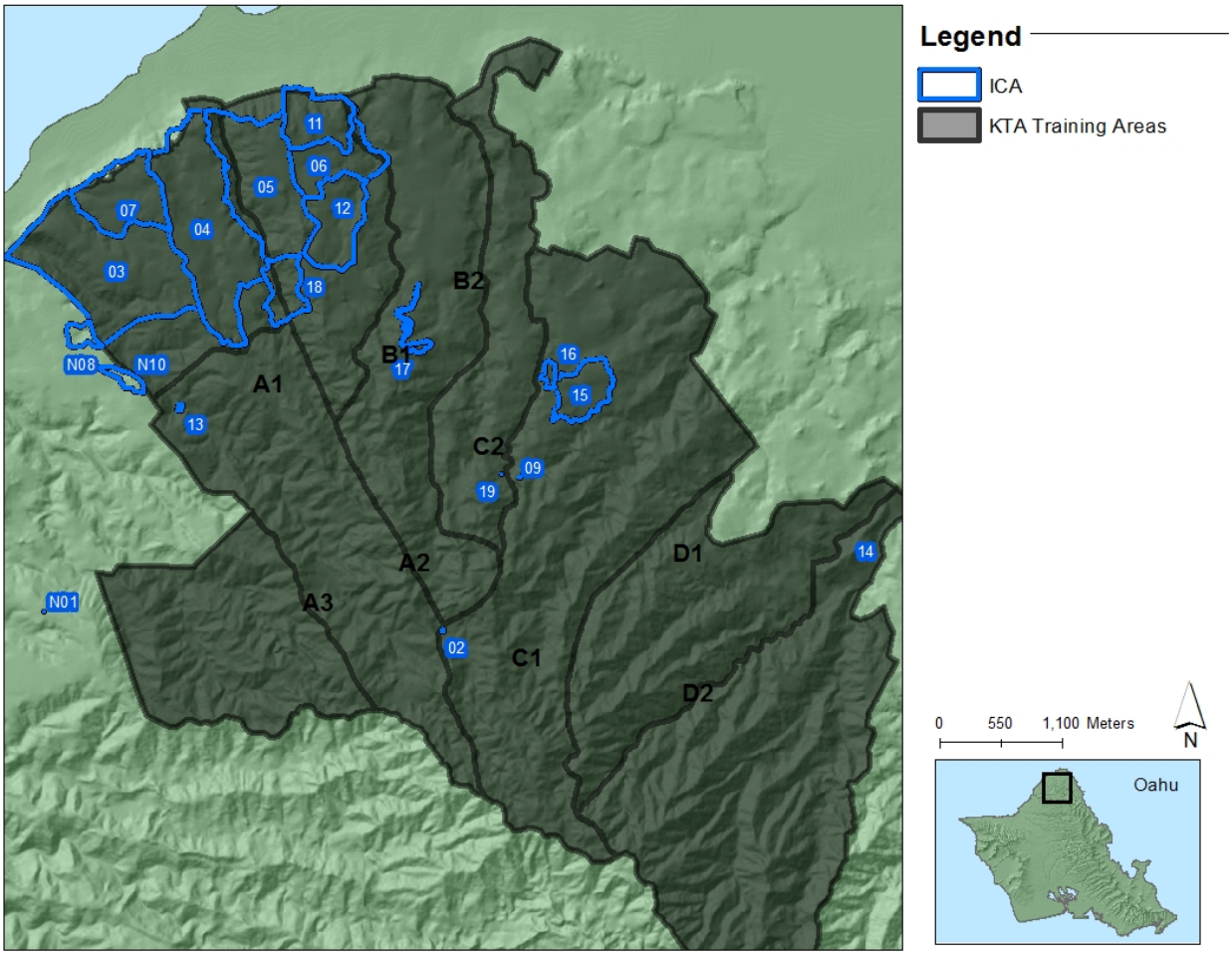
- **Monitoring**. Gigapan photopoints were taken after aerial spray operations. These will be analyzed to determine the efficacy of control efforts in the steep, core infestation.

Areas sprayed aerially, two and a half months post treatment. The red shapes marks dead *C. setaceus*.

***Chromolaena odorata*, Devil Weed**

Control of *C. odorata* is a high priority for OANRP. Please see the 2011 Year End Report, Appendix 1-2 to view the draft management plant for *C. odorata* control.

C. odorata *Incipient Control Areas at KTA*



- This year, OANRP again contracted OISC ($127,473) to conduct all *C. odorata* control across the western portion of KTA. This encompasses almost all of the Alpha 1 training range, as well as a portion of Alpha 2, and includes the following ICAs: KTA-ChrOdo-03, -04, -07 and AimuuNoMU-08 and -10. OISC conducted surveys and control across these ICAs. Mid-year, OISC and OANRP met to re-evaluate the status of control efforts. Given the continued large numbers of plants being found, it was decided that OISC would focus on sweeping assigned ICAs at least twice a year, and that OANRP would supplement their efforts by controlling OISC-identified hotspots. See Appendix 1-3-1 for a full description of OISC efforts. OANRP has already renewed this contract at an increased amount for 2015.
- OANRP staff conducts control across the following ICAs: KTA-ChrOdo-02, 05, -06, -09, -11, -12, -14, -15, -16, -17, -18, -19 and WaimeaNoMU-ChrOdo-01. In addition, the ER crew is treating hotspots in the OISC-managed ICAs (-03, -04 and -07). This year, staff spent 260.3 hours controlling 399 mature, 1,737 immature, and 650 seedlings of *C. odorata* plants at KTA. The table below summarizes these efforts.

KTA Control Efforts

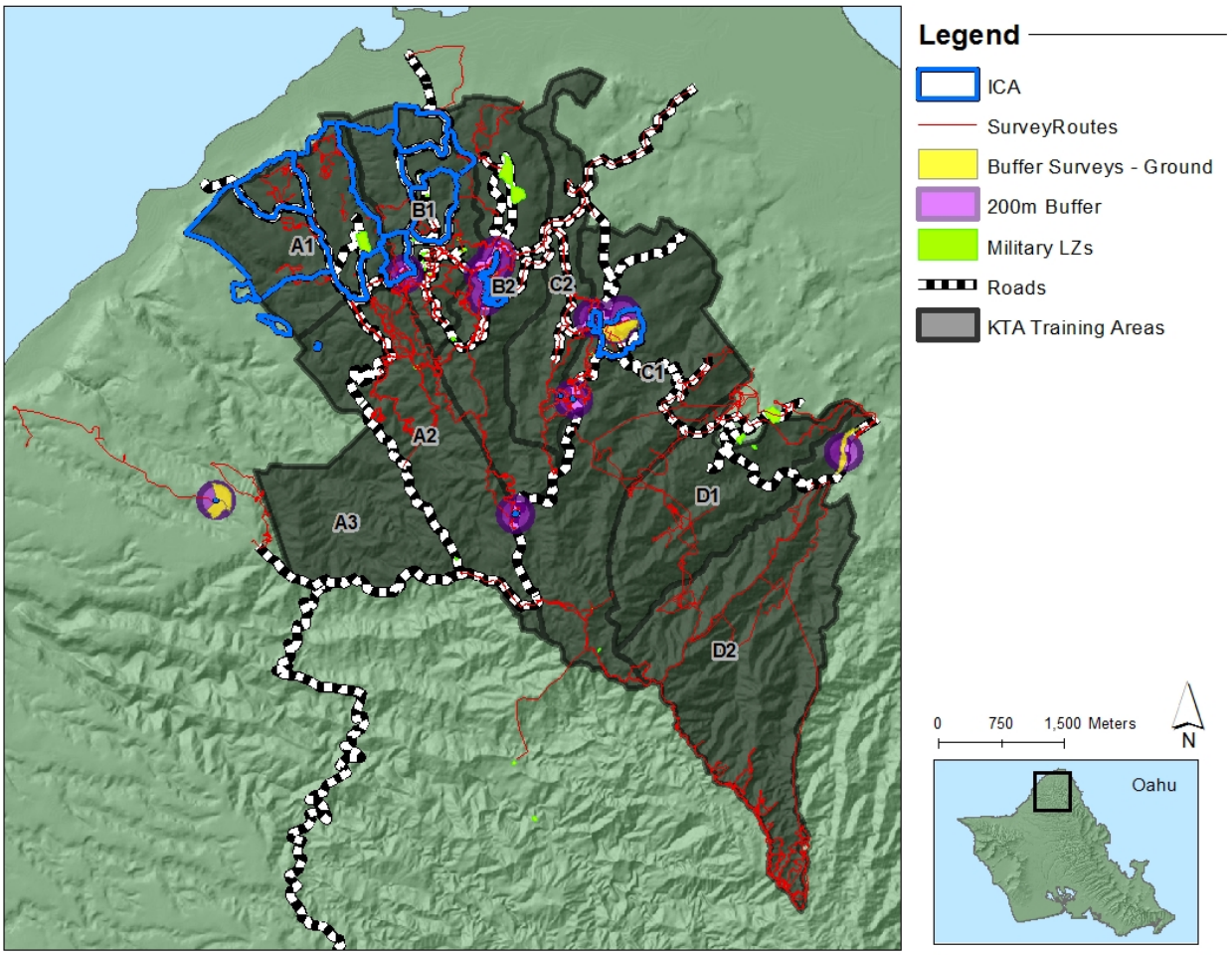
ICA	Status
WaimeaNoMU-ChrOdo-01	Outlier. Only 1 plant ever found here, an immature in 2011. Staff monitored this site four times this year and conducted some buffer surveys; however, the remaining buffer is on private land. It is likely this infestation site has been extirpated, but the buffer survey should be completed before ending effort here.
KTA-ChrOdo-02	Outlier. Only 1 plant ever found here, an immature in 2011. Staff monitored this site three times this year, and surveyed trails running through the 200m buffer. No additional plants were found. Habitat in the area is not ideal for *C. odorata*, as it tends to be densely vegetated, shady, and wet.
KTA-ChrOdo-03	Large ICA, OISC managed. OANRP conducted hotspot control in this ICA. Staff from First Wind assisted with this operation, bringing an ATV with a 25 gallon sprayer to treat the area. This collaboration was very effective, with 1 medium sized hot spot treated in its entirety, and 1 large hotspot partially treated. OANRP hopes to continue this collaboration with First Wind. Most of the hotspots in this ICA are not accessible via truck or ATV and will require backpack sprayers to control.
KTA-ChrOdo-04	Large ICA, OISC managed. OANRP conducted hotspot control in this ICA. Staff scoped most of the hotspots to determine the best method of control: truck-based power sprayer, ATV, or backpack sprayer. Several of the hotspots were treated and monitored. The remaining hotspots will be controlled in early winter of 2014, prior to the *C. odorata* flowering season.
KTA-ChrOdo-05	Large ICA. Staff visited this ICA eight times this year, spraying hotspots, sweeping the northern boundary of the ICA, and surveying part of the steep western gulch slope. 66.5 hours were spent here, controlling 120 mature, 650 immature and 500 seedling plants over 25.6 acres. This ICA is home to the densest part of the entire infestation. Staff plan to spray this core aerially in early winter 2014, prior to the *C. odorata* flowering season.
KTA-ChrOdo-06	Large ICA. Most of this area has been swept in the last two years. Hotspots in the ICA have been effectively suppressed with pre-emergent herbicides. 15 hours were spent here controlling 143 mature, 526 immature and 26 seedling plants across 3.8 acres.
KTA-ChrOdo-07	Large ICA, OISC managed. OANRP conducted hotspot control in this ICA. Three hotspots were monitored, with only three immature plants found (and pulled) at all sites; this suggests these areas are no longer true hotspots. However, there are several other hotspots in this ICA, all of which are a priority for monitoring and control next year.
KTA-ChrOdo-09	Outlier. Discovered last year, one mature plant was found in January 2013, and one immature was found in September 2013. This report year, the site was monitored 4 times, and no plants were found. The site was treated with a pre-emergent spray. Trails have been surveyed throughout the 200m buffer; areas between trails have not yet been surveyed, as they were deemed to be lower priority than trails. One immature plant was found on the edge of the buffer, leading to the creation of a new ICA, #19.
KTA-ChrOdo-11	Large ICA. No work was done in this ICA this year. It is a priority for sweeps in the coming year.
KTA-ChrOdo-12	Large ICA. This area has been exhaustively surveyed in the past. Actions here call for surveying and monitoring all trails and roadways in the ICA, rather than landscape sweeps. This year, trails in about half the ICA and all roads were surveyed over 7 hours. Only 3 mature and 3 immature plans were found (all controlled).
KTA-ChrOdo-14	New outlier ICA. One mature plant was discovered during annual road surveys this year. The site was visited a total of three times, and no other plants have been found. The plant located was treated with pre-emergent herbicide. Buffer surveys have begun in this area, but are not yet complete. 13.75 hours were spent at this site.

ICA	Status
KTA-ChrOdo-15	New large ICA. Plants were discovered at the CACTF training site during this year's annual road surveys in January 2014. This heavily used area is a priority for control, and 'no mowing' traffic cones and signs were installed at known plant locations. Trail surveys were conducted in the buffer, resulting in additional plants found. Buffer surveys are not yet complete at this location. 26.5 hours over 5 visits were spent on surveys and control of 11 mature and 53 immature plants.
KTA-ChrOdo-16	New small ICA. Staff noted a large mature plant while driving a road near a gravel pile in the course of other management. Trail surveys in the buffer around this plant resulted in the discovery of two immature plants in a separate location. Three more immature plants were found further down the road from the known mature plant. 5.35 hours were spent over three visits on surveys and control of 1 mature and 5 immature plants. The mature site location was treated with pre-emergent herbicide.
KTA-ChrOdo-17	New small ICA. Plants were found along the Mt. Kawela Road by staff in the course of other work. Trail surveys in the 200 m buffer were conducted, resulting in the discovery of another *C. odorata* location; the ICA was enlarged to include this new site. Most of the trails have been surveyed, but the remaining portions of the 200m buffer are still a priority, given that habitat in the area is suited to *C. odorata*. 7.5 hours were spent on 6 visits, controlling 2 mature and 8 immature plants.
KTA-ChrOdo-18	New large ICA. After discovering mature and immature plants just above the Echo Gate during the course of other management work, a new ICA was created connecting these plants with ICA -05 below. The area directly around the plants, near Echo Gate, was treated twice; 2.8 hours were spent controlling 2 mature and 11 immature plants. The northern part of the ICA, directly abutting -05, was swept. Staff spent 28 hours covering 14.79 acres, this is a third of the ICA area. No plants were found in the northern part of the ICA, suggesting the Echo Gate plants may be an outlier location.
KTA-ChrOdo-19	New outlier ICA. One immature plant was found here during buffer sweeps. Some trails within the 200m buffer of this ICA have been swept, but more surveys are needed to fully define this ICA. While this find is disheartening, its location on a trail is not surprising.

C. odorata seedlings recruiting in a known hotspot, 27 months following treatment with a pre-emergent (Oust™); this delayed recruitment demonstrates the efficacy of pre-emergent products.

- This year, OANRP prioritized surveys of trails across the entire KTA area, specifically for *C. odorata*. Crews surveyed trails both within buffers around known plants and in the areas mauka of the Kahuku Motocross Track. Trails within the primary *C. odorata* infestation were not surveyed, as these areas are monitored via large-scale ICA sweeps. These surveys complement annual weed surveys of every road and Military LZ in KTA. In addition, staff conducted many surveys in the Charlie 1, Delta 1 and Delta 2 ranges as part of the Jungle Operations natural resources review process. Most of the surveys focused on the summit and upland areas, although some were done in lowland areas well-suited to *C. odorata*; some surveys followed trails and others did not. While staff searched for rare taxa and unusual weeds as well as *C. odorata*, OANRP is reasonably confident that any mature *C. odorata* would have been found. New *C. odorata* locations were found during road surveys, trails surveys, and in the course of other management work; none were found during Jungle Opeartions surveys. Fortunately, all finds have been in heavily trafficked areas with prime *C. odorata* habitat (sunny, somewhat dry, patchy vegetation). No plants were found in the mauka regions of KTA.

OANRP* C. odorata *Surveys at KTA

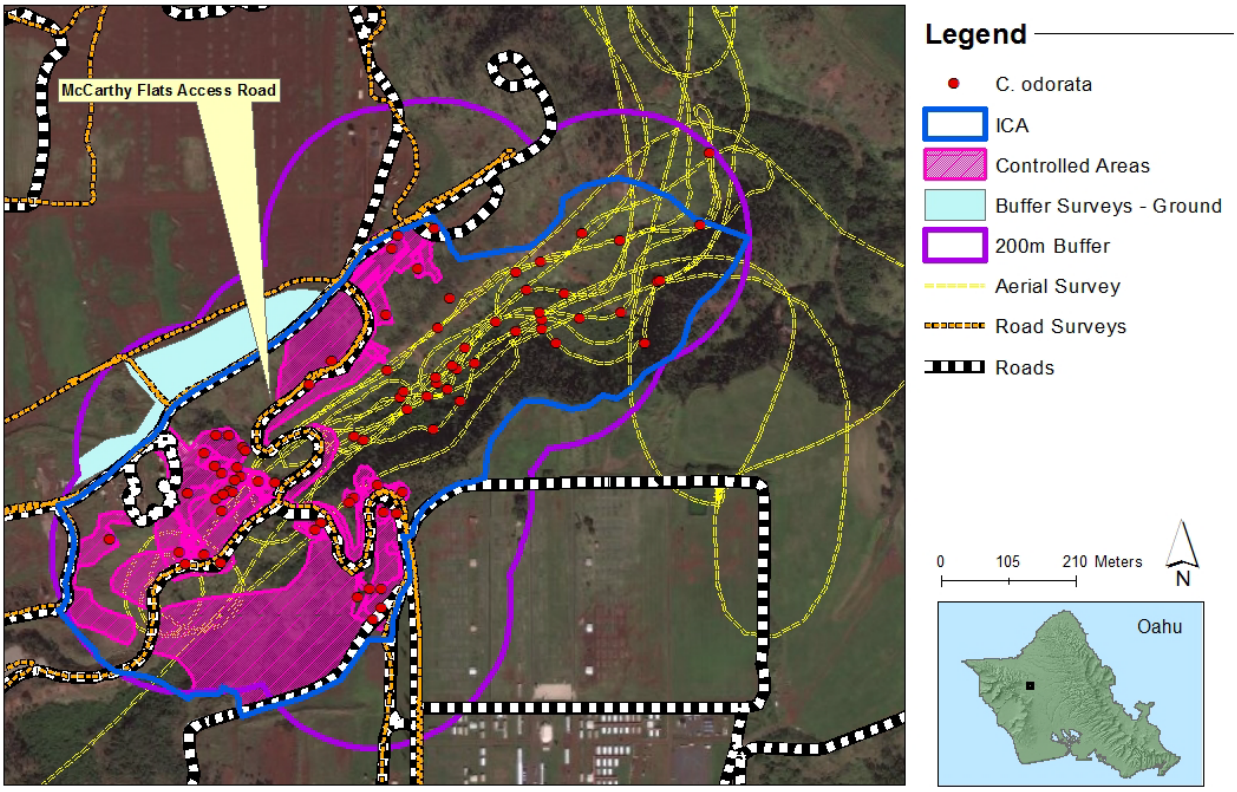


C. odorata *Overview at SB*

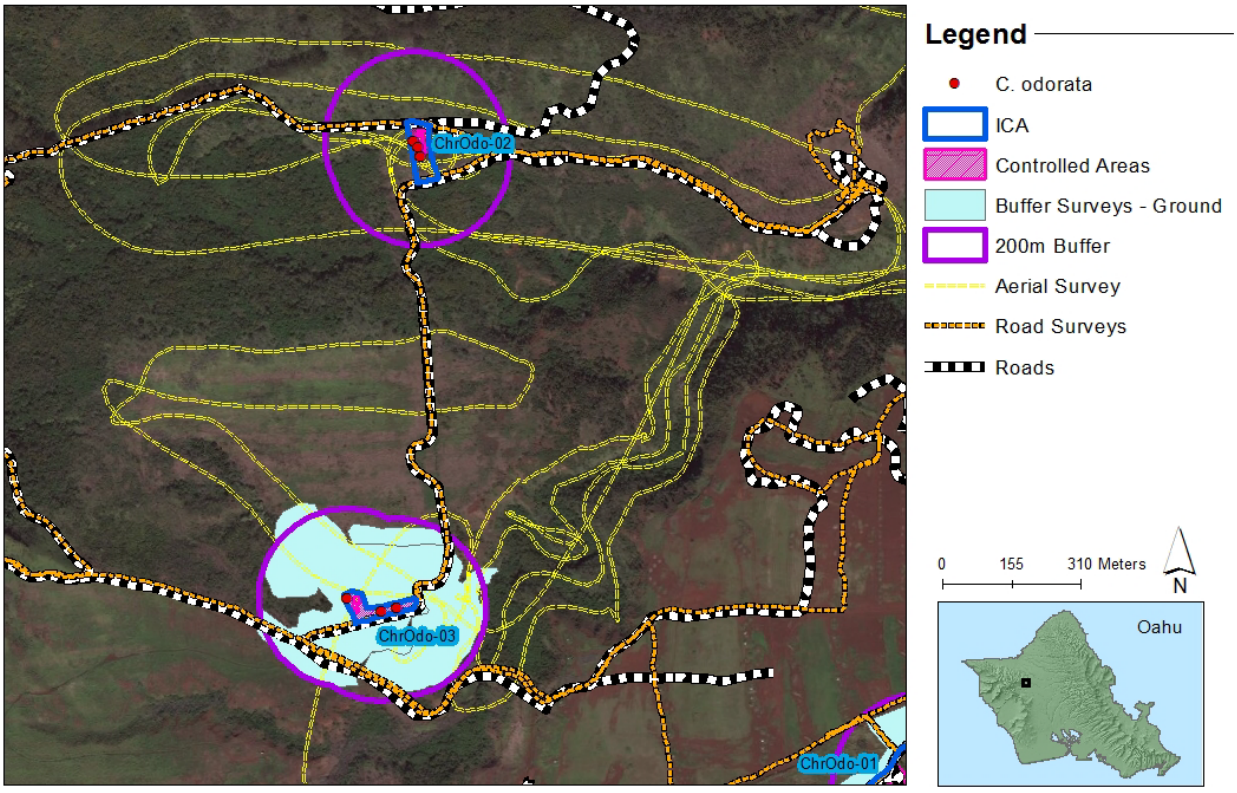
- Control efforts at SBW are limited by range availability and the need for a UXO escort in the area. Fortunately, OANRP has been able to take advantage of regularly scheduled range maintenance 'cold' days, which have provided sufficient access. The table below summarizes control efforts at Schofield in 2014.

Effective treatment of *C. odorata*; note the dead leaves at the edge of the brown grass

Schofield Barracks* C. odorata *ICA #1



Schofield Barracks* C. odorata *ICAs #2 and 3



SBW Control Efforts

ICA	Status
SBWNoMU-ChrOdo-01	Primary infestation. The majority of effort at SBW has been at the primary infestation site. Mohiakea West: Areas to the mauka, or west side of the McCarthy Flats access road have been the control priority, as the infestation is relatively small here. Staff spent significant time conducting surveys in this mauka area, identifying *C. odorata* hotspots, spraying grass to improve access, and using binoculars to examine dense grass patches. While there continue to be plants in this mauka area, most of the region has been surveyed, and fewer and fewer plants are found in known hotspots. Mohiakea East: In the area makai of the McCarthy Flats access road, relatively minimal effort has been spent thus far. In part, this is because access to the area is limited; dense grass covers much of the area, prohibiting ground sweeps due to UXO concerns. Staff focused efforts on spraying a wide buffer along the McCarthy Flats road, to minimize the risk of passing vehicles inadvertently spreading seed. In addition, 'no mowing' signs and traffic markers have been placed at known plant locations, so that maintenance staff don't work in these areas. Aerial surveys of the gulch were conducted to better map the infestation. Unfortunately, *C. odorata* forms localized, dense patches in the gulch. Treatment in this area will be challenging due to UXO. Staff plan to spray *C. odorata* from the air, and identify and clear paths into the core to facilitate follow-up efforts on the ground.
SBWNoMU-ChrOdo-02	Outlier. This site was discovered by Cultural Resources staff and reported to OANRP in December 2013. Staff confirmed that it was indeed *C. odorata* during a site visit on February 1, 2014. Since then, the site has been sprayed and monitored three times. Plants were found on the first two visits, but not on the third. Given the dense grass covering the area, and the threat of UXO, it is not possible to conduct ground surveys, except along the road. Staff did conduct an aerial survey across the entire 200m buffer, extending it across likely habitat 800 m to both the east and west. It appears that this site truly is an outlier. When Cultural Resources first found the site, the plants were growing adjacent to a live *Schinus terebinthifolius* in an area that had burned in October 2013. While it is possible the plants had colonized the recently burned area, given the size and mature status of the plants so soon after the fire, it seems likely that the plants pre-dated the fire, and perhaps were protected by the *S. terebinthifolius*. The plants were approximately 20-40 m off the road.
SBWNoMU-ChrOdo-03	Outlier. This site was also found by Cultural Resources in the course of their work. It was reported to OANRP on July 31, 2014. Staff visited the site during the next available cold range date in September. The plants were found near a training target. Some were located in a forested area, where staff conducting road surveys would not have seen them. Two others were found on a red dirt cliff above the road. All plants were controlled. Ground surveys were conducted across a 200m buffer around the known plants. Almost the entire buffer was swept, and no additional locations were found. In addition, an aerial survey was conducted around the site, particularly in the gulch below the site and across a large grassy field to the north. Another couple days of surveys are needed to complete the buffer sweeps. Two possible outlier locations were found during the aerial survey; both were visited and determined to be look-a-like plants.

- It is clear that a much larger effort is needed if *C. odorata* is to be eliminated from Oahu. Currently, it seems likely that there are other, unknown infestations located off Army training facilities, given the ease with which *C. odorata* moves on vehicles and humans. The Chromolaena Odorata Working Group is one forum for discussing an island-wide control plan. OANRP will work with OISC and other partners to discuss next steps for this problematic species in the coming year.

1.8 Invasive Plant Spread Prevention on Training Ranges

The Army's potential to move weeds from one training area to another has been amply demonstrated. This year, OANRP continued to build on last year's efforts to increase the Army's awareness of alien weed threats and improve sanitation-related protocols, practices, and policies. This has involved coordinating more closely with Range Division, Integrated Training Area Management (ITAM), and various branches of DPW. The following is a list of highlights.

- Dump sites for sediment accumulated at the SBE and KTA Wash Racks were identified, and clearly defined with erosion control fencing, Seibert stakes, and signs (example in Appendix 1-2, Environmental Outreach 2014). The site for the KTA Wash Rack is conveniently located adjacent to it, less than ten meters off a paved road. The SBE site is located just off the Centerline road, less than five minutes drive from the entrance to the range, off a gravel road.

Left: Seibert stakes laid out in front of the SBE disposal site. Note the stakes were placed far enough apart to accommodate vehicle access for sediment dumping.

Right: OANRP staff installing erosion fencing around a disposal site.

The KTA disposal site has not yet been used, as this facility is relatively new and has not accumulated sufficient material yet. The SBE disposal site has been used, and staff monitored the sediment for invasive weeds; no species of concern were found. Unfortunately, on this visit staff noted that the Seibert stakes had been tampered with and removed. The Federal Biologist later rectified the situation, and the SBE washrack is clearly marked again, but this incident highlights the importance of regularly monitoring the sediment sites. In the coming year, a disposal site will be selected and marked for the new, under-construction, wash rack facility located on Schofield Barracks at the former Bowman Park.

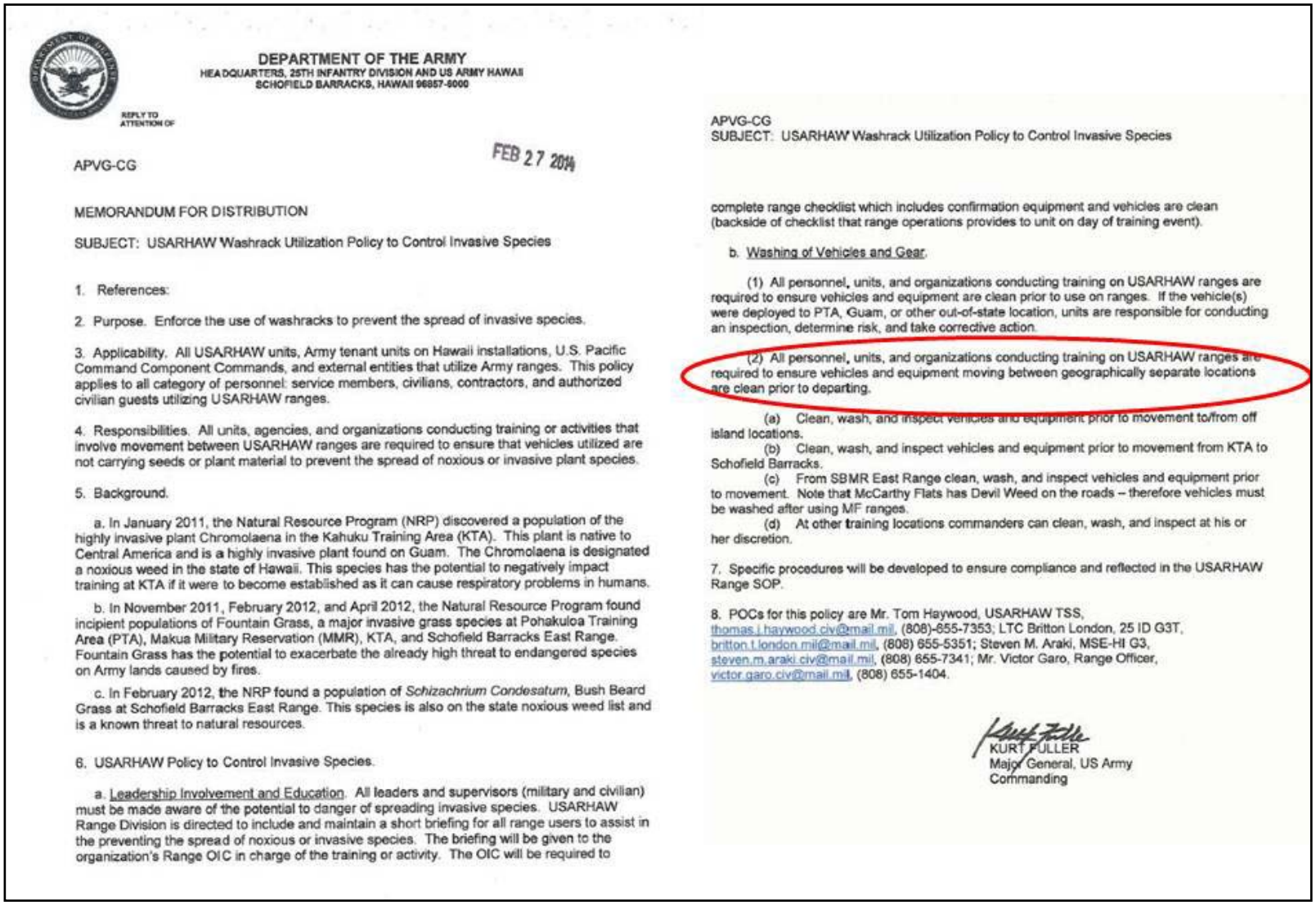
- Staff noted a new location of *Heterotheca grandiflora* on SBE this year. At all three known locations, plants were observed growing out of sand. At one site, the sand was spread around the base of the rappel tower, at another, it was spread below a par-course type obstacle, and at the third, the sand was spilling out of bags left on an LZ. In tracing the source of the sand, it appears that there is no stockpile on SBE, but rather, bags are filled elsewhere and brought on range as needed. In the coming year, staff will survey sand piles on Schofield Barracks and identify a way

to sanitize them. While it is unclear how much of a threat *H. grandiflora* poses, it is an example of how facility maintenance activities can directly lead to invasive species spread.

Left: leaves and flowers of *Heterotheca grandiflora*.
Right: *H. grandiflora* growing beneath par-course structure on SBE.

- A meeting was held with Range Maintenance staff, Integrated Training Area Management staff, and contract maintenance staff to highlight the potential for invasive plants to spread between training ranges. Requirements for washing vehicles upon exiting ranges were clearly stated, as well as requests to avoid 'no mow' areas and report any potential plant sightings.

Excerpt from Range Maintenance presentation



DEPARTMENT OF THE ARMY
HEADQUARTERS, 25TH INFANTRY DIVISION AND US ARMY HAWAII
SCHOFIELD BARRACKS, HAWAII 96857-6000

REPLY TO ATTENTION OF

APVG-CG

FEB 27 2014

MEMORANDUM FOR DISTRIBUTION

SUBJECT: USARHAW Washrack Utilization Policy to Control Invasive Species

1. References:

2. Purpose. Enforce the use of washracks to prevent the spread of invasive species.

3. Applicability. All USARHAW units, Army tenant units on Hawaii installations, U.S. Pacific Command Component Commands, and external entities that utilize Army ranges. This policy applies to all category of personnel: service members, civilians, contractors, and authorized civilian guests utilizing USARHAW ranges.

4. Responsibilities. All units, agencies, and organizations conducting training or activities that involve movement between USARHAW ranges are required to ensure that vehicles utilized are not carrying seeds or plant material to prevent the spread of noxious or invasive plant species.

5. Background.

a. In January 2011, the Natural Resource Program (NRP) discovered a population of the highly invasive plant Chromolaena in the Kahuku Training Area (KTA). This plant is native to Central America and is a highly invasive plant found on Guam. The Chromolaena is designated a noxious weed in the state of Hawaii. This species has the potential to negatively impact training at KTA if it were to become established as it can cause respiratory problems in humans.

b. In November 2011, February 2012, and April 2012, the Natural Resource Program found incipient populations of Fountain Grass, a major invasive grass species at Pohakuloa Training Area (PTA), Makua Military Reservation (MMR), KTA, and Schofield Barracks East Range. Fountain Grass has the potential to exacerbate the already high threat to endangered species on Army lands caused by fires.

c. In February 2012, the NRP found a population of *Schizachrium Condesatum*, Bush Beard Grass at Schofield Barracks East Range. This species is also on the state noxious weed list and is a known threat to natural resources.

6. USARHAW Policy to Control Invasive Species.

a. Leadership Involvement and Education. All leaders and supervisors (military and civilian) must be made aware of the potential to danger of spreading invasive species. USARHAW Range Division is directed to include and maintain a short briefing for all range users to assist in the preventing the spread of noxious or invasive species. The briefing will be given to the organization's Range OIC in charge of the training or activity. The OIC will be required to

complete range checklist which includes confirmation equipment and vehicles are clean (backside of checklist that range operations provides to unit on day of training event).

b. Washing of Vehicles and Gear.

(1) All personnel, units, and organizations conducting training on USARHAW ranges are required to ensure vehicles and equipment are clean prior to use on ranges. If the vehicle(s) were deployed to PTA, Guam, or other out-of-state location, units are responsible for conducting an inspection, determine risk, and take corrective action.

(2) All personnel, units, and organizations conducting training on USARHAW ranges are required to ensure vehicles and equipment moving between geographically separate locations are clean prior to departing.

(a) Clean, wash, and inspect vehicles and equipment prior to movement to/from off island locations.

(b) Clean, wash, and inspect vehicles and equipment prior to movement from KTA to Schofield Barracks.

(c) From SBMR East Range clean, wash, and inspect vehicles and equipment prior to movement. Note that McCarthy Flats has Devil Weed on the roads – therefore vehicles must be washed after using MF ranges.

(d) At other training locations commanders can clean, wash, and inspect at his or her discretion.

7. Specific procedures will be developed to ensure compliance and reflected in the USARHAW Range SOP.

8. POCs for this policy are Mr. Tom Haywood, USARHAW TSS, thomas.j.haywood.civ@mail.mil, (808)-655-7353; LTC Britton London, 25 ID G3T, britton.t.london.mil@mail.mil, (808) 655-5351; Steven M. Araki, MSE-HI G3, steven.m.araki.civ@mail.mil, (808) 655-7341; Mr. Victor Garo, Range Officer, victor.garo.civ@mail.mil, (808) 655-1404.

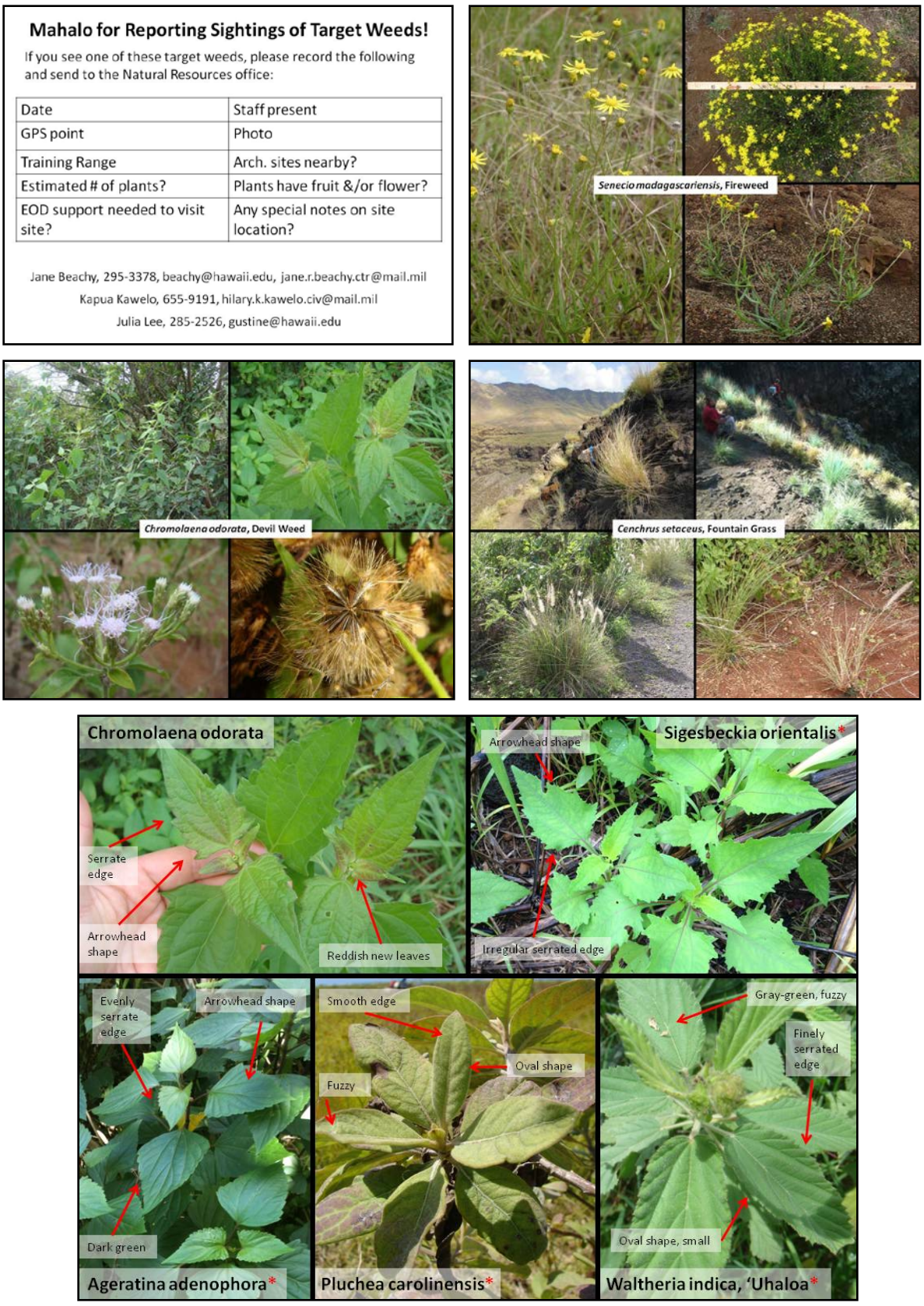
KURT FULLER
Major General, US Army
Commanding

Washrack Utilization Policy shared with maintenance staff

- Last year, both the SBE and KTA wash racks were plagued by mechanical issues which limited their availability. While some mechanical issues persisted at KTA, both wash racks were at least partially functional and available for use all year (365 days). This is a major improvement over last year, when the KTA facility was available for 137 days, and the SBE facility was closed for approximately six months. This year, the SBE wash rack was used 199 days (84%) of 237 scheduled. The KTA wash rack was used 45 days (80%) of 56 scheduled. This is a major increase at KTA; last year, OANRP accounted for all 16 days used out of only 137 days available. The Wash Rack Utilization Policy (see above) approved in February 2014, hopefully helped to improve these statistics from last year, although there is clearly much room for improvement. Both ranges are heavily used, with training occurring at each a minimum of 200 days/year.
- The placement of 'No Mowing' signs was updated at *C. odorata* locations on both SBW and KTA, and new, permanent metal signs were installed in place of temporary laminated ones. These signs are critical in communicating with maintenance staff where OANRP has identified a high priority weed, and where roadside vegetation control will be conducted solely by OANRP staff.

Metal "No Mowing" sign installed on KTA

- This year, Cultural Resources (CR) staff found and reported two outlying *C. odorata* infestations on Schofield Barracks. To further develop this productive partnership, OANRP staff conducted a short presentation to CR staff, highlighting the top four invasive plants that CR may come across in the field. Booklets of identification information, both hard copy and digital, were given to CR for reference. Since CR frequently works in highly impacted areas, where training use is high and IP taxa are generally not found, this collaboration helps OANRP to at least partially reach less-visited areas.



Examples of identification resources provided to Cultural Resources staff, including look-a-like species.

1.9 Novel Weed Control Technique Development

Collaborative Research with Dr. James Leary, CTAHR

OANRP continues to collaborate with Dr. James Leary on various Incision Point Application (IPA) and Herbicide Ballistic Technology (HBT) weed control projects. For a complete description of IPA and HBT, please see the 2009, 2010, 2011, 2012 and 2013 MIP and OIP Status Reports.

Herbicide Ballistic Technology

Little time was spent on HBT trials this year, in favor of increased effort on IPA efficacy trials (see below). Staff did monitor several trials, including the KTA Aerial Tagged Trial and the LZ Black Aerial Landscape Trial, both of which involved aerial treatment of *Psidium cattleianum* with triclopyr projectiles. Results of these monitoring efforts will be analyzed and presented in the coming year.

Incision Point Application

Work continued on development of IPA as an effective management tool. Staff continued installation and monitoring of efficacy trials, expanded operational use of IPA techniques, tested IPA tools, and shared field data with Dr. Leary.

This year, staff incorporated IPA control methods into select weeding operations. The operational field data generated is very useful for Dr. Leary, who analyzes it to examine the time, cost and efficiency of large scale weeding efforts. Staff also troubleshot IPA equipment, using both the hydropack and the sheep drencher set-ups. Both types of equipment have unique limitations and benefits. The hydropack works well for all-day operations, but is difficult to clean. The sheep drenchers are small, easy to carry, and convenient, but are not sturdy and often break. Hopefully new set-ups and/or modifications to existing set-ups will improve operations in future.

Unrelated to IPA trials conducted with Dr. Leary, staff tested the efficacy of a similar technique involving drilling holes around the trunk of trees and filling the holes with undiluted glyphosate. A large *Ficus* was effectively controlled using this method, and promising results were observed on *Cryptomeria japonica*. This technique may be an effective complement to IPA, particularly for hard to control species. Gas- and battery-powered drills are heavy, with power restrictions; tools refinement is needed for this technique.

Last year, Dr. Leary hired a temporary, part-time assistant to install efficacy trials. These trials test four different herbicide active ingredients on invasive trees. OANRP staff and the assistant worked together to install trials on 23 different species. OANRP staff monitored these trials over the last year. Some trials are located on Waimea Valley and Puu Ohulehule Conservancy land; their assistance in hosting and reading trials is greatly appreciated. It is expected the trials will run at least a year, or until the treated trees have clearly died or recovered from treatment; this may take up to three years. The status of these trials is summarized in the "Status of IPA Efficacy Trials" table below. Also included in the table are the results of the earliest trials OANRP worked on with Dr. Leary. Some of these early trials tested only one product, Milestone©, others included an experimental product Dr. Leary was using under an Experimental Use Permit (aminocyclopyrachlor), and still others were joint projects with NARS staff. As the efficacy trials continue, OANRP will continue to work with Dr. Leary to update the table and create a reference detailing which chemistries work on which taxa. In the coming year, staff hopes to install a few additional trials on new target weeds, and re-install trials on taxa which have proven to be challenging to control, such as *Syzigium cumini*.

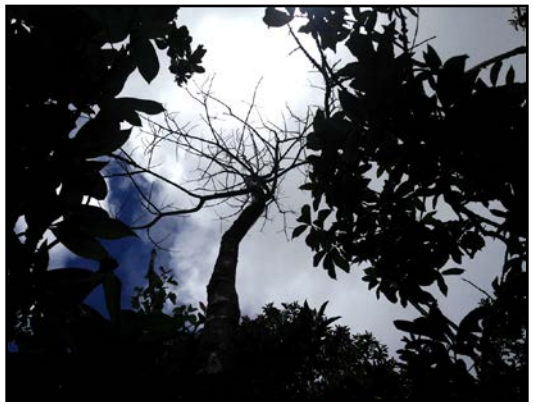
Status of IPA Efficacy Trials

Species	Trial Status	Date Installed	Comments	Tentative Recommended Treatment			
				Dose (0.5mL/cut)	Herbicide BEST	Herb. 2nd	Herb. 3rd
Acacia confusa	Complete	2011-09-06	Last reading at 30 months. Results poor for all chemistries but ACP (all trees dead) and AMP (no trees dead, 2 defoliated, 2 partially foliated). More trials needed.	1 cut/10cm	AMP		
Aleurites moluccana	On-going	2013-11-22	Last reading at 10 months. 2 of 5 IMZ trees dead, rest in poor health. 1 of 5 AMP trees dead. GLY and TCP ineffective.	1 cut/15cm	IMZ	AMP	
Araucaria columnaris	Complete	2011-11-07	OANRP assisted NARS with installation of trial only. At last reading at 16 months, TCP was not effective, but AMP, GLY, and IMZ all showed some efficacy. Results were not definitive.				
	On-going	2013-11-07	Last reading at 7 months. TCP ineffective. Too early to judge other treatments.				
Ardesia elliptica	On-going	2013-11-15	Last reading at 6 months. 1 of 5 IMZ trees dead, others very poor. Too early to judge other treatments	1 cut/15-20cm	IMZ		
Callitris columenllaris	Complete	2012-01-08	No effective control at 21 months.				
	On-going	2013-12-06	Last reading at 6 months. Too early to judge efficacy				
Casuarina glauca	Complete	2012-01-08	No effective control at 7 months, trial disturbed before 21 months.				
	On-going	2013-12-06	Last reading at 6 months. All chemistries defoliating trees, but too early to judge efficacy				
Chrysophyllum oliviforme	Reinstall	2013-09-20	Last reading at 6 months. Difficult to read trial, due to thick canopy. All trees had green cambium. Need to reinstall.				
Citharexylum caudatum	On-going	2013-10-25	Last reading at 11 months. TCP not effective. Others are somewhat effective; may be too early to be evaluated. Plan to reinstall at higher rate				
Coffea arabica	On-going	2013-11-08	Last reading at 7 months. 3 of 5 IMZ trees were dead. Some effects visible for other chemistries, but too early to judge their success	1 cut/10cm	IMZ		
Cordia alliodora	On-going	2013-08-30	Last reading at 7 months. 4 of 5 IMZ trees 100% defoliated. TCP not effective. Too early to judge other chemistries	1 cut/15-20cm	IMZ		
Corymbia citriodora	Complete	2011-09-06	No effects seen by 11 months. Conduct trial on smaller trees, or use higher doses.				

Species	Trial Status	Date Installed	Comments	Tentative Recommended Treatment			
				Dose (0.5mL/cut)	Herbicide BEST	Herb. 2nd	Herb. 3rd
Cryptomeria japonica	On-going	2014-01-07	Last reading at 8 months. GLY and IMZ most promising, with some dead trees and major defoliation, but too early for definitive results	1 cut/15-20cm	GLY	IMZ	
Elaeocarpus grandis	On-going	2013-12-13	Last reading at 5 months. All chemistries showed some effect, but IMZ clear leader, with 2 of 5 trees dead and rest showing major defoliation	1 cut/15-20cm	IMZ		
Fraxinus uhdei	On-going	2013-11-08	Last reading at 7 months. 4 of 5 IMZ trees dead. Other chemistries showed some effect, but too early to judge their success	1 cut/20cm	IMZ		
Grevillea robusta	Complete	2010-11-16	Trial only tested AMP, not other chemistries. Of 12 plants treated, 9 were relocated after 29 months, and all were dead. Dr. Leary conducted trials using all chemistries, and recommends AMP for this taxon.	1 cut/15cm	AMP		
Heliocarpus popayensis	On-going	2013-11-22	Last reading at 10 months. 4 of 5 IMZ trees dead. 2 of 5 AMP trees dead. Need to monitor trial further to determine success of all chemistries	1 cut/15-20cm	IMZ	AMP	
Leptospermum scoparium	On-going	2014-01-14	Trial to be read. Results pending.				
Leucaena leucocephala	Complete	2010-11-16	Trial tested AMP only, not other chemistries. Trees 1-3 m tall were used. At 3 months, 13 of 20 trees were dead and all were 100% defoliated. At 29 months, 8 of 20 were relocated, and all were dead; others suspected to have fallen down	1 cut/10cm	AMP		
	Complete	2011-11-07	OANRP assisted NARS with installation of trial only. Trial tested all chemistries. Short stature plants with trunk 'brains' were used. Last reading at 16 months. 5 of 5 AMP trees were dead. Other chemistries ineffective.	2 cuts/brain	AMP		
Melaleuca quinquenervia	On-going	2013-10-04	Last reading at 5 months. All chemistries showed some effect, but too early to judge success.				
Morella faya	On-going	2014-01-07	Last reading at 7 months. 1 of 5 IMZ trees dead, most 100% defoliated. Other chemistries show some effect, but too early to judge their success	1 cut/10cm	IMZ		
Pimenta dioica	On-going	2013-11-07	Last reading at 7 months. 4 of 5 IMZ trees 100% defoliated. Too early to judge success of other chemistries.	1 cut/15-20cm	IMZ		

Species	Trial Status	Date Installed	Comments	Tentative Recommended Treatment			
				Dose (0.5mL/cut)	Herbicide BEST	Herb. 2nd	Herb. 3rd
Psidium guajava	On-going	2013-09-27	Last reading at 10 months. 1 of 5 IMZ trees dead, all 100% defoliated. Other chemistries show some effect but not conclusive	1 cut/10cm	IMZ		
Schefflera actinophylla	Complete	2011-03-09	OANRP assisted NARS with installation of trial only. Last reading at 15 months. 4 of 4 trees dead for GLY, IMZ, and AMP. TCP not effective.	1 cut/15-20cm	GLY	IMZ	AMP
Spathodea campanulata	On-going	2013-08-23	Last reading at 11 months. All IMZ trees were 100% defoliated, but none were completely dead. Other chemistries showed some effect, but results inconclusive.	1 cut/15-20cm	IMZ	GLY	
Syzigium cumini	Complete	2011-03-09	OANRP assisted NARS with installation of trial only. Last reading at 15 months. No treatment except experimental product ACP.				
	On-going	2013-11-15	Last reading at 6 months. All chemistries showed slight effect, but too early to judge success. An earlier trial using AMP only suggested it can be effective on small size classes.				
Toona ciliata	Complete	2011-09-06	Last reading at 30 months, in 2014. All IMZ trees dead. 1 TCP tree alive. 1 AMP tree dead, others had resprouted.	1 cut/15cm	IMZ	TCP	AMP
Trema orientalis	On-going	2013-12-18	Last reading at 10 months. 2 of 5 IMZ trees dead, rest in poor health. 1 of 5 AMP trees dead. GLY and TCP trees showed varying symptoms.	1 cut/20cm	IMZ	AMP	

ACP = Aminocyclopyrachlor, AMP = Aminopyralid, GLY = Glyphosate, IMZ = Imazapyr, TCP = Triclopyr



Dead *Elaeocarpus grandis*, five months after trial installation

Blechnum appendiculatum Herbicide Control Trials

Background: *Blechnum appendiculatum* (palm fern) is an escaped ornamental fern from Central and South America that spreads by spores and subterranean stolons. It readily invades natural areas forming nearly solid mats on the forest floor where it displaces low-growing plants (Mootoka *et al.* 2003) and is thought to inhibit seedling recruitment around some of the rare plant species managed by OANRP. In previous field trials good results were achieved by trenching (isolating patches of the fern by cutting the network of stolons around the perimeter of the mat) followed by a foliar application of Garlon 5% G4 in water. DLNR has also had good results with herbicides containing the active ingredient imazapyr, however, observed it migrated at least a foot from the treatment area (Hardman, unpub. data).

These previous trials suffered from lack of replicates and no control group so conclusions were limited and often qualitative. We set out to systematically evaluate differences in efficacy between three herbicides with different active ingredients, without labor-intensive trenching. All were foliar applications and applied according to label rates (5 fluid ounces of herbicide mixture to 1 m^2). The three formulations tested were: Garlon 10% (*a.i.* triclopyr) G4 with crop oil, Ranger pro 2% (*a.i.* gyphosate) with water and Polaris 2% (*a.i.* imazapyr) with water. This is the first time gyphosate has been tested against this species.

Research questions

1. Which of three herbicide formulations kills palm fern most effectively at 6 months with no trenching regardless of patch size?
2. Which of the three herbicides remains effective at suppressing regrowth from rhizomes at 1 year?
3. How far outside of the treated area do herbicides migrate (as indicated by changes in fern vigor)?

Additional questions which may be answered in this study include:

4. How susceptible are co-occurring plants to the herbicide treatment? Species which occur in at least 5 or more plots of each group could be used in analysis

Methods: Palm fern patches share rhizomes; therefore herbicide efficacy is expected to vary by patch size. We controlled for this by arranging plots in a randomized block design, with each of the three herbicide treatments and a control plot replicated within each discreet fern patch (block). In March 2014 we located 10 patches of palm fern in Ekahanaui MU. Within each patch four 1 m^2 plots were established no closer than 1 m to the patch edge and to one another. This meant that no patches measured less than 25 m^2. At each monitoring event a photo point was taken, the percent live cover of palm fern recorded (mean from two different observers), the presence of dead fern outside of the plot boundary noted as well as the presence of any co-occurring species. These data were taken immediately prior to treatment on March 20 (day 0); 42 days, 70 days, and 179 days (approx. 6 months) after treatment. We plan to conclude the study one year after treatment (March 2015), with monitoring at 9 months post-treatment.

Preliminary results: No pre-treatment differences in live cover were evident between groups and data was normal (one-way ANOVA, $F_{3,39} = 0.56$, $p = 0.644$). Reduction in live fern cover by treatment is shown in Figure 1. It is clear that all treatments outperformed the control group, which actually increased over 6 months. Declines in fern cover for the Polaris group were slower to manifest than for the other two herbicide groups which showed immediate declines after one month. Due to its mode of action, however, Polaris may prove better at suppressing regrowth over the long term.

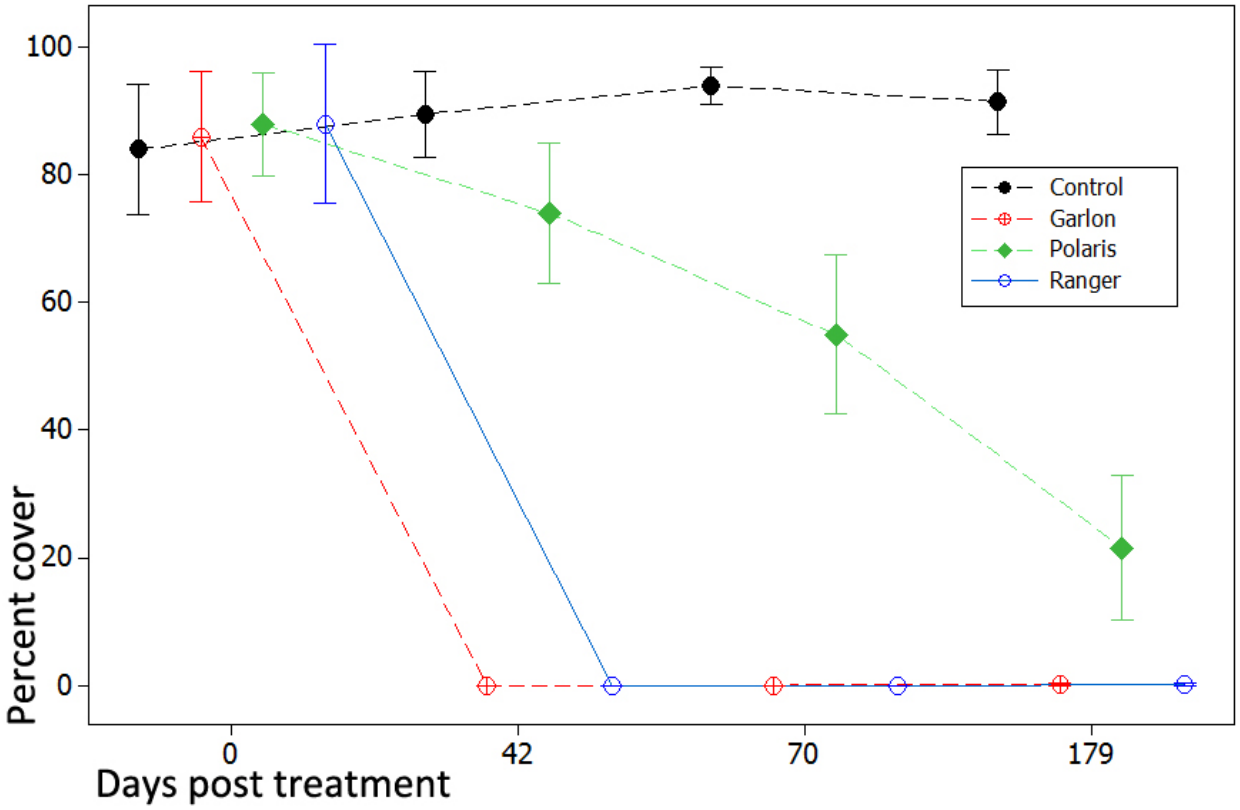


Figure 1. Palm fern live cover over time by treatment (bars are ± 1 SEM).

At 179 days post-treatment, changes in live cover for each plot were subtracted from day 0 values. The effect of treatment and block was analyzed using General Linear Model (GLM) and post-hoc comparisons analyzed using a Tukey's HSD. Changes due to treatment are shown in Figure 2. Block was not a significant contributor to variation in the response variable. This result suggests that patch size did not influence herbicide efficacy.

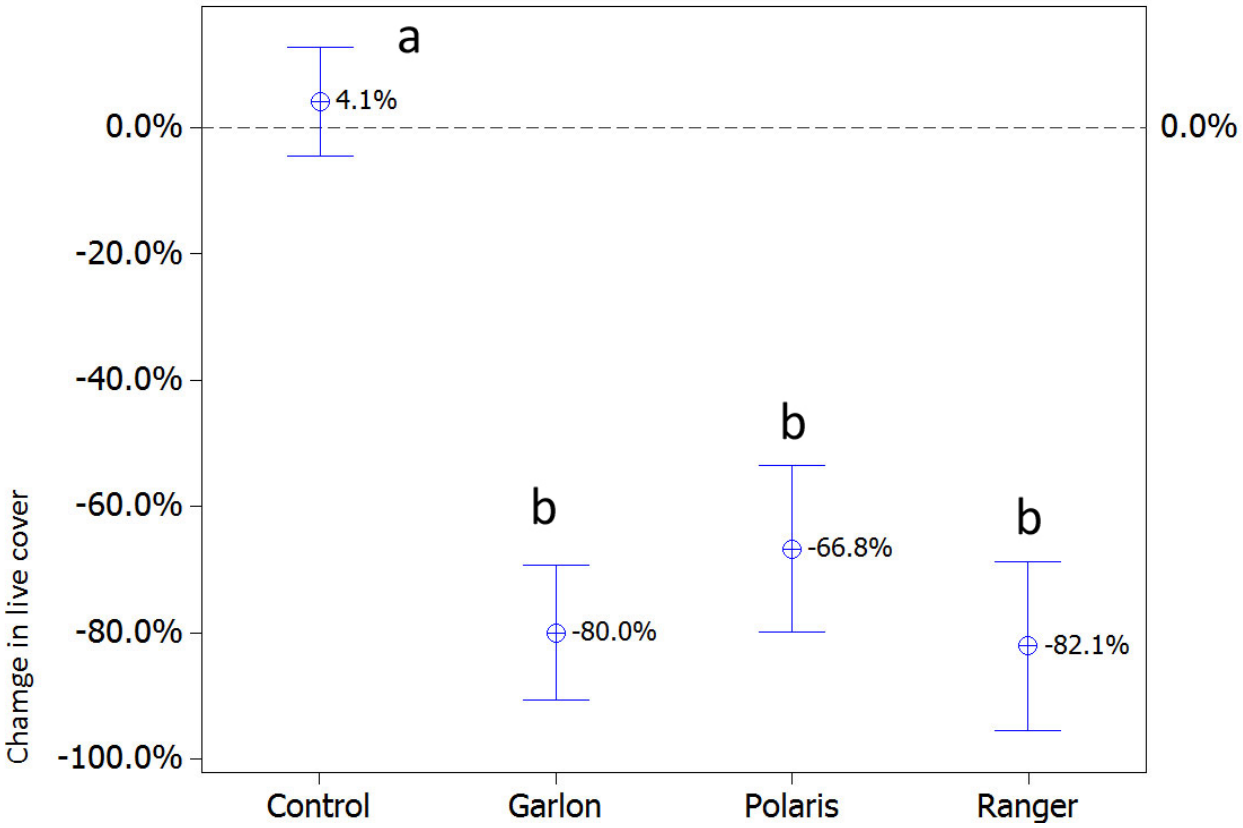


Figure 2. Reduction in palm fern live cover 6 months post-treatment (bars are 95% CIM). Letters indicate a significant difference between groups.

Live cover was significantly affected by treatment (GLM, $F_{3,39} = 64.52$, $p = 0.000$) but individual herbicide treatments did not differ significantly from one another.

So far migration of herbicide outside of the plots has not been observed. Impacts to species other than palm fern are not yet quantified but will be possible to determine for common species. The only widespread native species within plots were members of the genus *Pisonia*. Common aliens include *Aleurites moluccanus*, *Oplismenus hirtellus* and *Passiflora suberosa.*

1.10 Ecosystem Restoration with Common Native Plants

Emphasis of restoration efforts with common native species was again focused this year inside the snail enclosures at Hapapa and Palikea, and additionally in the Kahanahaiki enclosure. A general summary of the snail enclosure restoration projects can be found in Appendix 1-3-3. These somewhat straightforward projects have served as a good stepping stone to build the restoration program. They are small defined areas where the species planting list is guided by snail host trees, and supplemental weed control is conducted on a regular basis thanks to the snail team tending to the enclosure frequently.

However, work in these enclosures has highlighted the difficulties in many of the steps along the way to execution including: Project planning, associated weed control, collection, and propagation. In addition to these, one of the largest hurdles is coordinating all these efforts across three field teams and program Specialists. Some future focuses for each of these steps are identified below.

Project planning: One of the greatest difficulties in selecting restoration projects is trying to figure out how to most efficiently balance weed control and outplanting common native plants to achieve the greatest native cover gains. While the program learns more about addressing this question, in general, future re-vegetation projects will be conducted to:

- Improve/create habitat for sites of rare taxa (ex. Snail enclosures, or *Drosophila sp.* habitat sites)
- assist with minimizing weed control needs on a small scale (ex. within rare taxa Population Units)
- address problematic weed control issues (ex. *P. cattleianum* stands or sites where incipient weeds have been removed)
- achieve broader MU cover goals such as <50% non-native canopy cover (ex. Planting *Acacia koa*)
- create fuelbreaks

Associated Weed Control: Often the weed control associated with common native outplants is more aggressive than not, in order to make light available to outplants. The weed response is different at each site, often depending on weeds present on site and in the MU. Planting timing is also different at each site. Sometimes it is beneficial to plant immediately after a weed control effort, and other times it is beneficial to wait for resprouts or a flush from the seedbank to treat again without outplants to dodge. Projects conducted this year will continue to coordinate weed control and plantings with consideration to:

- Needs for immediate follow-up weeding
- Weeds present on site or in immediate area
- Overall goals of site

Collection: Fruit collection has been more challenging than anticipated. While referred to as *common* natives, individuals are sometimes scarce, and the fruiting individuals even more so. As a result, collections are often opportunistic and sometimes haphazard. Additionally, timing of fruiting is not consistently known for most species across MUs. Therefore, collection focuses this year include:

- Develop a shared database or spreadsheet where field staff can easily populate phenology observations.

- Standardize common native collection protocols that address but are not limited to: tagging plants, founder amounts, collection intervals, seed banking, taking cutting, etc.

Propagation: With experienced seed and greenhouse propagation staff on hand, propagation methods are continually improved. Staff is working out methodologies for everything from germination to optimal pot size for planting and growing large quantities of plants. Streamlining all these processes will help project planning, and ultimately get more plants out the door. There is also much to be learned about field propagation methodologies including seed sows, and transplants/divisions. Some focuses for field propagation work this year include:

- Compare the value of seed sows vs. outplants. Use a variety of metrics including cost (in staff time), % cover, amount of seed used. Results will likely differ by species.

- Compare fresh vs processed seeds. Determine average germination rates for species.

Future Plans

This coming year, plans for restoration with common natives will be developed for a number of projects including:

- Outplanting after *Psidum cattleianum* removal from Kahanahaiki Gulch

- Outplanting within West Makaleha fence exclosure (outplanting in open areas, and areas recently cleared of *P. cattleianum*)

- Outplanting at Ohikilolo Ridge (along ridges and crests following *Schinus teribinthifolius* removal, and in selected erosion scars)

- Outplanting in Palikea around rare plant reintroductions, in an area cleared of *P. cattleianum*, and to enhance *Drosophila montgomeryi* habitat and host species (more details of this project can be found in the Palikea MU Plan, section xx).

- Outplanting at Lower Ohikilolo around rare plants

Works Referenced

Hawaii Pacific Weed Risk Assessment, https://sites.google.com/site/weedriskassessment/home. HPWRA,2012. Web. 25 October 2012.

Motooka, P., L. Castro, D. Nelson, G. Nagai, and L. Ching. 2003. Weeds of Hawai‘i’s Pastures and Natural Areas; An Identification and Management Guide. College of Tropical Agriculture and Human Resources, University of Hawai‘i at Manoa.

CHAPTER 2: FIVE YEAR RARE PLANT PLANS

1.1 INTRODUCTION

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

- **Species Description:** The first few slides provide an overview of each taxon. The IP stability requirements are given, followed by a taxon description, biology, distribution, population trends, habitat and taxonomic background.
- **Historic Collections Table:** This information was selected from Bishop Museum specimen records and collections listed in published research, the Hawaii Biodiversity and Mapping Program and other collectors notes.
- **Pictures:** These photos document habitat, habit, floral morphology and variation; and include many age classes and stages of maturing fruit and seed. This will serve as a reference for field staff making collections and searching for seedlings.
- **Species Occurrence Maps:** These maps 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.
- **Habitat Characteristics and Associated Species:** These tables summarize habitat data taken using the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form. The data is meant to provide an assessment of the current habitat for the in situ and outplanting sites. Temperature and rainfall estimates are also included for each site when available.
- **Population Structure:** Data from monitoring the population structure for each species is presented with a plan to establish or maintain population structure at levels that will sustain stability goals.
- **Population Estimate History:** A review of population estimates for each Population Unit(PU) is displayed in a table. Estimates come from the MIP, OIP, USFWS 5-year Status Updates and OANRP field observations. In most cases, these estimates cannot be used to represent a population trend.
- **Monitoring Plan:** Current monitoring techniques and plans are discussed in this section. Monitoring of the in situ and reintroduced 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 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 goals.

- **Reproductive Biology Table:** 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 casual observations, pollinator syndromes as reported in the MIP and OIP, or other published literature. The information on seeds is from data collected at the Army seed lab and from collaborative research with the Harold L. Lyon Arboretum.
- **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 in the nursery or a garden. For those taxa that do not produce storable seed and cannot be established in micropropagation, a living collection of plants in the nursery 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 based only 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 prior to the time period in storage where a decrease in viability is detected. For example, *Delissea waianaeensis* shows no decrease in viability after ten years. OANRP would not have to re-collect prior to ten years as the number of viable seeds in storage would not have yet begun to decrease. The re-collection interval will be 10 years or greater (10+ yrs). If its viability declines when stored collections are tested at year 15, the interval will be set between 10 and 15 years. Further research may then be conducted to determine what specific yearly interval is most appropriate 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. Every 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.
- **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. The major 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 as 'YES, NO or PARTIAL' for each PU. A summary of the status of genetic storage collections is displayed in the last column.

- **5-Year Action Plan:** This slide displays the schedule of 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.
- **Management Discussion:** A summary of the management approach, overall strategy and important actions for each taxon.

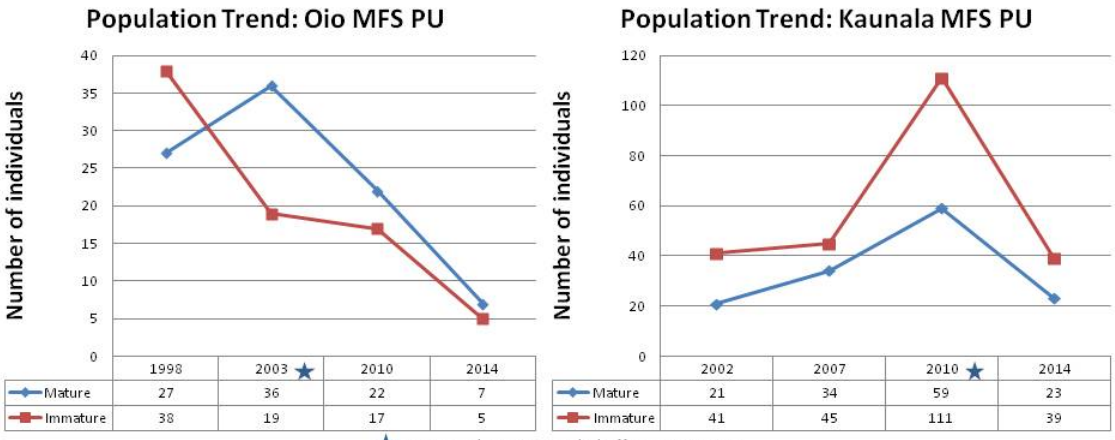
Eugenia koolauensis

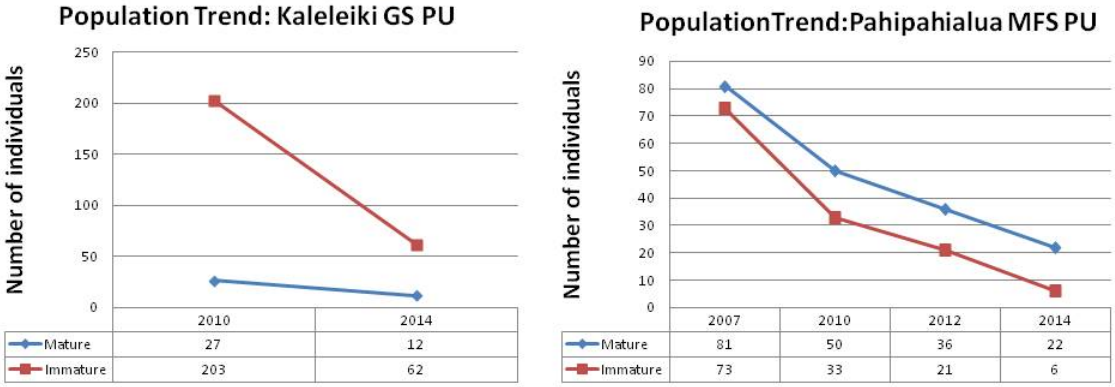
- **Scientific name:** *Eugenia koolauensis* (Degener)
- **Hawaiian name:** nioi
- **Family:** Myrtaceae (Myrtle family)
- **Federal status:** Listed endangered March 28, 1994
- **Requirements for Stability:**
  - 3 Population Units (PU)
  - 50 reproducing individuals
  - –Factors for setting goal as >25 plants for a long-lived perennial: doubled due to threat from rust (*P. psidii*)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
  - 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, 2-5 cm long, and 1-3.3 cm wide. The leaf margins are strongly revolute. The upper leaf surfaces have dense brown hairs when young. Older leaves are glossy and hairless, or bear short hairs near the veins. The lower leaf surfaces are densely covered by short brown hairs or rarely moderately covered. 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 (though occasionally produces two seeds; OANRP Seed Laboratory observations). The species has been observed with flowers and fruits year round, but peak fruit production usually occurs in the summer. The flowers of *E. koolauensis* are presumably insect pollinated. The red and yellow fleshy berries suggest that fruit eating birds are the main dispersal agents for the species. Since the seeds are large and lacking a durable seed coat, they would not be expected to remain viable long after the fruit ripens. In fact, seeds are desiccation-sensitive and do not survive drying (OANRP Seed Laboratory observations), which may imply that seeds do not survive for long outside of the fleshy fruit. 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:** *E. 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 328-1,000 ft in elevation. The species has also been recorded from the Waianae Mountains, 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 1957), known as Palikea Gulch. In 2000, a few plants were discovered in the same area in Palikea and Kaimuhole Gulches. Recorded elevations for the species in the Waianae Mountains are from 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 1957). Although elevations were not recorded for the West Molokai specimens, the plant or plants were likely located near the summit of Maunaloa, which is 1381 ft high in elevation. Little native vegetation remains on Maunaloa, and it is unlikely that any *E. koolauensis* plants survive there today.

- **Population trends:** The largest number of individuals of *E. koolauensis* occurs within the U.S. Army Kahuku Training Area (KTA) in the Northern end of the Koolau Mountains. Observations of these sites by OANRP from 1996-2006 showed that nearly all populations contained seedlings and saplings in addition to mature trees. During that period, the numbers of individuals were stable or slightly increasing. Most trees at Kaunala, Pahipahialua, Oio and Kaleleiki were fenced, heavy fuels were removed to reduce the risk of fire and weed control was ongoing. Since 2006, the species has been observed to be rapidly declining across its range (see population trend charts below) due to an introduced pathogenic rust, *Puccinia psidii.* The first sign of rust on *E. koolauensis* was observed in March 2006 in 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 affects plants of all sizes and ages. Some small, immature plants were quickly defoliated and all plants show some sign of infection. Few if any trees are considered to be in good health and nearly all new leaves are quickly infected and killed. Some trees are still able to produce flowers, but flowers and immature fruit are also infected and killed. Since 2006, there has been a 70% decline of all known mature and immature plants (excluding seedlings) in the largest PUs. The decline in the number of mature and immature plants has been observed in each of the MFS PUs: Pahipahialua (82%), Oio (78%), Kaunala (65%), and at the Kaleleiki (63%) genetic storage PU.





Eugenia koolauensis

- **Current status:** *E. koolauensis* is still extant in the northern Koolau Mountains and a single tree remains in the northern Waianae Mountains. The center of abundance for the species is in the Action Areas of the Kahuku Training Area and the northern end of the Kawailoa Training Area. All plants have been heavily impacted by rust (*Puccinia psidii*).

- **Habitat:** *Eugenia koolauensis* occurs in dry to mesic forests, usually on gulch slopes. In the Koolau Mountains the plants occur in dry mesic forests with native trees such as ohia lehua (*Metrosideros polymorpha*) and/or lama (*Diospyros sandwicensis*), hoawa (*Pittosporum glabrum*), hao (*Rauvolfia sandwicensis*), alaa (*Planchonella sandwicensis*). These sites also have non-native areas with stands of strawberry guava (*Psidium cattleianum*), shoebutton ardesia (*Ardesia eliptica*), ironwood (*Casuarina equisetifolia*) and paperbark (*Melaleuca quinquenervia*). The known plants in the Waianae Mountains are located in dry forests with lama (*Diospyros* sp.), wiliwili (*Erythrina sandwicensis*), lonomea (*Sapindus oahuensis*). The trees are located along the margin where the remaining forest borders a highly degraded area with *Urochloa maximum* and are highly 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.

- **Taxonomic background:** *Eugenia koolauensis* is currently recognized as 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 and Australia. *Eugenia reinwardtiana* had already been known as a rare plant in most regions of Hawaii except for the northern Waianae Mountains where it can be locally abundant, but there have not been recent surveys of this taxon since the introduction of *P. psidii*. 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 threat 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. The PUs at Kaunala, Pahipahialua, Oio and some plants at Kaleleiki are now fenced and protected from pigs. Alien plants threaten *E. koolauensis* by altering the species' habitat, competing with it for moisture, light, nutrients, growing space, and serve as a reservoir for *Puccinia psidii*. Also, the spread of highly flammable alien grasses increases the incidence and destructiveness of wildfires. The single tree in Kaimuhole Gulch was killed by the Waialua fire in August 2007. The trees in the Palikea site were scorched, but were not immediately killed.
  - Weed control has been ongoing at the largest PUs to reduce alien cover and favor native habitat. Recently, relatively healthy *E. koolauensis* plants have been observed surviving underneath both native and alien vegetation compared with others in areas more exposed to *Puccinia psidii* spore rain. Because of this and a shift in strategy to focus on propagation, removal of alien plants will be temporarily halted within the fences.

- **Threats in the Action Area:** Major threats in the action area at KTA due to army training are fire, trampling, and the introduction of competing non-native plant species. Fire in the action area has been documented to have affected populations of this species twice in the last 10 years, and the fuel load near some plants is high. Additionally, some of the onsite populations are threatened by habitat disturbance from motor cross bikes.

Eugenia koolauensis

- **Threats (continued):** In April 2005, a pathogenic fungus *Puccinia psidii* Winter 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 most trees has been severe and lethal (see pictures below). All trees appear to have been at least partially defoliated by infections of *Puccinia psidii* and many smaller immature trees have since died. *Puccinia psidii* has been observed to infect flowers and fruits and certainly affects overall health and fecundity reducing seed production and recruitment. No mature fruit has been collected from any of the trees since 2009. Collections of seed, cuttings, air layers and whole plants have been successfully propagated and established in the OANRP nursery. The threat from *Puccinia psidii* to plants in the nursery is kept under control with a rotation of several fungicides and basic propagation and cultural techniques. Plants can be kept healthy and these are producing flowers and viable fruit. The pathogen appears to be thriving in the habitat for *E. koolauensis* in KTA where there are many other Myrtaceous host plants. Of the 80 known host plants worldwide, 42 occur in Hawaii. Control methods recommended by government agriculture and botanical gardens include: replanting with non-Myrtaceous species or using fungicides. There are currently no fungicides approved by the Hawaii Department of Agriculture for use in natural areas. While repeated fungicide applications have been shown to be effective in controlling the rust (Martins 2011), rotating bi-weekly applications of several different chemicals (to prevent resistance) onto wild trees in remote natural areas is not considered a sustainable effort at this time. Instead *inter-situ* sites with access to these management options will be established to manage a living collection.

Eugenia koolauensis

- **Outplanting Considerations:** Future outplantings could be at risk of being genetically swamped by *E. reinwardtiana* if outplanted close to *E. reinwardtiana*. In addition, *E. reinwardtiana* is a host for *Puccinia psidii*. Wild stands of this tree are also infected by *Puccinia psidii* and like the prognosis for *E. koolauensis*, is not positive. Outplantings of *E. koolauensis* are not currently planned, but in the Koolau Mountains should be limited to the portion of the mountain range where only *E. koolauensis* has been found (see map below). For the Waianae Mountains, a 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).

Map removed to protect rare resources, available upon request

Selected Historic Collections of *E. koolauensis*

Data compiled from Bishop Museum Herbarium Records provided by Bishop Museum, 2014.

Area (All in the Koolau Mountains)	Year	Collector	Pop. Reference Code/Notes
Pupukea	28 Sep 1925	H. St. John	PAU-C
Pupukea	28 Sep 1925	Judd, C.S.	PAU-C
Pupukea	2 Nov 1925	Brown, F.B.H.	PAU-C
Hauula	8 Sep 1926	Judd, C.S.	on top of small cliff
Kahawainui Gulch	2 Mar 1928	Judd, C.S.	
Kaipapau Valley (North Slope)	11 Oct 1931	Degener, O.	Isotype
Papali Gulch	1933	Judd, C.S.	on trail
Small valley E of Waipilopilo Stream	7 Jul 1935	Degener, O.	HAU-A
Kamananui Stream (North fork, South slope)	16 Apr 1949	H. St. John	Not visited yet
Kamananui Stream (North fork, South slope)	18 Nov 1952	Wilson, K.A.	Not visited yet
Waialae Nui	23 Jan 1988	Takeuchi, W.N.	Not visited yet

Remaining Unsurveyed Historic Locations for *E. koolauensis*

Area	HNHP EOCODE	Last Observed	Location
Kaipapau	PDMRT030J0.002	1931	610,861.817 2,390,154.791
Papali*	PDMRT030J0.005	1994?	612,142.289 2,388,442.462
Waimea (Kamananui)	PDMRT030J0.003	1952	601,995.477 2,391,754.927
Malaekahana (Ohiaai)	PDAPO0K030.026	1933	605,569.445 2,394,857.376
Malaekahana (Kahawainui)*	PDMRT030J0.006	1928	608,978.388 2,392,755.762
Waialae Nui	n/a	1994	No point location available

*priority for OANRP relocation surveys, other areas have known sites nearby that will already be represented in the living collection

Map removed to protect rare resources, available upon request


Talbert Takahama (NARS) at the Kaleleiki PU


Mature tree at the Pahipahialua PU

Puccinia psidii* rust on *E. koolauensis


Puccinia psidii rust on E. koolauensis
(below left-right) rust on new growth, seedling, flowers fruit
Puccinia psidii rust on E. koolauensis

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
Hanaimoa	*in situ*	None	None
Kaiwikoele and Kamananui	*in situ*	OIP (KTA)	None
Kaleleiki	*in situ*	OIP (KTA)	None
Malaekahana	*in situ*	None	None
Ohiaai and East of Oio	*in situ*	OIP (KTA)	None
Palikea and Kaimuhole	*in situ*	None	None
Papali	*in situ*	None	None

Habitat Characteristics at Manage for Stability Population Units

Population Unit	*in situ* Population Reference Code	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Kaunala	KNL-B	680-800	Moderate to Steep	Intermediate-Closed	Mid to Upper-Slope	East to Northeast	1696
Oio	OIO-F	700-800	Moderate	Intermediate-Closed	Mid to Upper-Slope	East to Northeast	2047
Pahipahialua	PHI-A	680-780	Moderate	Intermediate	Mid to Upper-Slope	Northeast	1619

Information was compiled from OANRP observation forms & GIS data; Rainfall data complied from Rainfall Atlas of HI (Giambelluca et. al. 2013).

Associated Species at Manage for Stability Population Units

Population Unit	PRC	Canopy	Understory
Kaunala	KNL-B	AcaKoa, BobEla, CasEqu, CasGla, ChrHal, ChrOli, CorFru, DioHil, DioSan, EucRob, FreArb, GreRob, LepTam, MelQui, MetPol, NesSan, PasSub, PitCon, PlaSan, PsiCat, PsiGua, PsyMar, PsyOdo, RauSan, SanFreFre, SapOah, SidPol, XylHaw	AdiHis, AlySte, ArdEll, AspNid, CarMey, CarWah, CasGla, ChrHal, ChrOli, CibCha, CliHir, ConBon, CorFru, CycPar, FreArb, LepTam, OplHir, PasEdu, PasSub, PlaSan, PsiCat, PsiCom, PsiNud, PsyOdo, SetPal, SphChi
Oio	OIO-F	CasEqu, CasGla, ChrOli, GreRob, PasFoe, PasSub, PimDio, PsiCat, PsiGua, SyzJam, BobEla, ChrHal, DioSan, NesSan, PsyOdo, RauSan	ArdEll, ArtCil, CliHir, CorFru, CycDen, CycPar, LanCam, LeuLeu, MacMap, OplHir, PasCon, PasSub, PimDio, PsiCat, PsiGua, RubRos, SpaCam, AlySte, CarMey, CarWah
Pahipahialua	PHI-A	AleMol, ArdEll, CasEqu, CorFru, GreRob, BobEla, BobTim, ChrHal, LepTam, MetPol, MyrLes, NesSan, PisSan, PitCon, PitFlo, PitGla, PlaSan, PsiCat, SchTer, PsyOdo, RauSan, SanFreFre, XylHaw	ArdEll, AruGra, CasEqu, ChaNic, CliHir, CocOrb, ConBon, CorFru, CycDen, CycPar, DooKun, FreArb, LanCam, OplHir, PasSub, PsiCat, SetPar, SphChi, StaUrt, AlySte, CarMey, CarWah, CibCha, LepTam, MetPol, NepBro, PsiNud, PsyOdo, ScaGaua, SetPal,

Species are listed in alphabetical order by exotic, then native, as observed by OANRP; non-native taxa are underlined

Population Structure

- Currently, none of the Population Units have more than the number of mature plants required to meet stability goals (50 mature individuals) and immature plants are not expected to survive to maturity due to poor health from infection by *Puccinia psidii*.
- Many immature plants and seedlings have been observed at most PUs. The Kaunala PU, Kaleleiki PU and the Pahipahialua PU have had many immature plants and seedlings and still currently have more seedlings and immature plants than mature plants.
- *Puccinia psidii* is present on all plants at all sites and is negatively impacting population structure by slowing or stopping production of viable seeds and by killing plants. Since 2006, in the largest PUs, there has been a 70% decline of all known mature and immature plants (excluding seedlings). Over the last 4 years, there has been a 54% reduction in the total number of plants (mature, immature, seedlings).
- Without control methods for *P. psidii*, the trees are unlikely to produce more viable seeds, hence no new seedlings are expected at any of the sites. As the populations decline, collections of cuttings will be made from trees of all size classes. New growth on trees is ideal for cuttings, however *P. psidii* prevents new growth, hence making rooting success more difficult and at a slower rate by forcing the use of old (and likely infected) growth for cutting material.
- Soil seed bank potential has been studied at the OANRP seed laboratory. Radicles will emerge from seeds kept dark and imbibed (moist) for at least one year, but cotyledons will not emerge. Once these half-germinated seeds are exposed to light, cotyledons emerge and the seedlings continue to grow. This suggests that, despite the fact that seeds cannot tolerate desiccation, a seed/seedling soil seed bank can exist for at least one year as long as conditions remain wet enough so that the seeds do not dry out. However, no mature fruit has been observed on the wild trees since 2009.
- Population trends (see charts above and table below) document the decline observed at four of the larger PUs. The increase seen at the PUs during the 2010 observations was due to an increase in the amount of time spent searching and counting every plant.

Population Estimates for the Largest PUs

Year	Kaunala			Oio			Pahipahialua			Kaleleiki			Total
	Mat	Imm	See	Mat	Imm	See	Mat	Imm	See	Mat	Imm	See	
2007	36	45	89	17	14	40	37	42	171				617
2010	54	108	131	22	17	15	50	33	377	126			933
2012	38	93	54	16	5	7				163			812
2014	23	39	31	7	5	0	22	6	141	7	34	80	428

Mat: Mature Plants, Imm: Immature Plants, See: Seedlings

This table shows results from population estimates conducted by OANRP at the four largest PUs: Kaunala, Oio, Pahipahialua and Kaleleiki from 2007-2014. Once *Puccinia psidii* was detected on the wild trees in 2006, more thorough surveys were completed of these sites. As a result of more staff hours dedicated to thorough surveys in 2007-2010, more plants were discovered and counted. This is shown in the increases in the numbers of plants at Kaunala, Oio and Pahipahialua from 2007 to 2010. At the Kaleleiki PU, size classes were not standardized during monitoring in 2010 and 2012 when the sites were thoroughly searched. During that time, new trees were discovered close to the known fenced site. Since 2010, despite new finds and thoroughly searching each site, the total population has declined steeply and this trend is expected to continue because the plants that are still alive are in poor health.

Population Estimate History for other PUs

	Population Monitoring History (Mature/Immature/Seedling)							
Population Unit	**1998**	**2002**	**2003**	**2006**	**2007**	**2008**	**2010**	**2014**
Aimuu				5/3/0			5/19/6	11/9/5
Hanaimoa	1/0/0	1/0/0					2/1/1	2/2/0
Kaiwikoele and Kamananui						16/16/15	6/62/19	13/70/19
Malekahana	Not known							
Ohiaai and East of Oio			5/7/57			6/8/10	5/1/9	4/1/0
Palikea and Kaimuhole		3/0/0			2/0/0		3/0/0	1/0/0
Papali			1/0/0					0/0/0

Monitoring Plan

Sites in Manage For Stability PUs will be monitored using the Hawaii Rare Plant Restoration Group (HRPRG) Rare Plant Monitoring Form (RPMF) to record population structure and the age class, reproductive status and vigor of all known plants during collection trips. The sites will be searched for new plants and plants larger than 20cm will be tagged. This monitoring data will document population size at the remaining sites, determine if any individuals are resistant to the rust and guide *in situ* threat management and genetic storage needs. This is important to inform the strategy to secure a living collection representing all known populations. As populations decline, the priority will be to collect from the PU where the risk of losing important unrepresented founders is the greatest. In addition, other groups may be interested in securing collections and this information will help to guide their collection efforts. Having updated population data will also document the demise of the species from *Puccinia psidii* to call attention to the importance of preventing new diseases from entering Hawaii and help to select sites if an experimental treatment of *Puccinia psidii*. Seedlings will be marked with flagging at or around each group to prevent trampling and record locations for future salvage efforts for the living collection.

At sites that are designated as Genetic Storage, monitoring will be more frequent until collections are secured. Once secured in cultivation, the trees at these sites are expected to die and will not be monitored. The *inter situ* outplanting sites will be monitored annually using the HRPRG RPMF to record population structure, age class, reproductive status and vigor. All outplants will be accounted for along with a total population census. This data will be used to guide future outplanting and treatment of *Puccinia psidii*. Additional monitoring may be needed to track plant health and *Puccinia psidii* infections on the outplants.

Manage for Stability Population Units: Oio, Kaunala, Pahipahialua

- All plants will be accounted for during a census monitoring for the next two years until collections are secured. Additional visits may be needed just to secure collections. Once genetic storage goals are met, the sites will be monitored every three years.

Genetic Storage Population Units:

Palikea and Kaimuhole PU: Population monitoring will be done only as time allows since only one tree is remaining and is already secured in collections.

Aimuu, Malaekahana, Hanaimoa, Papali, Kaiwikoele and Kamananui, Kaleleiki and the Ohiaai and East of Oio PU: All plants will be accounted for during a census monitoring while collecting over the next two years. Once secured in cultivation, the trees at these sites are expected to die and will not be monitored.

Reproductive Biology Table

	Observed Phenology				Reproductive Biology		Seeds	
Population Unit	Vegeta-tive	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit	Dormancy
ALL	Dec-Mar	Mar-Sep	May-Oct	May-Nov	Hermaphroditic	insect	1	PY
Oio		April-Aug		April-Sept	Hermaphroditic	Insect	1	Physiological Dormancy (PY)
Kaunala	Jan-Feb	Mar-Aug	May	May-June				
Pahipahialua	Jan-Mar	April-Sept	May-Sept	May-Nov				
Kaleleiki	Mar-Sept	no plants have been seen reproductive						
Aimuu		May						
Hanaimoa		June		Aug				
Kaiwikoele & Kamananui	No data							
Malaekahana	No data							
Ohiaai and East of Oio		April-Aug						
Palikea and Kaimuhole		May						
Papali	No data							

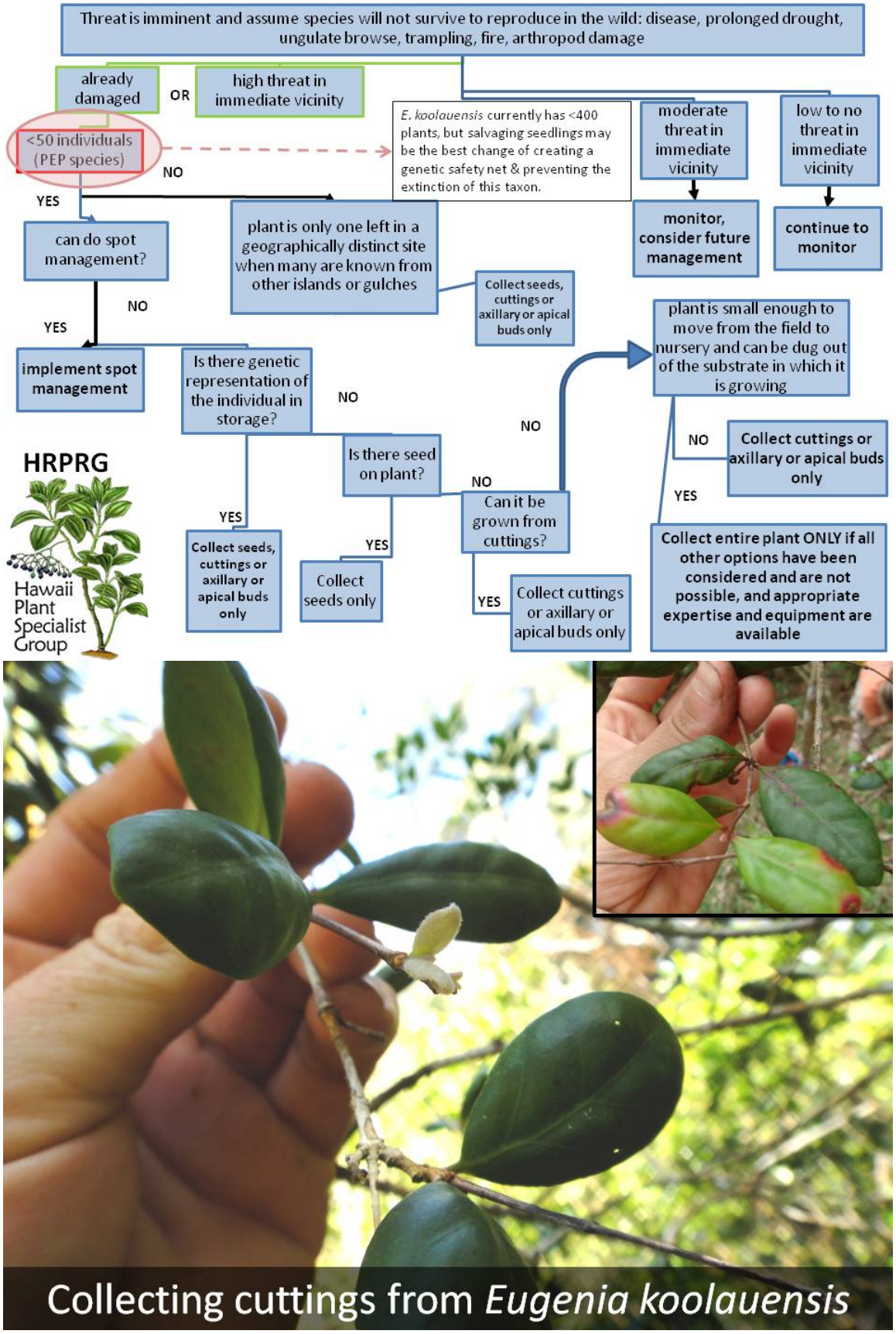
Genetic Storage Plan

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 maintain living collection in the nursery and an *inter situ* collection

Genetic Storage Plan Comments:

• Seeds have some slight level of physiological dormancy, as seeds take longer than 30 days to germinate. Average germination, however, is high (91%). Seed storage would be the preferred genetic storage method, however, seeds are desiccation-sensitive. Seed banking must utilize cryopreservation techniques. Cryopreservation protocols will be researched at the National Center for Genetic Resources Preservation (NCGRP, Fort Collins, CO), once enough seeds can be harvested from the OANRP living collection. In lieu of this, a collection of *Syzygium sandwicensis* was sent to NCGRP to initiate protocol development (Myrtaceae; desiccation-sensitive) and living collections of plants are kept at the nursery to represent each of the PU. Once nursery plants are cloned, replicates will be planted at an *inter situ* site at Waimea Botanical Garden where they can continue to be treated with fungicides. The living collection at the nursery will expand to include new founders as they become available. If cryopreservation protocols cannot be established for seeds of *E. koolauensis*, it will be attempted for buds and other meristematic tissues at NCGRP.

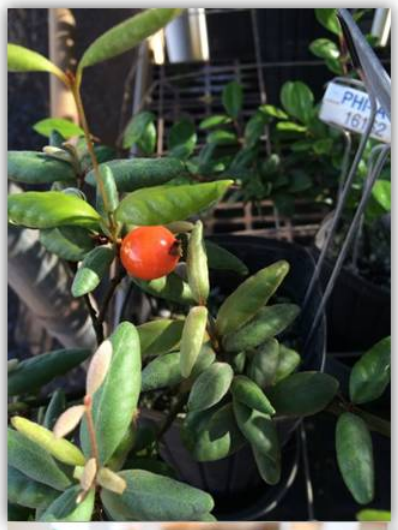
• Cuttings will be collected from all sites to establish a living collection in the OANRP nursery. Currently, OANRP has clones of 33 individual founders. In some cases, when propagules from larger plants are not available, whole plants will be removed from wild sites. Protocols for determining when whole plants can be removed from the wild have been developed by the HRPRG. These methods will be used to dig up and transport small whole plants to the OANRP nursery for propagation as part of the living collection. The HRPRG Salvage decision tree (below), however, only allows for salvaging whole plants of species with less than 50 individuals (PEPP species). Given the severity of the *P. psidii* infections, which has ceased reproduction of *E. koolauensis* at all sites, made clonal propagation nearly impossible, and caused the rapid decline of this species, OANRP proposes applying the whole plant harvesting (salvaging) to *E. koolauensis*. Salvaging now with 428 plants (64mature/112immature/252seedling) remaining will allow for *ex situ* representation from remnant plants at most known sites. A total of 150 founders (117 additional founders) will be secured from across the known range. The collection strategy will be to represent every population site and sample from individuals growing across each site to maximize the chances of capturing the most genetic diversity. Both known founders from the Waianae Mountains are already secured and collections from the other sites will be a priority over the next few years.


Threat is imminent and assume species will not survive to reproduce in the wild: disease, prolonged drought, ungulate browse, trampling, fire, arthropod damage
already damaged
OR
high threat in immediate vicinity
<50 individuals (PEP species)
NO
YES
E. koolauensis currently has <400 plants, but salvaging seedlings may be the best change of creating a genetic safety net & preventing the extinction of this taxon.
moderate threat in immediate vicinity
low to no threat in immediate vicinity
monitor, consider future management
continue to monitor
can do spot management?
NO
YES
implement spot management
plant is only one left in a geographically distinct site when many are known from other islands or gulches
Collect seeds, cuttings or axillary or apical buds only
Is there genetic representation of the individual in storage?
NO
YES
Collect seeds, cuttings or axillary or apical buds only
Is there seed on plant?
NO
YES
Collect seeds only
Can it be grown from cuttings?
NO
YES
Collect cuttings or axillary or apical buds only
plant is small enough to move from the field to nursery and can be dug out of the substrate in which it is growing
NO
Collect cuttings or axillary or apical buds only
YES
Collect entire plant ONLY if all other options have been considered and are not possible, and appropriate expertise and equipment are available
HRPRG
Hawaii Plant Specialist Group
Collecting cuttings from Eugenia koolauensis

Note that cuttings have only one leaf each and no new leaves. This is often the only material remaining.

Cuttings rooted with Clonex on OANRP mist bench. Rooting occurs in 1-10 months in perlite/ vermiculite.

Nursery Living Collection



Mature fruit will be sent to the USDA-ARS National Center for Genetic Resources Preservation in Ft. Collins, CO for research. Seedlings resulting from successful processing will be returned to OANRP.

Inter situ Management Plan

Proposed *inter situ* Outplanting Sites	Population Reference Site Codes for *inter situ* sites	Number of Plants	Propagule Type	Propagule Population Source	Number of Founders in Source Population	Plant Size	Pot Size
Kaiwikoele and Kamananui	NMH-C	50	Outplants grown from cuttings of wild plants and seedlings from nursery stock	ALL Koolau Sites	150	30-100 cm	0.5 gallon 'shorty'
Waimea Botanical Garden	WAI-B	50	Outplants grown from cuttings of wild plants and seedlings from nursery stock	ALL Koolau Sites	150	30-100 cm	0.5 gallon 'shorty'

- The *Puccinia* rust is the primary threat to this species and would rapidly infect and kill any outplants. Because of this, no outplanting is planned in the next five years. Although chemical controls are effective for plants kept in cultivation, no control methods are available to treat wild trees or outplants in natural areas. According to the Hawaii Department of Agriculture, there is currently no fungicide that is labeled for use in a "Natural Area" in Hawaii. However, products used legally and effectively in the OANRP nursery are also labeled for use on trees and shrubs in a "landscape." The *inter situ* sites above are considered managed landscape areas where chemicals labeled for that use can be applied. These sites at Kaiwikoele and Kamananui and within the public gardens at Waimea Botanical Garden (WBG) will be used to develop propagation and planting techniques, test rust control methods and collect fruit for storage trials. They are both on WBG property and staff that maintain the existing collections there are eager to partner and expand the collection. The management unit fence constructed by WBG around some of the trees in the Kaiwikoele and Kamananui PU and this site will be used as a managed outplanting. The site is preferred because of the partnership with WBG, close proximity to an access road and ongoing intensive management of the landscape there. A new site will also be developed within WBG to secure additional founders. Stock will be propagated from all wild Koolau founders. Once replicated, stock would be available for conservation use by other agencies wanted to help with this taxon.

- As the living collection is secured and replicated at the OANRP nursery, partnerships with other agencies should be developed to establish sites within other existing fences such as: Manuwai, Kaleleiki, Wailupe and Upper Kapuna to replicate the collections and develop *Puccinia* rust control methods. Partnerships with other botanical gardens to donate replicates of the living collection will be pursued.

Stabilization Goals Update for MFS PUs

Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does population structure support long-term population stability?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are Genetic Storage goals met?
Kaunala	No	No	Yes	Partial (100%)	No	Partial (100%)	No	No	No
Oio	No	No	Yes	Partial (100%)	No	Partial (100%)	No	No	No
Pahipahialua	No	No	Yes	Partial (100%)	No	Partial (100%)	No	No	No

Partial (100%): All of the plants in the PU have this threat partially controlled (fuel reduction)
There is currently no PU that meets the requirements for stability. All plants are fenced at the three MFS PUs. Weeds are managed periodically within all exclosures, however this may in fact increase spore rain on smaller plants that are covered (protected) by weeds so most weeding efforts will be discontinued. Genetic Storage goals will be met by establishing a nursery and garden living collection.

5 Year Action Plan

Manage for Stability Population Units	OIP YEAR 7 Oct.2014-Sept.2015	OIP YEAR 8 Oct.2015-Sept.2016	OIP YEAR 9 Oct.2016-Sept.2017	OIP YEAR 10 Oct.2017-Sept.2018	OIP YEAR 11 Oct.2018-Sept.2019
Oio	•Collection for Nursery Living Collection	•Collection for Nursery Living Collection •Census monitoring		•Census monitoring	•Outplanting into *inter-situ* sites at Waimea Botanical Garden and Kawiwikoele and Kamananui fence
Kaunala					
Pahipahialua					
Genetic Storage Population Units					
Aimuu	•Collection for Nursery Living Collection	•Collection for Nursery Living Collection •Census monitoring		•Census monitoring	
Hanaimoa					
Kaiwikoele and Kamananui					
Kaleleiki					
Malaekahana					
Ohiaai and East of Oio					
Palikea and Kaimuhole					

Management Discussion for *E. koolauensis*

The primary efforts for stabilization of *E. koolauensis* include: A) securing founders in a nursery living collection; B) monitoring of mature plants at *in situ* populations; C) *in situ* habitat protection (maintain fences); D) research on cryopreservation techniques for *ex situ* seed storage; and E) outplanting where needed to establish new *inter situ* sites to help hold replicates of the founders and research threat control methods. *Eugenia koolauensis* is in decline throughout the its range and no management is currently available to reduce or eliminate infections by *Puccinia psidii*.

The immediate strategy for this taxon is to salvage collections from 150 wild founders from across the known range. Collections will be made from plants of all size classes and ages. When necessary, whole plants will be removed from wild sites, secured in cultivation at the OANRP nursery and established as a living collection. Infections of *Puccinia psidii* are considered 100% lethal and no new plants are expected to be established on site. Monitoring will continue at all MFS PUs and complete census monitoring will continue every two years. The existing fences will be maintained around the MFS PUs, but other habitat protection and management will be discontinued until the wild plants and outplants can be protected from infection or be sufficiently controlled with legal application of fungicide chemicals. Once a living collection is established in the nursery, *inter situ* sites should be used to conduct experimental outplanting and as a back-up to the nursery collection. Fruit collected from these plants will be submitted to the USDA-ARS NCGRP for testing and to develop protocols for long-term genetic storage. In the longer term, the genetic storage goals will be met using the nursery living collection until collections are established at botanic gardens (or other inter situ sites), or when mature seeds can be collected and stored. Once plantings have been established at the *inter situ* sites, management strategies may have to be adapted to maintain healthy plants and control other host species of *P. psidii*.

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Euphorbia herbstii

- **Scientific name:** *Euphorbia herbstii* W. L. Wagner
- **Hawaiian name:** *`akoko*
- **Family:** Euphorbiaceae (Spurge family)
- **Federal status:** Listed (as *Chamaesyce herbstii*) endangered on October 10, 1996
- **Requirements for MIP Stability**
  - 3 Population Units (PUs)
  - 25 reproducing individuals in each PU
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology:** *Euphorbia herbstii* is a milky-sapped tree 3-8 m tall. The leaves are usually 8-19.5 cm long, oppositely arranged, and held in a horizontal plane. The inflorescences are open, branched, measure 7-17 cm long, and bear 3-15 cyathia (specialized flower-like inflorescences with a single central female flower surrounded by much-reduced male flowers). The capsules measure 5-10 mm long, and up to 8 mm in diameter, are colored green or green and red, and contain three seeds. Little is known about the breeding system of *E. herbstii*. 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. Flowering has been recorded as being from August to October (Nagata 1980). Bees and flies visit the flowers of *E. herbstii* (Lau pers. comm. 2000), and presumably act as pollination agents for the taxon. Native bees, *Hylaeus makaha* and *H. ulaula* have been observed on flowering outplants in Makaha (Karl Magnacca, pers. comm., 2014).

modified from: Makua Implementation Team (MIT). 2003.

Euphorbia herbstii

- **Description and biology continued:** Fruiting is reported from October to January (Nagata 1980), and OANRP has observed mature fruit as late as February. Mature *Euphorbia* capsules split open explosively when they dry, flinging the seeds for a short distance. The seed or seeds of the colonizing ancestor of *E. herbstii* probably arrived in Hawaii attached to a bird (Carlquist 1970), as most *Euphorbias* 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 dispersibility in upland oceanic island plants whose ancestors were weedy lowland plants (Carlquist 1970). However, in spite of being an upland forest species, *E. herbstii* has a copious amount of the sticky substance on its seeds (Koutnik 1987). Dispersal of its seeds in pre-human times is thus theorized to have been carried out by birds, including the many now extinct flightless Hawaiian birds. *Euphorbia herbstii* can live for at least one or two decades (Lau pers. comm. 2000), but within the last decade, OANRP has only observed plants living for one decade or less.
- **Known distribution:** *Euphorbia herbstii* has a known disjunct range. It has been recorded from elevations of 530-700 m. The main portion of the species' range is in the northern portion of the Waianae Mountains in the Mokuleia region. Two population units were known from this region: Makaleha and the adjacent gulches of Pahole and Kapuna. It has never been found south of the Mokuleia region except for the recently extirpated colony in the southern Waianae Mountains in South Ekahanui Gulch in Honouliuli Preserve.
- **Population trends:** *E. herbstii*'s population units have been decreasing in number, and the numbers of plants in them have been shrinking. Of the 3 recorded *E. herbstii* population units, only the Kapuna to Pahole one is now extant. The population in South Ekahanui Gulch was first discovered in the late 1970's, when 15 mature trees and several seedlings were reported. In 1987, the number was reported to be about 11 trees. The number declined to four trees by 1991, and two trees by 2000. The last two trees died in 2001. In Makaleha, it was described as being "locally dominant" in a very small area in 1950 (Hatheway 1952). In 1987, 10-12 were recorded by Steve Perlman, but none were observed when he searched the site again in 2001. The only extant population unit is in Pahole and Kapuna gulches of the Pahole NAR. Almost 200 plants were estimated around 1997, but that dropped slightly to about 170 trees in the MIP in 2003. By 2005, the estimates were revised and 56 trees were known. In 2008, a total of 45 wild plants were known. Now only 21 plants remain, 11 of which are mature.

modified from: Makua Implementation Team (MIT). 2003.

Euphorbia herbstii

- **Habitat:** *Euphorbia herbstii* typically grows in gulch bottoms and on gulch slopes. It usually occurs in mesic forests dominated by a diverse mix of tree species. The habitat characteristics and associated species are described below.

- **Taxonomic background:** There are 16 native species of *Euphorbia* in Hawaii; all are endemic. Several alien species of this genus are also found in Hawaii. Despite prior consideration of the taxon *Chamaesyce* as a subgenus of the large genus *Euphorbia,* Koutnik (1987), recognized it on the generic level, but was later recognized as a clade within the genus *Euphorbia* (Yang & Berry 2011).

- **Threats:** Major threats to *E. herbstii* include feral pigs and goats. These ungulates degrade the species' habitat, and harm the plants by feeding on them, trampling them, or uprooting them while rooting for food. All sites with extant plants are now within ungulate-free management units fences. Alien plants threaten the species 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. Slugs have been observed to impact plants, but this should be investigated further and better documented. The primary concern is that for unknown reasons, many apparently healthy plants have been observed to quickly decline and die within a period of several weeks to a few months after showing an initial decline in vigor. This has been observed at the Makaha introduction, and augmentation outplantings and wild sites in the Kapuna to Pahole PU. At this time, the cause is undetermined, but plants exhibit symptoms of wilt and loss of turgor pressure resulting in the death of both immature and mature plants. In some outplanting sites, dying plants are located closely to apparently healthy plants and no strict pattern has emerged. In other cases, plants in areas with open canopy or on slopes die more than plants with intermediate to closed canopies or plants in gulch bottoms, suggesting some amount of light, heat, and/or water availability may affect plant survival. This difference in microclimate and other possible explanations for the plants living less than 10 years should be investigated. Research is needed on how soil moisture, composition and nutrients, canopy cover, associated species, aspect and slope affect plant survival. Furthermore, more information on plant disease, plant nutrients and other indicators of plant health is needed.

modified from: Makua Implementation Team (MIT). 2003.

Euphorbia herbstii

- **Outplanting considerations:** Hawaiian *Euphorbias* have been successfully crossed experimentally in many combinations (Koutnik 1987), and there are also several known cases of natural hybridization between co-occurring Hawaiian *Euphorbias*. In some cases hybridization has resulted in hybrid populations such as ones involving *E. rockii* and *E. clusiifolia* in the Koolau Mountains. Another situation involving hybrids in Hawaiian *Euphorbias* is observed in the transition zone between two habitats, where hybrids form a zone of intergradation between the *Euphorbia* of one habitat and the *Euphorbia* of the other habitat. Such intergradation zones involving *E. multiformis* var. *multiformis* of the forest understory and *E. celastroides* var. *amplectans* of the exposed rocky ridge tops are common in the Waianae Mountains. Hybrids involving *E. herbstii* and the common *E. multiformis* var. *multiformis* which often grows with or near *E. herbstii* have been observed. Seeds grown from an *E. herbstii* plant at one of the wild sites in the Kapuna to Pahole PU was thought to be a hybrid (pictures below) and it was removed from the outplanting. The leaves were less than 6cm long in the hybrid and the fruit is recurved to the side of the cyathia; both of which are traits found in *E. multiformis*, not *E. herbstii*.

Euphorbia herbstii* hybrid with *E. multiformis* var. *multiformis

modified from: Makua Implementation Team (MIT). 2003.

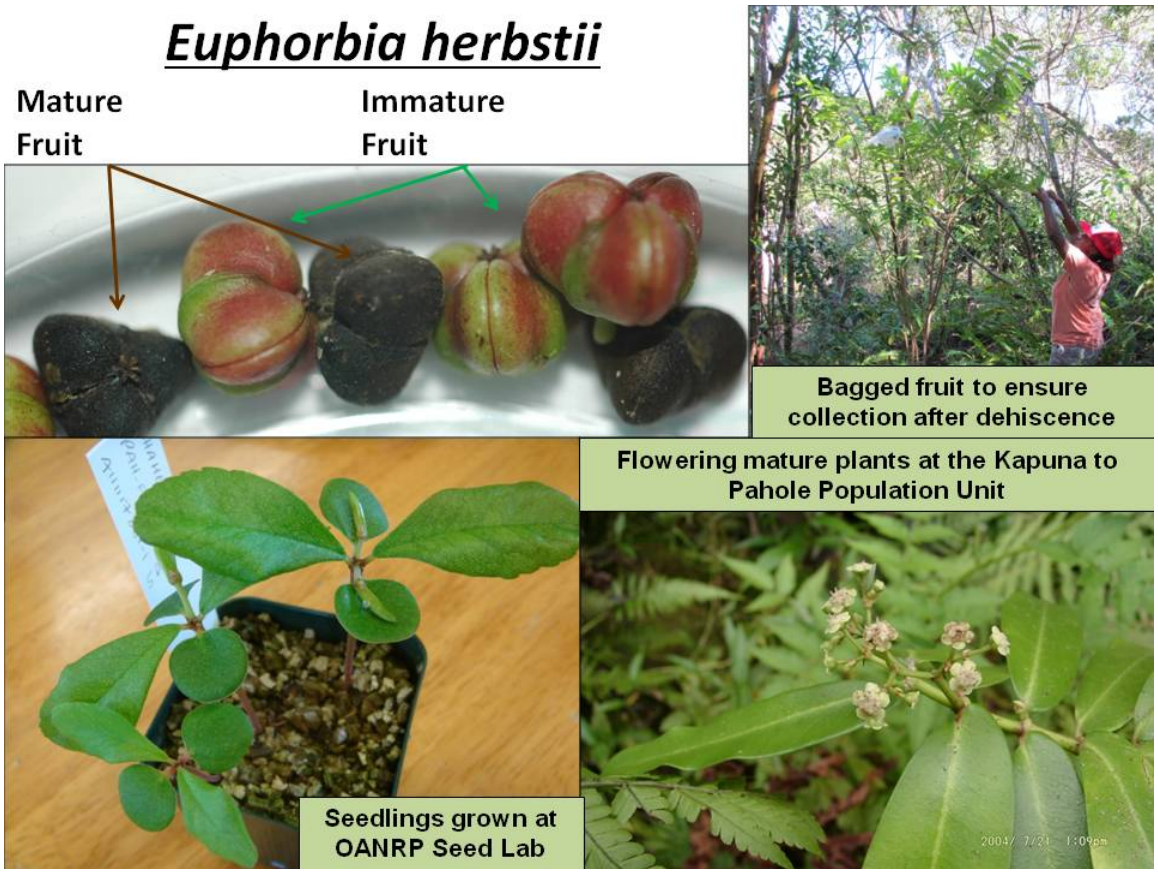
Map removed to protect rare resources, available upon request

Selected Historic Collections of *Euphorbia herbstii*

Area	Year	Collector	Population Unit & Notes
Mokuleia (slopes of Kaala)	26 April 1912	Forbes, C.N.	
Makaleha	30 Aug 1922	Skottsberg, C.J.F.	
Pahole Gulch (Kukuiala)	9 Oct 1934	Swezey, O.	Kapuna to Pahole
Pahole Gulch (Kukuiala)	12 April 1936	Fosberg, F.R.	Kapuna to Pahole
East Makaleha	30 July 1950	Degener, O.	
Mokuleia (Peacock Flats)	23 April 1962	Degener, O.	Kapuna to Pahole
Pahole Gulch	23 July 1973	Heart, T.	Kapuna to Pahole
West Makaleha	6 Dec 1969	Montgomery, S.L.	West Makaleha
Kapuna Gulch	27 Dec 1969	Herbst, D.R.	**Holotype** 'Below Peacock trail'
Pahole Gulch	1 Jan 1985	Gustafson, R.	
Ekahanui (South)	15 Jan 1987	Perlman, S.P.	
Kapuna Gulch	16 Sep 1990	Welton, P.	

Data compiled from Bishop Museum Herbarium Records provided by Bishop Museum, 2014.

Map removed to protect rare resources, available upon request



Euphorbia herbstii Collection and Propagation

Green-colored immature fruit are bagged for collection, and seeds are removed after being dehisced into the bag. Seeds are stored, or germinated and grown in the nursery for outplanting.

Euphorbia herbstii

Outplanting in Makaha

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Kapuna to Pahole	in situ and Augmentation	MMR	Pahole and Kapuna
Kaluaa	Introduction	None	Kaluaa and Waieli
Manuwai	Introduction	None	Manuwai
Manage Outplanting as a Propagule Source			
Makaha*	Introduction	None	Makaha Subunit I

*outplanting managed as a propagule source for the MFS PU

The only remaining wild plants are in the Kapuna to Pahole MFS PU. This PU will be augmented as well as used as a propagule source for the other PUs. The Kaluaa PU will be established with an introduction of stock grown from the Kapuna to Pahole PU. The introduction at the Makaha PU has not been successful and will be replaced by the Kaluaa PU. Once the Kaluaa PU is established, management at the Makaha PU will be discontinued. The Makaha site will be used only as a propagule source and will be monitored only occasionally for any new plants. Once propagules are available, the Manuwai PU will be established by introducing plants grown from stock planted at the other PUs.

Habitat Characteristics

Population Unit	Population Reference Codes	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Kapuna to Pahole	KAP-C, KAP-E PAH-F, G, I PAH-R	1926-2129 2011-2051	Moderate	Intermediate-Closed	Gulch bottom to Upper-slope	Northeast to Northwest	1443-1565
Kaluaa	To be determined when outplanting site is selected						
Manuwai	To be determined when outplanting site is selected						
Makaha	MAK-A*	2185	Moderate	Intermediate-Closed	Mid-slope	Northwest	1789

*=outplanting site at this PU will not be continued as this is not an MFS PU
Information was compiled from OANRP observation forms & GIS data; Rainfall data complied from Rainfall Atlas of HI (Giambelluca et. al. 2013).

Associated Species

Population Unit	Population Reference Code	Canopy	Understory
Kapuna to Pahole	KAP-C, KAP-E PAH-F, G, I PAH-R*	AleMol, PsiCat, AleMacMac, AntPla, AspNid, BobBre, BudAsi, ChaObo, ChaTom, CibCha, CopFol, CopLon, CyaSupSup, CyrDen, DioHil, DioSan, ElaBif, Fluneo, FreArb, GreRob, GynTri, HibArnArn, KadAff, MetPol, MonHib, NesSan, pipalb, PisBru, pissan, PisUmb, PlaSan	Ageade, AgeRip, BleApp, BudAsi, Clihir, CycDen, CycPar, MelMin, OplHir, OxaCor, PasCon, PsiCat, Rubros, SchTer, TriSem, YouJap, AlySte, CarWah, ChaTom, CibCha, CopFol, DipSan, DooKun, KadAcu, KadAff, MicStr, NepExaHaw, PipAlb, PisSan, TecGau,
Kaluaa	To be determined when reintroduction site is selected		
Manuwai	To be determined when reintroduction site is selected		
Makaha	MAK-A	AleMol, CofAra, PsiCat, PsiGua, SchTer, SyzCum, TooCil, AcaKoa, AntPla, ClaSan, DioHil, DioSan, ElaBif, GynTri, HibArnArn, MetPol, MyrLes, NesSan, PanBee, PipAlb, PisBru, Pissan, PisUmb, PlaSan, PsyOdo, SapOah, StrPen, UreGla, XylHaw	BleApp, BudAsi, CofAra, ConBon, CorFru, CycPar, KalPin, LanCam, PasEdu, AlySte, AspNid, BidTor, CarMey, CarWah, ChaObo, ChePla, CopFol, CyaSupSup, DooKun, DubPla, EraGra, EupMul, HibArnArn, LepTam, LysHil, MelMak, MicSpe, MicStr, NesSan, PipAlb

*PAH-R is the augmentation, but is located at the PAH-G wild site.

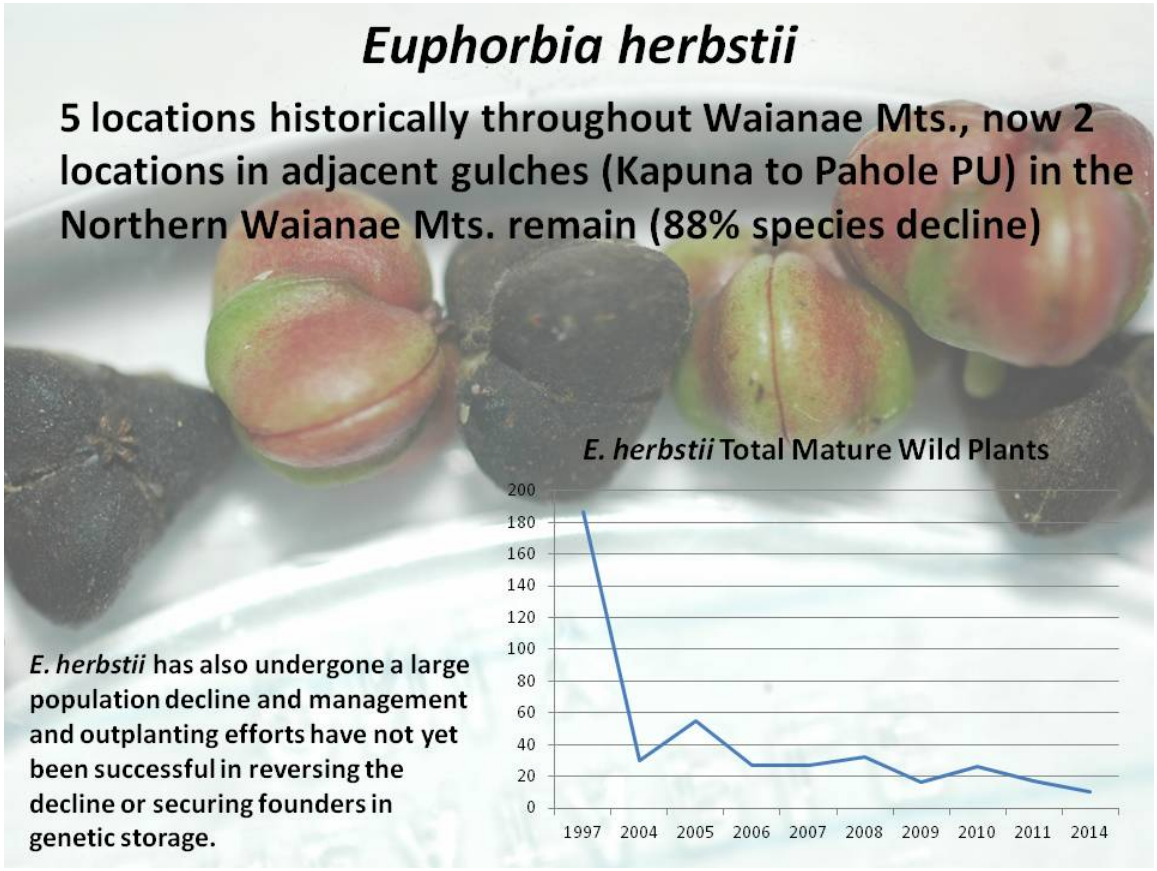
Species are listed in alphabetical order as observed by OANRP; introduced taxa precede native taxa and are underlined: AbuGra, CycPar

Population Structure

- In the Pahole to Kapuna PU, seedlings are observed and grow into immature plants at both the *in situ* and augmentation sites. The majority of wild plants have died since monitoring began, but some seedlings are still observed to survive to be new immature plants. Immature plants do survive to flower and reproduce but not enough to slow the overall decline. Of the 100 wild plants that OANRP has monitored since 2004, 79% have died. Once tagged, plants lived for 6-7 years (4 years as mature plants). Of the 316 plants that were outplanted since 2006, only ¼ survive, and outplants live for only 5 years, 3 of which are as mature plants. The overall life span of outplants is difficult to assess due to being planted as small immature plants that were grown for at least a year in the nursery. Most of the wild plants known in the 1990's and some of the remnant wild plants are estimated to have lived for more than ten years. However, now, most wild plants and outplants are not surviving for more than ten years. If most plants continue to fail to survive for longer than ten years, adjustments to outplanting targets and stability goals could be made to accommodate for shorter-lived plants and the large decline in number of plants of this species. Once this decline was initially detected, the species became an official PEPP species (Plant Extinction Prevention Program; 50 or fewer wild plants).

- The Pahole augmentation is located among the wild plants. It is difficult to determine what specific micro-site conditions are most suitable for this species. Just over 40% of the outplants have survived and OANRP is still working to understand what causes such poor survival. For instance, while less than 30% of the outplants planted at the Pahole augmentation in 2011 and 2012 survive in 2014, 100% of the plants planted in 2006, are alive and healthy. These 2006 outplants are located at the bottom of the subgulch and may receive more water than plants on the slopes.

- In Makaha, outplanted immature plants have been observed to mature and flower. Seedlings were observed at the reintroduction in Makaha less than two years after reintroducing immature plants, but all of these seedlings; however, died after two years. Survival at the Makaha introduction has been poor (4 mature healthy plants and 29 immature plants in poor health remain) and the site is considered unsuccessful. The outplanted cohorts of 61 plants from 5-7 years ago only have one surviving plant. ¼ of the plants planted 2-3 years ago (12 plants) survive, and the majority of plants from the 2013 outplanting have recently died over the 2014 summer. This site will not be receiving more plants and there are no plans to establish another introduction in Makaha of this species in the next five years.



Monitoring Plan

- All plants at all sites will be monitored twice annually using the Hawaii Rare Plant Restoration Group (HRPRG) Rare Plant Monitoring Form (RPMF) to record population structure and the age class, reproductive status and vigor of all known plants. The sites will be searched for new plants and accessible large immature (>40cm) and all mature plants that are collected from will be tagged. If there is any observed threat to the health and safety of plants due to repeated monitoring and/or tagging, reductions in the number of tagged individuals will be made so that no harm is done to the plants.

- Further monitoring and research is needed to determine why the species is in decline. For plants found in poor health during monitoring trips, samples will be taken for analyses at the UH-CTAHR Agricultural Diagnostic Service Center to detect disease or other pathogens and measure nutrient levels. In order to help investigate what factors are associated with the decline, all live wild plants and outplants, and as many dead plants as can be relocated will be added to the GIS database so details of their history, founder source and any micro-site characteristics measured can be displayed for analyses. Soil testing can be used to detect varying composition, moisture and nutrient levels and presence of microbes at each individual or group of plants. A more detailed understanding of the native and non-native vegetative cover around surviving outplants and wild plants would help determine how exposure and weed competition may be involved. A better understanding of each of these factors would eventually help habitat management strategies and site selection for outplanting. If any important factors are identified, they can be tested by additional outplanting as propagules become available.

- The reintroduction sites will be monitored twice annually using the HRPRG RPMF to record population structure, age class, reproductive status and vigor. All outplants will be accounted for along with a total population census. This data will be used to guide future outplanting. Populations have been monitored in the past only annually, and in the spring. This may have limited our understanding of when and how plants die, as well as our assessment of maturation, as plants are typically vegetative during the spring.

Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit (PU)	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit	Dormancy
ALL	Aug-Oct	Aug-Jan	Oct-Feb	Monoecious (cyathia)	Insect	3*	Not Dormant

* Ovary 3-carpellate but often only 0-1 seed per fruit observed

- Bees and flies visit the flowers of *E. herbstii* (Lau pers. comm. 2000), and presumably act as pollination agents for the taxon. Native bees, *Hylaeus makaha* and *H. ulaula* have been observed on flowering outplants in Makaha (Karl Magnacca, pers. comm., 2014).
- Mature *E. herbstii* capsules split open explosively when they dry, flinging the seeds for a short distance. Therefore, OANRP deploys organza drawstring bags around ripening fruit and return two weeks later to collect the seeds that have burst out of the dehisced fruit.
- *(excerpt from MIT 2003* - E. herbstii *has a copious amount of sticky substance on its seeds. Dispersal of its seeds in pre-human times is thus theorized to have been carried out by birds, including the many now extinct flightless Hawaiian birds).* Seeds of *E. herbstii,* have been observed to be covered by a mucilaginous substance, when seen in collection bags.
- Seeds germinate readily (first seeds germinate prior to 30 days) and therefore are considered to have no dormancy.

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.
Seeds	Reintroductions	Seed banking	10 years	Yes	Collections will be made from reintroductions ASAP

• The OANRP seed bank has received seeds to store from 52 founders in the Pahole to Kapuna PU. The re-collection interval is currently set at 10 years, and the majority of the collections have reached this age. Unfortunately, the majority of those founders are now dead. In attempts to establish the Makaha introduction and Pahole augmentation, the seed bank has lost 50% of its founder representation. Of those founders depleted from the seed bank that have also died at the wild populations, 7 had seeds that were germinated and were not successfully propagated to outplanting size. The remaining founders had progeny that were outplanted but the plants died at the outplanting sites.

• The urgency to collect from all remaining plants cannot be overstated. The amount of assumed genetic variation (estimated by the number of founders) that has been lost within the last several years for this species is over half the maximum potential. Collections from founders with many seeds in storage will be used to develop propagation and outplanting methods in order to conserve founders with only a few seeds remaining in storage.

• Given the poor survival of outplants and the difficulty in obtaining seeds for propagation, vegetative propagation will be used to secure and replicate plants for restoration efforts. Cuttings will be taken from outplants, nursery collections and other sources to develop propagation methods. Once protocols are developed, wild plants could also be secured with clones. If necessary, a nursery or *inter-situ* living collection could be used as a propagule source and research collection. Genetic Storage goals can also be met by holding these clones in the nursery. These methods, if developed, will greatly improve our ability to produce plant material for research and experimental outplantings.

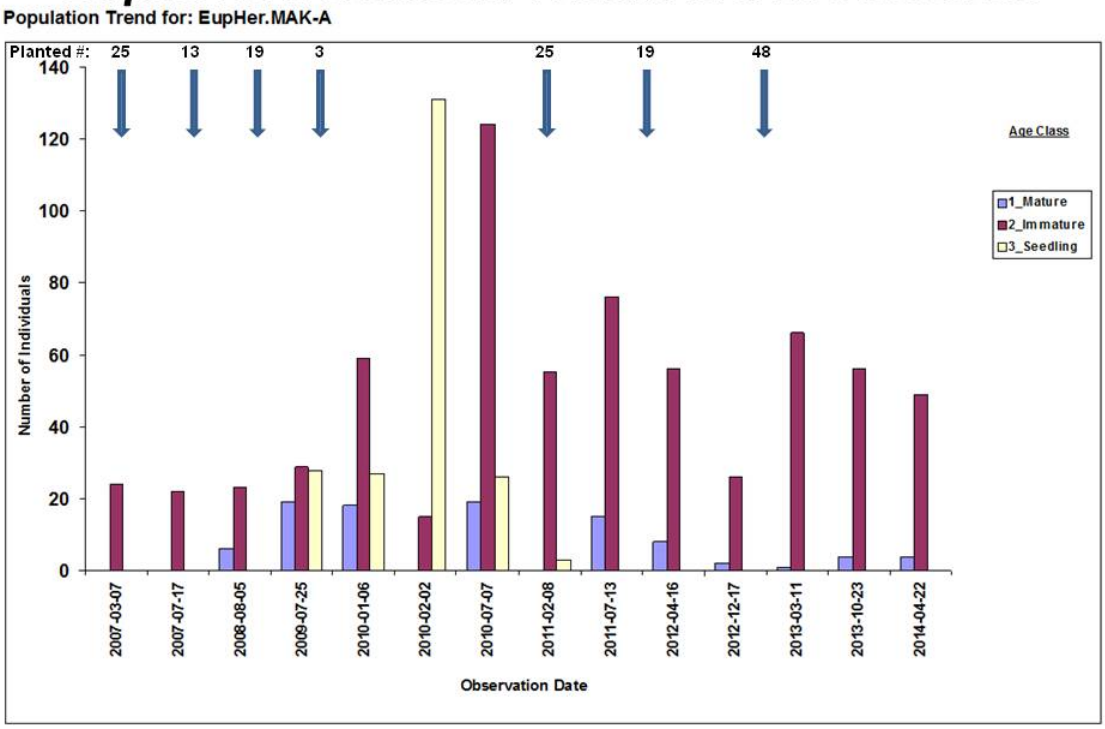
Reintroduction Plan

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
Pahole to Kapuna	PAH-R	112	Immature plants	ALL	56	30-100 cm	1-gallon tall
Makaha	MAK-A	112	Immature plants	ALL	56	30-100 cm	1-gallon tall
Kaluaa	KAL-A*	150	Immature plants	ALL	56	30-100 cm	1-gallon tall
Manuwai	ANU-A*	150	Immature plants	ALL	56	30-100 cm	1-gallon tall

*Not yet established

Reintroduction Plan Comments: The augmentation of the Kapuna to Pahole PU began in February 2006. This site has had better survival than the Makaha PU and is used to establish plants for collection as well as meet stability targets. Outplanting will continue there to investigate reasons for the decline and hold founders for seed collection. As propagules become available, new sites will be established in the Kaluaa PU and Manuwai PU. Sites will be selected and prepared for outplanting in the next few years, but are dependent on being able to obtain sufficient numbers of propagules from the Kapuna to Pahole PU. No more outplanting will occur at the Makaha PU. OANRP will focus on propagating plants vegetatively as well as from seeds from outplants to reduce the burden on seed-producing plants and secure as many founders as possible in cultivation.

Euphorbia herbstii: Makaha introduction



Outplanting started with 25 plants in 2007. All planting dates are marked with arrows and the number planted. The number of immature plants and seedlings increased dramatically in 2010, but all of these plants have since died.

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?
Pahole to Kapuna	YES	NO	YES	YES	NO	NO	NO	NO	YES
Kaluaa	Population Unit is not established								
Makaha	NO	NO	YES	YES	NO	NO	NO	NO	N/A*
Manuwai	Population Unit is not established								

*Only the Kapuna to Pahole PU has wild plants that will be used for Genetic Storage. All other PUs will be established using the stock from the Kapuna to Pahole PU.
The stability targets and threat control will be assessed for the other PU once they are established.

5 Year Action Plan

Proposed Actions for the following years:					
Manage for Stability Population Units	**MIP YEAR 10 October 2014 – September 2015**	**MIP YEAR 11 October 2015 – September 2016**	**MIP YEAR 12 October 2016 – September 2017**	**MIP YEAR 13 October 1 2017- September 2018**	**MIP YEAR 14 October 1 2018- September 2019**
Pahole to Kapuna	•Monitor •Collect •Outplant	•Monitor •Collect	•Monitor •Collect	•Monitor •Collect	•Monitor •Collect
Kaluaa	•Select and prepare outplanting site	•Outplant	•Outplant •Monitor •Collect	•Outplant •Monitor •Collect	•Monitor •Collect
Makaha	•Monitor •Collect	•Monitor •Collect	•Monitor •Collect	•Monitor •Collect	•Monitor •Collect
Manuwai		•Select and prepare outplanting site	•Outplant •Monitor	•Outplant •Monitor •Collect	•Outplant •Monitor •Collect

Management Discussion for *Euphorbia herbstii*

The primary efforts for stabilization of *E. herbstii* are: A) *in situ* habitat health and threat protection; B) research on the cause of decline in large immature and mature plants; C) maintaining the amount of founders represented in *ex situ* seed storage; and D) outplanting to establish new sites only as material becomes available from founders already secured in genetic storage. Threat control will include fence maintenance and weeding in all Management Units. Weed control should done strategically to avoid creating light gaps around existing plants. Particular attention should be paid to not trample the area around the plants. All sites will be monitored at least once a year in the winter to detect seedlings and assess maturation and in the summer to document seasonal decline. Additional monitoring will be necessary to investigate the cause of decline in populations at all sites. Monitoring crews will be directed to pay particular attention to the health of each individual plant and search for clues as to what may be causing otherwise healthy plants to begin to decline. Plants beginning to decline should be searched for damage and document any symptoms of disease. More research is needed on biotic and abiotic variables that may be the cause of this decline and how to avoid and/or overcome it. Assistance from partner agencies (NARS), and expertise in plant health (UH-CTAHR, HDOA, UH-Botany) will be sought on these topics.

As the number of founders available decreases, it will be increasingly important to ensure that the remaining plants survive to produce viable seeds for the next generation. A significant limiting factor to the success of this taxon is that there are few seeds produced per fruit. Obtaining seeds for storage and propagation has been difficult. It is also difficult to decide to remove seeds from the wild sites, only to have poor survival of the resulting outplants. In the short-term, each individual plant is critical to the survival of the taxon and efforts should be made to maintain the health and increase the likelihood that they produce as many seeds as quickly as possible. Methods to provide water to wilting plants and to fertilize outplants will be developed. The genetic storage goals will be met and maintained by collecting and storing mature seeds that are not needed for propagation for living collection. Vegetative propagation techniques will be developed to provide sufficient material to investigate the cause of decline and conduct experimental outplantings. Genetic Storage goals can also be met by holding these clones in the nursery. The long-term strategy for this taxon will be to focus on maintaining the MFS PUs that will serve as the source for propagules and stock to establish the Kaluaa PU and Manuwai PU.

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Sanicula mariversa

- **Scientific name:** *Sanicula mariversa* Nagata & Gon
- **Hawaiian name:** none known
- **Family:** Apiaceae
- **Federal status:** Listed endangered on October 29, 1991
- **Requirements for MIP Stability**
  - 3 populations
  - 100 reproducing individuals in each population
  - –Factors for setting goal as >50 plants: short-lived perennial with infrequent, inconsistent flowering
  - Threats controlled
  - Complete genetic representation in storage

- **Description and biology:**
  - **Habit**- *Sanicula mariversa* is a perennial herb with its leaves, stems, and flowering and fruiting stalks above the ground. The plant has a thick underground storage root.
  - **Leaves**- The basal leaves are three to five-lobed, and measure up to 23 cm (9 in) across.
  - **Flowers & Fruits-**Flowers and fruits are borne in masses on stems up to 0.7 m (27 in) in height. Some of the yellow flowers are perfect (possessing male and female reproductive parts) and others are staminate (possessing only male reproductive parts). The fruits are 4-6 mm (ca. 0.2 in) long, and are covered with hooked bristles.

Modified from: MIT 2003, Wagner et. al. 1990

Sanicula mariversa

- **Description and biology continued:**
  - **Life History-**The leaves and stems of *S. mariversa* die each year, typically in May, leaving the storage root as the only living part of each plant. The plants are dormant through the warm and dry summer months until new growth emerges at the onset of the wet season. The emergence of new leaves usually takes place in October or November. The species flowers from January through May, and their fruits mature in April through July (see the Reproductive Biology Table below for more details). The longevity of individuals of the species is unknown. Since the plant is a small herb, its longevity is presumed to be less than 10 years, and it is therefore a short-lived taxon for the purposes of the Makua Implementation Plan. The age at which wild plants mature is not known. The earliest that plants grown in cultivation have flowered is after four years.
  - **Pollination & Dispersal Biology**-The massed yellow flowers of this species suggest pollination by insects. The fruit's bristles indicate that the fruits are capable of dispersal by birds.

- **Distribution:** *Sanicula mariversa* is endemic to the Waianae Mountains. It was not discovered until the late 1970's when it was found on Ohikilolo Ridge. There is also a sizeable colony in Keaau Valley, on the ridge separating Keaau Valley from Makaha Valley. It has also been reported at Puu Kanehoa, which is south of Kolekole Pass. An immature plant was seen there sometime in the 1970's (Obata pers. comm. 2000), but has not been seen since. The species is also known from two sites along Kamaileunu Ridge; one near the peak of Puu Kawiwi and one further down the ridge.
- **Taxonomic background:** *Sanicula mariversa* is the only *Sanicula* recorded in the Waianae Mountains. It is one of the four species of *Sanicula* occurring in Hawaii, all of which are endemic to Hawaii.
- **Outplanting considerations:** There are no hybridization concerns with respect to the outplanting of *S. mariversa* in the Waianae Mountains since no other species of *Sanicula* occur in the mountain range.

Modified from: MIT 2003, Wagner et. al. 1990.

Sanicula mariversa

- **Habitat:** *Sanicula mariversa* is found at mesic sites, usually on north and west-facing slopes just off the ridge tops. Most of the known plants grow in deep soil. However, the plants at Puu Kawiwi grow in the cracks of a nearly vertical rock face. At the primary site on Ohikilolo Ridge and at the Keaau PU, most *S. mariversa* plants are growing at sites now dominated by non-native grasses. The remnants of the native vegetation at these sites, together with the composition of similar, but more intact locations in the Waianae Mountains, indicate that the native vegetation was originally a mix of native sedges, grasses, herbs, ferns, and shrubs. A good percentage of the ground would have been covered by lichens and mosses (Lau pers. comm. 2000). At the other site on Ohikilolo Ridge, the plants are growing where ohia (*Metrosideros* spp.) shrubland grades into open slopes. This site has a canopy of ohia trees and a understory dominated by palaa (*Odontosoria chinensis*).

- **Threats:** Feral goats seriously threaten *S. mariversa* by denuding the slopes where the plants grow, and by disturbing the substrate, thereby accelerating the process of erosion. Erosion scars grow progressively larger, and in addition to eroding out individual plants, the scars destroy the deep-soiled slopes, which constitute *S. mariversa*'s prime habitat supporting the highest densities of the species. All known occurrences are now protected by fences. The Keaau, Kamaileunu and Puu Kawiwi PU are all surrounded by small population fences, while the Ohikilolo PU is protected within the larger management unit fence. Alien shrubs and trees, and the taller and denser of the alien grasses also constitute serious threats to *S. mariversa*. The short alien grass dominating the sites at Ohikilolo Ridge and Keaau does not seem to be extremely detrimental to the species. Removing the grass may cause more harm than good, unless it can somehow be replaced with native groundcover. Fire is a possible threat to the known sites, but no fires have been known to occur there and may be unlikely due to the mostly sparse, short vegetation.

Modified from: MIT 2003, Wagner et. al. 1990

Original description of *Sanicula mariversa*

Description from Nagata & Gon 1987. *Sanicula mariversa* (Apiaceae), a New Species from 'Ohikilolo Ridge, Wai'anae Mountains, O'ahu in the Hawaiian Archipelago.

Herba decidua, caulibus 40-70 cm altis, la- minis foliorum basalium peltatis cordati-ovatis reniformibusve coriaceus 10-15 cm longis 1/2- 2/3(3/4)-lobatis, umbellis 1-4, pedunculis 5-25 mm longis adscendentibus costatis, cum 7-14 flori- bus masculis et plerumque 3 (vel 1-4) floribus perfectis, floribus masculis in pedicellis 3-5 mm longis, corollis luteis 1 mm longis, fructibus 4- 6 mm longis 3-4 mm latis sessilibus vel sub- sessilibus, calycibus plerumque aculeas exce- dentibus, aculeis 1-1.5 mm longis arcuatis. Chromosomatum numerus n = 8.

Deciduous herb; leaves dying back to ground level during the arid summer months. Stem erect, 40-70 cm tall, branching. Rootstock stout, up to 20 cm deep. Basal leaves with blades pel- tate, cordate-ovate to reniform, coriaceous, dark green, 10-15 cm long, 13-23 cm wide, palmately 3-5 lobed, the lobes cleft 1/2-2/3(3/4), and them- selves variously lobed and serrate with mucronate teeth. Petiole 13-31 cm long. Cauline leaves gradually smaller, less dentate and tend- ing to be lobed nearly to the base, becoming subsessile. Umbels in more or less umbellate, racemose or corymbose clusters of 1-4, the pe- duncles stiff, ascending, strongly ribbed, 5-25 mm long and 0.8-1 mm in diam. Involucral bracts 10-12, oblong-lanceolate, often tinted red, the midrib prominent, 1-3 mm long. Umbels with 7-14 male flowers and 1-4 (generally 3) perfect flowers. Staminate flowers on pedicels 3-5 mm long; calyx connate at base, the lobes 1-1.2 mm long, ovate, acute to shortly acumi- nate, often purplish at apex; corolla yellow, petals nearly orbicular, 1 mm long and wide, mucronate at apex, strongly reflexed. Stamens 5, yellow, divergent, the filaments 2 mm long, slightly inflexed. Perfect flowers with similar calyx and corolla; styles recurved, 2 mm long. Fruit sessile or subsessile, 4-6 mm long, 3-4 mm wide, somewhat flattened, the calyx generally exceeding the prickles. Prickles uncinate, often reddish at apex, the base bulbose; 1-1.5 mm long; dense. n = 8.

Selected Historic Collections of *S. mariversa*

Area	Year	Collector	Pop. Reference Code/Notes
Ohikilolo	1985	Nagata, K.M.	MMR-A
Keaau	1987	Perlman, S.P.	KEA-A
Kamaileunu	1994	Takahama, T.K.	MAK-A
Puu Kawiwi	2000	Perlman, S.P.	MAK-B

The above collections represent all known occurrences of *S. mariversa*. An occurrence was reported near Puu Kanehoa in the 1970's (Obata pers. comm. 2000), but no collections were made. No other sites been discovered since 2000 and all these sites are protected with MIP management actions.

Data compiled from Bishop Museum & National Tropical Botanical Garden PTBG Herbarium Records.

Map removed to protect rare resources, available upon request

Population Units

Manage For Stability Population Units	Population Unit Type	Which Action Area is the PU inside?	Management Units for Threat Control
Ohikilolo	*in situ* & augmentation¥	MMR	Ohikilolo
Keaau	*in situ* & augmentation*	MMR	Keaau & Makaha
Kamaileunu	*in situ*	None	Kamaileunu I
Genetic Storage Population Units			
Puu Kawiwi	*in situ*	None	Kamaileunu II

¥The Ohikilolo augmentation will be conducted in early 2015.
*This outplanting has not yet been planned. It will likely occur within the Ohikilolo Management Unit.

Habitat Characteristics for all *in situ* Sites

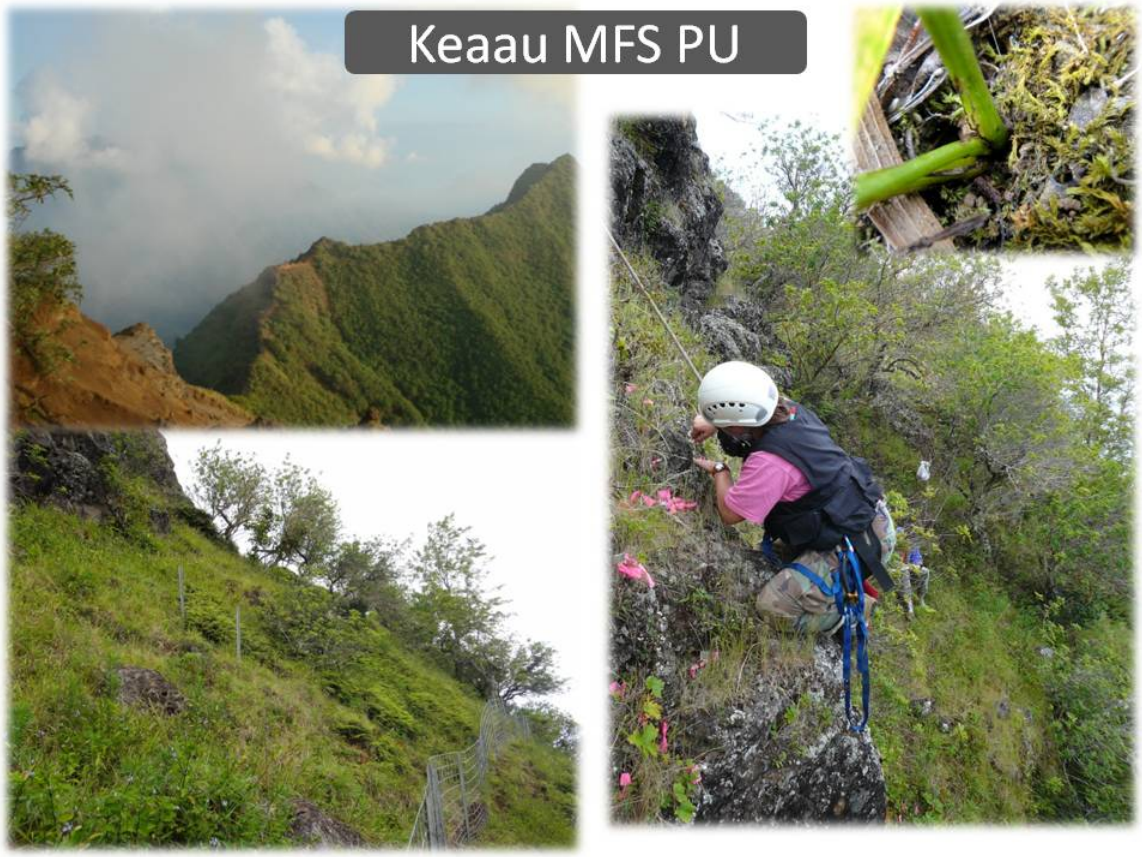
PU	*In Situ* PRC	Elev. (m)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Ohikilolo	MMR-A MMR-B*	827	Steep – Vertical	Open	Upper slope – Ridge crest	North	1329
Keaau	KEA-A	831		Open		Northwest	1462
Kamaileunu	MAK-A	846		Open - Intermediate		Northwest	1052
Puu Kawiwi	MAK-B	823		Open		West	1582

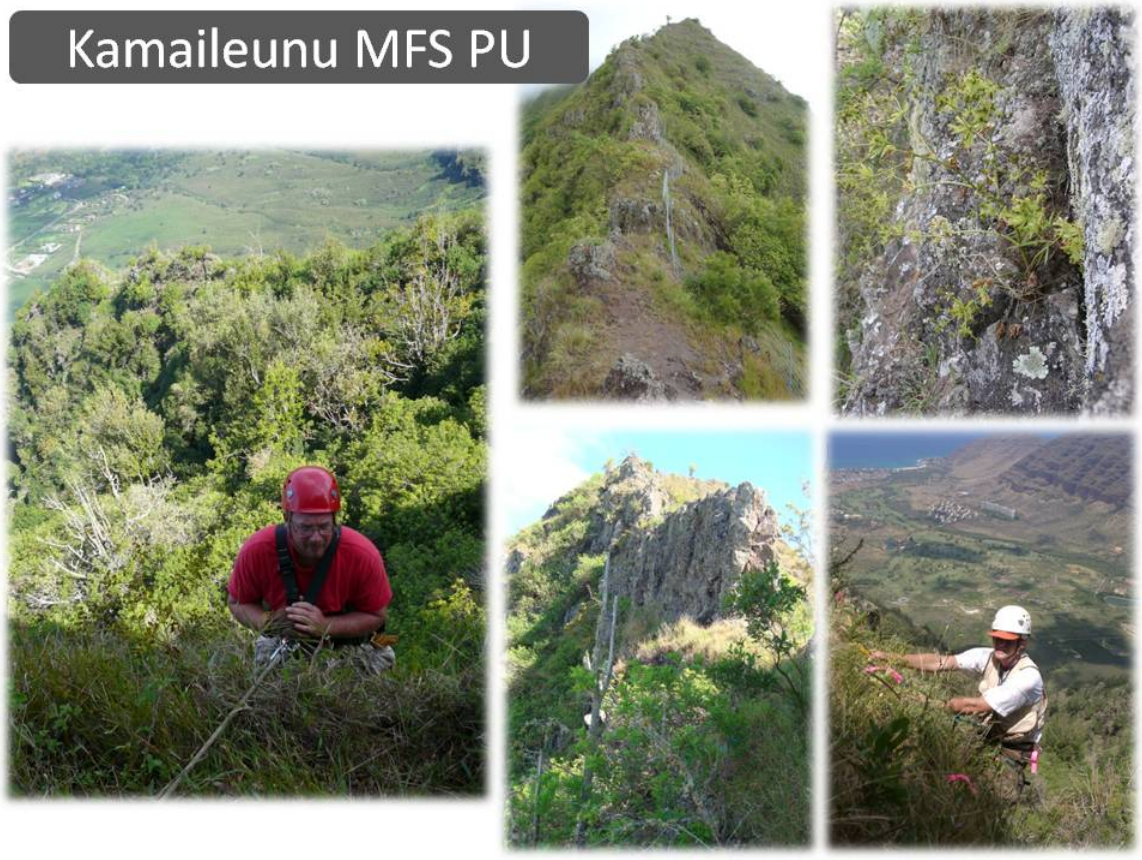
Information was compiled from OANRP observation forms & GIS data; Rainfall data complied from Rainfall Atlas of HI (Giambelluca et. al. 2013). PRC = Population Reference Code. * Data is for MMR-A only.

Associated species

PU	PRC	Canopy	Understory
Ohikilolo	MMR-A MMR-B	DodVis, MetPol, MetTre, MyrLes, Grerob, Schter	Ageade, Agerip, Anaarv, Andvir, Bleapp, Cenery, CupCar, Erikar, Gampur, Kalpin, Kylbre, Lancam, Melmin, Melrep, Pitaus, Schter, Setpar, Spoind, Stadic, Vulbro, Bidtor, Carmey, Carwah, Cocorb, Dodvis, Dordec, Eragra, Luzhaw, Metpol, Mettre, OdoChi, Pitgla, Pteaqu, Sphchi, Tetfil
Keaau	KEA-A	Metpol, Pitcon, Aracol, Grerob, Schter, SyzCum	Ageade, Agerip, Axofis, Bleapp, Cenasi, Conbon, Cracre, Cupcar, Ehrsti, Emifos, Emison, Erikar, Gampur, Kalpin, Lancam, Lintri, Melmin, Pascon, Polpan, Setpar, Stadic, Trisem, Verlit, Vulbro, Carmey, Carwah, Dodvis, Dordec, Micstr, Odochi, Plepar, Psinud, Pteaqu
Kamaileunu	MAK-A	Grerob, SchTer	Ageade, AgeRip, Lancam, Melmin, Melrep, Opufic, Sonole, Spoind, Bidtor, Dodvis, Dordec, Plepar, Spehaw
Puu Kawiwi	MAK-B	DodVis, SopChr, AcaCon, GreRob, Schter	Ageade, Agerip, Conbon, Erikar, Kalpin, Lancam, Melmin, Melrep, Opucoc, Opufic, Salcoc, Schter, Sonole, Spoind, Verlit, Trisem, Verlit, Artaus, Bidtor, Carmey, Carwah, Cheoah, Dodvis, Dordec, Eragra, Eravar, Eupcel, Eupmul, Leptam, Luzhaw, Melten, Metpol, Ostant, Peptet, Plepar, Schman, Schmen, Sidfal

Species are listed in alphabetical order as observed by OANRP; introduced taxa are underlined followed by native taxa (not underlined)


Keaau MFS PU


Kamaileunu MFS PU

Population Structure and Trends

- It has been difficult to monitor populations of *S. mariversa* for stability due to terrain, habitat and the taxon's life cycle. Plants are on xeric-mesic cliffs that often require rappelling to access plants. During the drier half of the year (May-November), plants lose leaves and persist as dormant tubers in the ground and it is uncertain if every tuber exits dormancy every winter, or can skip several years. One tuber that did not re-sprout by the following spring was dug up and discovered to be dead. This makes navigating the terrain for close monitoring extremely difficult if tuber location is unknown. Because of this, the accuracy of estimates of the numbers of immature and seedlings at each site varies greatly. Mature plants are easy to detect but counts of mature plants alone are insufficient to determine population stability.

- Thorough censuses were conducted in 2007 at the Ohikilolo, Keaau, and Kamaileunu PU. This required a significant effort and rappelling to cover the entire expanse of the sites. Hundreds of seedlings and small immatures were observed, much more than in any other year. Many immature plants were tagged and in the years since, several of the immature plants have matured. The difficultly, however, in determining which plant the tags referred to, as well as the impact to the plants and possible dormant tubers, made the thorough monitoring and tagging of immature plants impossible to continue.

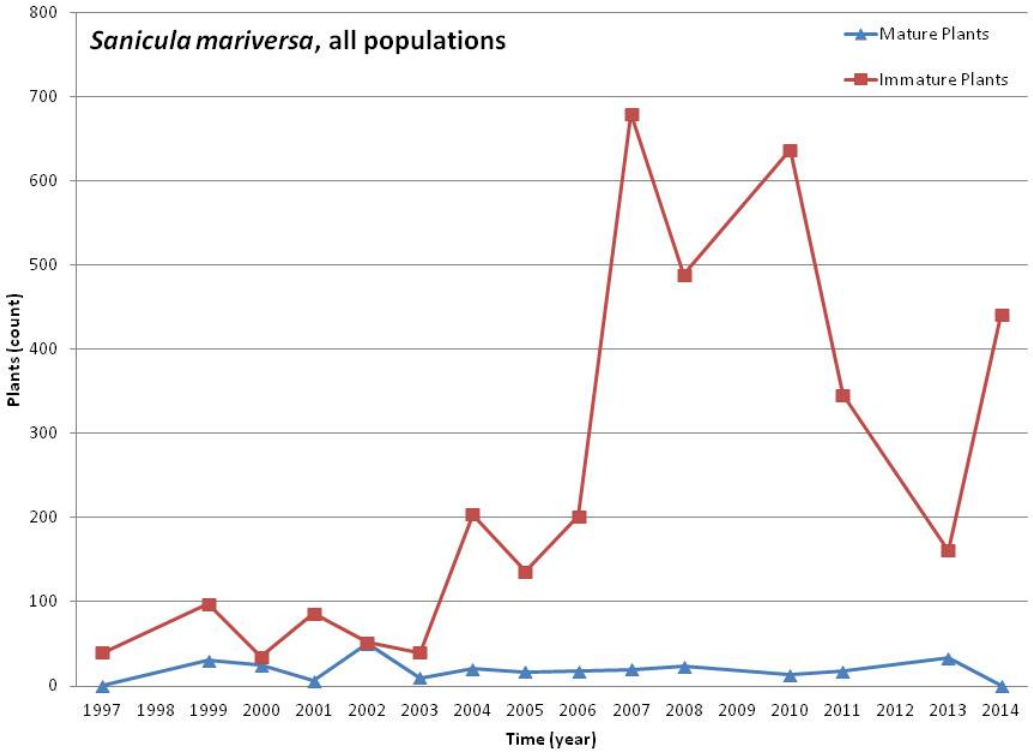
- Since OANRP monitoring started in 1997, the fewest mature plants ever observed was in 2014, prompting further concern over the stability of the populations. Increased effort will be dedicated to monitor populations in the coming years. While this is likely to increase the total number of immature plants observed at each site the number of mature plants is unlikely to increase due to monitoring alone since flowering plants are usually easy to detect. As of 2014, with the possible exception of the Kamaileunu PU, the number of mature plants appears to be declining.

Population Structure and Trends

- *S. mariversa* seeds likely have complex morphophysiological dormancy, complicating our understanding of seed bank persistence of this species, though it is assumed to form a long-term, persistent seed bank. A seed sow study conducted in August 2008 at the Kamaileunu PU included 8 plots of 30 seeds each (pooled from several plants) and saw 70% germination after 5 months (seeds from this PU germinate twice as fast as seeds from any other PU in the laboratory). Over the next year, almost half of the seedlings persisted as small immature plants and 1 new seedling was observed. After two years, 8% of the seedlings persisted as immature plants. The plots have not been monitored since, so it is unknown how many persisted and matured. The data suggest that the majority of seeds that enter into the soil seed bank each year at/from the Kamaileunu PU do not persist in the soil over one year. Without knowing the fate of the remaining 8 seeds, we cannot determine whether the seed bank at this PU is persistent or not (we do not know if the 8 seeds died, germinated after two years, or are still alive in the ground). Depending on the number of mature plants and seeds available over the next several years, OANRP will conduct this seed sow study at Ohikilolo or Keaau, and possibly repeat it at Kamaileunu, to compare results among populations with plants that have seeds with varying germination rates. Variation in germination rates and levels/degrees of dormancy have been documented in dozens of species, particularly when populations occur at different elevations, or have differing temperatures, habitats, and soil salinity, moisture, and nutrients (Baskin and Baskin 2014). To determine soil seed bank persistence, a buried seed bag study should be conducted, and OANRP does not currently have plans to conduct these trials (but could in the future).

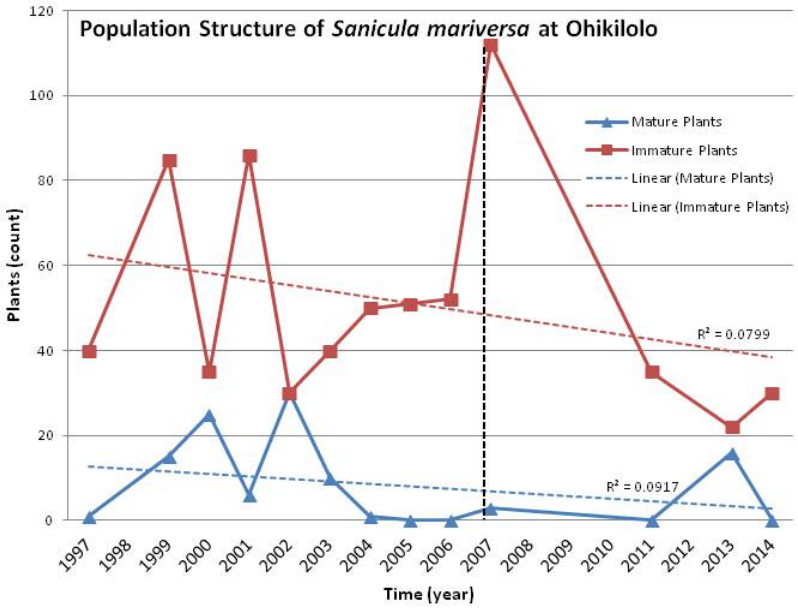
- Population trends for all populations (Figure 1) and for each of the three MFS PUs (Figure 2-4) are displayed below.

Population Structure and Trend Fig. 1



Population Structure and Trend: Ohikilolo Figure 2

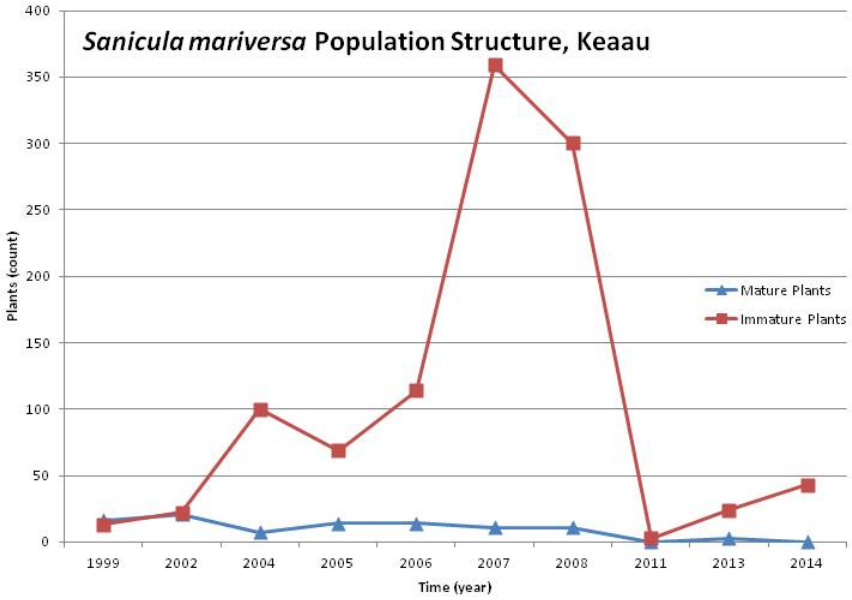
Population Monitoring History showing the number of plants (mature/immature/seedlings)										
	1997	2000	2002	2003	2004	2006	2007	2011	2013	2014
Ohikilolo (MMR-A,B)	1/40/0	25/35/20	30/30/30	10/40/0	1/50/0	0/52/0	3/112/0	0/35/0	16/22/0	0/30/200



Observation data from the MMR-A site in the Ohikilolo PU show the status since 1997. Intense monitoring was completed once in 2007 as indicated by a dashed line in the graph to the left.

Population Structure and Trend: Keaau Figure 3

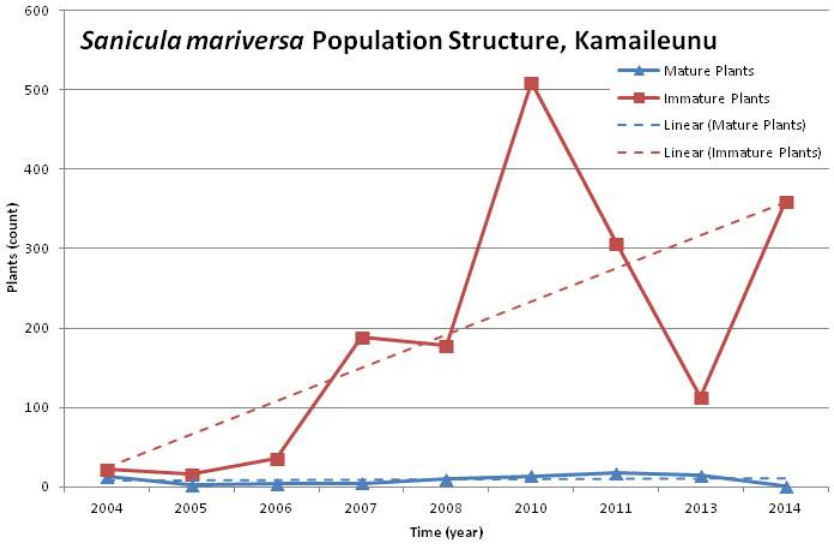
Population Monitoring History showing the number of plants mature/immature/seedlings										
	1999	2002	2004	2005	2006	2007	2008	2011	2013	2014
Keaau (KEA-A)	16/13/0	21/22/5	7/100/0	14/69/0	14/114/0	11/359/5	11/300/40	0/3/0	3/24/0	0/43/0



Observation data from the KEA-A site in the Keaau PU show the status since 1999. Intense monitoring was completed twice in 2007-2008 as indicated by a dashed line in the graph to the left.

Population Structure and Trend: Kamaileunu Figure 4

Population Monitoring History showing the number of plants mature/immature/seedlings										
	1999	2002	2004	2005	2006	2007	2008	2011	2013	2014
Kamaileunu (MAK-A)	16/13/0	21/22/5	7/100/0	14/69/0	14/114/0	11/359/5	11/300/40	0/3/0	3/24/0	0/43/0
Kawiwi (MAK-B)			0/32/4			1/21/1	2/11/0	0/1/0	0/1/0	0/8/0



Observation data from the MAK-A site in the Kamaileunu PU show the status since 2004. This is the only PU that shows a gradual increase in immature plants.

Monitoring Plan

- All *in situ* sites in MFS PU will be monitored annually using the Hawaii Rare Plant Restoration Group (HRPRG) Rare Plant Monitoring Form (RPMF) to record all new mature plants. As shown in the population structure data above, increased effort in 2007-2008 resulted in documentation of the most plants to date at those sites. This, however, is considered to be potentially damaging to the site and small plants. The benefits of determining the actual population size must be balanced with the threat to the health and safety of plants from more intensive monitoring and/or tagging. In the coming years, OANRP will conduct more thorough population census monitoring every three years and delineate an accessible portion of the site to monitor thoroughly, counting every individual every year. No plants will be tagged.

- The Puu Kawiwi site will be monitored annually during the expected flowering season to look for mature plants. If mature plants are observed, another collection trip will be planned to secure mature fruit.

- The reintroduction sites will be monitored annually using the HRPRG RPMF to record population structure, age class, reproductive status and vigor. All outplants will be accounted for along with a total population census including any F1 seedlings and immature plants. This data will be used to guide future outplanting. Any seed sowing trials will also be monitored at least annually.

Reproductive Biology Table

	Observed Phenology[1]			Reproductive Biology		Seeds		
Population Unit (PU)	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Suspected Disperser	Average # Per Fruit	Dormancy
Ohikilolo	Jan-Mar	Mar-May	May-July	Hermaphroditic, Monocarpic	insect[2]	bird	2	MPD[3,4]
Keaau	Feb[1]	Apr-June	Apr-June					
Kamaileunu	[1]	June[1]	May-July					
Puu Kawiwi	[1]	Mar-June	May-July					

[1]Some sites have not been visited, or have been visited very infrequently, outside of the fruiting months of May through July.

[2]Insects have been observed visiting flowers at some PU. Insects that have been identified at the Kamaileunu PU are introduced syphid flies (*Allograpta obliqua* and *Toxomerus marginatus*) and an endemic butterfly, *Udara blackburnii.*

[3]At least 4 other species of *Sanicula* from Eastern North America and Europe have seeds with varying levels (deep vs. non-deep complex) of morphophysiological dormancy (MPD). *S. mariversa* at least has physiological dormancy (delay in germination) and morphological dormancy can be determined if embryos grow during the time between harvest and germination.

[4]It is important to note a major difference in the germination rate of the seeds from plants in the Kamaileunu PU in comparison to all other sites. These seeds germinate twice as fast as the other sites (see Genetic Storage slide for additional information).


immature fruit
flowers
mature fruit
seedlings


Mature
Flowering
Plant


Leaves


Base of a Mature Plant at Ohikilolo

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.
seeds	*in situ* populations	seed bank (-18°C, 20%RH)	5-10 years	Yes	new founders from wild populations, seeds from reintroductions

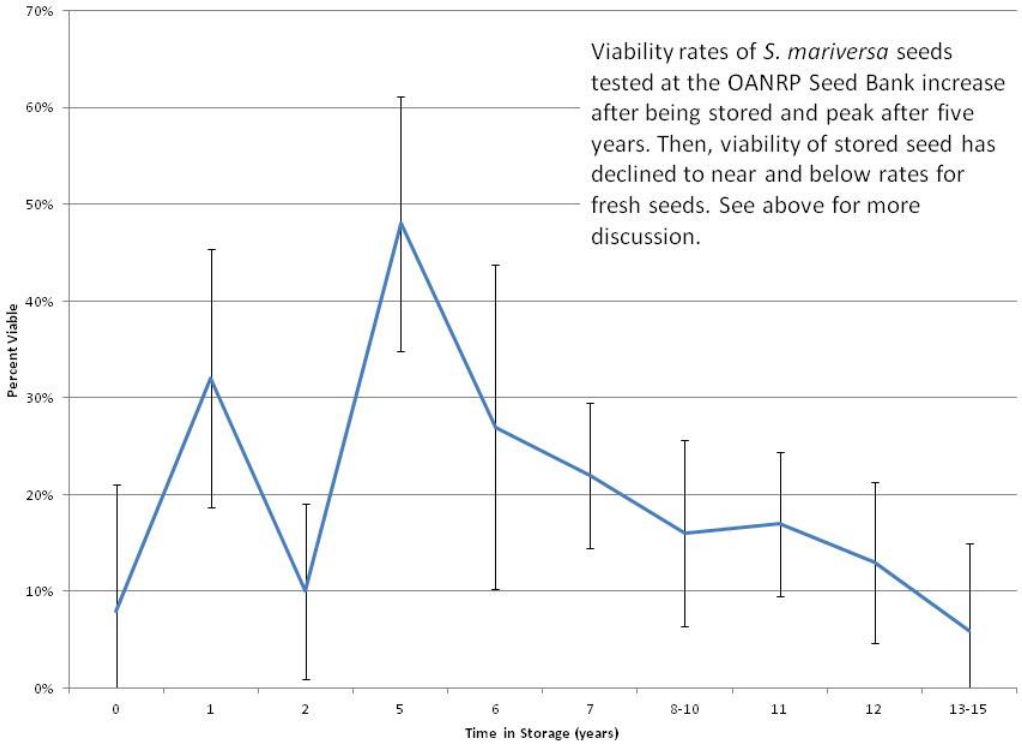
- Seeds of *S. mariversa* have shown a decline in viability under conventional seed banking methods, and the re-collection interval has been set at 5-10 years (year to be determined specifically for each PU). Viability of fresh seeds was assessed primarily from collections between 1999-2002, and was estimated at 8%. Viability of collections stored for ten years or longer is estimated at 14%. Maximum germination (34%), however, is achieved after six years in storage, followed by a slow decline in viability (Figure 5).

- Assessing initial viability is complicated by our previous lack of understanding of the methods to overcome dormancy. Fresh seeds germinate in 280 ± 126 days, and initial tests often concluded prior to seeds overcoming dormancy. Peak germination at 5-6 years after storage has similar germination rates (285 ± 81 days) and collections over ten years in storage take 233 ± 99 days to complete germination. This suggests that seeds are still dormant even after this time in storage; likely an indication of morphological dormancy (the embryo started to grow upon imbibing after storage). Seeds from plants in the Kamaileunu PU only take 127 ± 33 days to finish germinating, while all others take 275 ± 174 days. This indicates a difference in the level/degree of dormancy of seeds from Kamaileunu in comparison to all other PU and could suggest other physiological or phenotypic differences at this PU.

- Once outplants are established, they will also be the source for making seed collections.

- Complicated by dormancy, it has been difficult to assess the storage potential of seeds of this species. Initial viability assays with low germination were originally thought to be an effect of dormancy, but continued low viability of frozen seeds after five years of storage indicate a break in dormancy has not yet occurred. Rather, a negative trend in viability suggests that these seeds may be short-lived or sensitive to freezing. Further studies will allow us to investigate the variation in viability due to dormancy and aging.

Viability of Stored Seeds of *S. mariversa* Figure 5



error bars = ± 1SE

Reintroduction Plan

Manage for Stability Population Units	Reintroduction Site(s)	Number of Plants	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population	Plant Size	Pot Size
Ohikilolo	MMR-F ¥	212	seedlings	MMR-A	60	5-15cm	4" pot
Keaau	KEA-B *	~200	seedlings	KEA-A	~65	5-15cm	4" pot
Kamaileunu	none planned +						

¥Outplanting to be initiated in January 2015. The plants will be planted into clearly marked areas where individuals can be associated with their tags. Accurate maps and GIS data and access trails will be developed through the site to prevent trampling of dormant tubers. Plants will be planted at low densities as well to avoid trampling.

*Reintroduction not started yet. Seeds will be sown in 2015-2016 for a 2017 outplanting. OANRP will look for sites within the Ohikilolo MU as there is not enough space in the existing Keaau PU fence for a large augmentation. If there are enough seeds available (not needed for Genetic Storage requirements), we will move seeds within the Keaau PU fence to maximize suitable habitat.

+None planned within the next five years.

Previous attempts to seed sow and outplant with this species in the Ohikilolo MU were largely unsuccessful, but have helped to guide the current strategy. In 1999, hundreds of seeds were collected from the Ohikilolo wild site. This was the largest fruiting event since annual observations began in 1996. A total of 299 seeds were moved to an adjacent site near the wild plants and sown onto similar substrate into 22 plots. In follow-up monitoring of the site over the years, no plants were observed. Using more of the same seed collections, in 2001, small immature plants were grown at the OANRP nursery and planted in marginal habitat in an exposed, recovering landslide area. 30 outplants were installed into this exposed area in the Ohikilolo forest patch fence up the ridge from the wild site. Twenty-two small plants re-emerged during the next winter and 19 were observed in 2003, but none were seen in 2004 or since then. Future attempts will favor using outplants over seed sowing to maximize the chances of getting at least immature plants established. The outplants will be grown for a longer time, through the first summer dormancy, so they will be larger and more likely to survive transplanting. Also, more appropriate sites with intact substrate will be selected and prepared. However, when mature seed is available at the Keaau, Ohikilolo and Kamaileunu sites, seed sowing trials similar to those conducted previously will be repeated. If effective, these trials will provide information on the germination and establishment rates for plants and begin to test new areas to expand populations with outplanting.

Stabilization Goals Update

Population Unit	Population Unit Stability Target		Management Unit Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does population structure support long-term population stability?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are Genetic Storage goals met?
Ohikilolo	No	No	Yes	Partial	No	Partial	No	No	Partial
Keaau	No	No	Yes	Yes	No	No	No	No	No
Kamaileunu	No	No	Yes	No	No	No	No	No	Yes
Puu Kawiwi	No	No	Yes	No	No	No	No	No	No

5 Year Action Plan

	Proposed Actions for the following years:				
Manage for Stability Population Units	MIP YEAR 10 October 2014 – September 2015	MIP YEAR 11 October 2015 – September 2016	MIP YEAR 12 October 2016 – September 2017	MIP YEAR 13 October 1 2017- September 2018	MIP YEAR 14 October 1 2018- September 2019
Ohikilolo	•Monitor •Collect fruit •Begin & complete outplanting	•Monitor •Collect fruit	•Monitor •Collect fruit	•Monitor •Collect fruit •Determine if more outplanting is needed	•Monitor •Collect fruit
Keaau	•Monitor •Collect fruit	•Monitor •Collect fruit	•Monitor •Collect fruit	•Monitor •Begin outplanting	•Monitor
Kamaileunu	•Monitor •collect fruit	•Monitor •collect fruit	•Monitor •Collect fruit	•Monitor •Determine if outplanting is needed	•Monitor •Begin outplanting •Collect fruit
Genetic Storage Population Units					
Puu Kawiwi	•Monitor •Collect mature fruit	•Monitor •Collect mature fruit	•Monitor •Collect mature fruit	•Monitor •Collect mature fruit	•Monitor •Collect mature fruit

Due to the short re-collection interval and low number of mature plants each year, OANRP will try to collect fruit every year to reach and maintain Genetic Storage requirements.

Management Discussion for *S. mariversa*

The primary efforts for stabilization of *S. mariversa* include A) *in situ* habitat health and threat protection; B) monitoring of mature plants at *in situ* populations; C) maintaining the amount of founders represented in *ex situ* seed storage; and D) outplanting where needed to establish new sites. Threat control will including fence maintenance and weeding. Weed control should be expanded to include peripheral areas as more habitat may be needed to meet stabilization goals. Canopy-forming alien trees and grasses (*Melinus minutiflora*, *M. repens*) should be removed. Since OANRP monitoring started in 1997, the fewest mature plants ever observed was in 2014, prompting further concern over the stability of the populations. Increased effort will be dedicated to monitor populations in the coming years. While this is likely to increase the total number of immature plants observed at each site, the number of mature plants is unlikely to increase due to monitoring alone, since flowering plants are usually easy to detect. As of 2014, with the possible exception of the Kamaileunu PU, the number of mature plants appears to be declining.

Stabilization goals require maintaining 100 reproducing plants at each PU. The largest amount of reproducing plants ever recorded in a single year was a combined 51 mature plants at the Ohikilolo and Keaau PUs in 2002. The total number of mature plants ever observed at any PU is far below the stability goal and given the population structure data above is unlikely to ever meet that goal in any year. For each MFS PU to *maintain* the goal of having 100 mature plants the size of the habitat must significantly increase. Each of the current sites is a discrete, relatively small (<1500ft^2) section of steep to vertical cliff with rocky ledges. Erosion and landslides occur often in this habitat and there is a risk of losing an entire site. Establishing new sites by outplanting and moving seeds may be important for the long-term persistence of this species. If census monitoring data indicate that the populations are stable, then the requirement of 100 mature plants annually may be an excessive goal to achieve stability. If the populations are increasing or stable, OANRP may recommend a modification of the stability targets, especially in the required number and frequency of reproducing plants. Even with a reduction in the number and/or the requirement to meet it annually, significant effort will be required to increase the number of mature plants every year. Site stability (*i.e.* no significant decrease in the amount of immature and mature plants) may be a more important stability goal to achieve in comparison to the minimum number of reproducing plants. If seeds can only be stored in the seed bank for less than ten years, new founders must be collected from yearly to maintain genetic storage goals of 50 plants per PU. Collections should continue at all sites annually. Outplanting will begin this year at the Ohikilolo PU and will be an experimental effort to develop propagation, cultivation, site selection and planting methodology. Lessons learned in this effort will be adapted for additional outplanting as needed at other PUs to establish new sites.

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Tetramolopium filiforme

- **Scientific name:** *Tetramolopium filiforme* (Sherff) var. *filiforme* and
  T. filiforme (Sherff) var. *polyphyllum* (Sherff) Lowrey
- **Hawaiian name:** None known
- **Family:** Asteraceae (Sunflower family)
- **Federal status:** Listed Endangered October 29, 1991
- **Requirements for MIP Stability**
  - 4 Population Units (PU) (both varieties are represented in management units; found in both MMR and SBWR AA)
  - 50 reproducing individuals in each population (short-lived perennial)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology:**
  - **Habit**- *Tetramolopium filiforme* is a dwarf shrub 5-15 cm (2-6 in) tall, and is often mounded in shape. The narrow leaves are clustered at the branch tips, and measure 1-2 cm (0.4-0.8 in) long.
  - **Leaves**- Leaves are narrow (.4-1.2mm wide) and are clustered at the branch tips, and measure 10-20mm long.
  - **Flowers-**The flower heads are purplish-white, and are held up above the foliage on long slender stalks. The ray florets are female, and their rays are white to pale lavender. The disk florets are functionally male, and are colored maroon or rarely yellow. Flowering usually occurs in the late winter and spring (Lowrey 1986). The plants are capable of self-pollination (Lowrey 1986). *T. filiforme* is likely insect-pollinated, as are most conspicuous-flowered species in the sunflower family.

Modified from: Makua Implementation Plan, 2003. Oahu Army Natural Resource Program

Tetramolopium filiforme

- **Description and biology continued:**
  - **Fruit-** The achenes (a type of dry, seed-like fruit) measure 2-2.7 mm (*ca.* 0.1 in) long, bear sparse, short glandular hairs or are hairless, and are tipped with bristles almost as long as the achenes. *Tetramolopium filiforme* is presumed to be wind-dispersed, as bristle-bearing achenes are characteristic of the wind-dispersed members of the sunflower family. The species may additionally be bird-dispersed, as the bristles can cause the achenes to stick to birds' feathers (Lowrey 1995). Another characteristic of *Tetramolopium* achenes indicating dispersal by birds are sticky glandular hairs on the achenes, which would contribute to their adherence to feathers. With *T. filiforme*, however, this feature is either not well developed, or completely absent (Lowrey 1986).
  - **Seeds**- 1-2mm long by .45mm wide (measured in OANRP Seed Conservation Lab)

- **Distribution:** *Tetramolopium filiforme* is endemic to the Northern Waianae Mountains. It is abundant on Ohikilolo Ridge on the Makua Military Reservation, and also found in small outlying populations, which are located from Kahanahaiki in the North to Kamaileunu Ridge, Puu Kalena, and Puhawai to the south. The plants occurring beyond Ohikilolo Ridge are predominantly var. *filiforme*, except for the population at Puu Kalena, which has been identified as var. *polyphyllum*. Both varieties occur on Ohikilolo Ridge. Variety *polyphyllum* is found only at the higher and slightly wetter portion of Ohikilolo Ridge, while the plants on the low, dry, seaward end of the ridge are all morphologically typical var. *filiforme*. Both varieties appear to coexist in between the two extreme habitats. Furthermore, while the majority of the plants show var. *polyphyllum* traits to some degree at the highest portion on the ridge, it appears that nowhere along the ridge do all the plants represent var. *polyphyllum*.
  - The species ranges from 340-900 m (1,100-3,120 ft) in elevation. The low elevation plants of the species, as well as the plants at Puhawai, are of var. *filiforme* morphology, while the highest elevation plants at Puu Kalena (3,163 ft) and the majority of the Ohikilolo mauka (3,052 ft) populations are var. *polyphyllum*.
  - In 2012 a new population identified as *Tetramolopium lepidotum* subsp. *lepidotum* was discovered near Puu Kumakalii, just over 220m from the wild Puhawai population, and 260m from the augmentation site. In the MIP, outplanting sites were directed away from populations of *T. lepidotum* subsp. *lepidotum* to avoid mixing. This new site however, is in between wild and outplanted populations of *T. filiforme*.

Modified from: Makua Implementation Plan, 2003. Oahu Army Natural Resource Program

Tetramolopium filiforme

- **Population trends:** Feral goats had brought the number of plants on Ohikilolo Ridge down significantly between 1980 and 2000. In the 1970s, there were many plants growing along the crest of the ridge (Obata pers. comm. 2000). Due to the subsequent increase in the number of goats on the ridge in the 1980s and 1990s, the species declined in abundance on the accessible portions of the ridge top and was listed as Endangered in 1991. That the species has not declined more steeply than it has, and still numbers in the thousands, is due to the large number of plants found on cliff faces inaccessible to goats (see pictures below). The fence along the ridge separating Makua and Koiahi gulches from Ohikilolo and Keaau gulches was completed in 2000 and the last goats were removed from Makua in 2003. Within the fence, where goats are now excluded, plants are returning to the ridge top.

- **Habitat:** At the seaward extreme of the Ohikilolo population unit, *Tetramolopium filiforme* is growing in an open dryland habitat. The higher, more inland plants are in dry-mesic to mesic habitats. In general, the species grows on exposed rocky ridges and on sparsely vegetated, nearly vertical cliffs, and are often rooted in cracks in the rock.

- **Taxonomic background:** The genus *Tetramolopium* is divided into three sections: section *Alpinum*, section *Tetramolopium*, and section *Sandwicense*. Although *T. filiforme* is best placed in the section *Tetramolopium*, the species also possesses characteristics that are otherwise unique to the section *Sandwicense*. This combination of characteristics of two sections of the genus in *T. filiforme* is hypothesized to be the result of a hybridization event in the distant past between two different species of *Tetramolopium*. One parental species is thought to be an undetermined member of the section *Tetramolopium*. The other parental species is thought to be *T. lepidotum*, which is a member of the section *Sandwicense*, and is the only member of the genus recorded from the Waianae Mountains besides *T. filiforme* (Lowrey 1986, Okada *et al.*1997). This hypothesis is supported by the results of molecular genetic analysis (Okada *et al.*1997).

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Tetramolopium filiforme

  - **Taxonomic background continued:** The two varieties of *T. filiforme* are differentiated primarily by their leaf characteristics, particularly the leaf shape and the presence or absence of teeth along the leaf margin. Variety *filiforme* has extremely narrow, linear leaves with no teeth along the leaf margins, whereas variety *polyphyllum* has leaves that widen towards the leaf apex, and its leaf margins bear prominent teeth.
  - It had been thought that the two varieties on Ohikilolo Ridge are distinct, and geographically separated (Lowrey 1986), however it has been observed that the two morphological types are not clearly separated geographically (Lau pers. comm. 2000). In any given subpopulation along the higher portion of the ridge, plants are found that fit the description of one of the two varieties, as well as plants with characteristics intermediate between the two varieties. The taxonomy of *T. filiforme* on Ohikilolo Ridge and throughout the Waianae Mountains needs to be clarified through further study.
- **Threats:** Feral goats threaten *T. filiforme*, although many of the plants grow on steep cliffs where the animals cannot reach them. To a certain extant, pigs degrade the habitat around the cliffs, but are unable to directly access the plants. Ungulates degrade the plants' habitat by hastening the spread of invasive weeds. They also disturb substrates above the cliffs, thereby increasing the size and frequency of landslides and rock falls on the cliff faces. These disturbances can directly affect plants growing in areas inaccessible to ungulates. The PUs in Makua and Schofield are protected within fences.
  - Alien plants threaten *T. filiforme* by altering the species' habitat and competing with it for moisture, nutrients, and growing space. Also, the spread of highly flammable alien grasses increases the incidence and destructiveness of wildfires. *Tetramolopium filiforme* is one of the Makua target taxa most threatened by fire. Over the last two decades fires have burned into the lower reaches of the Ohikilolo Ridge population unit, and have almost reached the Kahanahaiki colony.
  - Infestations of at least two species of non-native scale insects have been observed on *T. filiforme* (Lau pers. comm. 2000). Elsewhere in the Waianae Mountains, scale insects have been observed on *T. lepidotum* being tended by ants. When tended by ants, scale infestations can become very serious. No evidence of scale insects being tended by ants have yet been reported on *T. filiforme* plants, but *T. filiforme* populations should be monitored for it.

Modified from: Makua Implementation Plan, 2003. Oahu Army Natural Resource Program

Tetramolopium filiforme

- **Outplanting considerations:** The Hawaiian *Tetramolopium* species are all highly interfertile with one another. In greenhouse experiments, all of the Hawaiian species, except the two not available at the time, were crossed in all combinations. These produced first, second, and third generation hybrid progeny (Lowrey 1986). In the wild, the various Hawaiian species appear to be maintained as separate entities through either geographical or ecological separation.

  As mentioned above, the other species of *Tetramolopium* recorded from the Waianae Mountains is *T. lepidotum*. It has been recorded from most parts of the mountain range not occupied by *T. filiforme*. Its habitat requirements are similar to *T. filiforme*'s. Its numbers have always been much lower than *T. filiforme*'s numbers. Its four currently known populations contain a total of fewer than 200 plants. The species has been documented at locations not far removed from *T. filiforme*'s range. A specimen was collected at the head of Makua Valley near the valley rim in 1932, not very far from *T. filiforme* locations on Ohikilolo Ridge; and a small colony is known on the eastern side of Waianae Kai, not far from the Waianae Kai *T. filiforme* site. As mentioned previously, a population of *T. lepidotum* were found in between the wild and augmentation sites at Puhawai. Future outplantings of *T. filiforme* in Lihue (Kalena PU, Puhawai PU) should be conducted well away from the small wild population of *T. lepidotum*. Sites need to be determined for these outplantings.

Modified from: Makua Implementation Plan, 2003. Oahu Army Natural Resource Program

Selected Historic Collections of *T. filiforme*

Area	Year	Collector	Pop. Reference Code/Notes
Waianae Mts., Makaha Pacific Ocean Main Hawaiian Islands Oahu USA	18??	Hillebrand, W.B	Unknown
Waianae Mts., Ohikilolo ridge	1975	Herbst, D.R. J.Obata 5333	Unknown MMR-A
Ohikilolo ridge, S Makua Valley, cone on N slope	1978	Lowrey, T.K. J.Obata 420	
Makua-Keaau ridge	1986	Lau, J	KEA-A
Keeau Valley, 1st ridge S of Ohikilolo ridge	1987	Perlman, S. J.Obata	KEA-A
Ohikilolo Ridge. Largest population on Makua Valley side of ridge, north facing	1987	Perlman, S. J.Obata	Unknown
Ohikilolo ridge, on Makua Valley side of ridge trail	1987	Perlman, S. J.Obata	Unknown

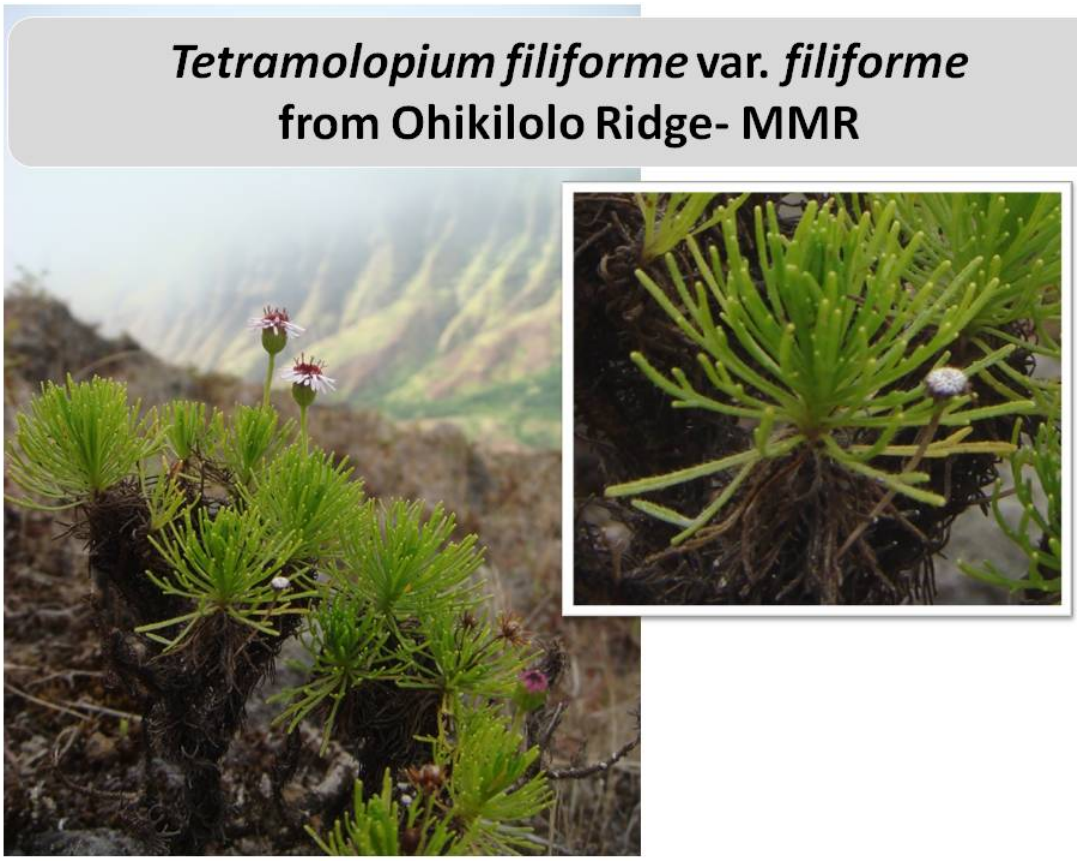
Joel Lau, botanist

John Obata at Ohikilolo Ridge

Map removed to protect rare resources, available upon request

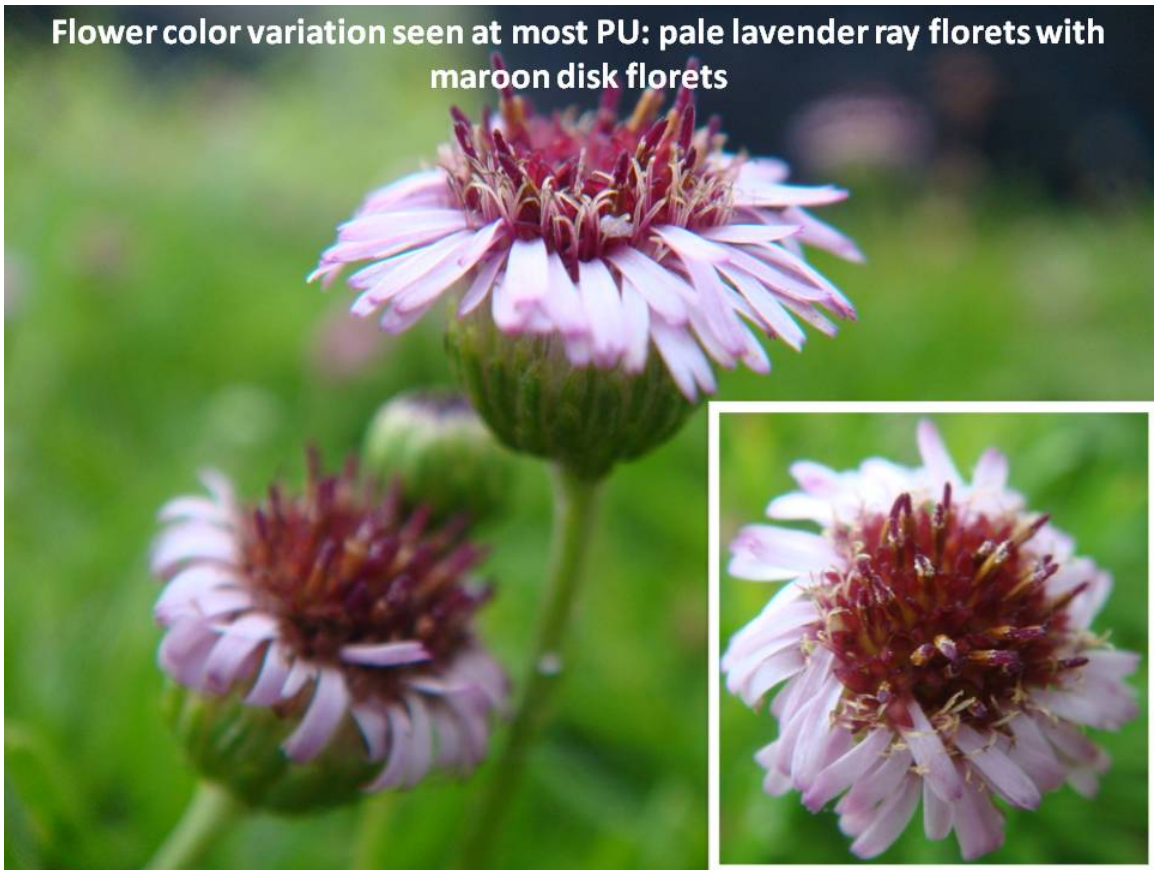
Tetramolopium filiforme var. ***filiforme*** at Puu Ohikilolo

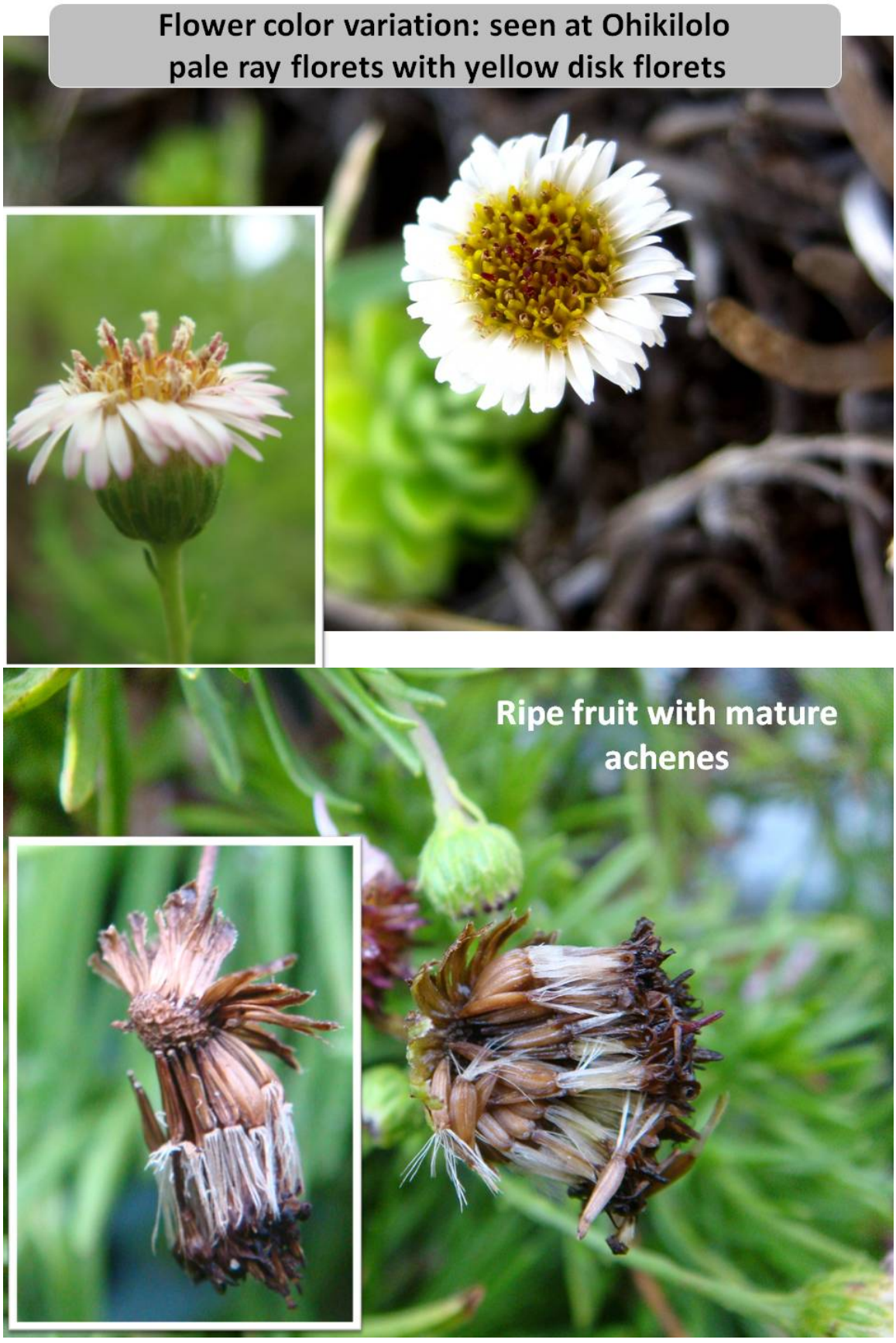
***Tetramolopium filiforme* var. *filiforme* from Ohikilolo Ridge- MMR**



***Tetramolopium filiforme* var. *polyphyllum* at Ohikilolo Ridge**

Map removed to protect rare resources




Flower color variation: seen at Ohikilolo
pale ray florets with yellow disk florets
Ripe fruit with mature
achenes

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Kalena	*in situ* and augmentation	SBW	Lihue
Ohikilolo	*in situ*	MMR	Ohikilolo
Puhawai	*in situ* and augmentation	SBW	Lihue
Waianae Kai	*in situ*	None	Waianae Kai

Genetic Storage Population Units			
Kahanahaiki	*in situ*	MMR	None
Keaau	*in situ*	MMR	None
Makaha/Ohikilolo Ridge	*in situ*	MMR	None

Habitat Characteristics

Manage for Stability Population Units	*in situ* PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Kalena	SBW-B	3163	Vertical	Open	Upper Slope	N	1460
Ohikilolo	TetFil.MMR-J	2600	Steep		Crest	N	1700
	TetFil.MMR-K	2620	Steep		Crest	NNW	1669
	TetFil.MMR-L	2552-2592	Vertical		Crest	N/S	1700
	TetFil.MMR-M	2700	Steep		Crest	N	1630
	TetFil.MMR-N	2680	Vertical		Upper Slope/Crest	N	1329
	TetFil.MMR-O	1781	Vertical		Mid Slope	N	1283
	TetFil.MMR-P	2100	Vertical		Upper Slope	N	1224
	TetFil.MMR-Q	2726	Steep		Crest	NNW	1329
Puhawai	TetFil.SBW-A	2800	Steep		Crest	E	1240
	TetFil.SBW-C	3163	Vertical		Upper Slope	N	1256
Waianae Kai	TetFil.WAI-A	2300	Vertical		Crest	N	1531
	TetFil.WAI-B	2200	Vertical		Upper Slope/Crest	N	1458
	TetFil.WAI-C	2250	Vertical		Mid Slope	SW	1531

Information was compiled from OANRP observation forms & GIS data; Rainfall data complied from Rainfall Atlas of HI (Giambelluca et. al. 2013).
PRC = Population Reference Code.

Habitat Characteristics

Genetic Storage Population Units	*in situ* PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Kahanahaiki	MMR-G	1200-1280	Vertical	Open	Upper Slope	N	1302
Keaau	KEA-A	1841-1919	Vertical		Upper Slope	NE	1286
Makaha/Ohikilolo Ridge	MAK-A	2640	Vertical		Upper Slope	NE?	1629
	MAK-B	2477	Vertical		Upper Slope	East?	1668
Ohikilolo	MMR-A	3052-3552	Steep		Crest	SE	1527
	MMR-B	1200-1700	Flat		Crest	N	1075
	MMR-C	2120	Vertical		Upper Slope	N	1173
	MMR-D	2907	Steep?		Upper Slope	N	1584.5
	MMR-E	2600-2900	Vertical		Upper Slope/Crest	N	1539
	MMR-F	2650	Steep		Crest	N	1667
	MMR-H	981	Vertical		Upper Slope	N	917
	MMR-I	2717	Steep		Crest	N	1371

Information was compiled from OANRP observation forms & GIS data; Rainfall data complied from Rainfall Atlas of HI (Giambelluca et. al. 2013).
PRC = Population Reference Code.

Associated Species

PU	Population Reference Code	Canopy	Understory
Kahanahaiki	TetFil.MMR-G	SchTer, DodVis	AgeRip, ArtAus, DodVis, CarWah, MyoSan
Kalena	TetFil.SBW-B	BudAsi, SchTer, DubLax, MetPol, PipAlb,	AgeRip, BleApp, KalPin, RubArg, VerLit, ArtAus, CarWah, MacAng, RumAlb,
Keaau	TetFil.KEA-A	Not recorded	AgeRip, LanCam, SchTer, ArtAus, CarMey,
Makaha/ Ohikilolo Ridge	TetFil.MAK-A TetFil.MAK-B	Not recorded	Not recorded
Ohikilolo	TetFil.MMR-A-F TetFil.MMR-H TetFil.MMR-I TetFil.MMR-J-Q	GreRob, LeuLeu, SchTer DioSan, DodVis, MetPol, MetTre, PsyOdo, RauSan,	AgeAde, AgeRip, BidAlb, BidPil, BleApp, Brorig, CenEry, ConBon, CupCar, EmiFos, EriKar, EupHir, GamPur, KalPin, KylBre, LanCam, LepThu, LeuLeu, Lintri, LuzHaw, MelMin, AnaArv, ArtAus, BidTor, CarMey, CarWah, DodVis, DorDec, DubHer, EraGra
Puhawai	TetFil.SBW-A TetFil.SBW-C	EucRob, KalPin, PsiCat, SchTer, VulBro, DodVis, EupMul, LepTam, MetPol	AgeRip, BidAlb, CheVir, ConBon, EmiFos, EpiObr, KalPin, LanCam, LobMar, MelMin, MelRep, OxaCor, PluCar, PsiCat, ArtAus, BidTor, CarWah, DiaSan, DodVis, EraVar, EupMul, LepTam, LepThu, LobNii, MetPol, PepTet, PlePar, PolPelPel,
Waianae Kai	TetFil.WAI-A TetFil.WAI-B TetFil.WAI-C	AcaCon, GreRob, LanCam, SchTer, DodVis, SchMan	AgeRip, ConBon, EmiFos, KalPin, NepBro, OpuFic, VulBro, ArtAus, BidTor, CarMey, DodVis, EupCel, LobNii, MelTens, SchMan, Sidfal,

Information was compiled from OANRP observation forms. Alien taxa are underlined and listed alphabetically first, followed by native taxa (also listed alphabetically by six letter taxon code).

Population Structure

- Relatively little is known about *T. filiforme* population structure. Most of the information OANRP has obtained has been from annual monitoring of the Puhawai augmentation site, SBW-C, as well as irregular monitoring of wild sites. Many of the wild populations are quite numerous (*i.e.* MMR-A had 585 individuals in 2014) but individual plants are only tagged when collected from and not followed over their lifetime. Sites are also visited so infrequently that plants die between monitorings, hence little data is collected. Monitoring these population units is also quite challenging as the majority of them are accessible only by rope, including the Puhawai augmentation site.

- *T. filiforme* is a relatively short lived perennial (less than 10 years), but populations have persisted for decades.

- Plants within each age class (seedling, immature, mature) can be observed in each PU, however it is unclear how long plants remain as seedlings or immature plants across the population units. No life cycle studies have been conducted on this species. Seedlings are extremely small, and may or may not be observed in the populations, depending on the time of year.

- Mature F1 plants have been observed two years after initial planting of mature plants at the Puhawai outplanting site. Outplants were planted as mature plants and live for less than one year. Only 5 plants (out of the 38 planted in 2013, and 105 planted since 2006) survive. Seedlings and new immature and mature plants, however, have been observed throughout the entire augmentation site. This suggests that while outplants do not persist much past one year, they produce viable seeds and form a soil seed bank that persists after they die.

Monitoring Plan

- *In situ* sites in MFS PUs will be monitored on a priority basis described below using the Hawaii Rare Plant Restoration Group (HRPRG) Rare Plant Monitoring Form (RPMF). The form will be used to record population structure, age class, reproductive status, and vigor of all accessible plants. Sites will be searched for new plants and all new mature plants collected from will be tagged. If there is any threat to the health and safety of plants due to repeated monitoring and/or tagging, reductions in the number of tagged individuals will be made so that no harm is done to the plants. This monitoring data will serve to document the populations at the remaining sites to guide *in situ* threat management and genetic storage needs.

- The reintroduction sites in all PUs will be monitored at least annually using the HRPRG RPMF to record population structure, age class, reproductive status and vigor. All outplants will be accounted for, along with a total population census. This data will be used to guide future outplanting.

- Sites within the high fire-threat areas of Makua Military Reservation and Schofield Barracks West Range will be priority for monitoring over those outside the high fire-threat areas. These include MMR-D, MMR-H and SBW-A and B. Also, larger sites that have not been visited in more than a decade, such as MMR- F,P and important outlier sites, such as KEA-A, will also be a priority. These are all within the Action Areas for Makua and Schofield.

Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Head (filled)	Dormancy
Kahanahaiki	Oct		July-Oct	monoecious	Insects?	*7-8*	Not Dormant
Kalena	Oct	Oct	May-Oct			4 (n=78)	
Keaau			Nov			18 (n=2)	
Makaha/ Ohikilolo Ridge						*7-8*	
Ohikilolo	Jun-Sep	July-Oct	Jun-Oct			8 (n=97)	
Puhawai	year-round	year-round	year-round			13 (n=32)	
Waiane Kai			Dec			N/A	unknown

• Lower populations on Ohikilolo ridge have mature fruit from July to August while the mauka populations are collected in October. Flowering time is noted in Wagner, Herbst & Sohmer (1999) as a distinguishing trait between var. *filiforme* (which was suspected to occur at lower elevations and flower a few weeks earlier than var. *polyphyllum*) and var. *polyphyllum*. Collections from these sites should be planned accordingly.
•There has not been enough monitoring of all PUs to determine phenology. Based on regular observations of a few PUs, however, plants appear to be reproductive year-round, but it is unknown whether this applies to all PUs.
•No floral visitor observations have been made and it is presumed that the taxon is insect-pollinated as is common for Asteraceae. With high wind conditions along the cliffs where this species is found, it is hypothesized that wind may move pollen as well.
•From all the PUs from which fruit has been harvested, seeds germinate readily and do not appear to be dormant.
•Mean (filled) seed set for the taxon is 7-8 seeds per collected head (n=209). This mean has been applied to PUs where no data was available and are shown in italics above.

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.
Seed (large PU), Cuttings (small PU)	wild plants	Seed Banking (-18°C, 20% RH) & Clones in Nursery	15+ years	Yes	Fruit collections from new wild plants & clonal nursery collection & reintroductions

Genetic Storage Plan Comments:
For small PUs, cuttings are taken from wild plants and maintained as large plants in the nursery for harvesting viable seeds. These seeds have been used as propagules for the Puhawai augmentation. Once this reintroduction is completed, seeds will be banked. When these seed collections age, new seeds will be collected from both wild and reintroduced plants at the augmentation. If this is not possible, new clonal collections will be made and the process repeated. If no more plants exist, the banked collection will be regenerated by growing and collecting from nursery plants. The collections in the nursery must be isolated to ensure that seeds collected from each group are not being crossed with other PUs. This method is more efficient than collecting from wild plants because most seeds can be collected before being dispersed, however, each plant produces few fruit and a significant effort and amount of space must be dedicated to this collection. Even in the nursery, the plants are short-lived and must be continually cloned to maintain founders.

For the larger PUs, 50 (viable) seeds will be harvested from 50 plants at the wild sites to maintain genetic storage requirements at the collection interval (fifteen years). Experience from previous collection attempts suggest that it may be an unreasonable expectation to collect enough seeds because the plants are small, readily disperse fruit into the wind before it can be collected, and are short-lived. As moderate sized collections (25-50 viable seeds) exist from dead plants in the seed bank, we could include these founders as meeting genetic storage requirements if we collect enough seeds from greater than 50 founders. This should be balanced by requiring collections from twice as many founders. In these large PUs, this may also be a better strategy to capture the amount of genetic variation at these sites with fewer visits. Because few seeds are available on each collection trip, several visits to each site may be needed to secure enough to meet the stability goal. Modifying the stabilization requirement from 50 (viable) seeds from 50 plants per PU to 25 (viable) seeds from 100 plants per PU would allow us to reach and maintain the genetic storage requirements with fewer visits.

Reintroduction Plan

Manage for Stability PUs	Reintroduction Site(s)	Reintroduction Size	Propagule Type	Source Populations (N of plants at each site)	N (total) of Founders Represented	Plant Size	Pot Size
Puhawai	SBW-C	100 plants & ≥15,000 seeds	Immature Plants & Seeds	<5	4	3-10 cm	2-4"
Puhawai	SBW-D	100 plants & ≥15,000 seeds	Immature Plants & Seeds	<5	*	3-10 cm	2-4"
Kalena	SBW-E	100 plants & ≥15,000 seeds	Immature Plants & Seeds	12	*	3-10 cm	2-4"
Waianae Kai	WAI-D	100 plants & ≥15,000 seeds	Immature Plants & Seeds	30	*	3-10 cm	2-4"

***Outplanting has not started and the number of founders is to be determined**

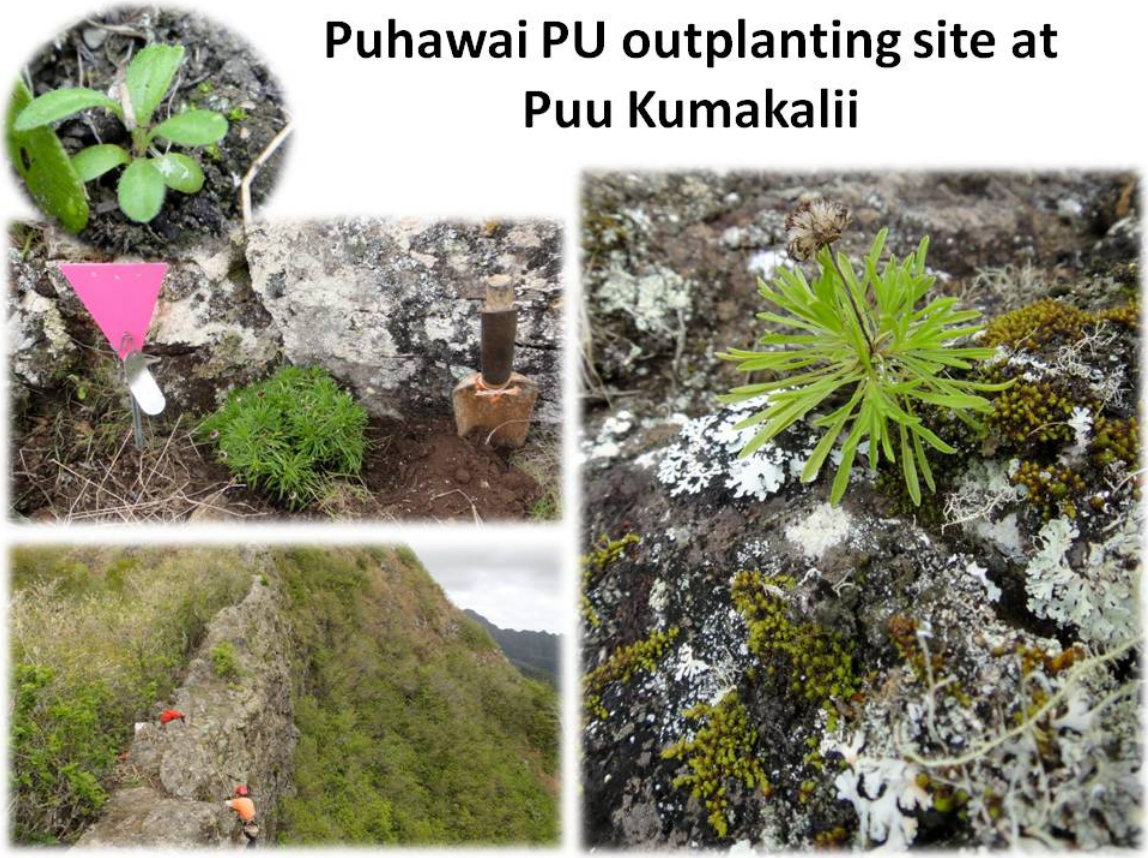
Outplanting is needed at three of the four MFS PUs that do not meet the stability goal for the minimum number of mature plants (50). None of these three PUs (Puhawai, Kalena, Waianae Kai) have been observed with more than fifty plants since they were first discovered. Only the Ohikilolo PU will not need outplanting to maintain that stability goal. Outplanting will be done using both plants and seeds. The plants will grown from cuttings of the wild plants and from seeds collected from the nursery collection. Seeds collected from the nursery plants may also be used to sow on site when not necessary for genetic storage, though the current nursery collection does not produce enough seeds for *in situ* seed sowing. Seed sowing may be useful for establishing plants in areas where planting holes cannot be dug into shallow soil ledges. The number of seeds to sow, as shown above, is our rough estimate of what would be needed to produce 100 plants *in situ*. Based on other seed sow studies, it is likely

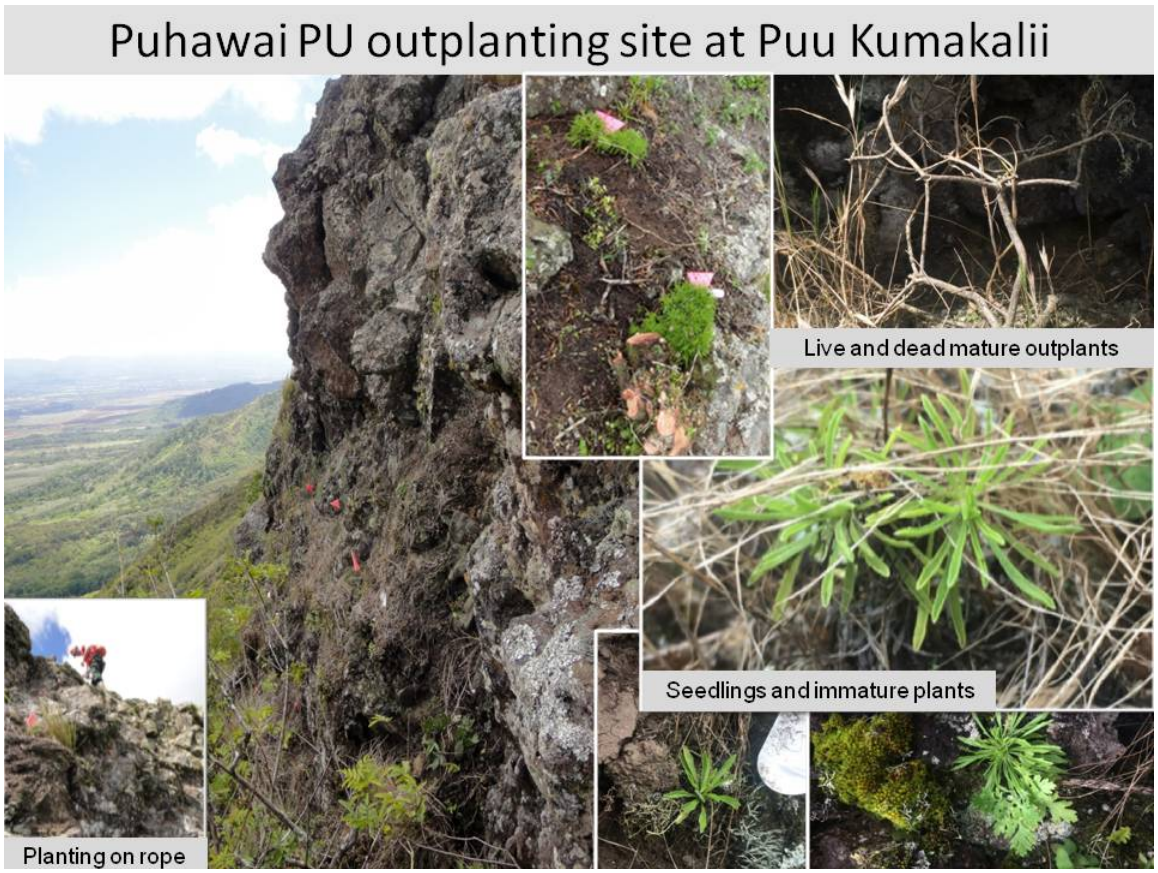
•Puhawai: The existing planting site (SBW-C) at Puu Kumakalii will be monitored for the next two years to determine whether it is likely to reach stability goals. If not, a new outplanting site (SBW-D) will be needed. This site will be sought in the next few years as an option to replace SBW-C and isolate the *T. filiforme* stock from the wild *T. lepidotum* subsp. *lepidotum* plants. The wild *T. lepidotum* site in Lihue is within the outplanting zone designated for *T. filiforme* in the MIP. It is 220 meters from the wild site at Puhawai, and 260 meters from the SBW-C outplanting site. If a new outplanting site (SBW-D) is located, management of the Puhawai PU should be moved to there. If not, and the PU remains below stability goals, it will be augmented according to the plan for SBW-C above.

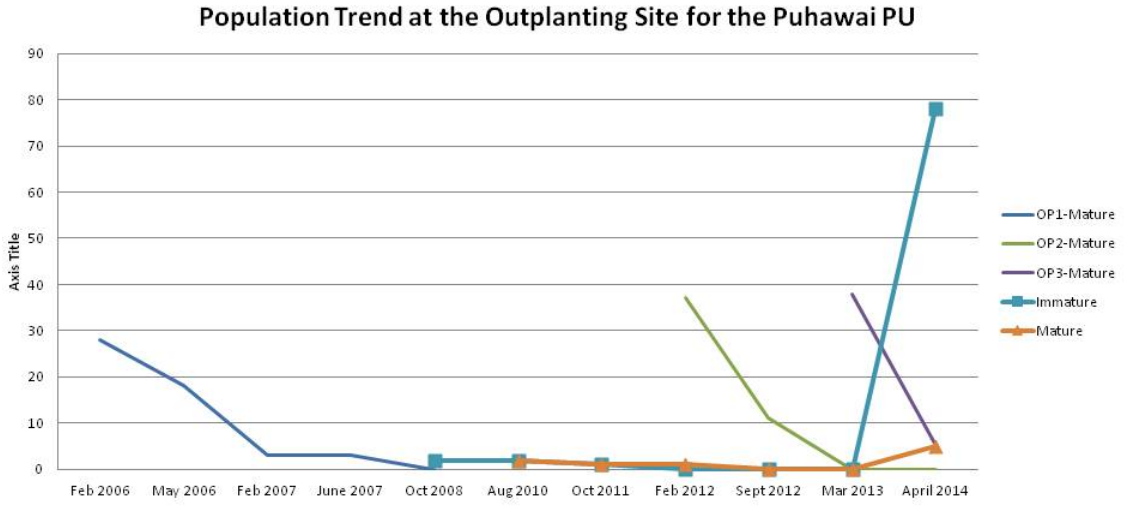
•Kalena: The wild site is difficult to access and not feasible for augmentation at this time. A new outplanting site is needed within Lihue or adjacent MUs and it will be sought and prepared for outplanting. Plants and seeds grown from the nursery collection will be used to establish the new site. It is likely that several attempts will be needed to establish enough plants to meet stability goals.

•Waianae Kai: This PU is below the minimum number of plants, however should be surveyed more before outplanting. If needed, the outplanting will be established by securing a nursery collection and then using clones and seeds from those to augment the wild site.

Puhawai PU outplanting site at Puu Kumakalii







The reintroduction at Puhawai (SBW-C) was started in 2006 (OP1) with 28 plants grown from seeds collected from a nursery living collection. The nursery collection was grown from cuttings of the wild plants. Seeds were collected, stored and germinated for outplanting. Only six plants from this cohort lived longer than one year. At that time, three small new immature plants were observed. By 2008, all of the outplants were dead, but two of the three F1s were present. In 2010, two mature and two immature naturally-recruited plants were present. The site was supplemented with 37 additional plants (OP2) in 2012, and 38 more plants (OP3) in 2013. At last monitoring in April 2014, five outplants had survived, but in addition, many seedlings, immature plants, and five mature plants established on-site. Although survival of the outplants after three years is poor (<10%), the population has doubled since the last outplanting. Outplanting onto the cliff habitat preferred by *T. filiforme* is logistically challenging. It requires working carefully in delicate habitat to transport plants and create planting holes in small dirt ledges amongst the rocky cliffs. These methods can be repeated at other sites when propagules become available. By using a combination of both outplants and seeds, all available habitat can be used for planting and sowing.

Stabilization Goals Update for MFS PUs

PU	PU Stability Target		MU Threat Control					Genetic Storage
	Has the Stability Target for mature plants been met?	Does population structure support long-term population stability?	Ungulates	Weeds	Rodents	Fire	Slug	Are Genetic Storage goals met?
Kalena	No	No	Yes	No	No	No	No	No
Ohikilolo	Yes	Yes	Yes	Partial	No	No	No	No
Puhawai	No	No	Partial	No	No	No	No	No
Waianae Kai	No	No	No	No	No	No	No	No

5 Year Action Plan

Proposed Actions for the following years:					
Manage for Stability Population Units	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 1 2016- September 2017	MIP YEAR 14 October 1 2017- September 2018	MIP YEAR 15 October 2018- September 2019
Kalena	•Monitor •Collect cuttings&seeds •Locate site (SBW-E)	•Monitor •Collect cuttings&seeds •Locate site (SBW-E)	•Monitor •Collect cuttings&seeds •Prep SBW-E	•Monitor •Collect seeds •Outplant (SBW-E)	•Monitor •Collect seeds •Outplant (SBW-E)
Ohikilolo	•Monitor •Collect seeds	•Collect seeds	•Monitor •Collect seeds	•Collect seeds	•Monitor
Puhawai	•Monitor •Collect cuttings&seeds •Locate new site	•Monitor •Collect cuttings&seeds •Locate new site	•Monitor •Collect seeds •Outplant (SBW-C/D)	•Monitor •Collect seeds •Outplant (SBW-C/D)	•Monitor •Collect seeds
Waianae Kai	•Monitor •Collect cuttings&seeds	•Monitor •Collect cuttings&seeds	•Monitor •Collect cuttings&seeds	•Monitor •Collect cuttings&seeds	•Monitor •Outplant (WAI-C)
Genetic Storage Population Units					
Kahanahaiki	•Monitor •Collect seeds	•Monitor •Collect seeds		•Monitor •Collect seeds	
Keaau		•Monitor •Collect seeds	•Monitor •Collect seeds		•Monitor •Collect seeds
Makaha/ Ohikilolo Ridge			•Monitor •Collect seeds		•Monitor •Collect seeds

Management Discussion for *Tetramolopium filiforme*

The primary efforts for stabilization of *T. filiforme* include: A) *in situ* habitat health and threat protection at the MFS PUs; B) monitoring populations; C) securing founders in a nursery living collection; D) outplanting where needed to establish new sites. The existing management fences will be maintained. Weed control should be expanded into *T. filiforme* habitat on Ohikilolo to remove *Grevillea robusta* and *Schinus terebinthifolius* canopy around *in situ* sites. Preventing grasses such as *Erharta stipoides, Meliunus minutiflora* and *Urochloa maximum* from reaching the cliff habitat at Ohikilolo and in Lihue should also be a priority for weed management. Management at the three smaller MFS PUs (Puhawai, Kalena, Waianae Kai) will continue to focus on establishing nursery living collections that can be used to produce seeds for growing plants for outplanting and using in seed sowing projects. New outplanting/seed sowing sites must be identified and prepared within the Lihue MU or adjacent areas (Kaluaa and Waieli MU and Manuwai MU) to meet stability goals for the Puhawai and Kalena PUs. Recently, management for this species has focused on the smaller MFS PUs at Puhawai and Kalena. Few sites in the large PUs, however, at Ohikilolo and Keaau, that are within the Makua Military Reservation Action Area, have been monitored within the last decade. It will be a priority to revisit these sites to update population estimates and monitor the site for threats. While there are expected to be several hundred plants remaining at those sites, the most current observations for many sites are at least ten years old and many are up to eighteen years old. Goats were the primary threat to the sites in the Ohikilolo MU and have been controlled, but little weed or other threat management has been conducted. The threat of weeds to these populations will be assessed and a weed control strategy will be formulated if these large populations are severely impacted.

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CHAPTER 3: *ACHATINELLA MUSTELINA* MANAGEMENT

3.1 INTRODUCTION

In consultation with USFWS in 1998 it was determined that the Army would manage *Achatinella mustelina* throughout the Waianae Mountains while protecting the broadest genetic diversity. In 2000 OANRP began surveys and collected DNA samples to guide the management effort. Subsequent surveys followed and by 2003 the area was divided up into six Evolutionarily Significant Units (ESUs). The largest two units were further subdivided geographically bringing the total of managed areas to eight (Fig. 1). The Mauka Implementation Plan (MIP) stated the goal for these eight units is to have at least 300 snails in each unit. In addition, the predators of *A. mustelina* including Black rats (*Rattus rattus*), the Rosy Wolf Snail (*Euglandina rosea*), and Jackson's chameleons (*Chamaeleo jacksonii* subsp. x*antholophus*) will be controlled at managed sites. OANRP has made significant progress toward these goals in recent years. At four of the eight sites the 300 goal is met. At three ESUs, enclosures are used to protect Population Reference Sites (PRS) from all threats and in 41 other PRS rat control is ongoing. See ESU tables in each section for threat control status at individual PRS.

Figure 1. Locations of *Achatinella mustelina* Evolutionarily Significant Units (ESU) on Oahu.

Conservation actions are currently focused entirely on in situ populations. At this time captive propagation for *A. mustelina* is not a feasible conservation tool. Unfortunately, Hawaii Tree Snail Conservation Laboratory (HTSCL) populations are not stable and Fish and Wildlife does not recommend using the lab for captive propagation. OANRP will continue to cooperate with partners to develop this tool in the future. The lack of captive propagation puts increased pressure on field conservation. Field conservation remains challenging. Despite continued efforts, there is still no feasible control tool for *E. rosea* or Jackson's Chameleons. While rat control is ongoing at many snail PRS, building enclosures that exclude predators is the only current option affording complete protection from all threats to *A. mustelina*.

There are currently no suitable enclosures to protect *A. mustelina* in the following ESUs: B1, B2, C, and E. This year, staff focused on determining locations for enclosures that would protect snails from these ESUs. Terrain considerations limit many locations of quality habitat, as enclosures are restricted to relatively flat areas. In spite of these limitations, construction of three additional enclosures is proposed over the next three years. As shown in Table 1, "ESU population, rat control, and enclosure status" details current status of snails in each ESU, enclosures proposed for construction, and proposed ESU representation within each enclosure. To ensure the well-being of snails inside, enclosure technology is continually refined and improved. For further details on this process, see Development of Tree Snail Protection Enclosures: From Design to Implementation PCSU Draft Technical Report (OANRP 2013). See PRS sections below for details on what enclosure could be used for various ESUs. For some ESUs the number of snails receiving rat control is great than the number indicated as MFS. This is due to additional efforts of Oahu Snail Extinction Prevention Program (OSEPP) and State of Hawaii Division of Forestry and Wildlife (DOFAW) at "No Management" (NM) sites.

Table 1. ESU population, rat control, and enclosure status

ESU	# Snails in MFS PRS	# Snails in NM PRS	# Snails in PRS with Rat Control	# Snails in Enclosures	Planned Enclosure for Additional Snails Currently not in Enclosures
A	179	73	179	110 (Kahanahaiki)	Kahanahaiki
B1	457	22	427	0	†3 Corners
B2	307	245	307	0	†3 Corners
C	392	32	396	0	†Kaala
D1	380	289	380	380 (Hapapa)	Hapapa
D2	210	34	138	0	Hapapa or †Makaha
D	0	534	37	0	†Kaala and Hapapa
E	213	41	198	0	†Kapuna
F	430	20	449	34 (Palikea)	Palikea

MFS PRS = Manage for Stability Population Reference Site
NM PRS = No Management Population Reference Site
† Proposed for construction

The number of snails reported in tables throughout this report represents the number of snails counted by staff on the date indicated. These are always underestimates of the total number of snails on site. Typically the number counted is around 25% of the snails at a site. This should be considered when reviewing the tables and figures. Additionally, search areas, time person-hours spent searching, and time of day were not always consistent over the years, and these discrepancies are noted in the following sections when applicable. Protocols have now been established for MFS PRS within all ESUs to be monitored at regular intervals using standardized timed-count monitoring, along with ground shell plot searches for select PRS. Intervals vary base on management needs and are most intensive in enclosure to ensure population stability. Ground shell plots (GSP) are deployed in areas with terrain and vegetation that allow frequent plot visitation. In addition, they are placed in areas with high concentrations of snails. Search areas, person-hours spent searching, and the time of day will remain consistent within each PRS, in order to maintain comparable parameters of population growth and mortality. Due to difficulties in detecting tree snails, detection rates are expected to be variable, and subsequently timed-count numbers may vary to a small degree. If there is a decline greater than 25% in timed-counts, or greater than 10% mortality is detected in ground shell plots, more frequent timed-count monitoring will occur to verify the population decline, and adaptive management strategies will be considered.

3.2 ESU-A

3.2.1 Description

ESU-A represents the northernmost range of *A. mustelina*, which extends across the following three gulches: Kahanahaiki, Pahole, and Kapuna (Fig. 2 and 3). The elevation ranges between 2150 feet (ft) and 2300 ft and the habitat consists of mixed mesic forest. While surveying, OANRP staff often find snails in *Nestigis sandwicensis, Myrsine lessertiana, Coprosma longifolia, Psychotria spp*, and *Metrosideros polymorpha*. This area receives about 1400-1500 mm of rainfall per year (Giambelluca 2013). There has been an observed decline by OANRP at this ESU in recent years.

Figure 2. Photographs showing diversity of *Achatinella mustelina* in ESU-A

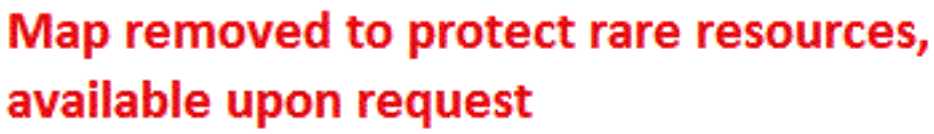

Figure 3. Map of ESU-A showing current and historic locations of *Achatinella mustelina*

3.2.2 Management History and Population Trends

Rats and *E. rosea* occur at all PRS sites; however, they are controlled at all MFS sites and a few NM sites. *Euglandina rosea* are excluded from within MMR-A Kahanahaiki enclosure. There have never been any reports of Jackson's chameleons near the PRS sites. However, there was a report of a Jackson's chameleon at the Peacock Flats campground. There are 13 PRS sites within the ESU (Table 2). Four sites are designated as MFS: MMR-A Kahanahaiki Enclosure, MMR-C Maile Flats, MMR-O Giant Olopua tree and PAH-B Pahole Enclosure. Combined, these four MFS PRS have 179 snails. The other nine sites are NM PRS and have a total of 56 snails; however, many of these sites have not been recently monitored. The MFS PRS are discussed individually in sections to follow. The NM PRS are discussed together in one section.

Table 2. ESU-A population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: A Pahole to Kahanahaiki												
KAP-A Just below Makua rim on trail above hunter's cabin.	No Management	7	2014-05-29	6	1	0	0	Yes	No	No	No	No
KAP-B Chaher weeding site	No Management	1	2005-09-27	1	0	0	0	Yes	Yes	No	No	No
KAP-C One Acre Site	No Management	9	2013-10-08	6	2	1	0	Yes	Yes	No	No	No
LEH-F West Makaleha off of Keawapilau ridge	No Management	1	2005-03-08	1	0	0	0	Yes	No	No	No	No
MMR-A Kahanahaiki Exclosure	Manage for stability	110	2014-09-15	56	31	23	0	Yes	Yes	Yes	Yes	No
MMR-C Maile Flats	Manage for stability	12	2014-09-15	8	3	1	0	Yes	Yes	Yes	No	No
MMR-D Kahanahaiki Gulch	No Management	8	2004-09-27	4	4	0	0	Yes	Yes	No	No	No
MMR-M East Rim 2A ridge	No Management	17	2014-09-17	0	7	10	0	Partial	No	No	No	No
MMR-N Kahanahaiki gulch at Steph Joe's slug boxes	No Management	1	2010-06-19	1	0	0	0	Yes	Yes	No	No	No
MMR-O Giant Olopua	Manage for stability	15	2014-09-15	6	7	2	0	Yes	No	Yes	No	No
PAH-A Cyasup Pahole gulch reintro lower site	No Management	1	2004-07-26	1	0	0	0	Yes	Yes	No	No	No
PAH-B Pahole Exclosure	Manage for stability	42	2013-05-13	24	16	2	0	Yes	Yes	Yes	Yes	No
PAH-C below Pahole snail exclosure	No Management	28	2011-04-19	15	7	6	0	Yes	No	No	No	No
	ESU Total:	252		129	78	45	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.

3.2.2.1 MMR-A Kahanahaiki Enclosure PRS

Construction of a predator resistant enclosure at Kahanahaiki began in 1998 with the goal of excluding rats and *E. rosea*. The enclosure is constructed of solid plywood standing four foot tall with an overhang on the top and measures a perimeter of 50m. A variety of barriers along the wall have been used

experimentally over the years with varying success. When OANRP began monitoring in 1998 there were 37 snails detected in the new enclosure (Fig. 4). Early counts were not standardized in effort and thus should be considered only a rough guide. In the years following the enclosure construction, snails continued to increase in numbers and peaked at 95 in 2008. In 2010, *E. rosea* were found inside the enclosure, and only 12 *A. mustelina* were counted. It is not clear how the *E. rosea* entered the enclosure but there are a few possible avenues. Holes were detected under the enclosure wall in 2010; in addition, *E. rosea* could have entered over the top between trips to refresh the salt. The holes under the wall were repaired in 2010 and then in 2011 OANRP installed the cut mesh barrier to Kahanahaiki, the prototype developed for the enclosure at Puu Hapapa PRS in ESU-D. The installation went well and staff continued to gain confidence in the enclosure at Kahanahaiki.

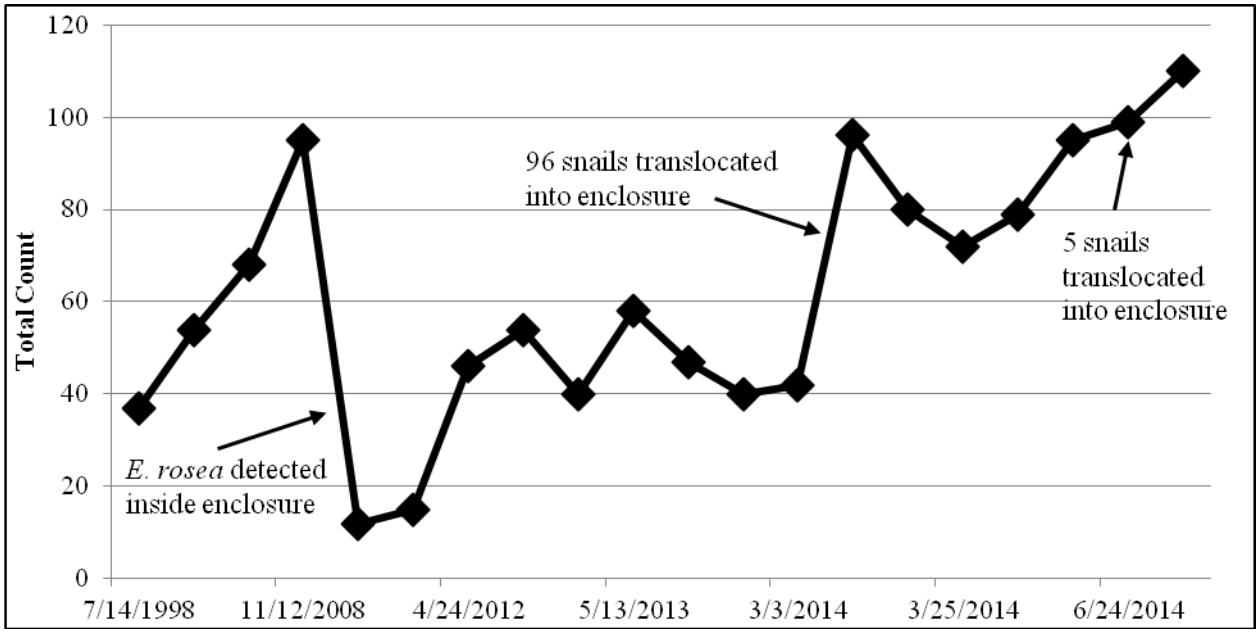

Figure 4. Population counts of *Achatinella mustelina* at MMR-A Kahanahaiki Enclosure PRS

In 2012 OANRP began the removal of a large *Psidium cattleianum* stand about 100 m to the east of the Kahanahaiki enclosure, in MMR-C Maile Flats PRS. This project required the removal of snails from within the area to facilitate the weed removal. A total of 31 snails were moved into the enclosure from the project site. In October of 2013 OANRP finished the installation of the angle and electrical barriers using the prototype developed for the enclosure at Puu Hapapa PRS in ESU-D. Also at this time, habitat restoration began in the enclosure, described in Appendix 1-3-3, Snail Enclosure Restoration.

With the completion of all barriers and continued declines in the number of snails in MMR-C Maile Flats PRS, OANRP decided to translocate additional MMR-C snails into the enclosure. A reconnaissance search for *A. mustelina* in Maile Flats was conducted prior to translocation, and trees with snails were marked with flagging. A total of 96 snails were moved on March 3, 2014. Five additional snails were translocated into the exclosure on June 24, 2014. To quantify long-term population trends and assess if the translocated population is self-sustaining over time, a timed-count monitoring and ground shell collection methodology was implemented. Timed-count monitoring of pre-existing snails and ground shell collection within the enclosure was conducted prior to translocation. Two weeks after translocation, timed-count monitoring was repeated. Counts were made three times during the first quarter following translocation, then twice for the second quarter, to assess variability in detection rates. Counts were made once per quarter thereafter. Ground shell counts were read two weeks after translocation, then

every other week over the next six weeks to assess mortality in response to translocation efforts, then quarterly thereafter.

Following the translocation of *A. mustelina* into the enclosure in 2014, snail timed-counts gradually increased over time, from 80 snails in March 2014, to 110 by September 2014 (Fig. 6). Timed-counts in the enclosure varied little among counts occurring within the same quarter. A total of 12 shells were recovered from the ground during the first six months of monitoring in the enclosure (Fig. 7), representing less than 10% mortality. These included 9 small, 2 medium, and 1 large shells.

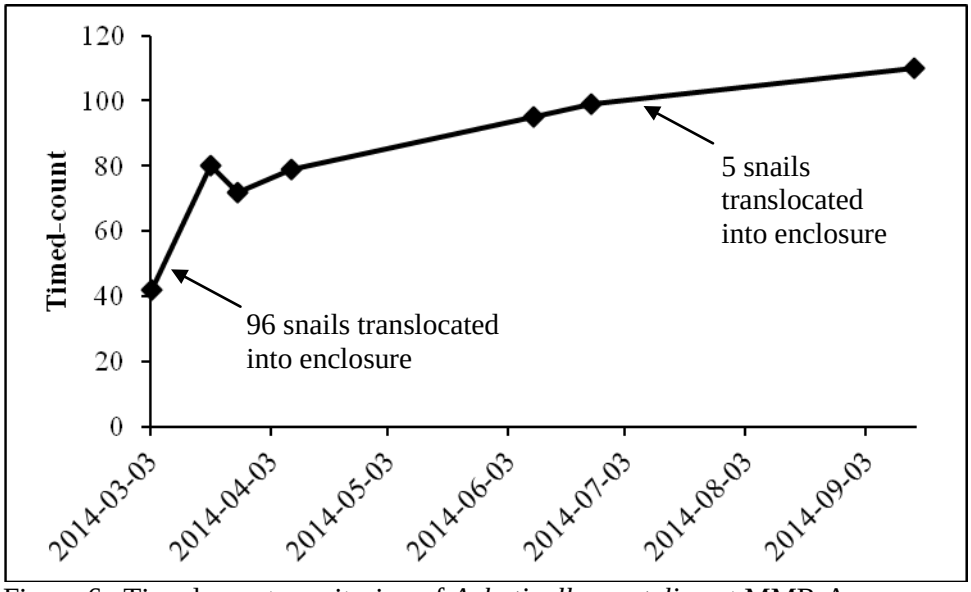

Figure 6. Timed-count monitoring of *Achatinella mustelina* at MMR-A Kahanahaiki Enclosure PRS following snail translocation. The initial timed count documented snails already present in the enclosure, prior to the snail translocation.

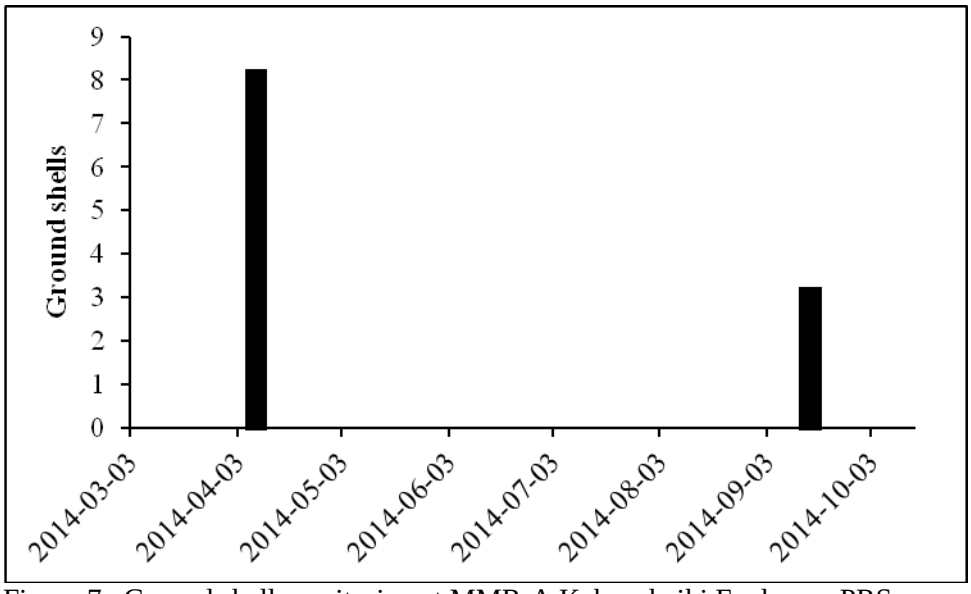

Figure 7. Ground shell monitoring at MMR-A Kahanahaiki Enclosure PRS following *Achatinella mustelina* translocation. Ground shells were monitored

every two weeks during the first six weeks, then quarterly thereafter. Shells were present on only two occasions.

3.2.2.2 MMR-C Maile Flats PRS

This PRS site outside the MMR-A enclosure occurs over 24 acres known as 'Maile Flats', and has been managed and monitored by OANRP since 1998. Three surveys were performed over the past nine years in Maile Flats (Fig. 8). In 2004, 181 snails were found over 135 person hours. In 2009, 250 snails were found over 104 person hours. Staff partly attributed this increase in snails to having already-flagged trees to search and a new protocol of searching with binoculars. In 2012, only 99 snails were found over 100 person hours; this count was a 60% decline from the 2009 count.

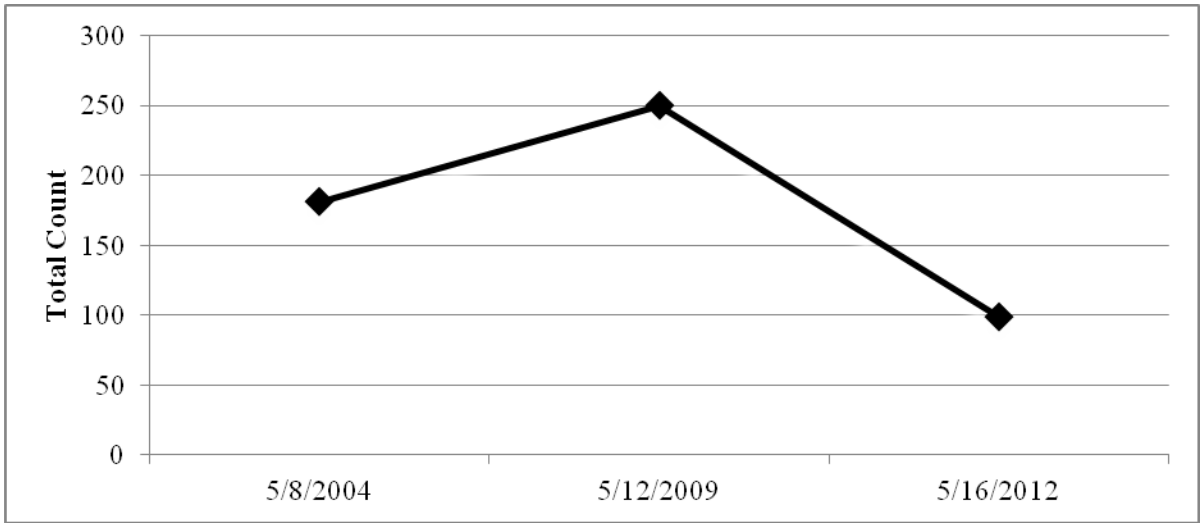

Figure 8. Population counts of *Achatinella mustelina* at MMR-C Maile Flats PRS

The area adjacent to the snail enclosure historically contained the highest concentration of snails in the Maile Flats PRS since management began in this area. Population estimates in this area, using the mark-recapture method, declined from 65 in 2009 to 8 in 2014. Of further concern, between 2009 and 2012, the number of host trees containing snails dropped by 50% across the Maile Flats PRS. Additionally, the number of snails found per tree declined such that fewer trees had more than one snail present, and none had more than 5 snails per tree (Fig. 9). Reasons for the decline are unclear but could include predation by rats and *E. rosea,* drought, change in climate and senescence of host trees..

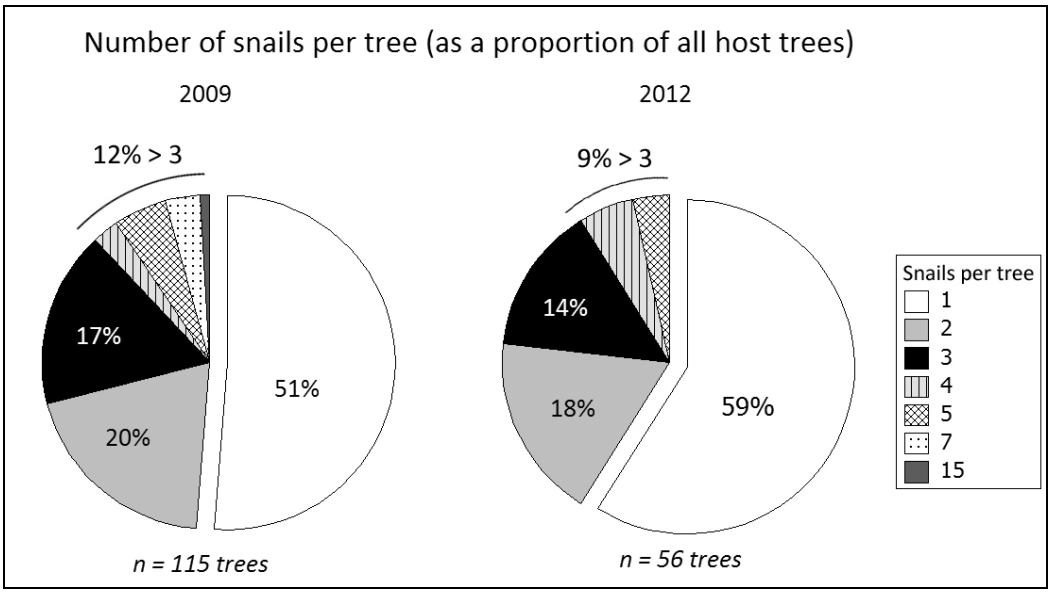

Figure 9. A pie-chart comparison of the proportion of host trees in MMR-C Maile Flats PRS with single or multiple *Achatinella mustelina* individuals in 2009 and 2012.

3.2.2.3 MMR-O Giant Olopua PRS

The 'Giant Olopua' site is a location of a single *N. sandwicensis* that is approximately 40 meters south of the MMR-A Kahanahaiki enclosure and has always been known to have snails. In March of 2014 five snails were moved into the tree in an effort to stimulate reproduction. In September 2014 all 15 snails were observed again. On the same day, an *E. rosea* was found about 30 meters away in a *N. sandwicensis* that also had three live *A. mustelina*.

3.2.2.4 PAH-B Pahole Enclosure PRS

The Pahole Enclosure PRS has been monitored by the HTSCL since 1998. This site was once a very dense patch of *Pisonia sandwichensis*; however, the large trees began to die in about 2000 and were nearly extirpated over approximately two years. With the canopy gone, the light gap increased significantly thus causing the soil to dry out and create poor environmental conditions. Over the next few years the population crashed, likely due to multiple factors. OANRP assisted the DOFAW with transplanting, seed sowing and outplanting over the years in an effort to improve the habitat.

Threat monitoring at this site has not been consistent over the years until OSEPP began more focused effort in cooperation with the DOFAW during the past year. Unfortunately OSEPP found an *E. rosea* in the enclosure in June 2014. This enclosure has not been outfitted with the three barriers installed at Kahanahaiki, and this may require a more intensive restoration of the structure as the corrugated tin wall is showing considerable degradation. DOFAW has also installed an A-24 grid around the enclosure to control rats in the area, benefiting both snails in and outside of the enclosure. OANRP staff maintains these traps as part of the larger effort across Kahanahaiki MU.

3.2.2.5 ESU-A No Management PRS

As shown in Fig. 10, the snail counts for the two NM PRS, KAP-A and KAP-C, have declined in recent years. Most of the other PRS have very small numbers and have not been monitored consistently. PAH-C is the notable exception with 28 snails counted in 2011. However, this site does not have multiple

monitoring records. At PAH-C DOFAW installed an A24 rat control grid and OANRP maintains the traps. The only other PRS site where threats are controlled is KAP-C. At this site, DOFAW maintains a rat control grid.

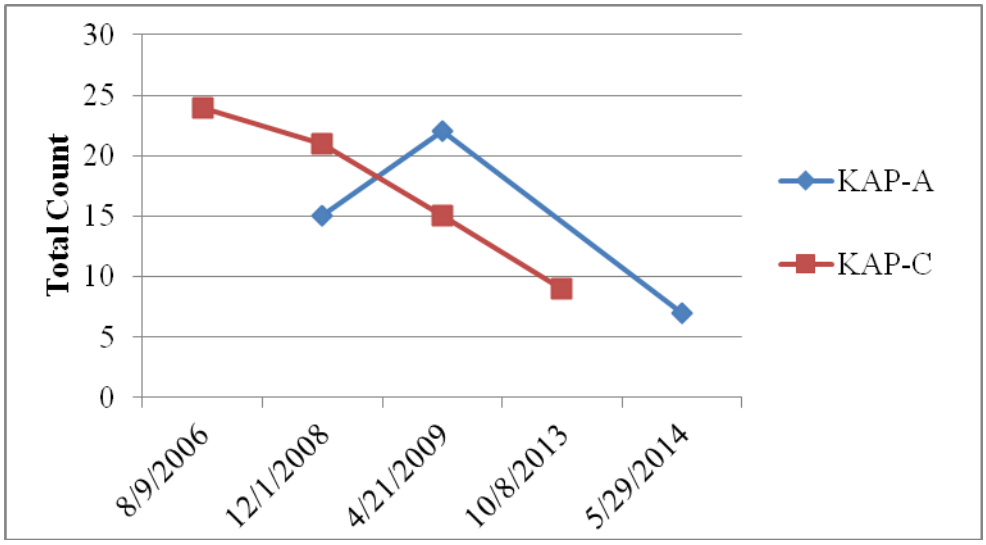

Figure 10. Population counts of *Achatinella mustelina* at KAP-A Hunter Cabin NM PRS and KAP-C One Acre NM PRS

3.2.3 Future Management

OANRP staff agree that continued active management including monitoring, threat control and translocation are required to meet goals in ESU-A (Table 3 and 4). Current management and monitoring of MMR-A Kahanahaiki Enclosure will continue. Installation of the remote monitoring system needs to be completed; this is of high management priority. Additional upgrades to the enclosure will be considered, including further fortification of the buried section of the wall with plastic lumber. Outplanting of host trees will continue as needed along with removal of invasive plants. Given the declining trend at MMR-C Maile Flats and the threat of *E. rosea* at MMR-O Giant Olopua, OANRP plans to collect the remaining snails at these MFS PRS and release them inside the MMR-A enclosure in the next year. OANRP will continue to maintain the A24 grid and salt the PAH-B Pahole Enclosure. OANRP staff have provided the DOFAW with information on pricing to refurbish the enclosure. At the current time there is no plan for OANRP to assist in a major overhaul of the site. Snails from No Management PRS should be moved into the MMR-A Kahanahaiki Enclosure within the next two years. All NM PRS that have less than 20 counted snails should be targeted as a secondary priority to moving the MFS PRS. There is available habitat and the enclosure is below the 300 snail goal. The Kahanahaiki enclosure should be used to protect the majority of known snails from ESU-A until the PAH-B Pahole Enclosure is upgraded. Once upgraded, OANRP will work with OSEPP and DOFAW Biologists to determine future translocations into the Pahole Snail Enclosure. Translocations will allow gene flow between the populations and spread the individuals across the two secure sites.

Table 3. ESU-A Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-A Kahanahaiki Enclosure	TCM	quarterly to twice a year	all	Conduct night TCM with 2 personnel 2 hours each, for 4 person-hours total; quarterly until March 2015 to ensure stability, then twice a year thereafter.
	GSP	quarterly	all	GSP MMR-A-0.

MMR-C Maile Flats	TCM	annual	all	Consider moving remaining snails into MMR-A enclosure.
MMR-O Giant Olopua	TCM	quarterly to twice a year	all	Conduct night TCM with 2 personnel 0.5 hours each, for 1 person-hour total; quarterly until March 2015 to ensure stability, then twice a year thereafter. Consider moving remaining snails into MMR-A enclosure.

Table 4. Three Year Action Plan for ESU-A

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2016 – September 2017
MMR-A Kahanahaiki Enclosure	• Implement monitoring plan • Rat control • Install Remote Monitoring system • Maintain enclosure and monitor for predators	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Conduct additional outplanting if needed	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators
MMR-C Maile Flats	• Conduct three night surveys to collect remaining snails and translocate them to MMR-A		
MMR-O Giant Olopua	• Conduct three night surveys to collect remaining snails and translocate them to MMR-A		
PAH-B Pahole Enclosure	• Rat control • Salt the enclosure	• Rat control • Salt the enclosure	• Rat control • Salt the enclosure
No Management PRS	• Work with the DOFAW develop a translocation plan to move them into Kahanahaiki enclosure • Translocate snails	• Translocate snails	• Translocate snails
KAP-C One acre site	• Work with DOFAW to determine feasibility of enclosure construction	• Construct enclosure if approved and funded	• Develop translocation plan • Translocate snails

OANRP has been in discussion with the DOFAW and more recently OSEPP about the possibility of constructing an enclosure at KAP-C One-Acre PRS. The benefits of an enclosure at this site include: the site is very accessible, there are healthy *N. sandwicensis* host trees, and the terrain is flat. The negative aspects are that it is 150 ft lower in elevation, (2000 ft vs. 2150 ft) and may also be dryer and hotter as compared to other PRS. OSEPP has deployed data loggers to collect data to quantify differences from other PRS in the ESU. If this PRS is not dryer and hotter OANRP will further explore the possibility of constructing an enclosure at this site with DOFAW and OSEPP partners. If an enclosure is built here it would be a good location for the two PRS in Kapuna Gulch or could be used for the Ekahanui (ESU-E) snails.

3.3 ESU-B

3.3.1 Description

ESU-B covers an area from Koiahi Gulch on Ohikilolo, across Ohikilolo into Makaleha and as far east as Kaawa Gulch, approximately seven kilometers (Fig. 11 and 12). Because this ESU is so broad, it is broken into two separate areas: ESU-B1 in the west and ESU-B2 in the east. The subdivision of ESU-B has no genetic basis, rather, it was determined from a purely geographical standpoint. ESU-B1 ranges in elevation from 2200 ft at Koiahi gulch to 2900 ft at Ohikilolo. ESU-B2 ranges from 2400 ft to 3400 ft in elevation. Across such an elevational range host trees vary from mesic types commonly including *N. sandwicensis* and *M. lessertiana* to wet forest *Perrotetia sandwicensis* and *M. polymorpha*. This ESU receives about 1500-1900 mm of rainfall a year (Giambelluca 2013). In the section below, ESU-B1 will be presented first followed by ESU-B2.

Figure 11. Photographs showing diversity of *Achatinella mustelina* in ESU-B

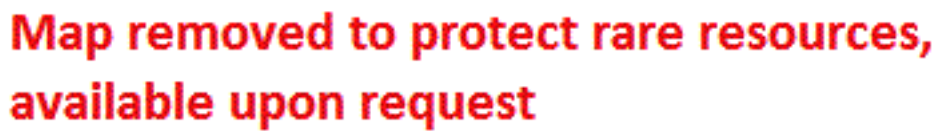

Figure 12. Map of ESU-B showing current and historic locations of *Achatinella mustelina*

3.3.2 ESU-B1, Management History and Population Trends

There are three PRS with MFS designation within ESU-B1: MMR-E Ohikilolo Mauka, MMR-F Ohikilolo Makai and MMR-H Koiahi Prikaa Reintro (Table 5). Combined, 457 snails have been counted at these PRS. There are 6 other PRS that are designated as NM. A total of 22 snails were counted across these sites; however, many sites have not recently been monitored. ESU-B1 on Ohikilolo ridge is unique because *E. rosea* has never been seen by OANRP staff nor ever reported to OANRP's knowledge. In addition, Jackson's chameleons have never been found nor reported. Rats are managed at all MFS PRS.

Table 5. ESU-B1 population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: B1 Ohikilolo												
LEH-L 3 Points	No Management	6	2013-04-30	4	1	1	0	Yes	No	No	No	No
MMR-E Ohikilolo Mauka	Manage for stability	70	2012-05-02	45	6	19	0	Yes	Yes	Yes	No	No
MMR-F Ohikilolo Makai	Manage for stability	357	2014-03-12	204	115	38	0	Yes	Yes	Yes	No	No
MMR-G Ohikilolo Alemac Site	No Management	1	2010-12-02	1	0	0	0	Yes	No	No	No	No
MMR-H Ohikilolo Koiahi Prikaa Reintro Site	Manage for stability	30	2014-04-09	15	12	3	0	Yes	Yes	Yes	No	No
MMR-I Hedpar MMR-B	No Management	2	2002-06-03	2	0	0	0	Yes	No	No	No	No
MMR-J One ridge east of Lower Makua Camp	No Management	5	2000-11-27	0	0	0	5	Partial	Yes	No	No	No
MMR-K Ctesqu ridge	No Management	3	1998-03-02	0	0	0	3	Partial	Yes	No	No	No
MMR-L Myrsine along Ohikilolo fence from 3 pts	No Management	5	1998-03-03	5	0	0	0	Partial	No	No	No	No
	ESU Total:	479		276	134	61	8					

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.

3.3.2.1 MMR-E Ohikilolo Mauka PRS

The Ohikilolo Mauka PRS has been monitored by OANRP since 2000 (Fig. 13). Snail counts since 2000 have been variable, as survey person-hours and search areas were not consistent. This PRS has the second highest concentration of snails among ESU B1 PRS, and the population appears to be stable. Since 1998, OANRP has been conducting rodent control around the PRS. In 2014, OANRP deployed additional A24 rat traps to the grid at Ohikilolo (see Chapter I Rodent Management for details).

3.3.2.2 MMR-F Ohikilolo Makai PRS

The Ohikilolo Makai PRS has been monitored since 2001, with counts of snails increasing over time (Fig. 13). This PRS represents the largest concentration of snails within ESU B1, having three times as many

snails as all other ESU B1 PRS combined. The areas searched do not cover the entire extent of the area occupied by snails, and detection rates are likely low due to thick native vegetation. Thus the actual number of snails at MMR-F is greatly underestimated. The A24 grid that covers the Mauka patch extends across this PRS area as well.

3.3.2.3 MMR-H Ohikilolo Koiahi Prikaa Reintro PRS

At 2450 ft, the PRS at Koiahi is the lowest in elevation and has the distinction of being the westernmost *Achatinella* on the island of Oahu. Unlike the two PRS discussed above, there has been a decline in the observation counts since 2010 (Fig. 13). Snails in Koiahi were first sighted in 2001 when the habitat was chosen as a potential outplanting site for *Prichardia kaalae*. On December 5, 2001 a total of 14 snails were counted during the day. In 2004 a total of 17 snails were observed. Then in 2010 two staff camped here and counted 19 snails during the day and another 31 at night for a total of 50 snails. That was the first time a night count was conducted, and contributed to the increase in numbers. During a short survey in 2013 only four snails were seen during the day so it was decided to perform another night survey. In March of 2014 two staff camped in Koiahi Gulch and counted 11 snails during the afternoon and another 9 at night for a total of 20 snails.

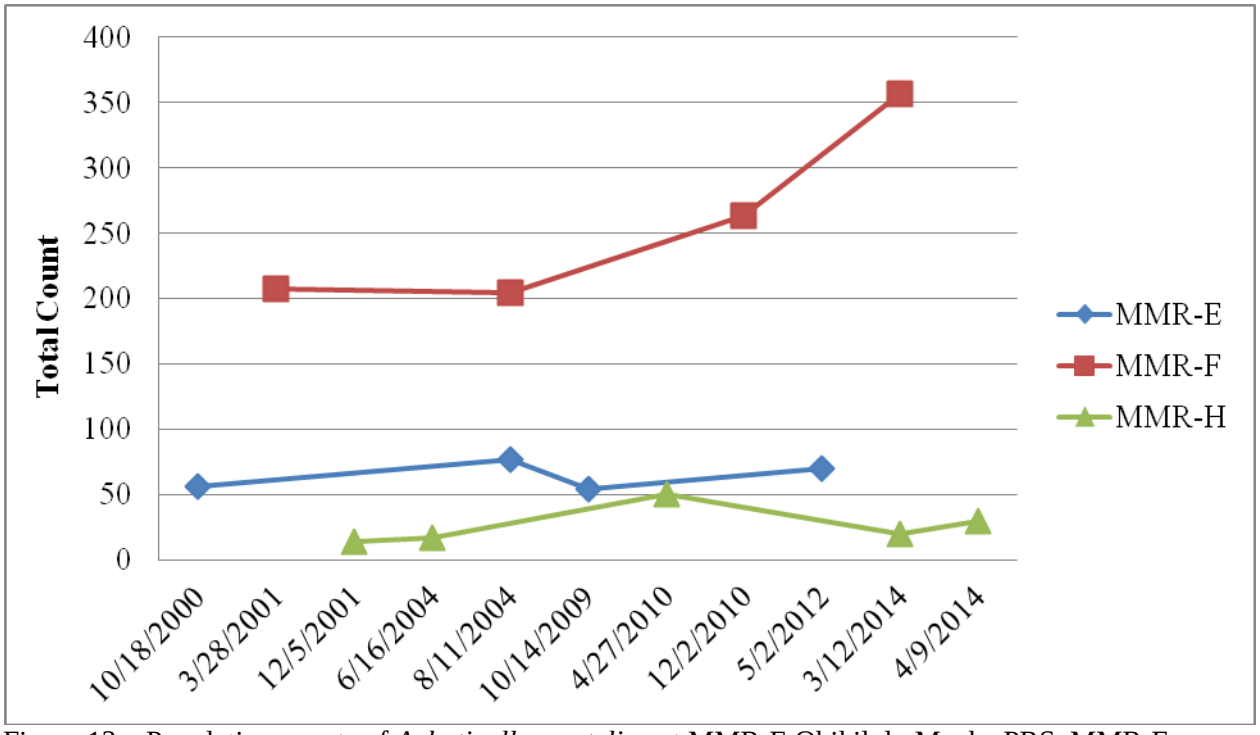

Figure 13. Population counts of *Achatinella mustelina* at MMR-E Ohikilolo Mauka PRS, MMR-F Ohikilolo Makai PRS, MMR-H Ohikilolo Koiahi Prikaa Reintro PRS

The decline at Koiahi has been a point of discussion at OANRP. It is possible that the declines were caused by snails being isolated from one another, thus reducing reproduction, rather than directly by predation. As mentioned above, OANRP has not found *E. rosea* or Jackson's chameleons in this ESU. Staff also searched the area for evidence of rat damage and found none. However, it is possible that rat predation was missed. Data collected from 2010 shows that 50 snails were seen in a total of 41 trees (40 *M. lesertiana* and 1 *Schinus teribinthifolius*). In March of 2014 twenty snails were seen in a total of 18 trees (16 *M. lessertiana* and 2 *S. teribinthifolius*). Staff returned a month later to do a more thorough search and found 30 snails in 23 different trees.

To address these concerning declines OANRP took two management steps. An A24 grid was deployed to address rat threats. Thirty snails were concentrated into a centrally located *M. lessertiana* with hopes of stimulating reproduction. Most of the snails (27) were within 40 meters of each other but three snails were brought over from the gulch to the west, about 100 meters away.

3.3.2.4 No management PRS

The additional 6 PRS have 22 counted snails total. These are mostly small remnant sites that are of limited management utility as compared to the more robust MFS PRS.

3.3.3 ESU-B1, Future Management

Monitoring and rat control (adapted with best possible methods) will continue at all MFS PRS (Table 6 and 7). As this ESU site does not have a threat of *E. rosea* and the rats are controlled at all MFS PRS, no extensive management changes are necessary. *Euglandina rosea* will continue to be a focus to ensure that it is not inadvertently introduced. No enclosures are planned in the future as current threat control appears adequate. An enclosure is planned to be constructed at 3 Corners specifically for ESU-B2 snials. ESU-B1 snails could be placed in the enclosure with ESU-B2 snails to increase genetic diversity. OANRP is currently supporting a genetic study that will be used to determine if mixing of B1 and B2 is the best approach. OANRP will continue to monitor the Koiahi PRS quarterly and if numbers continue to decline they will be collected and moved up to the Ohikilolo PRS. The management trigger for translocation will be if the timed count drops to 15 snails (50% decline in snails from the most recent count). OANRP has no planned management actions at the NM PRS.

Table 6. ESU-B1 monitoring plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-E Ohikilolo Mauka	TCM	every 2 years	2016, 2018	Establish first full "sweep" through mauka patch. Track number of hours and use as baseline to standardize by.
	GSP	annual	all	GSP MMR-E-1
MMR-F Ohikilolo Makai	TCM	every 2 years	2015, 2017	Establish first full "sweep" through makai patch. Track number of hours and use as baseline to standardize by.
	GSP	annual	all	GSP MMR-F-1, MMR-F-3, MMR-F-4
MMR-H Ohikilolo Koiahi	Survey		2015	Conduct night survey to find areas that still have snails. After initial survey, adjust monitoring schedule/goals based on results.
	GSP	quarterly	all	Conduct quarterly GSP at Koiahi in conjunction with rat control to help determine if snails should be moved to the forest patch (MMR-F).

Table 7. Three Year Action Plan for ESU-B1

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2016 – September 2017
MMR-E Ohikilolo Mauka	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control

			• Consider moving snails to 3 corners enclosure
MMR-F Ohikilolo Makai	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Consider moving snails to 3 corners enclosure
MMR-H Ohikilolo Koiahi	• Implement monitoring plan • Rat control • Translocate as directed in plan	• Implement monitoring plan • Rat control • Translocate as directed in plan	• Implement monitoring plan • Rat control • Translocate as directed in plan

3.3.4 ESU-B2, Management History and Population Trends

ESU-B2 extends across the gulches of Makaleha from West Makaleha, east to Kaawa gulch. Unfortunately, there are *E. rosea* known from this ESU site. Rats are also present at all sites. However, Jackson's chameleons have not been found. ESU-B2 covers a significant amount of area, and OANRP conducts threat control at the two PRS that are designated MFS: LEH-C East Branch of East Makaleha Culvert 69, and LEH-D East Branch of East Makaleha Culvert 73. OSEPP does additional rat control at another high-concentration site, LEH-E East Makaleha culvert 56-57. Combined the MFS sites have 307 counted snails (Table 8). There are 9 other PRS that are designated as NM and have a total of 245 counted snails; however, many sites have not recently been monitored. The NM PRS will be discussed below in a single section.

Table 8. ESU-B2 population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: B2	**East and Central Makaleha**											
AAW-A Kaawa Gulch	No Management	46	2009-11-17	38	6	2	0	No	No	No	No	No
LEH-A Central Makaleha (culvert 39)	No Management	63	2011-04-27	37	19	7	0	No	No	No	No	No
LEH-B East Makaleha (culvert 45)	No Management	33	2011-04-19	11	12	10	0	No	No	No	No	No
LEH-C East Branch of East Makaleha (culvert 69)	Manage for stability	263	2014-07-24	201	56	6	0	No	No	Yes	No	No
LEH-D East Branch of East Makaleha (culvert 73)	Manage for stability	44	2013-03-11	23	12	9	0	No	No	Yes	No	No
LEH-E East Makaleha (culvert 56-57)	No Management	42	2008-02-12	32	9	1	0	No	No	Yes	No	No
LEH-G East Makaleha (culvert 59)	No Management	3	2006-04-17	3	0	0	0	No	No	No	No	No
LEH-H East Makaleha (culvert 54)	No Management	34	2000-03-23	0	0	0	34	No	No	No	No	No
LEH-I East Makaleha (culvert 67)	No Management	16	2000-03-23	16	0	0	0	No	No	No	No	No
LEH-J East Makaleha (culvert 69 - lower down	No Management	2	2006-11-16	2	0	0	0	No	No	No	No	No
LEH-K Culvert 43 Ridge	No Management	6	2009-08-04	3	3	0	0	No	No	No	No	No
	ESU Total:	552		366	117	35	34					

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.

3.3.4.1 LEH-C, East Branch of East Makaleha Culvert 69 PRS

OANRP has been monitoring the LEH-C Culvert 69 PRS for 14 years. The data shows declining numbers since 2010 (Fig. 14). This is a very difficult PRS to monitor and manage due to steep and thickly vegetated terrain. Monitoring requires rappelling up to 300 ft to access snail areas and requires working in thick *Dicranopteris linearis*. There are *E. rosea* known from the area; however, they are only found occasionally. Rat damage was detected in the ground shell plot, and OANRP deployed an A24 rat

control transect along the ridge crest beginning in August 2014. While this effort does not fully cover the PRS it passes through a densely populated area accessible without ropes.

The number of snails seen along the ridge has declined from 423 in 2006, to 430 in 2010, and to 263 in 2014. Fewer small class size snails have been seen in this area as well. Currently, staff survey the ridge only at night whereas on May 19, 2010 the area was searched both during the day and night so there was a chance that some snails might have been counted twice along the ridge.

3.3.4.2 LED-D East Branch of East Makaleha Culvert 73 PRS

OANRP has been monitoring the Culvert 73 PRS for 10 years (Fig. 14). This PRS is located one ridge to the east of Culvert 69 and has similar habitat. The PRS does not appear to be in decline. It is likely there are more snails in this area as OANRP has not done extensive rappel searches. *Euglandina rosea* are assumed to be in the area but at low density as they have not been detected. Rat damage has not been detected but could easily be missed due to thick vegetation. As with Culvert 69, OANRP deployed an A24 rat control transect along the ridge crest in August 2014.

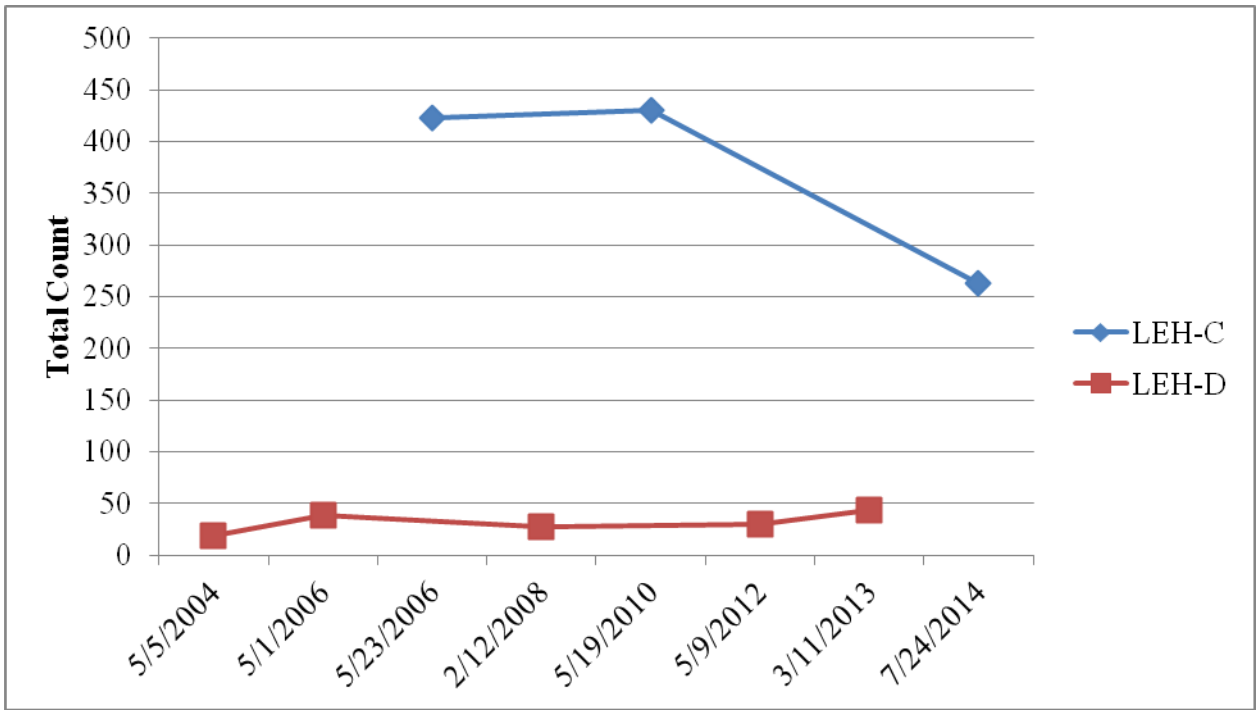

Figure 14. Population counts of *Achatinella mustelina* at LEH-C East Branch of East Makaleha Culvert 69 PRS and LEH-D East Branch of East Makaleha Culvert 73 PRS

3.3.4.3 No Management PRS

OANRP revisited some of these PRS in 2014 to get updated numbers and status. Unlike ESU-B1 there are relatively large numbers of snails (245) in the nine NM PRS.

3.3.5 ESU-B2, Future Management

Monitoring and rat control will continue, and hopefully rat management action will have a positive benefit on the population trend (Table 9 and 10). Unfortunately, it is not feasible to install an enclosure at the MFS sites or at most of the NM sites. OANRP is planning to install an enclosure at the 3 Corners

given that the terrain is suitable for construction and the area contains snail host trees. The habitat can be further improved through common native outplanting. When construction is complete, a subset of snails from ESU B2 and perhaps B1 could be combined into the enclosure. As mentioned above OANRP is supporting a genetics study that will help determine the best management approach. As goal numbers are met with the two MFS PRS, OANRP has no planned management actions at the NM PRS.

Table 9. ESU-B2 Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
LEH-C East Culvert 69	TCM	every 3 years	2017, 2020	Conduct night TCM for 12 person-hours, and day TCM for 24 person-hours in steep areas of site (see prior notes to replicate search areas).
	GSP	annual	all	GSP LEH-C1; stop if too much damage to vegetation is occurring.
LEH-D East Culvert 73	TCM	annual	all	Conduct day TCM for 8 person-hours.
	GSP	annual	all	GSP LEH-D-1; stop if too much damage to vegetation is occurring.

Table 10. Three Year Action Plan for ESU-B2

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2016 – September 2017
LEH-C East Culvert 69	• Implement monitoring plan • Rat control • Pursue construction of enclosure at 3 Corners	• Implement monitoring plan • Rat control • Pursue construction of enclosure at 3 Corners	• Implement monitoring plan • Rat control • Translocate snails to 3 Corners enclosure
LEH-D East Culvert 73	• Implement monitoring plan • Rat control • Pursue construction of enclosure at 3 Corners	• Implement monitoring plan • Rat control • Pursue construction of enclosure at 3 Corners	• Implement monitoring plan • Rat control • Translocate snails to 3 Corners enclosure
NM PRS			• Translocate snails to 3 Corners enclosure

3.4 ESU-C

3.4.1 Description

ESU-C (Fig. 15) is the most restricted in range of all 6 ESUs. It covers an area from North Haleauau Gulch to Puu Pane ridge, which runs up to the summit of Mt. Kaala (Fig. 16). The two furthest extant sites are separated by about 1 km. There are historic locations to the east in Manuwai, Alaiheihe and Palikea gulches, but snails have not been seen there for many years. There are two sites in North Haleauau at 2400 ft that are mesic with *Antidesma platyphylum* and *N. sandwicensis* while the site on the Puu Pane ridge crest is at 3100 ft and is much wetter with a canopy of primarily *M. polymorpha*. This ESU receives about 1400 mm at the lower sites and 1600 mm at the higher sites (Giambelluca 2013).

Figure 15. Photographs showing diversity of *Achatinella mustelina* in ESU-C

Map removed to protect rare resources, available upon request

Figure 16. Map of ESU-C showing current and historic locations of *Achatinella mustelina*

3.4.2 Management History and Population Trends

OANRP conducts rodent control at all three MFS sites (Table 11). *Euglandina rosea* has been reported and its prevalence is unknown. One Jackson's chameleon skeleton was seen near the North Haleauau area in 2012, however the density of this threat is altogether unknown. The MFS sites have a total of 392 counted snails. There are 11 other PRS that are designated as NM with a total of 32 counted snails. Most of these sites are historic and were well searched by OANRP with no snails found remaining. The NM PRS will be discussed below in a single section.

Table 11. ESU-C population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: C	**Schofield Barracks West Range, Alaiheihe and Palikea Gulches**											
ALI-A Palikea gulch	No Management	0	2009-06-02	0	0	0	0	No	No	No	No	No
ALI-B Palikea gulch west. Just east of Alaiheihe/Palikea dividing ridge.	No Management	0	2009-06-02	0	0	0	0	No	No	No	No	No
ANU-A Manuwai gulch	No Management	1	2004-06-02	0	1	0	0	No	No	No	No	No
IHE-A Alaiheihe Gulch Western Most Site	No Management	0	2005-03-22	0	0	0	0	No	No	No	No	No
IHE-B Alaiheihe middle site "Ptemac Site"	No Management	3	2009-06-02	1	2	0	0	No	No	No	No	No
IHE-C Alaiheihe below Nalu's LZ, TT's spot	No Management	0	2005-03-22	0	0	0	0	No	No	No	No	No
SBW-A North Haleauau Hame Ridge	Manage for stability	80	2013-06-29	36	39	5	0	Yes	No	Yes	No	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	No
SBW-C North Haleauau just above Pouteria pair territory	No Management	0	2009-09-06	0	0	0	0	No	No	No	No	No
SBW-P South Water gulch by Stenogyne kanehoana	No Management	10	2005-01-19	3	7	0	0	No	No	No	No	No
SBW-W Skeet Pass	Manage for stability	303	2014-08-27	190	89	24	0	Partial	No	Yes	No	No
SBW-X elepaio #4	No Management	1	2009-11-23	0	1	0	0	No	No	Yes	No	No
SBW-Y Elepaio #8	No Management	3	2009-11-23	0	3	0	0	No	No	Yes	No	No
SBW-Z Clair's Ridge	No Management	14	2010-06-03	10	4	0	0	Yes	No	No	No	No
	ESU Total:	424		249	146	29	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.

3.4.2.1 SBW-A North Haleauau Hame Ridge PRS

OANRP has been monitoring the SBW-A PRS since 1997. The counts peaked in June of 2013 with 80 snails seen (Fig. 17). However, since that time day observations have indicated that there has been a decline. OANRP staff will conduct a night survey in the next year to determine population trends. This is a difficult PRS to monitor and manage because it occurs in the impact area above Schofield Barracks where unexploded ordnance is present (UXO). OANRP staff are only able to access the site during periods without live-fire training on Range, and must be accompanied by a UXO escort. There are *E. rosea* known from the area, however, they are only found occasionally and the level of threat is unclear. Rat damage has not been detected with OANRP controlling rats in the area since 2009. During the elepaio nesting season, January through June, a contractor resets the rat traps every two weeks or as often as possible given range restrictions. From June through December, OANRP staff reset the traps every six weeks.

3.4.2.2 SBW-B North Haleauau One Ridge North of Hame PRS

OANRP has monitored the SBW-B PRS since 2000 (Fig 17). It is only about 100 m northwest of the SBW-A PRS discussed above. In May 2009 a total of seven snails were translocated from NM PRS SBW-C, which is located about 100 meters away and heavily impacted by pigs, to a fenced area within SBW-B. Four months later, four of the seven snails were found but thereafter, none of these snails were observed again. Overall, the number of snails counted has declined over the years. On the last night survey in June of 2013 staff counted 4 snails (Table 11). In November of 2013 staff conducted a day search and found only one. Another night survey will be conducted in the next year. *Euglandina rosea* are in the area and have been collected. Rat damage has not been detected but could easily be missed due to thick vegetation. Rat control is conducted by OANRP and contract staff as at SBW-A.

3.4.2.3 SBW-W Skeet Pass PRS

Discovered in 2009, the SBW-W PRS is by far the richest site for ESU-C with over 70% of the known snails found here. Located at a higher elevation on the ridge crest, it is a very different habitat than the PRS in North Haleauau. Snail counts have increased since 2011 (Fig. 17); however, this is due in part to an expansion of search area and time. The survey area has now been standardized and future searches will be conducted over the same area for the same amount of time. OANRP has been controlling rats in this PRS since 2012. In 2014, additional protection was added with A24s installed to supplement the Ka Mate traps deployed in December 2011. *E. rosea* has been detected on site and the threat level is not well understood.

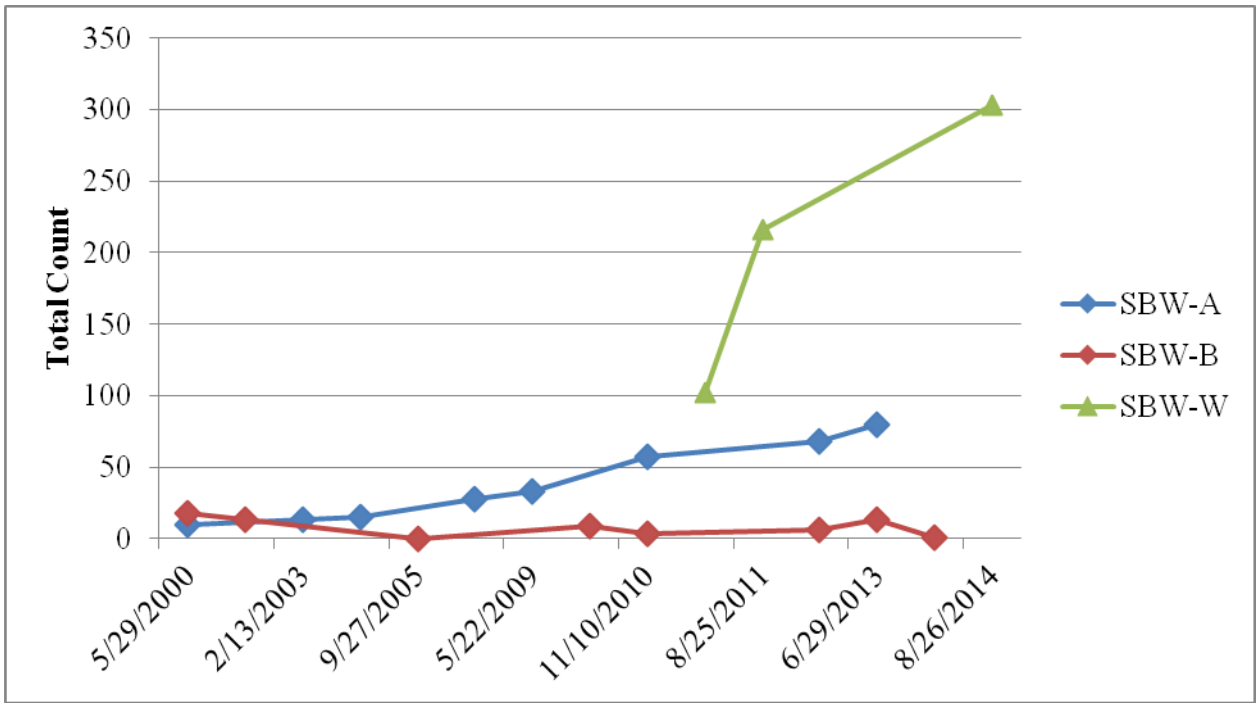

Figure 17. Population counts of *Achatinella mustelina* at SBW-A Hame Ridge PRS, SBW-B One Ridge North of Hame PRS in North Haleauau and SBW-W Skeet Pass PRS

3.4.2.4 No Management PRS

Of the NM PRS only SBW-Z is not historic. This site has not been revisited since 2010. OANRP will visit this site as time allows.

3.4.3 Future Management

OANRP plans to deploy A24 traps at the locations in Haleauau in 2014-2015 to increase rodent control. Staff will also continue to search for and remove any Jackson's chameleons found. Plans to build an enclosure that house snails in this ESU will be further developed this year. To date, sites on Mount Kaala are the most favorable for enclosure construction (Fig. 16). While Haleauau does have suitable habitat and terrain for an enclosure, the presence of UXO and access restrictions make it a poor candidate. The Skeet Pass PRS is too steep for enclosure construction. At Kaala, a site at 3600 ft elevation and about 1km from the nearest PRS has been identified as a possibility. Alternatively, there are sites closer to the summit of Kaala where an enclosure could be constructed. However, there is hesitation in building at these locations that are all above the current elevational range of *A. mustelina* by approcimately 400 ft. Considering global climate change, the range of these sites may already be suitable for snails. OANRP would like to work with modeling experts to discuss whether the Kaala summit area should be considered as a site for an enclosure and translocation. OANRP has also discussed the possibility of conducting a short term translocation to a site at this elevation to determine suitability and survivorship before investing in construction of an enclosure. Translocation is proposed for the MFS PRS, as well as the NM PRS with remaining snails, upon completion of the Kaala enclosure.

Table 12. ESU-C Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
SBW-A	TCM	annual	all	Conduct night TCM for 6 person-hours.

North Haleauau				
SBW-B North of North Haleauau	TCM	annual	all	Conduct night TCM for two person-hours. Pay special attention for the marked translocated snails from SBW-C.
SBW-W Skeet Pass PRS	TCM	every 2 years	2017, 2019	Conduct night TCM for 6 person-hours.

Table 13. Three Year Action Plan for ESU-C

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2016 – September 2017
SBW-A North Haleauau	• Implement monitoring plan • Install A24 Rat control • Investigate construction of enclosure at Kaala	• Implement monitoring plan • Rat control • If viable site is determined construct enclosure at Kaala	• Implement monitoring plan • Rat control • Translocate snails to Kaala enclosure
SBW-B North of North Haleauau	• Implement monitoring plan • Install A24 Rat control • Investigate construction of enclosure at Kaala	• Implement monitoring plan • Rat control • If viable site is determine construct enclosure at Kaala	• Implement monitoring plan • Rat control • Translocate snails to Kaala enclosure
SBW-W Skeet Pass PRS	• Implement monitoring plan • Rat control • Investigate construction of enclosure at Kaala	• Implement monitoring plan • Rat control • If viable site is determine construct enclosure at Kaala	• Implement monitoring plan • Rat control • Translocate snails to Kaala enclosure
NM PRS			• Translocate snails to Kaala enclosure

3.5 ESU-D

3.5.1 Description

ESU-D (Fig. 18) spans the largest area of all ESU, and hosts the largest number of snails counted. The area stretches 8 km from Makaha to Kaluaa (Fig. 19). Between Makaha and Kaluaa, snails occur in North and South Haleauau, Mohiakea and Waieli. Like ESU-B, ESU-D is split into two separate areas: ESU-D1 in the East and ESU-D2 in the West, separated by Kolekole Pass. These sub-ESUs are not genetically based but rather are a purely geographic split. ESU-D1 ranges in elevation from 2000 ft to 2800 ft and occurs mostly in mesic forest with *Pisonia umbellifera* and *M. lessertiana* as common hosts. This area receives about 1200 mm of rainfall per year (Giambelluca 2013). ESU-D2 ranges in elevation from 2400 ft to 3700 ft on the slopes of Kaala. With such an elevational range ESU-D2 has a wide variety of host trees. ESU-D2 receives about 1700-1900 mm of rainfall per year (Giambelluca 2013). In the middle section of this ESU, between Makaha and the Puu Hapapa snail enclosure, there are 24 NM PRS with a total of 529 *A. mustelina* counted over the years. Many of these areas have not been surveyed recently and are not a management priority. These snails are discussed below as ESU-D-NM.

Figure 18. Photographs showing diversity of *Achatinella mustelina* in ESU-D

Map removed to protect rare resources, available upon request

Figure 19. Map of ESU-D showing current and historic locations of *Achatinella mustelina*

3.5.2 ESU-D1, Management History and Population Trends

A predator proof enclosure was constructed at the KAL-G Puu Hapapa PRS in 2012. All predators including: *E. rosea*, Jackson's chameleons, and rats were removed by August, 2012, and have not been found since that time. Since predator removal, more than 1700 snails have been reintroduced from the HTSCL and translocated from PRS locations in Waieli and Kaluaa. Monitoring data show a stable population (detailed in the following section). Habitat restoration including regular weed control and restoration of snail host and cover plants has been ongoing (Appendix 1-3-3), Snail Enclosure Restoration Summaries). KAL-G Puu Hapapa is the only MFS PRS within ESU-D1, with 380 snails counted. There are 10 other NM PRS, with 289 snails counted (Table 14). However, these counts occurred prior to translocation, and consequently the number of snails remaining is less than that indicated in Table 14. The NM PRS will be discussed below in a single section.

Table 14. ESU-D1 population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D1	**North Kaluaa, Waieli, Puu Hapapa, and Schofield Barracks South Range**											
ELI-A	No Management	3	2010-02-09	1	2	0	0	Yes	No	No	No	No
South Waieli Gulch North Branch												
KAL-A	No Management	64	2011-08-31	24	19	21	0	Yes	Yes	Yes	Partial	No
Land of 10,000 snails												
KAL-B	No Management	20	2003-01-07	20	0	0	0	Yes	No	No	No	No
Gulch 1 Kaluaa												
KAL-C	No Management	2	2010-09-20	2	0	0	0	No	No	No	No	No
South Waieli Gulch North Branch												
KAL-D	No Management	20	2011-10-04	10	8	2	0	Yes	Yes	No	No	No
Gulch 3												
KAL-E	No Management	8	2012-04-16	8	0	0	0	Yes	Yes	No	No	No
Gulch 2												
KAL-F	No Management	27	2013-08-27	23	4	0	0	Yes	Yes	No	No	No
Central Kaluaa South Branch												
KAL-G	Manage for stability	380	2014-07-30	215	143	22	0	Yes	Yes	Yes	Yes	Yes
Puu Hapapa snail enclosure												
MIK-A	No Management	0	2012-10-04	0	0	0	0	No	No	No	No	No
Mikilua Gulch												
SBS-A	No Management	1	2007-03-20	1	0	0	0	Yes	Yes	No	No	No
Moho Gulch Lamsan and Amamic exclosure												
SBS-B	No Management	144	2009-07-14	77	34	33	0	No	No	No	No	No
Puu Hapapa												
	ESU Total:	669		381	210	78	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.

3.5.2.1 KAL-G Puu Hapapa Snail Enclosure PRS

OANRP has been carefully monitoring the KAL-G Puu Hapapa PRS since snails were first augmented into the enclosure in February 2012. Snail timed-counts increased over time in parallel with continual augmentations (the last of which occurred in March 2014), suggesting a stable population (Fig. 20). Monitoring is done quarterly during timed-counts at night (for monitoring details see Development of Tree Snail Protection Enclosures: From Design to Implementation PCSU Tech Report in draft (OANRP 2013). OANRP conducts quarterly monitoring for predators within the enclosure. Rat control is conducted outside the enclosure to reduce the surrounding threat.

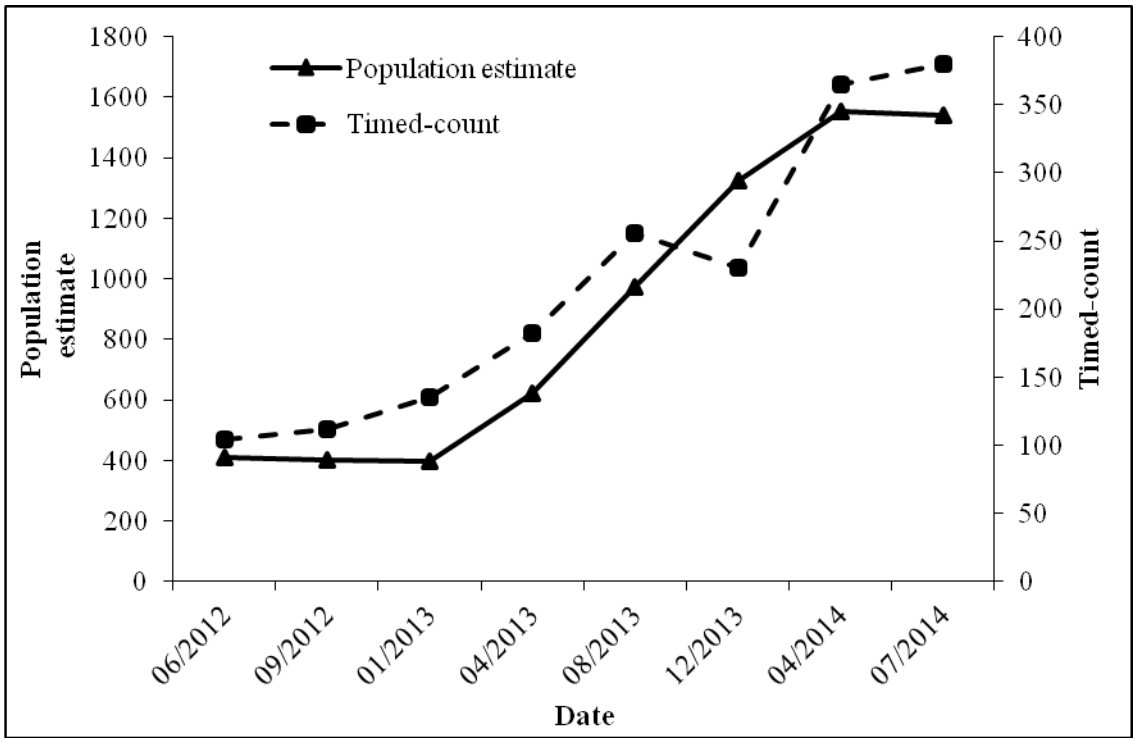

Figure 20. Timed-count monitoring of *Achatinella mustelina* in relation to population estimate at KAL-G Puu Hapapa Snail Enclosure PRS. The population estimate is determined by the number of snails augmented into the enclosure minus the number of shells recovered from ground shell plots.

3.5.2.2 No Management PRS

An additional 10 PRS are not managed in ESU-D1 and are located in Kaluaa and Waieli Gulches. OANRP and OSEPP have translocated snails from many of these sites to the Hapapa enclosure. However, as mentioned above, thorough survey efforts have not been conducted at most of these NM sites. Anecdotally, numbers of snails found in these PRS has been declining rapidly in recent years (D. Sailer pers comm). OANRP does not conduct any predator control at these sites and they will likely continue to decline. SBS-B PRS is the largest NM PRS, spanning the summit of Waieli Gulch, just north of the enclosure. Many of the snails in the enclosure came from this PRS.

3.5.3 ESU-D1, Future Management

OANRP will continue to direct management efforts for ESU-D1 inside the KAL-G Puu Hapapa enclosure. The enclosure will be intensively managed to ensure it remains predator free. The population inside will be closely monitored. OANRP recently installed an experimental sprinkler system in a *P. umbellifera* with a high density of snails in an attempt to provide needed moisture during dry hot periods, and to improve juvenile survivorship. This system can be set up on a timer or activated remotely in the future. OANRP will continue to experiment with this system and may expand it to other enclosures in the coming years. OANRP will consider moving additional snails from NM PRS sites into the enclosure over the next 5 years.

Table 15. ESU-D1 Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
KAL-G Puu Hapapa Snail Enclosure	TCM	quarterly	all	Conduct night TCM with 4 personnel for 6.5 person-hours total. Consider limiting TCM to twice a year.
	GSP	quarterly	all	GSP KAL-G-1

Table 16. Three Year Action Plan for ESU-D1

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2016 – September 2017
KAL-G Puu Hapapa Snail Enclosure	• Implement monitoring plan • Rat control • Maintain enclosure	• Implement monitoring plan • Rat control • Maintain enclosure • Conduct additional outplanting if needed	• Implement monitoring plan • Rat control • Maintain enclosure
NM PRS			• Consider additional translocation of snails to Hapapa enclosure

3.5.6 ESU-D2, Management History and Population Trends

ESU-D2 occurs in Makaha Valley. There are 5 MFS PRS and one site that are designated as NM. The five sites combined have a total of 244 snails counted (Table 17) Currently OANRP does rat control at two sites; MAK-A and MAK-D. *Euglandina rosea* is present within the ESU at concerning levels and staff have collected them along with OSEPP during the past year. No Jackson's chameleons have been detected.

Table 17. ESU-D2 population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D2 Makaha												
MAK-A Isolau ridge	Manage for stability	11	2014-08-20	8	3	0	0	Yes	Partial	Yes	No	No
MAK-B Kumaipo ridge crest	Manage for stability	21	2010-01-19	16	2	3	0	Yes	Partial	No	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	No
MAK-D On ledge below ridge crest above MAK-A site.	Manage for stability	127	2014-08-20	88	36	3	0	Yes	No	Yes	No	No
MAK-E Ridge east of Cyasup exclosure	Manage for stability	36	2009-06-18	28	6	2	0	Yes	Yes	No	No	No
MAK-F Waianae Kai trail to Kaala	No Management	34	2014-04-24	26	7	1	0	No	No	No	No	No
	ESU Total:	244		179	55	10	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.

3.5.6.1 MAK-A Isolau Ridge PRS

Snail counts at MAK-A Isolau Ridge PRS declined from 53 in 2003 to 19 in 2011 (Fig. 21). In 2013 a total of 10 snails were collected for captive rearing at HTSCL to represent the ESU in captive propagation. The snail count this past year was 11 snails. There is one *N. sandwicensis* known from this site that over the years had held the majority of the site's snail population. The health of this tree is declining, which may pose an additional threat to the remaining snails.

3.5.6.2 MAK-B Kumaipo Ridge Crest PRS

Snail counts declined from 32 in 2000 to 21 in 2010 at the MAK-B Kumaipo ridge crest PRS site (Fig. 21). The area is over-due for a current survey. Since the survey in 2000, this site has lost some *M. lessertiana* host trees, which may have contributed to the decline.

3.5.6.3 MAK-C Near Pinnacle Rocks PRS

MAK-C Near pinnacle rocks PRS is also due for a current survey, as this site has not been monitored since 2010 (15 snails counted) (Fig. 21). To date, night surveys have not been conducted at this site as it is not located near any OANRP camping sites.

3.5.6.4 MAK-D On Ledge PRS

Snail counts at MAK-D On ledge PRS increased from 27 in 2005 to 127 in 2014 (Fig. 21). This rise in numbers appears to be a true increase in population, as the survey methods were consistent (all were night counts and the same areas were covered).

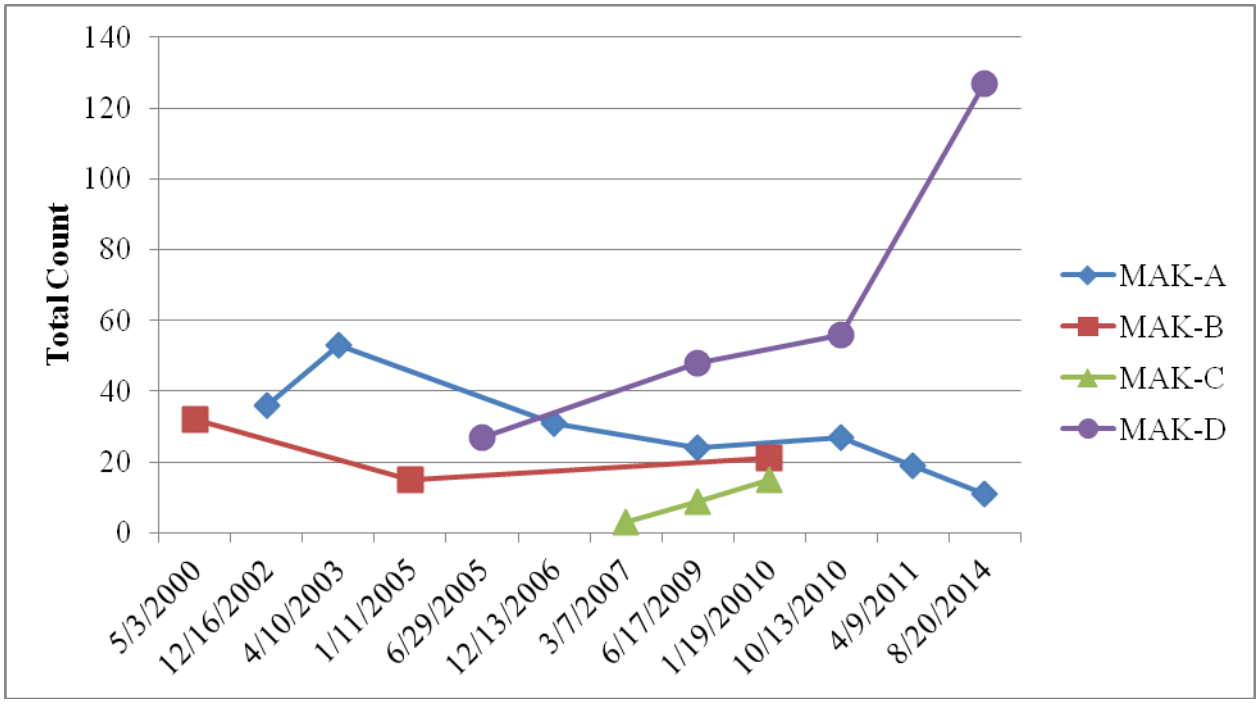

Figure 21. Population counts of *Achatinella mustelina* of MAK-A Isolau Ridge PRS, MAK-B Kumaipo Ridge Crest PRS, MAK-C Near Pinnacle Rocks PRS, and MAK-D On Ledge PRS in Makaha

3.5.6.5 MAK-E Ridge East of Cyasup PRS

MAK-E Ridge east of Cyasup PRS is also due for a current survey, with the only thorough survey completed in 2009 (36 snails counted). This area does not get visited often because it is less accessible than other PRS in Makaha.

3.5.6.6 No Management PRS

Snail counts at MAK-F Waianae Kai trail PRS increased from 23 in 2000 to 34 in 2014 with only two thorough surveys completed. There are likely more snails in this area than previously counted, as surveys are hampered by steep terrain with dense blackberry.

3.5.7 ESU-D2, Future Management

With so few snails and poor health of the host tree OANRP will consider translocating MAK-A Isolau Ridge PRS snails to MAK-D, as this PRS contains the highest concentration of snails in ESU D2. As with MAK-A if fewer than 10 snails are found OANRP will consider translocation for the MAK-B Kumaipo Ridge Crest PRS and MAK-C Near Pinnacle Rocks PRS to MAK-D On ledge PRS. Staff will make an effort to conduct the next survey at MAK-C near pinnacle rocks PRS at night in order to get the best estimation of how many snails remain. Staff will make an effort to survey MAK-E Ridge east of

Cyasup PRS in the coming year and to search at night. OANRP plan to survey MAK-F Waianae Kai trail PRS again in the near future using ropes during the day and also searching at night.

PRS surveys in ESU-D2 are a priority for OANRP in the next two years, as many have not been monitored in several years. Half of the sites will be surveyed in 2015, and the remainder in 2016. Monitoring will be done at night for all sites, as well as daytime searches on rappel at MAK-F Waianae Kai trail. A ground shell plot will be installed at MAK-D On ledge PRS to track mortality. Translocations from MAK-A Isolau Ridge PRS, MAK-B Kumaipo Ridge Crest PRS and MAK-C Near Pinnacle Rocks PRS to MAK-D On ledge PRS will be considered if fewer than 10 snails are found during monitoring, as MAK-D contains the highest concentration of snails in ESU-D2, and its population appears to be growing. OANRP will deploy an A24 rat control grid across MAK-A through E in the next year. This action will hopefully control rats at the ecosystem level and benefit the snails. The prototype grid for this tool is being developed in Kahanahaiki MU. However, the *E. rosea* threat still remains. It is unclear if there is a site appropriate to construct an enclosure to protect snails in ESU-D2. OANRP will continue to investigate sites within the ESU in the next year. MAK-D On ledge PRS has a desirable snail habitat and population growth; however the terrain is not suitable for enclosure construction. If no suitable location is found in ESU-D2, snails will be moved to the KAL-G Puu Hapapa enclosure in ESU-D1 in the next two years.

Table 18. ESU-D2 Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MAK-A Isolau Ridge	TCM	every 2 years	2015, 2017	Conduct night TCM with 3 personnel 2 hours each, for 6 total person-hours.
MAK-B Kumaipo Ridge Crest	TCM	every 2 years	2016, 2018	Conduct night TCM with 2 personnel 4 hours each, for 8 total person-hours.
MAK-C Near Pinnacle Rocks	TCM	every 2 years	2016, 2018	Conduct night TCM for 6 person-hours.
MAK-D On Ledge	TCM	every 2 years	2015, 2017	Conduct night TCM for 10 person-hours. Five hours in the lower area and 5 in the upper.
	GSP	annual	all	add GSP
MAK-E Ridge East of Cyasup	TCM	every 2 years	2016, 2018	Conduct night TCM for 4 person-hours.
MAK-F Waianae Kai	TCM	every 2 years	2015, 2017	Conduct night TCM for 4 total person-hours. Conduct day TCM on rope for 4 person-hours.

Table 19. Three Year Action Plan for ESU-D2

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2015 – September 2016
MAK-A Isolau Ridge	• Resurvey • Implement monitoring plan • Deploy A24 grid • Determine if snails should be translocated to D or F	• Implement monitoring plan • Rat control • If needed translocate	• Implement monitoring plan • Rat control • Translocate snails to enclosure at Makaha or Hapapa

MAK-B Kumaipo Ridge Crest	• Resurvey • Implement monitoring plan • Deploy A24 grid • Determine if snails should be translocated to D or F	• Implement monitoring plan • Rat control • If needed translocate	• Implement monitoring plan • Rat control • Translocate snails to enclosure at Makaha or Hapapa
MAK-C Near Pinnacle Rocks	• Resurvey • Implement monitoring plan • Deploy A24 grid • Determine if snails should be translocated to D or F	• Implement monitoring plan • Rat control • If needed translocate	• Implement monitoring plan • Rat control • Translocate snails to enclosure at Makaha or Hapapa
MAK-D On Ledge	• Resurvey • Implement monitoring plan • Deploy A24 grid	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Translocate snails to enclosure at Makaha or Hapapa
MAK-E Ridge East of Cyasup	• Resurvey • Implement monitoring plan • Deploy A24 grid	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Translocate snails to enclosure at Makaha or Hapapa

3.5.8 ESU-D-NM, Management History and Population Trends

When the ESUs were determined, the middle of ESU-D, comprised of 24 PRS sites, was designated NM. Instead, greater emphasis for management was placed on the geographic ends of the ESU-D. OANRP has only occasionally monitored the snails in the NM designation. The Lihue fence completed in December 2012 does however encompass many of these PRS sites and ungulate removal is near completion. Besides this, there is no other threat control performed. Located on the eastern slopes of Mt. Kaala, SBW-R PRS site has the greatest number of snails among the NM sites with 121 snails counted in 2014. Extensive ginger control is on-going in this area, but not much is known about additional threats to the snails at this site. Many of the NM PRS sites have not been surveyed for 7-12 years.

Table 20. ESU-D population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D	**No Management ESU Sites of Waianae Kai, Kaluaa, Puhawai, SBS, and SBW**											
PHW-A Lualualei, Puhawai below Tetfli finger	No Management	11	2009-11-05	10	0	1	0	No	No	No	No	No
SBS-C Lower Moho Gulch - Jennifer Crummer's spot	No Management	10	2003-04-16	10	0	0	0	No	No	No	No	No
SBS-D Two gulches west of Moho gulch enclosure	No Management	15	2012-12-19	12	2	1	0	No	No	No	No	No
SBW-AA Mt Kaala below blue trail fence	No Management	12	2012-10-25	7	5	0	0	Yes	No	No	No	No
SBW-BB Below transect 790	No Management	15	2013-10-10	6	5	4	0	Yes	No	No	No	No
SBW-D Kaala-Kalena ridge on "M" in Military	No Management	1	2000-02-18	0	0	0	1	Yes	No	No	No	No
SBW-E Kaala-Kalena ridge between Military and Reservation	No Management	1	2000-02-18	1	0	0	0	Yes	No	No	No	No
SBW-F North Mohiakea Banana Gulch	No Management	4	2006-06-22	3	0	1	0	Yes	No	No	No	No
SBW-G South of Puu Kalena	No Management	0	2003-10-14	0	0	0	0	Yes	No	No	No	No
SBW-H North Branch of South Mohiakea	No Management	10	1999-08-02	10	0	0	0	Yes	No	No	No	No
SBW-I South Mohiakea Sicyos site	No Management	32	2002-08-28	27	3	2	0	Yes	No	No	No	No
SBW-J Zandip site along Kalena-Kumakalii Ridge	No Management	10	2000-05-17	10	0	0	0	Yes	No	No	No	No
SBW-K Kumakalii-Kalena ridge-"TR" gulch on the map by "Wahiawa District"	No Management	25	2002-12-18	0	0	0	25	Yes	No	No	No	No
SBW-L Kalena-Kumakalii Ridge-Dike rock gulch	No Management	55	2002-10-07	42	13	0	0	Yes	No	No	No	No
SBW-M Puu Kumakalii	No Management	24	2002-02-18	0	0	0	24	Yes	No	No	No	No

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
SBW-N 1st Peak North of Kolekole Pass	No Management	5	2005-07-06	2	1	2	0	No	No	No	No	No
SBW-O North of Puu Kalena Alstri Notch	No Management	7	2000-02-18	2	5	0	0	Yes	No	No	No	No
SBW-Q North of Puu Kalena below Schtri Notch	No Management	81	2007-08-21	47	32	2	0	Yes	No	No	No	No
SBW-R Mt. Kaala southern end of Haleauau fenciline	No Management	121	2014-09-11	92	25	4	0	Yes	No	No	No	No
SBW-S Upper Banana Gulch	No Management	4	2007-08-29	3	1	0	0	Yes	Yes	Yes	No	No
SBW-T Albizzia Gulch	No Management	33	2009-06-10	25	1	7	0	Yes	Yes	Yes	No	No
SBW-U Gulch #1/Tri Gulch Camp	No Management	17	2007-08-22	13	3	1	0	Yes	No	No	No	No
SBW-V Gulch #4/Tri Gulch Camp	No Management	31	2007-08-22	21	9	1	0	Yes	No	No	No	No
WAI-A Waianae Kai - Hesarb site	No Management	10	2000-06-26	0	0	0	10	No	No	No	No	No
	ESU Total:	534		343	105	26	60					

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.

3.5.10 ESU-D, Future Management

There is a significant Jackson's chameleon threat documented from the PRS around Kumakalii. These PRS should be considered for translocation because otherwise they will likely be extirpated soon. Threats at other PRS are not well understood and OANRP should consider moving snails from these PRS into enclosures. As mentioned above OANRP is supporting a genetic study that will hopefully determine what is most appropriate for these snails. Specifically whether they should be moved into the enclosure at Hapapa or a future enclosure at Kaala.

3.6 ESU-E

3.6.1 Description

ESU-E occurs in the middle of the southern Waianae range in Huliwai and Ekahanui Gulches (Fig. 22 and 23). The greatest abundance of snails remains on the north facing slope of Ekahanui gulch. ESU-E is currently the most imperiled ESU due to recent population declines and habitat degradation. PRS sites

occur between 2200-2700 ft in elevation in mesic forest. The most common host tree in this ESU is *M. lessertiana*. ESU-E receives about 1200 mm of rainfall a year (Giambelluca 2013).

Figure 22. Photographs showing diversity of *Achatinella mustelina* in ESU-E

Map removed to protect rare resources, available upon request

Figure 23. Map of ESU-E showing current and historic locations of *Achatinella mustelina*

3.6.2 Management History and Population Trend

There are five MFS PRS and five NM PRS in ESU-E. Combined the MFS PRS counts total 213 snails and NM PRS counts total 41 snails. All the MFS PRS are in Ekahanui. Huliwai PRS are NM and have not been monitored for many years. Numbers were low when last monitored and have likely continued to decline. OANRP maintains an extensive rat control grid in Ekahanui that covers all MFS PRS except EKA-D and EKA-H. *Euglandina rosea* is prevalent in this area and anecdotally appears to be on the increase recently. One Jackson's chameleon was found in Ekahanui two years ago at 1800 ft in Palai gulch and the level of threat is unclear. MFS PRS are discussed individually below, and all NM PRS are discussed in a single section.

Table 21. ESU-E population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: E Puu Kaua / Ekahanui												
EKA-A Mamane Ridge and Near Plapripri EKA-A	Manage for stability	58	2014-08-27	38	15	5	0	Yes	No	Yes	No	No
EKA-B Below north population of Tetlep. Between Plapri EKA-A, EKA-B and EKA-C	Manage for stability	13	2014-08-27	13	0	0	0	Yes	No	Yes	No	No
EKA-C At Plapripri EKA-C site	Manage for stability	88	2014-08-28	69	18	1	0	Yes	No	Yes	No	No
EKA-D Puu Kaua	Manage for stability	11	2012-07-18	7	4	0	0	Yes	No	No	No	No
EKA-E Amastra site	No Management	8	2014-05-28	6	1	1	0	Yes	No	Yes	No	No
EKA-F from Plapri-C head along blue trail under cliffs mauka	No Management	1	2008-11-03	1	0	0	0	Yes	No	No	No	No
EKA-G Cenagr	No Management	0	2013-02-17	0	0	0	0	Yes	Yes	No	No	No
EKA-H South Ekahanui North Branch	Manage for stability	43	2012-09-11	33	6	4	0	Yes	No	Yes	No	No
HUL-A North Huliwai south branch	No Management	10	2007-10-04	6	4	0	0	No	No	No	No	No
HUL-B South Huliwai Gulch	No Management	1	2007-06-18	1	0	0	0	No	No	No	No	No
HUL-C Off Ridge Crest South of Puu Kanehoa	No Management	21	2005-03-01	4	9	8	0	No	No	No	No	No
	ESU Total:	254		178	57	19	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.

3.6.2.1 EKA-A Mamane Ridge PRS

EKA-A Mamane ridge PRS had a steady decline in counted snails between 2004 and 2014, from 183 in 2004 to 58 in 2014 (Fig. 24). Many of the *M. lessertiana* trees here that were the primary hosts for snails have died. Also *E. rosea* have been collected here in higher numbers than in the past. During a camping trip in May 2014 a total of 23 *E. rosea* were found here, some at the base of trees with snails.

3.6.2.2 EKA-B Below Tetlep PRS

EKA-B Below Tetlep PRS has fluctuated in observed numbers over the years with a high of 57 in 2012 (Fig. 24). However, the most recent count of 13 snails observed in 2014 is alarming as it was very thorough night survey across the entire area. Observations in 2010 did not follow current protocol because most staff involved in the survey did not have binoculars. It is difficult to interpret this trend as it is not as clear as EKA-A. *Euglandina rosea* was not reported to the same degree as at EKA-A. However, this threat is easily missed.

3.6.2.3 EKA-C Plapri PRS

Although snails were first found at EKA-C Plapri PRS in 2004, the first survey was not done until 2010. This is a difficult area to survey with steep ledges and cliffs. Over time more snails were found as the search area expanded. The increase in counted snail from 43 in 2010 to 136 in 2012 does not represent an increase in snail population but merely that the search area was expanded. The decline from 136 counted snails in 2012 to 88 in 2014 indicates a decline in the snail population as the survey area and effort were consistent (Fig. 24). Some of the *M. lessertiana* are dying back and OANRP staff have collected *E. rosea* below the snail trees.

3.6.2.4 EKA-D Puu Kaua PRS

EKA-D Puu Kaua PRS showed a steep decline in snail counts from 202 in 2004 to 15 in 2010 after many of the host *M. lessertiana* died during that time (Fig. 24). Neither the habitat nor the snail numbers have ever recovered. Survey efforts in 2010 and 2012 were exhaustive and covered known sites.

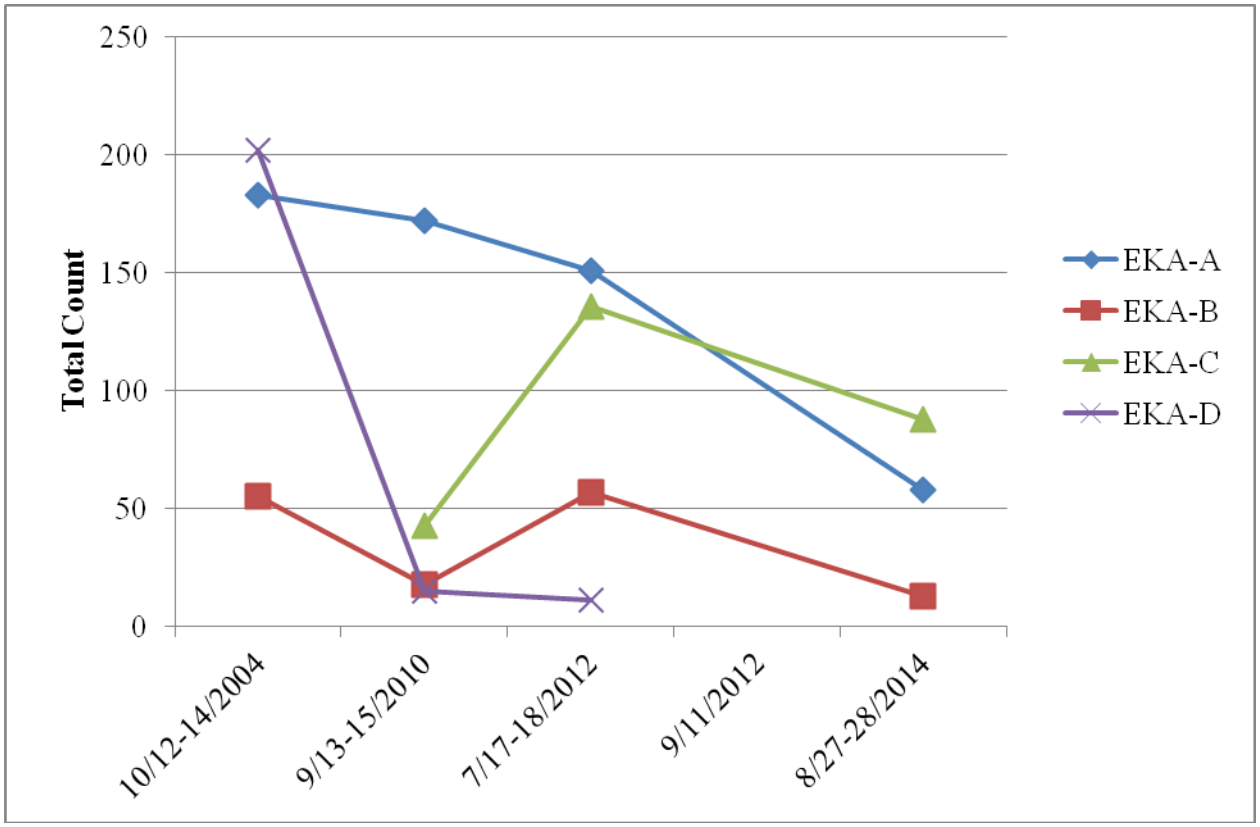

Figure 24. Population counts of *Achatinella mustelina* at EKA-A Mamane Ridge PRS, EKA-B Below Tetlep PRS, EKA-C Plapri PRS, and EKA-D Puu Kaua PRS in Ekahanui

3.6.2.5 EKA-H South Ekahanui North Branch PRS

EKA-H South Ekahanui North branch PRS is steep, difficult to navigate and prone to landslides. Some snails in this PRS site are only accessible by rope. This site has only been visited twice by OANRP because of these challenges. Forty three snails were reported in 2012 and 21 in 2013. In the past this area was not prioritized as an MFS. However, as the numbers in South Ekahanui PRS have declined, management of snails in this PRS site has become more imperative.

3.6.2.6 No Management PRS

Some of the NM PRS have not been surveyed since 2005. It is unlikely that there are very many snails remaining at these locations.

3.6.3 Future Management

ESU-E is the highest priority ESU for OANRP due to the recent declines. Monitoring and threat control with continue (Table 22 and 23), however there are no clear management solutions to the current issues. OANRP staff worked diligently in the last year to search for possible enclosure sites and debated the possibilities, but could not find a feasible site within Ekahanui. As described above, protection from *E. rosea* is likely the most critical management action needed. Currently the most favored option is to build an enclosure at Kapuna for ESU-E. The benefits are that they could be maintained there without mixing them into another ESU. The drawback is that it will likely take three years before construction is complete. A short term management option is to consolidate snails from EKA-B Below Tetlep, EKA-D Puu Kaua, and EKA-H South Ekahanui PRS at a single location within the rat grid (either EKA-A Mamane ridge or EKA-C Plapri PRS, as these are the largest sites). This will enhance reproduction potential and centralize management efforts (to include regular *E. rosea* searches), until an enclosure becomes available. As numbers do not reach the goal for the ESU, OANRP will look to incorporate the few remaining snails from NM PRS in future management strategies.

Table 22. ESU-E Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
EKA-A Mamane Ridge	TCM	every 2 years	2016, 2018	Conduct baseline survey, recording hours to use as standard. Determine night or day TCM.
	GSP	annual	all	GSP EKA-A1
EKA-B Below Tetlep	TCM	every 2 years	2016, 2018	Conduct baseline survey, recording hours to use as standard. Determine night or day TCM.
EKA-C Plapri	TCM	every 2 years	2016, 2018	Conduct baseline survey, recording hours to use as standard. Determine night or day TCM.
EKA-D Puu Kaua	TCM	every 2 years	2016, 2018	Conduct day TCM, 20 person-hours on rope, and 10 person-hours on foot. Refer to prior notes for delineated areas.
EKA-H South Ekahanui	TCM	every 2 years	2016, 2018	Conduct baseline survey, recording hours to use as standard. Day counts due to difficult access.

Table 23. Three Year Action Plan for ESU-E

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2016 – September 2017
EKA-A Mamane Ridge	• Implement monitoring plan • Rat Control • *E. rosea* Searches	• Implement monitoring plan • Rat Control • *E. rosea* Searches	• Implement monitoring plan • Rat Control • *E. rosea* Searches • Translocation to Kapuna enclosure
EKA-B Below Tetlep	• Rat Control • Resurvey • Determine if snails should be translocated to A or C	• Rat control • Translocate	• Rat control • Translocate
EKA-C Plapri	• Implement monitoring plan • Rat Control • *E. rosea* Searches	• Implement monitoring plan • Rat Control • *E. rosea* Searches Translocation to enclosure	• Implement monitoring plan • Rat Control • *E. rosea* Searches • Translocation to Kapuna enclosure
EKA-D Puu Kaua	• Rat Control • Resurvey • Determine if snails should be translocated to A or C	• Rat control • Translocate	• Rat control • Translocate
EKA-H South Ekahanui	• Rat Control • Resurvey Determine if snails should be translocated to A or C	• Translocate	• Translocate

3.7 ESU-F

3.7.1 Description

ESU-F (Fig. 25) occurs at the Southern end of the Waianae range centered around Puu Palikea (Fig. 26). The Palikea MU surrounds most of the snails with one small PRS at Mauna Kapu about 1.5 km to the south. Current locations range in elevation between 2400-3100 ft. The habitat at Palikea is mesic wet forest with snails occurring in a diversity of species including *M. lessertiana*, *C. longifolia*, *A. platyphylum* and *M. polymorpha*. The Palikea area receives about 1200 mm of rainfall a year (Giambelluca 2013).

Figure 25. Photographs showing diversity of *Achatinella mustelina* in ESU-F

Map removed to protect rare resources, available upon request

Figure 26. Map of ESU-F showing current and historic locations of *Achatinella mustelina*

3.7.2 Management History and Population Trends

This ESU has a total of eleven MFS PRS and nine NM PRS (Table 24). MFS PRS have a combined total of 430 counted snails and NM PRS have 20 counted snails total. OANRP has an extensive rat control grid in Palikea that covers all MFS PRS sites. The grid has been in place since 2010. Anecdotal observations indicate *E. rosea* is present here but not in as high numbers as some other ESU. One Jackson's chameleon was found in 2014 at Palikea, adjacent to the enclosure. Jackson's chameleons are commonly observed in the ranch land above Makakilo and have been reported from about halfway up the road that leads to the Palikea trailhead. It is likely only a matter of time before they are a significant threat to this ESU. A predator proof snail enclosure was completed in Palikea MU in 2012 with funds provided by Fish and Wildlife. Along with *A. mustelina* the enclosure also has a population of *Achatinella concavospira* and *Laminella sanguinea*. The latter two are managed by OSEPP. Enclosure maintenance and monitoring responsibilities are shared between OSEPP and OANRP. Restoration work to manage weeds and restore native cover and snail host trees has been underway for the last two years (See Appendix 1-3-3, Snail Enclosure Restoration Summaries for further details). MFS PRS are discussed individually below; all NM PRS are discussed in a single section.

Table 24. ESU-F population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: F Puu Palikea												
KAA-A Mauna Kapu (Palehua)	Manage for stability	21	2014-04-02	13	7	1	0	No	No	Yes	No	No
PAK-A Puu Palikea-Ohia spot	Manage for stability	53	2010-11-07	29	12	12	0	Yes	Yes	Yes	No	No
PAK-B Iele Patch	No Management	1	2008-10-29	1	0	0	0	Yes	Yes	Yes	No	No
PAK-C Steps spot	Manage for stability	5	2014-06-18	5	0	0	0	Yes	Yes	Yes	No	No
PAK-D Joel Lau's site	Manage for stability	5	2012-07-11	4	0	1	0	No	No	Yes	No	No
PAK-E Exogau site	No Management	0	2010-03-04	0	0	0	0	Yes	Yes	Yes	No	No
PAK-F Dodonaea site	No Management	2	2012-03-14	2	0	0	0	Yes	Yes	Yes	No	No
PAK-G Hame and Alani site just above Cyagri fence	Manage for stability	6	2010-11-07	6	0	0	0	Yes	Yes	Yes	No	No
PAK-H Mike Hadfield's study site at Puu Palikea	Manage for stability	17	2013-08-12	6	8	3	0	Yes	Yes	Yes	No	No
PAK-I One ridge truck side of E and F	No Management	3	2011-07-21	3	0	0	0	No	No	Yes	No	No
PAK-K Pilo site	Manage for stability	59	2012-10-24	32	15	12	0	Yes	No	Yes	No	No
PAK-L Olapa site north of Puu Palikea	Manage for stability	15	2011-05-25	12	2	1	0	Yes	Yes	Yes	No	No
PAK-M Middle Site	Manage for stability	201	2012-05-15	109	50	42	0	Yes	No	Yes	No	No
PAK-N Campside of Lobelia Ridge	No Management	1	2008-10-28	1	0	0	0	No	No	No	No	No
PAK-O Below camp fence	No Management	1	2009-09-23	1	0	0	0	No	No	Yes	No	No
PAK-P Palikea snail exclosure	Manage for stability	31	2013-09-17	18	11	2	0	Yes	Yes	Yes	Yes	Yes
PAK-Q outside snail enclosure	Manage for stability	14	2011-11-30	9	3	2	0	Yes	Yes	Yes	No	No

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
PAL-A Palawai next to Pri sp.	No Management	8	2014-05-14	6	1	1	0	No	No	No	No	No
PAL-B Delsub Lama Fence	No Management	2	2011-04-18	1	0	1	0	No	No	Yes	No	No
PAL-C Palawai Hesarb trail	No Management	2	2007-04-30	2	0	0	0	No	Yes	No	No	No
	ESU Total:	447		260	109	78	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.

3.7.2.1 KAA-A Mauna Kapu PRS

KAA-A Mauna Kapu PRS is the southernmost location of snails in the Waianae range and is the most geographically separated PRS site within ESU-F (Fig. 26). It is on the boundary line between DOFAW and private lands. Snail counts have fluctuated since the initial survey found 12 snails in 2005 (Fig. 27). The highest count (40 snails) was in 2010 when night surveys were first initiated. Survey efforts since 2010 have been consistent, and show a declining trend in the population, with only 21 snails counted in 2014. The majority of the snails have persisted in one large *N. sandwicensis* tree. This tree is in decline and has lost most of its leaves. The overall habitat is degraded, dominated by Bamboo, has few snail host trees present, and is presumed insufficient habitat for snails.

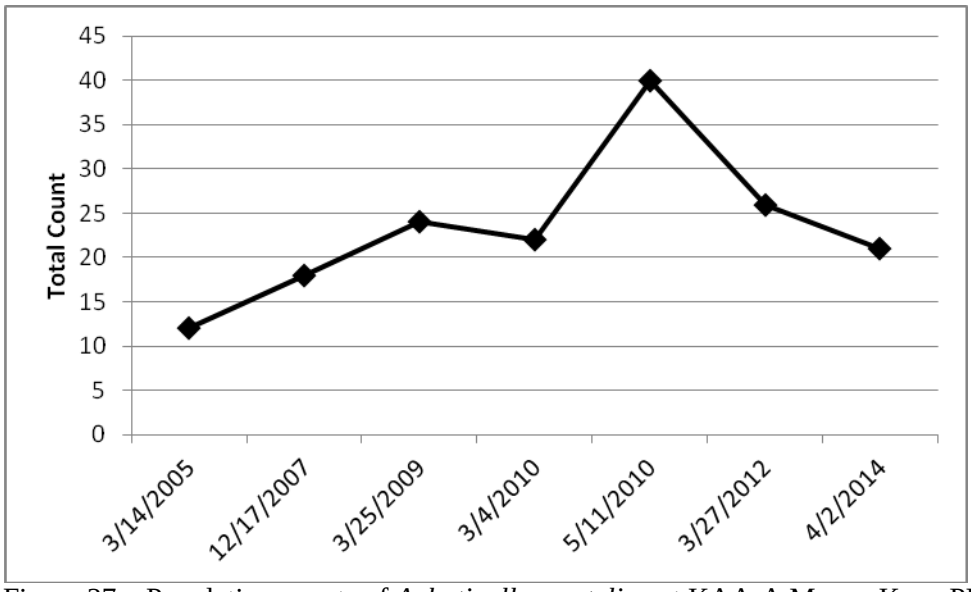

Figure 27. Population counts of *Achatinella mustelina* at KAA-A Mauna Kapu PRS

3.7.2.2 PAK-A Puu Palikea Ohia Spot PRS

PAK-A Puu Palikea Ohia Spot PRS is located near the Puu Palikea summit close to 3100 ft in elevation in short-statured *M. polymorpha*. This PRS has an inconsistent monitoring history. The most snails seen were 53 in 2010 on a night survey with experienced searcher (Fig. 29). This PRS is due for resurvey and recent efforts indicate there may be a decline. *Euglandina rosea* does not appear to be prevalent in this area.

3.7.2.3 PAK-C Steps PRS

PAK-C Steps PRS is near the summit along the Palikea trail. Historically many snails were counted at this site, and could be observed on *M. polymorpha* and *C. longifolia* along the 'steps'. This PRS has declined rapidly, with snail counts dropping from 32 in 2012 to only 5 in 2014 with consistent search efforts (Fig. 29). The cause of decline is unclear as it is within the rat control grid and *E. rosea* do not seem prevalent.

3.7.2.4 PAK-D Joel's PRS

PAK-D Joel's PRS has maintained low snail counts since monitoring began in 2004, with a maximum of 20 snails reported in September 2008. Numbers have declined since that time, with only 5snails counted in 2014 (Fig. 29). Methods have not always been consistent and experience staff needs to resurvey the area. As with PAK-C the cause of this decline is not clear.

3.7.2.5 PAK-G Hame PRS

PAK-G Hame PRS snail counts have oscillated since monitoring began in 2004 (Fig. 29). At this site there are also *A. concavospira*. This complicates the searching especially for inexperienced staff. OSEPP is actively managing the *A. concavospira* to the benefit of the *A. mustelina*. The highest number observed was in 2006 with 30 snails seen. Only 6 snails were observed in 2010. Again the cause of the decline is not clear.

3.7.2.6 PAK-H Hadfield's PRS

PAK-H Hadfield's PRS is the long term study site of Dr. Michael Hadfield, and many years ago had a high density of snails. OANRP has been monitoring the site since 2006 (Fig. 29). Snail numbers are not high but have remained stable since 2010, when 19 snails were counted. The variation in counts is attributed to the difference between day and night surveys.

3.7.2.7 PAK-K Pilo PRS

PAK-K Pilo PRS has the second highest concentration of snails in ESU-F. Fifty-nine snails were counted during the last survey, conducted in 2012 (Fig. 29). The increase in snails over time is due to an increase in the area searched.

3.7.2.8 PAK-L Olapa PRS

The counts for PAK-L Olapa PRS are unclear as the monitoring has been inconsistent and has not been recently surveyed. The most recent survey was in 2011, with 15 snails counted.

3.7.2.9 PAK-M Middle PRS

PAK-M Middle PRS has by far the highest snail count in Palikea, with nearly as many snails as all other MFS PRS combined. The numbers have been stable since September 2009, when 208 snails were counted (Fig. 28). Lower numbers in March 2009 (83 snails counted) are attributed to staff not seaching the entire area. This PRS is in the middle of the rat control grid and thus more protected from rats than other PRS on the edge of the grid.

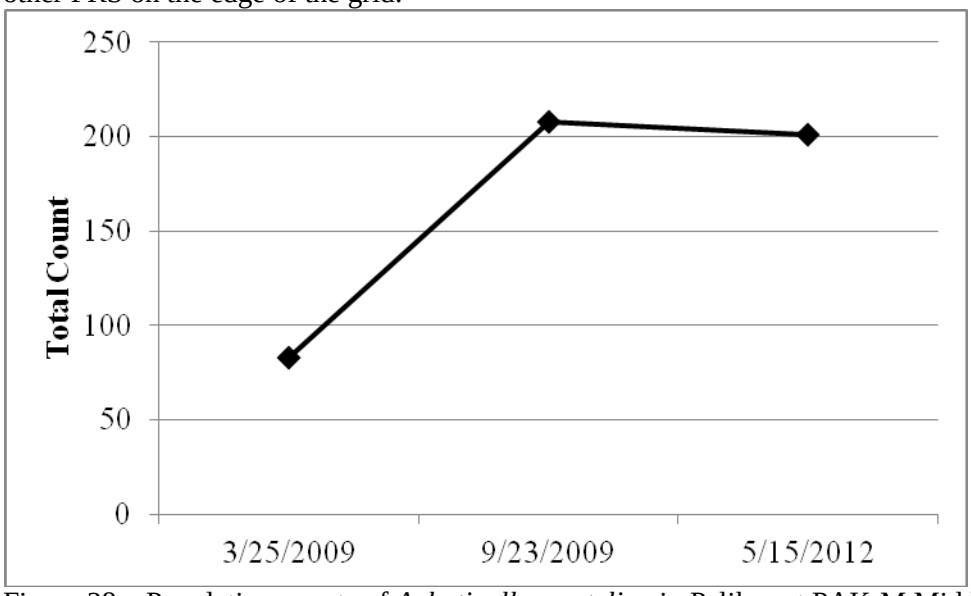

Figure 28. Population counts of *Achatinella mustelina* in Palikea at PAK-M Middle PRS

3.7.2.10 PAK-P Palikea Enclosure PRS

PAK-P Palikea Enclosure PRS was designated in November of 2011 when the enclosure was constructed and separated from PAK-Q by the wall of the enclosure. However, PAK-P and Q were once a single PRS. *A. mustelina* have not yet been translocated into the enclosure. OANRP will begin translocation in the next year. The number of snails is stable within the enclosure, with 31 snails counted during the most recent survey in 2013 (Fig. 29). Lower counts in 2011 and 2012 are attributed to incomplete searches within the enclosure. This PRS is protected by the enclosure from rats, *E. rosea* and Jackson's Chameleons. Since the enclosure was built, a total of 20 *E. rosea* have been removed at this PRS. A total of 14 were found outside the enclosure under the angle barrier, and six were found inside the enclosure. No *E. rosea* have been found inside since February 2014. As mentioned above, a Jackson's chameleon was found just outside the snail enclosure on July 2, 2014. However, none have been found inside and crews have spent many hours conducting night searches for this threat.

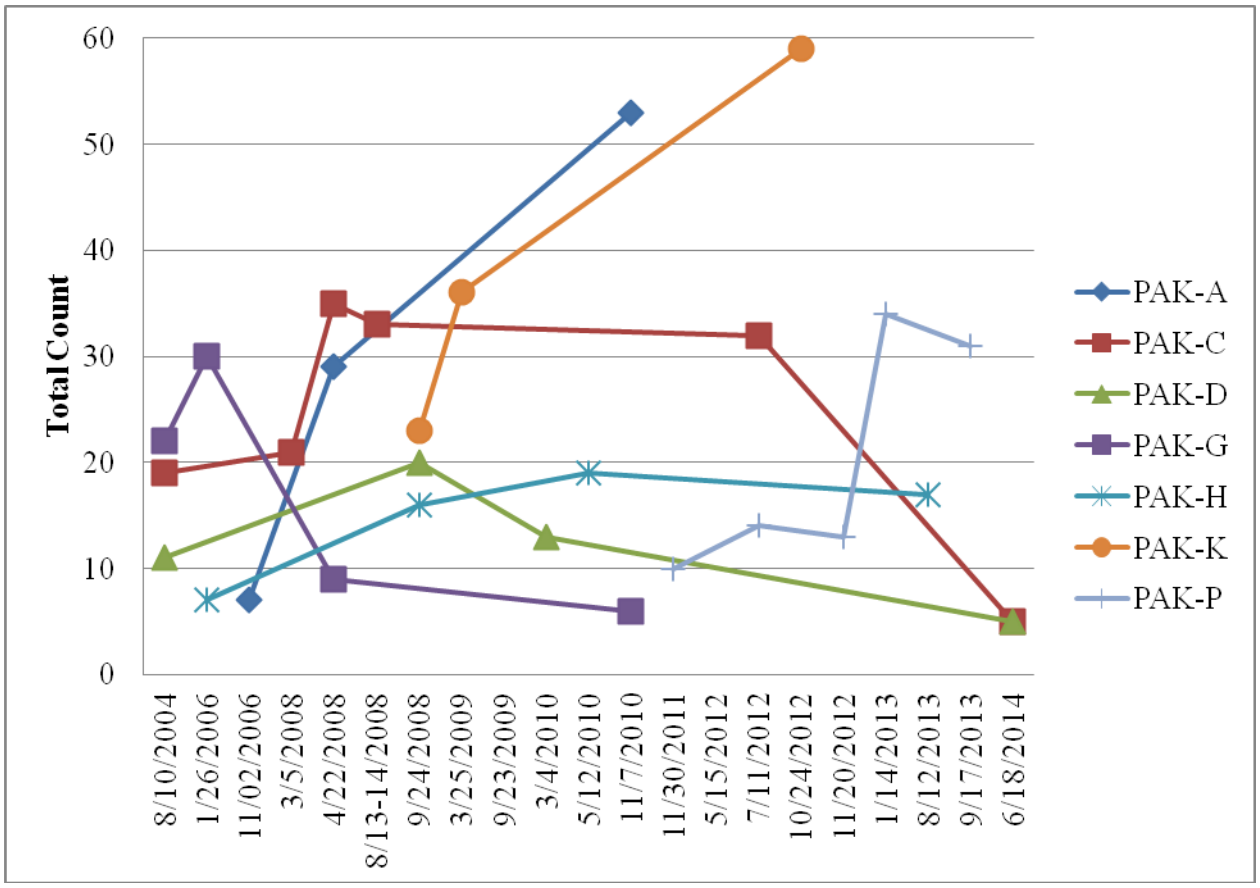

Figure 29. Population counts of *Achatinella mustelina* in Palikea at PAK-A Puu Palikea Ohia Spot PRS, PAK-C Steps PRS, PAK-D Joel's PRS, PAK-G Hame PRS, PAK-H Hadfield's PRS, PAK-K Pilo PRS and PAK-P Palikea Enclosure PRS

3.7.2.11 PAK-Q Outside the Enclosure PRS

There were no *A. mustelina* known in this area until enclosure construction began. After discovery the two PRS were split by the encolusre wall resulting in PAK-P and Q. There are only two observations of PAK-Q Outside the enclosure PRS. The most recent count was 14 snails in 2011.

3.7.2.12 No Management PRS

There are nine NM PRS designated in ESU-F. The most recent monitoring observations indicate that the number of snails at these sites varies from two to eight individuals. Many of the observation dates are old and it is likely that there are currently even fewer snails in many of these sites. Most of the NM PRS sites occur within the rat control grid and are afforded some protection from that particular threat.

3.7.3 Future Management

A combination of management approaches will be used to manage snail populations in ESU-F. The larger PRS (PAK-A Puu Palikea Ohia Spot, PAK-K Pilo, and PAK-M Middle) will be monitored regularly to ensure population numbers are stable while rat control and predator searches continue across the MU. Surveys at PAK-M Middle PRS will require experienced field as the terrain is steep and fragile. Two sites require more monitoring before a deciding if they should be moved to the enclosure (PAK-H Hadfields and PAK-L Olapa). Snails will be translocated within the next year from all other, declining

MFS PRS (KAA-A Mauna Kapu, PAK-C Step's, PAK-D Joel's, PAK-G Hame, PAK-Q Outside the Enclosure) to PAK-P Palikea Enclosure PRS where all predators are excluded. The PAK-P Palikea enclosure will become the management focus for ESU-F with the consideration that snails from many small PRS from this ESU will be moved into the enclosure in the next few years. GSP plots will be established inside the enclosure to monitor mortality of translocated individuals. OANRP will continue to cooperate with OSEPP to ensure the enclosure barriers are maintained and that the enclosure is predator free. All work conducted within this enclosure must be carried out cautiously, paying attention to the much rarer snails within the enclosure being managed by OSEPP. OANRP does not have plans to monitor or conduct threat management at the NM PRS sites, but will instead monitor opportunistically during the course of regular resource management.

Table 25. ESU-F Monitoring Plan for MSF PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
KAA-A Mauna Kapu	TCM	every 3 years	2017, 2020	Conduct night TCM with 2 personnel 2 hours each, for 4 person-hours total until translocation is complete. Translocation will require up to three visits.
PAK-A Puu Palikea Ohia Spot	TCM	every 2 years	2016, 2018	Conduct night TCM for 2 person-hours
	GSP	annual		GSP PAK-A-3
PAK-C Steps	TCM	every 2 years	2016, 2018	Conduct night TCM for 4 person-hours until translocation is complete. Translocation will require up to three visits.
PAK-D Joel's	TCM	every 2 years	2016, 2018	Conduct night TCM for 8 person-hours, (refer to VC for survey area boundaries) until translocation is complete. Translocation will require up to three visits.
PAK-G Hame	TCM	Every two years		Conduct baseline day surveys until translocation is complete. Translocation will require up to three visits.
PAK-H Hadfield's	TCM	every 2 years	2015, 2017	Conduct baseline day survey, recording hours to use as standard.
PAK-K Pilo	TCM	every 2 years	2015, 2017	Conduct day TCM for 4 person-hours .
	GSP	annual	all?	TBD
PAK-L Olapa	TCM	every 2 years	2015, 2017	Conduct baseline survey, recording hours to use as standard. Determine night or day TCM based on terrain.
PAK-M Middle	TCM	every 2 years	2016, 2018	Conduct baseline night survey, recording hours to use as standard.
PAK-P Palikea Enclosure	TCM	annual	2016, 2019	Conduct night TCM for 4 person-hour survey.
PAK-P Palikea Enclosure	TCM	Quarterly	2016, 2017	Once translocation is complete conduct night TCM, standard to be determined.
PAK-Q Outside the	TCM	every 2 years	2016, 2018	Conduct night TCM for 4 person-hours until translocation is complete.

Enclosure				Translocation will require up to three visits.

Table 26. Three Year Action Plan for ESU-F

PRS	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2015 – September 2016
KAA-A Mauna Kapu	• Rat Control • Translocate to enclosure	• Rat Control • Translocate to enclosure	•
PAK-A Puu Palikea Ohia Spot	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control
PAK-C Steps	• Rat Control • Translocate to enclosure	• Rat Control • Translocate to enclosure	• Rat control
PAK-D Joel's	• Rat Control • Translocate to enclosure	• Rat Control • Translocate to enclosure	• Rat control
PAK-G Hame	• Rat Control • Translocate to enclosure	• Rat Control • Translocate to enclosure	• Rat control
PAK-H Hadfield's	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control
PAK-K Pilo	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control
PAK-L Olapa	• Survey • Determine management approach	• To be determined in MIP Year 11	• To be determined in MIP Year 11
PAK-M Middle	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control
PAK-P Palikea Enclosure	• Implement monitoring plan • Rat control • Maintain enclosure	• Implement monitoring plan • Rat control • Maintain enclosure • Conduct additional outplanting if needed	• Implement monitoring plan • Rat control • Maintain enclosure
PAK-Q Outside the Enclosure	• Rat Control • Translocate to enclosure	• Rat Control • Translocate to enclosure	• Rat control

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CHAPTER 4: RARE VERTEBRATE MANAGEMENT

4.1 OIP ELEPAIO MANAGEMENT 2014

4.1.1 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 a minimum of 75 Oahu Elepaio pairs. Management of a pair includes monitoring and rodent control during the breeding season. 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 rodent control and Elepaio monitoring at Schofield Barracks Military Reservation (SBMR) (1998-present), Ekahanui Gulch in the Honouliuli Forest Reserve (2005-present), Moanalua Valley (2005-present), Palehua (2007-present), Makaha Valley (2005-2009), and Waikane Valley (2007-2008). This chapter summarizes Elepaio reproduction results at each of the sites currently being managed, and provides 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 2003 Biological Opinion.

4.1.2 Methods

Monitoring

Throughout the nesting season, from early January to late June, each managed Elepaio territory was visited at one or two-week intervals depending on breeding activity. Single male and paired territories where rodent control is not taking place are also monitored for breeding activity whenever possible, though their results are not included with that of managed pairs. 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. Nest success (successful nests/active nests) was calculated by the number of successful nests per the number of active nests. Active nests are nests known to have had eggs laid in them as determined by observations of incubation. Reproductive success (fledglings/managed pair) was measured as the average number of fledglings produced per managed pair. Some nests were abandoned for unknown reasons before eggs were laid. If a nest is abandoned after an egg is laid it is considered to have failed.

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 vocal recordings were used to lure birds into a mist-net. Each bird was weighed, measured, inspected for molt, fat, overall health, and then released unharmed at the site of capture within one hour.

Rodent Control

This breeding season saw the continued use of small-scale trapping grids containing only Victor® rat snap traps baited with peanut butter. Each grid, deployed throughout the territory of an Elepaio pair, consisted

of 12 snap traps that were tied to trees or rocks to prevent scavengers from removing them. Territories labeled as single or vacant may have also contained snap traps baited throughout the breeding season. These territories once contained an Elepaio pair, but one or both birds have not recently been observed. These territories continue to be baited to help control rodents throughout the management area. Traps were counted as having caught a rodent if hair or tissue was found on the trap. Traps were cleaned with a wire brush after each capture so previous captures were not counted twice. Rodent control was conducted for the duration of the Elepaio nesting season. At Ekahanui, a large-scale rat trapping grid containing 620 snap traps was deployed in 2011 for management of all Elepaio territories in the management unit. Traps at all four sites were checked and rebaited once a week for the first month (December) , then once every two weeks for the rest of the breeding season (January – June). Due to Army training at SBW the frequency of baiting was less often than the other management units (MUs). Fifteen pairs in Banana and North Haleauau gulches were baited only five times during the seven month breeding season. The frequency of re-baiting in December is higher in order to kill as many rodents as possible before Elepaio nesting begins, thus giving the birds the best chance at having successful nests. In 2013, Pono Pacific was contracted to conduct rodent control and monitoring of Elepaio at Moanalua. At SBW, Ekahanui and Palehua, they were contracted to conduct rat control only. OANRP conducted monitoring of birds at SBW, Ekahanui and Palehua. OANRP also assisted in monitoring Elepaio at Moanalua.

4.1.3 Results

With 81 Elepaio pairs managed during the 2014 breeding season, the OANRP fulfilled the required 75 pairs for species management. The results of management conducted for each area during the 2014 breeding season 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 MU. The map denotes all of the territories that were baited. 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 paired 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. Rodent control data and a summary of results are also presented.

Elepaio incubating eggs in an abandoned Red-billed Leiothrix nest at Ekahanui.

Schofield Barracks West Range

Schofield Barracks West Range Territory Occupancy Status and Rat Control 2014

Schofield Barracks West Range Site Demographic Data

SBW	2014	2013	2012	2011	2010
Singles	17	18	16	15	17
Pairs	57	60	58	56	45
Pairs with Rat Control	22	29	28	31	22
Active Nests[1]	16	18	23	34	22
Successful Active Nests[2]	8/16=50%	9/18=50%	16/23=70%	22/34=65%	11/22=50%
Unknown Nest Outcome[3]	3	0	0	0	5
Failed Active Nests	5	9	7	12	6
Family Groups Found[4]	8	15	11	11	9
Fledglings Observed[5]	20	28	28	46	25
Fledglings/Managed Pair[6]	0.91	0.97	1	1.48	1.14

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (sufficient time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[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 in SBW, 50% (8/16) were successful in producing 11 fledglings, while 31% (5/16) of the active nests failed. Another nine fledglings were found with eight managed pairs where no nesting had been observed (family groups). A total of 20 fledglings were observed in territories benefiting from rodent control management. Another 11 fledglings were observed in territories not protected from rats.

Rodent Control Results

In 2014, the number of rodents caught in snap traps decreased 20% from 2013. This is likely due to fewer site visits than the previous year, human error, or the snap trap orientation on a tree limb that could have been unfavorable to rodents. Mohiakea gulch was visited an equal amount of times (13), while Banana and North Haleauau each saw one fewer visit (5) than in 2013 (6).

Schofield Barracks West Range Rodent Control Data

SBW	# Traps	# Rats in Traps	Rats/Trap
2014	352	931	2.6
2013	372	1176	3.2

Summary

Access in SBW was again limited in 2014. Mohiakea gulch was fairly accessible throughout the breeding season, though monitoring at Banana and North Haleauau was limited due to weekly training by the Army and occasional maintenance and upgrades to the firebreak road. Managed Elepaio pairs in SBW decreased 24% from the previous year, though overall resident pairs just slightly decreased. Previously managed pairs may have suffered the loss of a mate and it is possible that a pair would permanently or temporarily abandon their territory. New pairs were also observed in SBW, taking up residence in suitable habitat previously unoccupied. Snap traps will be added to new paired territories prior to the start of the 2015 breeding season to increase the number of managed pairs within the MU.

Elepaio pair before being banded and released.

Honouliuli Forest Reserve - Ekahanui

Ekahanui Territory Occupancy Status and Rat Control 2014

Map removed to protect rare resources, available upon request

Ekahanui Site Demographic Data

EKA	2014	2013	2012	2011	2010
Singles	5	1	11	14	5
Pairs	30	39	31	30	32
Pairs with Rat Control	28	36	29	30	30
Active Nests[1]	14	26	21	15	12
Successful Active Nests[2]	7/14=50%	17/26=65%	9/21=43%	8/15=53%	1/12=8%
Unknown Nest Outcome[3]	3	3	0	1	6
Failed Active Nests	6	9	12	6	5
Family Groups Found[4]	12	8	6	15	2
Fledglings Observed[5]	21	29	18	26	3
Fledglings/Managed Pair[6]	0.75	0.81	0.62	0.87	0.10

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[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% (7/14) were successful, producing seven fledglings, and 43% (6/14) of active nests failed. Three nests had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Fourteen fledglings were found in 10 managed pairs where no nesting had been observed (family groups). A total of 21 fledglings were observed in territories benefiting from rodent control management.

Rodent Control Results

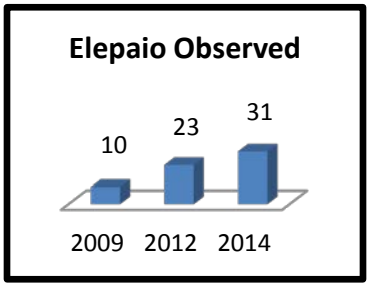
At the end of the 2013 breeding season a small trial was conducted in a portion of the trapping grid to answer whether or not hanging traps in trees catches more rats than when the traps are housed in wooden boxes on the ground. Results of this trial indicated that more rats may be caught if traps are in trees. For the 2014 Elepaio nesting season, the majority of the Victor® rat traps inside the grid were removed from their protective wooden boxes and placed higher off the ground on limbs of nearby trees. The majority of traps on the perimeter of the grid remained in the wooden boxes on the ground. This new technique proved very successful, resulting in a 40% increase in rodent catches. OANRP will be looking to move the remaining perimeter traps into trees, as well as, testing a protective cover for the snap traps that can also be attached to nearby tree limbs.

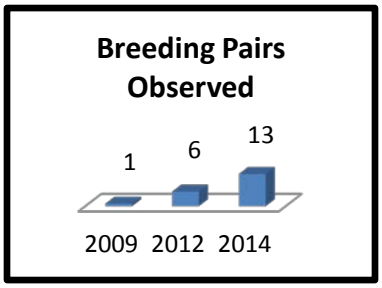
Ekahanui Rodent Control Data

EKA	# Traps	# Rats in Traps	Rats/Trap
2014	618	1285	2.1
2013	620	774	1.2
2012	619	520	0.8

Summary

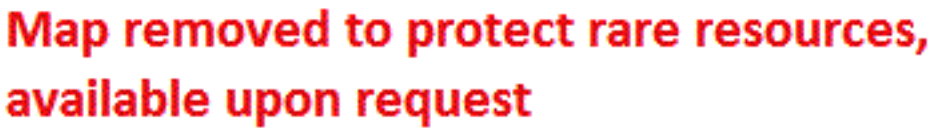
It was an average breeding season at Ekahanui in 2014. The previous year was a very successful one at this site, seeing many pairs added to the MU. This season saw the disappearance of eight managed pairs and fewer active nests. In March, the first ever observation took place of an Elepaio pair in Hawaii successfully fledging their young from the nest of a different bird species. The pair chose to use an abandoned Red-billed Leiothrix (*Leiothrix lutea*) nest. The pair began incubation in February and fledged a single chick in mid March. Elepaio have been observed nesting in exotic bird nests in the past, though a successful fledgling has never been recorded. In January, a survey took place in two drainages north of the Ekahanui MU. These drainages are known as North Ekahanui and Huliwai. Two surveys had already been conducted in 2009 and 2012 to monitor Elepaio population growth or decline possibly due to management occurring in gulches to the south. The 2012 survey showed a significant increase in the population of birds and the number of Elepaio pairs. The newest survey in early 2014 continued to show an increase in the population with the number of pairs more than doubling in two years. It's possible that successful management in Ekahanui is helping to increase populations in surrounding suitable habitat. Results of the survey in the North Ekahanui and Huliwai drainages are show in the graphs below.





Palehua

Palehua Territory Occupancy Status and Rat Control 2014



Palehua Site Demographic Data

HUA	2014	2013	2012	2011	2010
Singles	2	0	0	0	1
Pairs	11	17	16	17	18
Pairs with Rat Control	10	17	16	17	18
Active Nests[1]	8	16	8	13	10
Successful Active Nests[2]	4/8=50%	11/16=69%	3/8=38%	10/13=76%	2/10=20%
Unknown Nest Outcome[3]	0	0	0	2	0
Failed Active Nests	4	5	5	1	8
Family Groups Found[4]	4	5	3	5	2
Fledglings Observed[5]	10	21	6	16	4
Fledglings/Managed Pair[6]	1	1.24	0.38	0.94	0.22

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[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% (4/8) were successful in producing six fledglings, while 50% (4/8) nests failed. Four fledglings were found in three managed pairs where no nesting had been observed (family groups). A total of 10 fledglings were observed in territories benefiting from rodent control management. One fledgling was observed in a territory not protected from rats.

Rodent Control Results

The small-scale grids were again used at Palehua this year. There was a slight increase in rodent catches over the previous year.

Palehua Rodent Control Data

HUA	# Traps	# Rats in Traps	Rats/Trap
2014	168	434	2.6
2013	180	393	2.2

Summary

Palehua had a disappointing breeding season this year. Before the season began six pairs had disappeared, along with a banded female that was infected with the pox virus. She was part of a seventh pair lost at this site. Her mate remained as a single resident for the remainder of the season. It is not unusual for Elepaio pairs to leave their territory and not be seen for an entire breeding season, then return during the summer months. One of the six missing pairs was later observed in September and it's possible that this may be the case for other pairs.

Elepaio caught in mist-net.

Moanalua Valley

Moanalua Territory Occupancy Status and Rat Control 2014

Map removed to protect rare resources, available upon request

Moanalua Site Demographic Data

MOA	2014	2013	2012	2011	2010
Singles	7	14	19	10	8
Pairs	32	33	32	21	19
Pairs with Rat Control	21	23	24	16	17
Active Nests[1]	16	17	15	13	22
Successful Active Nests[2]	5/16=31%	14/17=82%	10/15=67%	5/13=38%	4/22=18%
Unknown Nest Outcome[3]	7	6	2	5	7
Failed Active Nests	6	3	5	3	11
Family Groups Found[4]	4	2	2	3	2
Fledglings Observed[5]	11	17	13	9	7
Fledglings/Managed Pair[6]	0.5	0.74	0.54	0.56	0.41

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[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, 31% (5/16) were successful in producing six fledglings, 38% (6/16) failed. Seven nests had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Five fledglings were found in four managed pairs where no nesting had been observed (family groups). A total of 11 fledglings were observed in territories benefiting from rodent control management. Three fledglings were observed in territories not protected from rats.

Rodent Control

The number of rodents caught this year was down 55% from the previous season. There were fewer snap traps used in 2014, but the cause for such a decline in catches is unknown.

Moanalua Rodent Control Data

MOA	# Traps	# Rats in Traps	Rats/Trap
2014	288	716	2.5
2013	312	1576	5.1

Summary

Moanalua Valley had a below average breeding season in 2014. Just five nests were successful from 21 managed pairs. A few active nests may have indeed been successful, but because of gaps within the monitoring the outcome of the nests are unknown. A highlight at Moanalua this year was the discovery of two Elepaio pairs using abandoned Japanese White-eye (*Zosterops japonicas*) nests. There was a similar occurrence this year at Ekahanui where a pair successfully fledged a chick in an old Red-billed Leiothrix (*Leiothrix lutea*) nest, though the outcomes of the nests at Moanalua are unknown.

Adult feeding 2 nestlings.

4.1.4 OIP Summary

Management Action Highlights 2014

- Conducted rodent control in a total of 81 territories with pairs at four management sites. The specific cause for such a significant drop from 105 managed pairs since the 2013 breeding season is unknown, but it's likely a combination of factors. The death of one or both birds within a pair during the non-breeding months was observed in at least one pair and likely occurred in others. It is possible some pairs put off breeding for the 2014 season and continued foraging outside the MU with the intent to return later in the year. It is also conceivable that pairs chose to find a more suitable territory outside the MU.
- After a successful trial, the majority of snap traps at Ekahanui were removed from protective ground boxes and secured on elevated tree limbs. The result was a 40% increase in rodent catches over the previous breeding season.
- In January, the third survey in six years was conducted in the North Ekahanui and Huliwai drainages north of the Ekahanui MU. Since 2009, and without any rat control, the population has increased 68% and the number of pairs has increased from one to thirteen.
- The table below summarizes the number of managed pairs and reproductive output since 2006.

Summary of Elepaio Management Table

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings	Fledglings/ Managed Pair
2014[1]	81	24	28	62	0.77
2013[1]	105	51	38	95	0.90
2012[1]	97	38	22	65	0.67
2011[1]	94	47	34	96	1.02
2010[1]	87	18	15	39	0.45
2009[2]	81	29	24	60	0.74
2008[3]	74	25	20	56	0.76
2007[3]	78	18	26	46	0.59
2006[4]	69	11	17	33	0.48

[1]SBW, Ekahanui, Moanalua, Palehua
[2]SBW, Ekahanui, Makaha, Moanalua, Palehua
[3]SBW, Ekahanui, Makaha, Moanalua, Waikane, Palehua
[4]SBW, Ekahanui, Makaha, Moanalua

Management Actions 2015

- Mist-net and band all adult and juvenile Elepaio within the MUs to improve yearly demographic monitoring.
- Conduct surveys within and beyond MUs to monitor bird movements and population growth of the species. This includes a follow-up survey of South Haleauau gulch in SBW to update the original survey that was conducted in 2010.
- Conduct rodent control and Elepaio monitoring at Ekahanui, SBW, Palehua and Moanalua to meet required 75 managed pairs.
- Continue to use snap trap grids consisting of 12 Victor® traps per Elepaio territory for rodent control at SBW and Moanalua. Approximately 50 automatic traps will be added to pairs at SBW to compensate for the limited access expected during the 2015 breeding season.
- Palehua will undergo an alteration to its current trapping grid. The 12 Victor® traps per Elepaio territory will be replaced with a large-scale trapping grid similar to what is currently being used at Ekahanui. This will allow for increased rodent control protection of all Elepaio pairs throughout the MU. At Ekahanui, traps still housed inside wooden boxes will be removed and attached directly to higher tree limbs making them more accessible to rodents.

4.1.5 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.*

   [One mortar landed above the firebreak road and started a fire in July 2014. The Army notified the USFWS in writing of this incident and the memorandum transmitted is attached at Appendix ES-8. A summary of these fires is included in the Executive Summary]

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 during the 2014 breeding season]

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]

Minimize loss of Oahu Elepaio habitat at SBMR, Schofield Barracks East Range (SBER), and Kawailoa Training Area (KLOA).

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.*

   [Four fires were started from training during this reporting period. These are discussed in the executive summary. Letters transmitted to the USFWS reporting each fire are contained as Appendices ES-7 and ES-8. Two of these fires impacted unoccupied elepaio critical habitat. A total of 0.62 acres of the 3.7 allowable acres were burned since July 2014]

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]

Manage threats to Oahu Elepaio and Oahu Elepaio habitat at SBMR, SBER, and KLOA.

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]

4.2 MIP Elepaio Management 2014

4.2.1 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, but the 1999 BO did include 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.

4.2.2 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 2014

Makua Site Demographic Data

Makua	2014	2013	2012	2011	2010	2009	2008	2007	2006
Single Males	0	2	2	2	2	1	1	2	4
Single Females	0	0	0	0	0	0	1	1	1
Pairs	0	0	0	0	0	2	2	2	1
Pairs with Rat Control	0	0	0	0	0	2	2	2	1
Active Nests[1]	0	0	0	0	0	1	1	0	0
Successful Active Nests[2]	0	0	0	0	0	0	0	0	0
Unknown Active Nests[3]	0	0	0	0	0	1	0	0	0
Failed Active Nests	0	0	0	0	0	0	1	0	0
Family Groups Found[4]	0	0	0	0	0	0	0	0	0
Fledglings Found[5]	0	0	0	0	0	0	0	0	0
Fledglings/Pair[6]	0	0	0	0	0	0	0	0	0

[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 occurrences where pairs were observed with fledglings in which no nests were found.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

During one site visit on 03 September 2014, no Elepaio were observed in the back of Makua Valley. The two single males that were found in separate territories during a trip to the valley last year were not detected in their previously observed locations. A breeding pair of Elepaio has not been observed in Makua Valley since the 2009 breeding season. This is the first survey where no Elepaio have been observed and the result is very unfortunate. It is important to note that due to logistical complications only one survey was able to be conducted in 2014 and it is possible that resident Elepaio of Makua Valley were not detected on this one day survey. Further surveys will continue to monitor Elepaio in the valley.

4.2.3 MIP Summary

Management Actions 2014

- There were no Elepaio territories monitored for breeding activity in Makua Valley.

Management Actions 2015

- Conduct yearly territory occupancy surveys at all territories and surrounding gulches within the Makua AA, monitoring and banding, and data entry and organization.

Adult Elepaio.

4.3 NENE MANAGEMENT 2014

4.3.1 Background

A family of four nene geese (*Branta sandvicensis*) have been obsereved using a construction site at the eastern end of the Wheeler Army Airfield runway for foraging activities. The nene first appeared at Wheeler in August 2014 and since that time have been observed a total of 6 days at the site (through October 6, 2014). The table and aerial photo below summarize observations through Oct 6, 2014.

Summary of nene observations through Oct 6, 2014

Date	Time(hrs)	Date	Observed	Location
8/14/14	0745-1000	8/14/14	4 birds, K59, K60, 001 and 002	New planted and watered grass
9/23/14	1813	9/23/14	4 birds, K59, K60, 001 and 002	Southeast corner of airfield next to Medevac helicopter park, evaporation pond being built.
10/3/14	0830-0900	10/3/14	4 birds, bands not observed	North west edge of construction site, adjacent to pooling water and green new grass
10/4/14	1100	10/4/14	4 birds, bands not observed, one bird could see transmitter.	North west edge of construction site, adjacent to pooling water and green new grass. Northern pintail duck also observed using same pool.
10/6/14	0715-0845 And 1000-1435	10/6/14	4 birds, K59, K60, 001 and 002	North west edge of construction site, adjacent to pooling water and green new grass

Aerial photo of the WAAF construction site.

The parent birds are Kauai Island individuals, translocated to Hawaii Island in an effort to reduce the number of nene near the Lihue airport. These birds left Hawaii Island and nested at the James Campbell National Wildlife Refuge (NWR) in Kahuku, Oahu. They successfully fledged two chicks, aided by ongoing predator control program at the NWR. All four geese have unique band numbers to distinguish them apart and the adult male bird has a satellite collar that records location periodically. Preliminary results show they have been found around the central Oahu area and the NWR.

Nene geese at Wheeler Army Airfield.

4.3.2 Nene Management Summary

In order to avoid any harm to the geese, the USFWS recommended all activity cease within 150 feet of the birds. In addition, OANRP outreach staff conducted an educational campaign. An article was published in the Hawaii Army Weekly that included information on how to report and avoid negatively impacting the nene. In addition, outreach staff produced posters with the same information for sites around Wheeler where the nene would most likely be observed including; the Wheeler Tower, Wheeler Airfield operations and the construction site offices. Additionally, the Leilehua golf course staff was notified to report any nene appearances. OANRP are coordinating closely with USFWS to modify practices at the construction site to reduce the site's attractiveness and are including nene in the Biological Assessment being prepared for Oahu training. OANRP developed a nene observation form on which construction workers and airfield employees can record data and to ensure consistency. This form is included below.

NĒNĒ GOOSE OBSERVATION FORM

Date:_____ Observer Name/Contact:_____

Time:_____ #Birds present:_____

Banded Y/N Band Number(s):_____

(*Only obtain band numbers using binoculars. Maintain safe distance (at least 10 meters) from nēnē at all times*)

Observations:

What are the geese doing? (Feeding, resting, preening, bathing, etc.)

What areas? (Water retaining area, planted grass area, etc).

_____

_____

_____

Please call or text DPW Environmental, Natural Resources Section, immediately when nēnē are observed:

Kapua Kawelo, Biologist **864-1014** Michelle Mansker, Chief **864-1005**

Please scan and email Nēnē Observation Form to: **Hilary.k.kawelo.civ@mail.mil**

Nene goose observation form used to standardize data collection.

4.4 OPEAPEA MANAGEMENT 2014

4.4.1 Background

OANRP conducted acoustic monitoring for the Hawaiian Hoary bat (*Lasiurus cinereus semotus)* or Opeapea from 2010 to 2013 on Oahu Army Installations. These surveys were conducted for over 301 nights in order to establish bat presence or absence and document potential seasonal use of habitats by the Opeapea. OANRP found Opeapea present at all Oahu Training Areas. Specific foraging behavior was documented from Kahuku Training Area, Dillingham Military Reservation and Schofield Barracks. In general, bat detections on Oahu are much lower than data collected on Hawaii, Maui and Kauai islands. Complete results from these surveys are presented in Appendix 4-1.

4.4.2 Opeapea Management Summary

OANRP secured funding in FY 15 to conduct more intensive bat surveys across a majority of the Army installations on Oahu including cantonment areas. These data will be used to inform the upcoming consultation with the U. S. Fish and Wildlife Service (USFWS). In the interim, the USFWS provided restrictions to minimize impacts to bats through an informal consultation. Consequently, the Army has ceased felling trees which are greater than 15 feet tall during the bat pupping season, June 1st through Sept 15th each year. This summer, permission was given to remove a few trees that were safety hazards. Each case was reviewed by the Army's expert arborist and photos were provided to the USFWS for their review and determination. These procedures will be formalized in the upcoming Section 7 consultation. Also, tree removal contracts are now being designed to include bat pupping season restrictions and the summer cutting limitations are being built into landscape maintenance timelines.

CHAPTER 5: *DROSOPHILA* SPECIES MANAGEMENT

5.1 BACKGROUND

Fourteen species of Hawaiian picture wing *Drosophila* flies are currently listed as threatened or endangered. Six of these are endemic to Oahu, and three – *D. montgomeryi*, *D. obatai*, and *D. substenoptera* – are currently known to occur on Army lands. OANRP work on *Drosophila* began in March 2013, and until recently has focused mainly on monitoring known populations and surveying for new ones. This report presents the first three-year plans for the two species currently under management, *D. montgomeryi* and *D. substenoptera*, drafted based on our survey results and in consultation with the weed control and restoration specialists. Results are also reported for *D. obatai*, which is not currently under management but will be formally included following consultation with USFWS. This is the first full year of *Drosophila* management for OANRP, and the first time systematic monitoring of *Drosophila* populations has been carried out on Oahu. Prior to this time, all surveys were done sporadically, and few sites were visited more often than quarterly.

5.2 SURVEY METHODS

Many species of Hawaiian *Drosophila*, including the picture wing group to which all of the endangered species belong, are readily attracted to baits of fermented banana and mushrooms. Both baits are spread on a cellulose sponge which is hung from a tree in a cool, shaded, sheltered site, and checked for flies after about an hour. Depending on the quality of the site (number and size of host plants, and microclimate) and the density of baiting spots, surveys typically consist of setting out 16-32 sponges, in groups of four or eight with groups separated by 20-100 m. Baits are checked at least every hour, as flies do not necessarily stay at baits for long periods; number and species of all picture wings on each sponge are recorded at each check. The greatest activity is typically during the cooler hours before 10 AM and after 2 PM, but flies may appear at any time. Direct quantification of *Drosophila* populations is extremely tenuous, as populations may fluctuate not only seasonally but from day to day. However, repeated surveys may yield useful data on long-term trends. Abundance numbers are reported as the maximum number of individuals observed on a survey day (compiled by adding the maximum observed at each discrete group of bait sponges at any one time, assuming that the same individual flies may move between sponges within a group but are unlikely to be seen at two different sponge groups), since numbers fluctuate through the day.

Known, significant populations of *D. montgomeryi* at Kaluaa MU and *D. substenoptera* at Palikea, where flies occur relatively consistently, were monitored monthly in order to determine approximate population trends through the year. Other known populations were visited periodically through the year. New populations of endangered *Drosophila* were searched for by looking in similar habitat both in areas suggested by other staff as having host plants, at historic collecting localities, and in new sites where surveys have been minimal.

5.3 RESULTS

5.3.1 *Drosophila montgomeryi*

Drosophila montgomeryi is a small yellow-brown species which breeds in rotting bark of *Urera kaalae* and *Urera glabra* (opuhe). During the last reporting period (March – October 2013), it was found at three sites which we consider to be two population units (PUs; see section 5.4). Conducting additional surveys during a productive winter wet season in this reporting period has increased this to nine sites at four PUs, effectively covering nearly its entire historic range in the Waianae mountains (Figure 1).

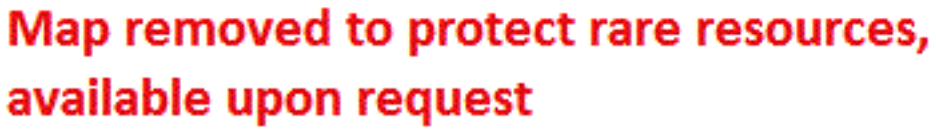


Figure 1. Distribution of *Drosophila montgomeryi* observations in 2014, with known *Urera* spp. sites and all survey points in the Waianae range.

Kaluaa & Waieli MU

Three sites in this MU – Puu Hapapa, North Kaluaa, and Central Kaluaa gulch 1 – have been monitored monthly since June 2013 (though not every site was visited each month) over a total of 32 survey days. Abundance of *D. montgomeryi* increased dramatically in the winter, with increasing rain and as treefalls from storms caused death or branch breakage of *Urera* near monitoring sites. Numbers were moderate to high at all sites between November 2013 and July 2014. However, month-to-month fluctuations were extremely high, particularly in North Kaluaa; these large swings were strongly correlated with those of some other species, including the common *D. ambochila*, *D. crucigera*, and *D. inedita*, but not *D. punalua* or the rare *D. divaricata*, suggesting that the effect was independent of at least host plant. There was also no obvious difference in weather or bait quality from high-abundance days that would explain the low numbers.

A fourth site for *D. montgomeryi* in this PU, Moho Gulch, was discovered in March 2014. It has a small exclosure built for *Urera kaalae*, but the fence has been heavily damaged by rockslides and is not being maintained. At present there is only one living mature *U. kaalae* (outplanted) and one large *U. glabra*, with several smaller *U. glabra* (all wild). A single natural seedling of *U. kaalae* was also seen. Direct access is limited due to intensive use of South Range for live-fire training, though it may be reached via Puu Hapapa as well.

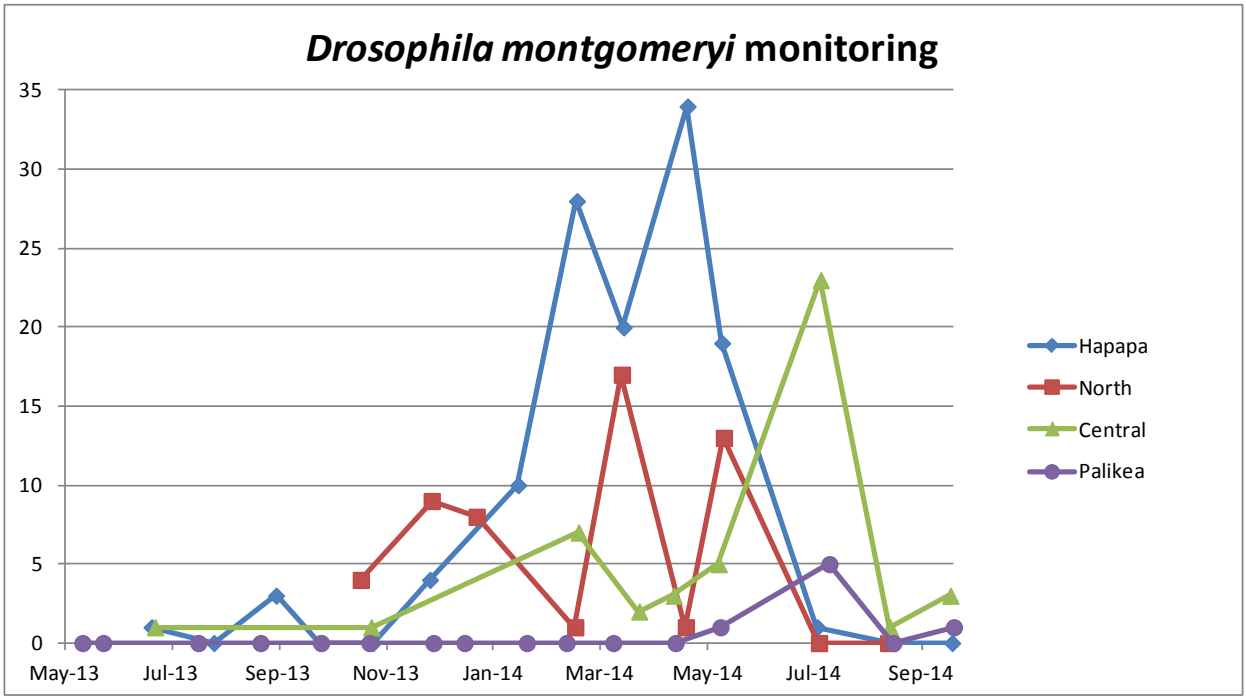


Figure 2. *Drosophila montgomeryi* numbers during monthly monitoring at three sites in Kaluaa PU (Puu Hapapa, North Kaluaa, and Central Kaluaa) and Palikea. Y axis is the maximum number observed across the entire site on the survey day (see Survey Methods, section 5.2).

Pualii

This site was surveyed for the first time this year. At the time of the first visit, the last wild *Urera kaalae* tree in North Pualii Gulch had recently fallen and the decaying trunk was supporting a large number of *D. montgomeryi*. Flies were still present at a followup visit two months later, after the tree was fully rotted out and dried. Only seven *U. kaalae* (all outplanted), and no *U. glabra*, remain at the site; with no reproduction currently occurring among *U. kaalae*, it will not remain a viable population of *D. montgomeryi* without management intervention. Nevertheless, it is an area of high-quality native habitat, both in the immediate vicinity and further downslope in the gulch.

Site	Days	Max No.
Kaluaa - Central	8	23
Kaluaa - North	10	17
Puu Hapapa	10	34
Moho Gulch	2	3
Pualii	2	6
Palikea	11	5
Waianae	4	86
Kawaiu	2	0
Makaha	5	0
Pahole	3	0
Palawai	1	0
Lihue	5	0

Table 1. Survey effort for *D. montgomeryi* across all potential sites in 2014 reporting year, in survey days.

Palikea

Despite continuous monitoring here since May 2013 (targeting *D. substenoptera*, which is consistently found in the area), *D. montgomeryi* was not detected until May 2014. The numbers were relatively low (one individual in May, and five in July), but they occurred during a time when the species was on a seasonal decline at other sites. The area where they were found is already a target for weed management and restoration, and has high potential for management to benefit *D. montgomeryi* (see Management Plan below). *Urera kaalae* is absent, but *Urera glabra* has already begun to increase naturally as weed control has reduced alien cover.

Waianae Kai

During explorations for new sites, a large population of *D. montgomeryi* was discovered in the northeastern subgulches of

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

Kumaipo stream, Waianae Valley. Three sites have been discovered so far, all at the base of Mt. Kaala and consisting of small patches (~0.5 ha) of diverse native forest constrained by alien-dominated vegetation above and below. Only *Urera glabra* is present, indicating that *D. montgomeryi* can thrive on it alone (*U. kaalae* was also found in nearby South Kumaipo Gulch as recently as 1995, but no longer occurs in the valley). All are located on or just below steep slopes that are vulnerable to landslides, which may preclude fencing as a matter of practicality. The middle gulch, where *D. montgomeryi* was found to be extraordinarily abundant during visits in January and February (Table 1) and is currently the only known site for the critically imperiled *D. kinoole* (see Other Species below), was impacted by boulders from ongoing severe erosion of the ridge to the north prior to a followup visit in May. Although originating about 200 meters away, a number of boulders rolled directly through the site and smashed several large *Urera* trees. During baiting at the time, many *D. montgomeryi* were observed resting on branches, though few were attracted to baits. The long-term impact on the population is uncertain; *Urera glabra* has a high capacity to regrow from damage such as this. Only three survey days have been spent in the valley to date, all focused in a relatively small area, so other sites may exist.

Lihue

The original rediscovery of *D. montgomeryi* was at Schofield West Range, South Haleauau Gulch near Puu Kalena in 2008. This site was revisited once in late 2013, but none were found. Access is difficult and it is probably still inhabited by the species, given the usual population fluctuations seen at other sites. Four additional days were spent surveying other significant stands of *Urera glabra* in Lihue, but *D.*

montgomeryi has yet to be found at any of them; most are relatively exposed, where it is unfavorable for *Drosophila*.

Other sites

Five additional sites are known for *Urera* in the Waianae range: Kawaiu Gulch, Pahole Gulch, Makaha Valley, Palawai, and Ekahanui. All were surveyed this year (11 survey days) except the last, which was visited twice during the 2013 reporting year. No *D. montgomeryi* have been found at any of these so far.

5.3.2 *Drosophila substenoptera*

Site	Days	Max No.
Palikea	11	7
Lower Opaeula	6	1
Lihue	2	1
Koloa	8	0
Kaala	2	0
Malaekahana	4	0

Table 2. Survey effort for *D. substenoptera* across all potential sites in 2014 reporting year, in survey days.

Surveys for this species have focused on finding new populations. Based on collection records, it requires moderately tall, non-boggy wet forest with its host plants, *Cheirodendron* sp. (olapa) and *Polyscias* (=*Tetraplasandra*) *oahuensis* (ohe mauka), a habitat which is relatively uncommon since these trees tend to occur most abundantly in short-stature forest near summit crestlines. Numbers of *D. substenoptera* have been low everywhere throughout the year, which has undoubtedly hampered our ability to detect *D. substenoptera*. Still, one new site was discovered (Lower Opaeula), and another rediscovered (Kalena). There are now three known PUs for *D. substenoptera* – Palikea, Kaala-Kalena, and Opaeula (Figure 3). PU trends are only graphed for Palikea as the other two PUs have insufficient numbers of survey days. At other sites *D. substenoptera* is highly sporadic, typically occurring as single individuals observed only once during a day.

Waianae Range

Monthly monitoring in the northern portion of Palikea MU has been ongoing since May 2013 (16 survey days total, 11 in the current reporting year). Aside from a large flush in late May 2013, numbers of *D. substenoptera* and another endangered species, *D. hemipeza*, have been consistently low, but they have

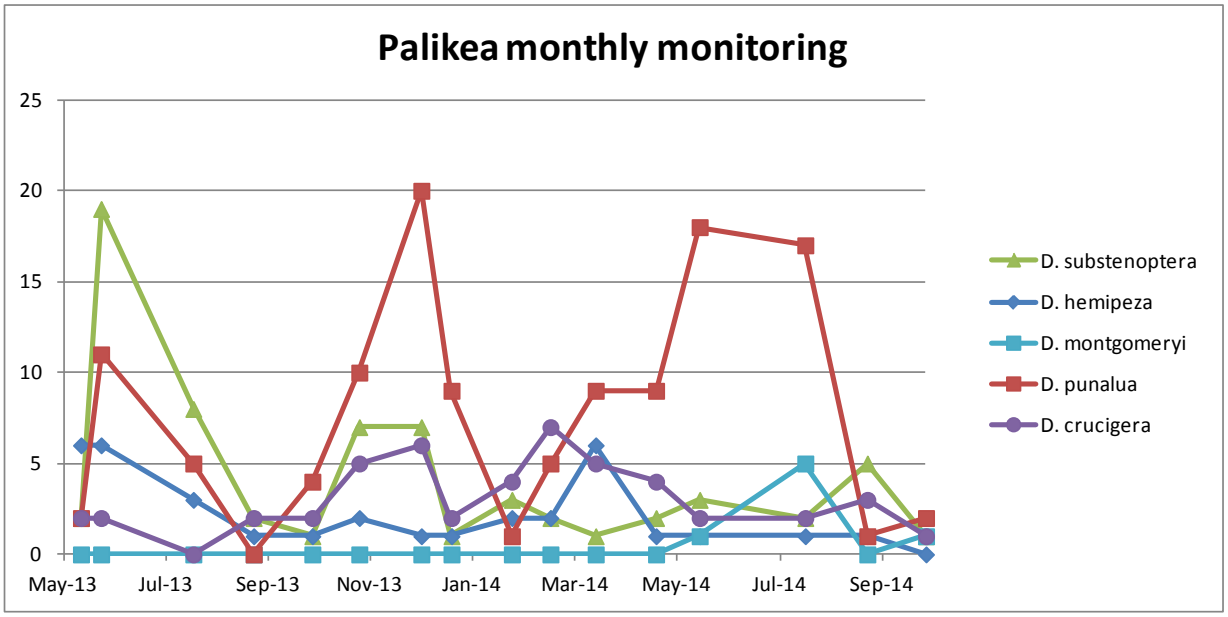


Figure 3. Monthly monitoring results for all species at Palikea, from May 2013 to October 2014.

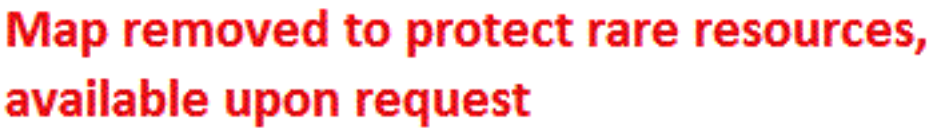


Figure 4. Distribution of *Drosophila substenoptera* observations in 2014.

always been present. Abundance was weakly correlated with that of the widespread species *D. crucigera* and *D. punalua* through January 2014, but since that time has shown no relationship (Figure 3).

At the Kaala-Kalena PU, the South Haleauau "Trinerve Gulch" site near Puu Kalena was visited and one individual observed there. *Drosophila substenoptera* was last sighted here in 2009. An additional day of surveying nearby gulches found more habitat, but with trees mainly located in steep areas where baiting is impossible. Near Kaala, the south slope was surveyed twice but no *D. substenoptera* were found (though other *Cheirodendron*-breeding flies did occur there; see section 5.3.4 below).

Koolau Range

In December 2013, a single *D. substenoptera* was observed at Lower Opaeula MU, the first record of the species in the Koolau range since 1972. Historically, *D. substenoptera* was more widespread and abundant on this side than in the Waianae range. However, collection effort has been limited due to the difficulty in accessing areas of intact habitat for this species. OANRP surveys in the Koolaus for *D. substenoptera* have been relatively few due to higher priorities elsewhere, and concentrated in only a few sites – 14 survey days at Koloa, nine at Lower Opaeula, and one at Waimano since April 2013. Finding additional Koolau populations is a high priority for this species; Helemano, upper Opaeula, Poamoho, and Kaukonahua have yet to be surveyed. Lower Opaeula and Koloa will continue to be checked given the extremely high quality of habitat there and low observation rate at sites where *D. substenoptera* is known to be present.

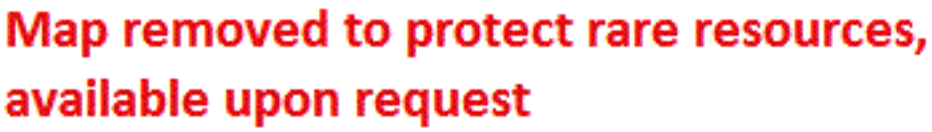


Figure 5. Distribution of *Drosophila obatai* observations in 2013 and 2014.

5.3.3 *Drosophila obatai*

Drosophila obatai was rediscovered in Manuwai Gulch MU in 2011, 40 years after the previous record in 1971. It breeds in rotting stems of *Chrysodracon* (=*Pleomele*) spp. (halapepe), which suffers from very low reproduction rates but remains widespread in the northern Waianae range thanks to its longevity.

Site	Days	Max No.
Manuwai	6	6
Makaleha, East	1	2
Makaleha, Central	1	0
Kaawa Gulch	1	0
Lihue - Pulee	6	1
Lihue - Mohiakea	3	0
Ohikilolo	3	0
Kawainui	1	0
Kaluakauila	1	0

Table 3. Survey effort for *D. obatai* across all potential sites in 2014 reporting year, in survey days.

With the new sites found this year, it is now known from seven sites in four potential PUs, although three of these PUs are within 1,200 m of each other and could potentially form one contiguous population. While it almost certainly was contiguous until recently (possibly up to ~50 years ago), native forest in general and *Chrysodracon* in particular is now much more fragmented, and moving between patches of host trees more difficult for the flies.

Last year, *D. obatai* was found again at Manuwai, as well as at two sites within the SBW action area: in Lihue (at the Coffee Gulch branch of Pulee Gulch) and nearby at Palikea Gulch in Kaala NAR. This year they were also found in the adjacent Guava Gulch branch of Pulee on two occasions. No more were found at Coffee Gulch in three more days of surveys, but the two sites are only 250 m apart (albeit across a dry ridge) and flies can probably move

between them with relative ease. Palikea Gulch is difficult to access and has not been revisited. Manuwai has continued to have *D. obatai* on a consistent basis regardless of the season. They were equally abundant in February, when *Drosophila* diversity was extremely high and a number of rare species were found (see Other Rare Drosophila below), and in May when these other species were absent or in much lower numbers. Still, only 3-4 *D. obatai* were seen at any one time at each site.

In addition, one *D. obatai* was found in the west branch of East Makaleha Gulch. This represents a significant extension westward, and indicates that the species still occupies its full historic distribution in the Waianae range. The Makaleha area consists of a series of large, steep valleys with remnant dry and mesic forest that have been little surveyed recently. In the 1970s, nearly all Oahu species of picture wing *Drosophila* were found in either East or West Makaleha. Surveys in the coming year will focus on this area.

5.3.4 Other Rare *Drosophila*

During the course of surveys, nine additional rare *Drosophila* were found in management units outside of Army lands. *Drosophila nigribasis* and *D. oahuensis* were also found on Schofield Barracks. All of these except *D. hemipeza* were found around Kaala, either near the summit or on the flanks in similar habitat to *D. obatai*.

Non-Target Rare *Drosophila* Observed During Surveys, Nov. 2013–Oct. 2014

Species	Sites	Total Obs.	Max. No./Day
flexipes	Manuwai, Pualii	42	14
hemipeza	Palikea, Hapapa	22	6
kinoole	Waianae	3	2
nigribasis	Kaala, Koloa	3	1
oahuensis	Kaala, Lihue, Koloa, Opaeula	4	1
paucicilia	Manuwai	21	8
reynoldsiae	Manuwai	3	2
sobrina	Makaleha	1	1
spaniothrix	Makaleha	3	3

Drosophila flexipes and *D. paucicilia* both breed in fermenting sap fluxes of *Sapindus oahuensis* (lonomea). Although this tree is relatively common in remnant mesic and dry forest, it often occurs at lower elevations where ants prevent *Drosophila* from persisting. Both were found in MUs last year in low numbers after having been nearly or entirely absent since 1977. In February, they occurred abundantly across Manuwai MU, and *D. flexipes* was the most common picture wing. A single *D. flexipes* was also found during each visit to Pualii.

Drosophila hemipeza is the only listed endangered species on Oahu that is known to be extant but does not occur on Army lands or OIP/MIP action areas, although it historically occurred at Kahuku Training Area and West Makaleha Gulch adjacent to Makua. It has been consistently found at Palikea MU but always in low numbers for several years. In 2014, a single individual was found at Puu Hapapa on two separate occasions, the first records of this species outside Palikea since 1974. It has been reared from *Cyanea*, *Lobelia*, and *Urera*, all of which are present at both sites.

The most exciting find of the year is the rediscovery of *Drosophila kinoole*. This species was known only from a single specimen reared from *Urera* at Kaluaa Gulch in 1971; it is a newly-emerged adult fly with

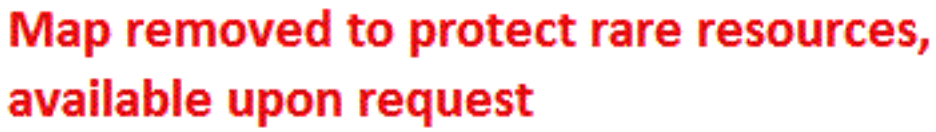


Figure 6. Observations of nine non-target rare *Drosophila* species during the 2014 survey season.

incompletely developed coloration, and the specimen was later heavily damaged after pinning. Until 2012, it was misidentified as a specimen of *D. aglaia,* a listed endangered species which has not been seen since 1997. Its natural appearance was uncertain, and it was thought to resemble *D. montgomeryi*. At the site in Waianae Valley where *D. montgomeryi* was found in high numbers, a few *D. kinoole* were also found and it was revealed to be strikingly different from any other species. Although it does not have any formal protection at this time, all members of the species complex it belongs to are either critically endangered or possibly extinct, and it should be considered a high conservation priority.

Drosophila nigribasis breeds in *Cheirodendron*; it is related to *D. substenoptera* but appears to favor wetter habitats. In our surveys, it is restricted to the summit of Kaala, not reaching very far down below the top, and Koloa.

Drosophila oahuensis is also a *Cheirodendron* breeder, and appears to span the habitat range of *D. nigribasis* and *D. substenoptera,* including both the near-summit area of Kaala and wet-mesic sites such as North Haleauau Gulch in Lihue. Only four were seen through the year, but it was found as single individuals from widely scattered localities.

Drosophila reynoldsiae breeds in *Polyscias* (=*Reynoldsia*) *sandwicensis,* and formerly occurred across the north slopes of the northern Waianae range. It was included in the original endangered species listing petition, but was dropped because it had not been seen since 1971 and was considered possibly extinct. It was rediscovered in Manuwai Gulch in company with *D. flexipes, D. paucicilia,* and *D. obatai*.

Drosophila sobrina also breeds in *P. sandwicensis*, as well as *Polyscias* (=*Tetraplasandra*) *oahuensis* in wetter habitats. It was historically widespread in both the Waianae and Koolau ranges and recorded from several MUs, including Palikea. The only record since 1977 had been a single individual from Manuwai found in 2010. One individual was seen in the west fork of East Makaleha Gulch in 2014. *Polyscias oahuensis* is relatively abundant at a number of regularly-surveyed sites, but no other *D. sobrina* were seen.

Drosophila spaniothrix is a relatively unknown species that also had not been collected since 1971. It has never been reared and its relationships are unclear, but it bears some similarity to the *Chrysodracon*-breeding species *D. gymnophallus* and *D. psilophallus*, and has been collected from the same sites. Three individuals were found at a dense patch of *Chrysodracon forbesii* at the top of Central Makaleha Gulch.

Drosophila kinoole, rediscovered at Waianae.

Drosophila nigribasis, rare on the wet summits.

Drosophila oahuensis, widespread but rare in wet forest.

Drosophila reynoldsiae, rediscovered at Manuwai.

Drosophila spaniothrix, rediscovered at Central Makaleha.

5.4 *DROSOPHILA MONTGOMERYI* MANAGEMENT PLAN

MIP Year 11-13, Oct. 2014 – Sept. 2017; OIP Year 8-10, Oct. 2014 – Sept. 2017

Management Goals

- Manage three population units (PUs) with stands of host trees (minimum 50 at each site), with natural recruitment and reproduction occurring.
- Control direct and indirect threats at managed PUs, including ungulates, weeds, fire, and alien invertebrates.
- Monitor fly populations over time for stability and management effectiveness.

Background

Systematics. *Drosophila montgomeryi* Hardy & Kaneshiro 1971 is a moderately small picture wing *Drosophila* fly endemic to the island of Oahu. It is a member of the *vesciseta* species subgroup, and is closely related to a complex of other species that breed in *Urera* including *D. opuhe* on Kauai, *D. pihulu* on Maui and Molokai, and *D. assita* on Hawaii. Another *vesciseta* subgroup species, *D. ambochila*, occurs sympatrically with *D. montgomeryi*; it breeds in papala kepau (*Pisonia* spp.) and is much more abundant. All these species may be separated by the wing marks, the pattern of long hairs on the front legs of the male, and the pigmentation of the thorax. *Drosophila montgomeryi* and *D. ambochila* also have distinctly different courtship dances, making it unlikely that they hybridize.

Ecology. The species occurs in mesic forest, where the larvae breed exclusively in decaying bark of opuhe (*Urera glabra* and *U. kaalae*). They were reared from *U. kaalae* by S. Montgomery at Ekahanui on two occasions, and were observed ovipositing in rotting trunks of both species by K. Magnacca. They also occur at at least two sites (Palikea and Waianae Valley) where only *U. glabra* is present. *Urera kaalae* is a small tree often occurring as a pioneer species on talus slopes and landslides along the steep backs and walls of gulches, typically maturing relatively quickly and living only ~15-20 years. Although described as "locally abundant" at Ekahanui in 1970 when *D. montgomeryi* was first collected on it, it is currently critically endangered with only 11 mature, 3 immature, and 21 seedlings remaining in the wild, along with ~70 outplants (S. Ching and D. Sailer, pers. comm.). *Urera glabra* is a larger, longer-lived tree, often with a sprawling habit and occurring in or near gulch bottoms on Oahu. While it remains widespread, its occurrence is patchy, and little seedling recruitment is seen. Since *D. montgomeryi* requires dead, rotting material to breed in, a site with relatively few trees (e.g., <10) may have no available breeding sites for most of the year.

Distribution. During the early collecting period (1968-75), nearly all records of *D. montgomeryi* were from the southern Waianae range, namely Ekahanui and Kaluaa gulches. There is one record from Alaiheihe Gulch in Lower Kaala NAR, and a single collection from the Koolau range, at Pia Gulch. In recent collections, it has been found at Palikea, Pualii, Kaluaa/Hapapa, South Haleauau, and Kumaipo Gulch (Waianae Kai) in the southern and central Waianae range. The recent Waianae Valley record is a range extension, though it appears that little if any searching had been done in that area previously. It has not been found anywhere in the Lower Kaala gulches, and no *Urera* has been seen there either. The southeastern Koolau range is outside our management area and has not been searched. Other sites with *Urera* have been surveyed (albeit usually only once) without success; those in Lihue have either had only one or two plants or been in open, exposed sites unfavorable for *Drosophila*. Makaha has abundant *Urera* and a better microclimate, but is still relatively open and dry and is outside the historic range. The

Figure 7. *Drosophla montgomeryi*, Puu Hapapa. Male (right) performing a courtship dance on a bait sponge.

continued presence of *D. montgomeryi* at nearly all historic and suitable sites suggests it is primarily limited by the availability of host plants.

Management History. The stabilization plan for *D. montgomeryi* calls for management of up to three PUs of at least 5 hectares each. Since monitoring can only assess relative fly population size and trends, management goals are focused on maintaining targets for host plants and areas of high-quality habitat rather than numbers of *Drosophila*. We chose Palikea, Pualii, and Kaluaa (including Puu Hapapa) as population units for active management. All three are within Honouliuli Forest Reserve, and are currently fenced and ungulate-free. South Haleauau (Puu Kalena) was originally considered for one of the managed PUs, but is excluded due to lack of accessibility on the active range and extremely difficult terrain, which imposes a severe limit on the work that can be done there. Kumaipo is accessible but ongoing erosion above the site poses a long-term risk to fencing the area. It also appears to be self-sustaining, at least for the time being. Palikea, Pualii, and one of the sites within Kaluaa have only a few host trees remaining, and *D. montgomeryi* is in danger of being extirpated at them if action is not taken soon to increase host plant numbers. Specific areas designated for active management are those where native vegetation is already present and relatively intact, or where restoration to suitable *Drosophila* habitat could be accomplished in the short term (5-15 years) without major disruption as a result of weeding, i.e. with minimum disturbance to the canopy light and moisture regime.

Current Status of *Drosophila montgomeryi* Population Units

Population Unit	MFS	Management Unit	Action Area	Current Management	*U. glabra*	*U. kaalae*[*]
Palikea	Y	Puu Palikea	none	ungulate fence, weeding, outplanting	Y	N
Pualii	Y	Pualii	none	ungulate fence	N	Y
Kaluaa	Y	Kaluaa & Waieli	none	ungulate fence, weeding, outplanting	Y	Y
South Haleauau	N	Lihue	SBW	ungulate fence	Y	N
Kumaipo	N	Waianae Kai	none	none	Y	N

* – all are outplanted at these sites

Site Descriptions

Palikea

This MU consists of a roughly rhomboid fenced area enclosing wet and wet-mesic forest at the southern end of the Waianae range. The area enclosed by the MU fence is approximately 9.5 ha. It includes several ridge and gully systems; just below the summit crestline the gulch bottoms are relatively flat before becoming steeper below. Vegetation on the crest and upper ridges is dominated by *Metrosideros polymorpha*, with a significant presence of *Cheirodendron trigynum* and *Ilex anomala*. In gulches, the vegetation is more mesic, and much of the area is heavily invaded by *Schinus terebinthefolius, Psidium cattleianum,* and *Morella faya*. Weed control efforts by OANRP have significantly reduced alien cover over the past several years, particularly in the area where *D. montgomeryi* is found. Many rare plants are found wild or outplanted in the MU, including *Cyanea grimesiana obatae, Cyanea superba superba, Cyanea membranacea*, *Lobelia yuccoides*, *Phyllostegia hirsuta,* and *Exocarpos gaudichaudii*.

The greatest concentration of *Urera glabra* is found near the middle of the MU, directly below a large *Ficus* tree that was killed several years ago. The opening created by removal of this tree and adjacent *Schinus* has allowed native vegetation to increase significantly, including *Urera*. Seven trees occur here, of which five are large enough to serve as breeding substrates; however, only one is a male. This is the only area where *D. montgomeryi* has been found. A patch also occurs near the makai fence boundary, but it is relatively exposed and surrounded by *Schinus*; no *D. montgomeryi* were found here at the same time they were highest at the other site. A few *U. glabra* are scattered in the southern portion of the fence, but are currently not in sufficient numbers to support *D. montgomeryi*. *Urera kaalae* was outplanted here, but none remain.

The high quality of habitat, ongoing weed control and restoration efforts, and availability of additional space for outplanting *Urera* spp. make this a high priority for management. The area to be managed for *D. montgomeryi* consists of approximately 5 ha of the mauka portion of the unit, where native vegetation is relatively intact and suited for restoration. *Urera* is currently present in relatively low numbers (as is *D. montgomeryi*), but it is one of the few sites where natural recruitment is occurring. Still, augmentation of the population, and especially spreading it throughout the management area, will more rapidly improve the habitat for *D. montgomeryi* than the current slow pace of natural recovery.

Figure 8. Population units of *D. montgomeryi* designated for management, with habitat management areas shown.

Pualii

This MU is similar to Palikea in size, about 10 ha, but with less diversity in habitat. The fenced unit primarily encloses North Pualii Gulch, together with a small portion of South Pualii. The unfenced portion of South Pualii has several wild *Urera kaalae* but is otherwise severely degraded and almost completely dominated by *Schinus*. *Urera kaalae* also formerly occurred naturally in North Pualii, but the last wild tree there died in 2014 (*D. montgomeryi* were observed ovipositing on its rotting trunk). Seven outplanted descendents remain in the same area. *Urera glabra* is not present at this time.

Although the area currently occupied by *Urera* and *D. montgomeryi* is extremely small, there are significant areas of native-dominated vegetation available for improvement. Immediately adjacent to the site is a talus slope dominated by tall *Planchonella sandwicensis* trees, similar to the gulches at Kumaipo. Downslope, the gulch is weedy in spots but contains large sections that are predominantly native, primarily *Pisonia* spp., *Planchonella sandwicensis*, and *Sapindus oahuensis*. The latter habitat continues outside the fence. The total area available for restoration in the short term is about 2.5 ha, including 0.7 ha outside the fence.

The extremely small number of *Urera* remaining here puts this population at high risk of extirpation. They could potentially die out if a year passes without any of the trees dying. However, the relatively large area of native-dominated habitat means there is a great deal of potential for expansion. This site is a high priority for management.

Kaluaa

The three sites within Kaluaa PU are significantly different from each other, and each is approximately the same size as the *D. montgomeryi* habitat at Pualii or Palikea (the fourth site, Moho Gulch, is considered part of the same population but is not being managed due to access issues). Therefore, they are each described separately. The total management area of all together is approximately 5 ha.

Central Kaluaa gulch 1

Central Kaluaa has been actively managed since the land was under management of the Nature Conservancy. The Nature Conservancy completed the fence in 2001 and began weed control actions shortly thereafter. The gulch is divided into three branches in its upper reaches. *Drosophila montgomeryi* has so far only been found towards the back of subgulch 1, the southernmost branch, where *Urera glabra* is found in moderate abundance along approximately 100 m of the gulch, with a total of 12 trees. It is most common at the end of this stretch, where five very large *U. glabra* trees occur and one large trunk recently died. *Urera kaalae* is also planted in the same area, though most are small. Other *U. glabra* are scattered throughout the lower portion of the gulch, mostly as single individuals.

The current occupied area is relatively small, as the gulch becomes weedy on the slopes in most places. However, much of the gulch bottom remains native, and several areas in this lower area have already been weeded and outplanted with rare plants, so there is a good potential for habitat expansion here. Still, with a moderate number of mature *Urera glabra* and immature *U. kaalae*, it is a medium priority for management.

North Kaluaa

This single gulch contains a significant amount of native-dominated vegetation, but has *Urera* only at the back above an internal fence within the MU. That section contains a small planting of *U. kaalae*, with only three mature trees remaining and no immatures, and two wild *U. glabra*. It is adjacent to a large slope with rare native outplants, as well as a small talus bowl that is suitable for *U. kaalae*. The gulch continues above, but is blocked by a waterfall. The very small number of host plants here, and the large area available for habitat expansion, make this a high priority for outplanting. However, it is only about 200 m in linear distance from the Hapapa site, so unlike Pualii, it is probable that *D. montgomeryi* is easily capable of recolonizing it if the flies resident here die out. A large patch of *U. glabra* occurs at the head of North Kaluaa gulch, accessible from Hapapa (several dry waterfalls block access from below).

Hapapa

This is a small bench just below the peak of Puu Hapapa. It has been the site of intensive management for several years, and has a predator-proof snail enclosure with a large number of plantings, including *Urera* spp. As a result, the population of both mature and immature host plants here is high compared to other sites, and management for *D. montgomeryi* is a low priority. However, most are concentrated in a small area (approximately 10 by 20 m) with about 30 *U. kaalae* and several large *U. glabra*. It would be beneficial to increase the physical area where *Urera* are at the site, in order to prevent a single event from removing most of the population. For example, a single treefall knocked down seven large *U. kaalae* in fall 2013, and narrowly missed several others.

Management Actions

Host Plant Restoration

Augmentation of host plant populations with outplants is an important part of *D. montgomeryi* management, since it appears to be limited by host availability. The two species, *Urera glabra* and *U. kaalae*, both suffer from poor recruitment, probably mainly due to seedling predation by slugs and pigs. They are dioecious (*U. kaalae* may become monoecious as it ages) and wind-pollinated, meaning that a certain number must be present within a given area for sufficient seed production. They differ in their life history characteristics, as described below, such that planting both is beneficial for short and long term survival of *D. montgomeryi*.

Figure 9. Typical habitat of *D. montgomeryi*, at Puu Hapapa. *Urera glabra* is on the left, *U. kaalae* on the right.

Urera kaalae is a small, few-branched tree, often growing as a pioneer species in sunny locations on landslide talus. It is relatively fast-growing and typically does not live very long, reaching maturity in 6 years under good conditions and rarely living longer than 20. As a result, it can provide a food source relatively rapidly from the time it is first planted. It is also highly susceptible to damage from treefalls, falling rocks, or other injuries, and has poor ability to resprout following major breakage. The short lifespan, combined with a lack of recruitment, is presumably the major contributor to the rapid decline of this species, which has only a few wild individuals remaining. Nevertheless, it grows readily from seed, and outplanted individuals generally have high survivorship.

Urera glabra grows considerably larger, often many-branched or sprawling, and frequently occurs in or near gulch bottoms (including high on side drainages). It is slower growing at first, but lives much longer, which contributes to its persistence despite low reproduction. Large broken branches are capable of surviving while partially attached to the parent plant, and can also reroot if touching the ground. Plants with repeated damage to the main trunk may form a coppice-like growth form rather than being arborescent. This makes *U. glabra* important for future persistence of *D. montgomeryi*, since each large tree may be able to shed branches every year without completely dying. It grows well from seed or cuttings.

Expansion of the occupancy of *D. montgomeryi* beyond the current areas via outplanting of *Urera* to other suitable sites within each MU is an important part of this plan. At present each site where *D.*

montgomeryi occurs is approximately 0.2–0.7 ha in extent. Additional restorable areas, where native vegetation predominates but *Urera* is currently not present or only one or two trees exist, are available at each site (yellow areas outlined on map above). Therefore, the 5 ha area for each PU called for in the original stabilization plan is possible for Kaluaa (combined area of all three sites) and Palikea. For Pualii, the existing and restorable area is currently only about 2.5 ha, but it may be possible to expand this over time with more extensive management.

Threats

Fire is a potential threat to all sites, particularly due to activity on adjacent military (Kaluaa), agricultural (Pualii), and residential (Palikea) areas. A fire in Aug.–Sept. 2014 burned over 1000 acres about 2 km from Palikea, though it did not reach the forest reserve boundary. Mitigation of the threat of fire is done on a landscape level, through the Army's wildfire management plan and participation in cooperative fire management efforts with the State of Hawaii.

Feral ungulates, particularly pigs, are important indirect threats because they damage or destroy host plants, and can also alter the forest microclimate by opening frequent gaps. All sites currently occupied by *D. montgomeryi* are already ungulate-free.

Invasive weeds are a significant factor in suppressing the recruitment and growth of native host plants for *Drosophila*, particularly understory trees like *Urera*. Christmasberry (*Schinus terebinthefolius*), strawberry guava (*Psidium cattleianum*), and blackberry (*Rubus argutus*) are among the most problematic. Christmasberry forms enormous, sprawling growths that shade out all other vegetation and are capable of covering entire gulches; large individuals leave very large light gaps when removed, which can lead to a drier microclimate and increased growth of other weeds before native plants have a chance to recover. Strawberry guava often grows at a very high stem density and is capable of readily resprouting from cut stumps or roots, making removal difficult. Blackberry forms dense, thorny mats, excluding seedlings from wetter gulch bottoms. Due to the need of *Drosophila* for shade and moisture, some alien canopy trees will need to be tolerated for the time being. Some, such as toon (*Toona ciliata*), recruit prolifically and promote conversion from native forest, and thus need to be controlled eventually. Others, like kukui (*Aleurites moluccana*), have low recruitment rates and native understory trees such as *Urera*, *Pisonia*, and *Charpentiera* grow well beneath them.

The western yellowjacket, *Vespula pensylvanica*, is regarded as a major threat to picture wing *Drosophila* on Maui and Hawaii. It is also present on Oahu, but is much less conspicuous than on other islands and its impacts have not been determined. Because they are strongly attracted to heptyl butyrate, *Vespula* numbers can be easily monitored. Determination of the range and abundance of *Vespula* at *Drosophila* sites on Oahu will be a focus of the upcoming year. If warranted and feasible, control measures may be implemented in the following years.

Jackson's chameleon (*Triceros jacksonii*), an invasive African lizard, is likely also a threat as it is known to consume large numbers of insects. Chameleons spend most of the time in trees, where they are usually difficult to spot. They are known to occur at Puu Hapapa, but are probably widespread.

Ants are a serious problem for almost all native invertebrates. The sites where most *Drosophila* are currently found are generally outside the ranges of the worst invasive ant species, the big-headed ant (*Pheidole megacephala*) and long-legged ant (*Anoplolepis gracilipes*). However, the Papuan fire ant, *Solenopsis papuana*, is virtually ubiquitous in mesic and wet forests up to the highest summits. It is very small, generally cryptic and inconspicuous, and almost completely unstudied; its impacts are unknown. A project is currently underway by UH-Manoa researchers to test the effects of *S. papuana* on the native insect fauna, and *Drosophila* in particular.

Population Monitoring

Monthly monitoring will continue at Palikea and the three Kaluaa sites, in order to obtain more data on the seasonal population fluctuations of this species. Pualii will be monitored quarterly to track the population there. Future work will include exploring different monitoring and surveying techniques, such as different lures.

Captive Rearing and Reintroduction

Many species of picture wing *Drosophila* have been reared in the laboratory, some for over 30 years. This involves inducing females to lay eggs on tissue paper soaked in an extract from the host plant; larvae then feed on a yeastless artificial medium. Due to the prodigious reproductive capacity of these flies, they are capable of producing several hundred individuals in one generation (~2 months) from a single female. Thus, it is an important technique that can be used to raise flies for reintroduction into sites where they have been extirpated, starting from relatively few wild individuals. While *D. montgomeryi* has not been bred, we expect that it will not be significantly more difficult than for other species. Experimental rearing will begin in 2015 under supervision of Dr. Kenneth Kaneshiro of UH-Manoa, in order to confirm the viability of this method.

Three Year Action Plan for *Drosophila montgomeryi*					
Population Unit	Occd. Area (ha)	Addl. Area (ha)	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2015 – September 2016
Palikea	0.3	4.7	• plant 50 Uregla • weed control • threat evaluation • monitor monthly	• plant 50 Urekaa • weed control • threat control • monitor monthly	• threat control • weed control • monitor monthly
Pualii	0.2	2.3	• plant 50 Uregla • weed control • threat evaluation • monitor quarterly	• plant 50 Urekaa • weed control • threat control • monitor quarterly	• weed control • threat control • monitor quarterly
Kaluaa					
Central Kaluaa	0.7	1.8	• weed control • threat evaluation • monitor monthly	• plant 50 Uregla • weed control • threat control • monitor monthly	• plant 50 Urekaa • weed control • threat control • monitor monthly
North Kaluaa	0.2	1.5	• plant 50 Uregla • weed control • threat evaluation • monitor monthly	• plant 50 Urekaa • weed control • threat control • monitor monthly	• weed control • threat control • monitor monthly
Hapapa	0.2	0.5	• weed control • threat evaluation • monitor monthly	• weed control • threat control • monitor monthly	• plant 50 Urekaa • weed control • threat control • monitor monthly

5.5 *DROSOPHILA SUBSTENOPTERA* MANAGEMENT PLAN

MIP Year 11-13, Oct. 2014 – Sept. 2017; OIP Year 8-10, Oct. 2014 – Sept. 2017

Management Goals

- Manage three population units (PUs) with stands of reproducing host trees (minimum 50 at each site).
- Control direct and indirect threats at managed PUs, including ungulates, fire, weeds, and alien invertebrates.
- Monitor populations over time for stability and management effectiveness.

Background

Systematics. *Drosophila substenoptera* (Hardy 1969) is a medium sized picture wing *Drosophila* fly endemic to the island of Oahu. It is a member of the *neopicta* subgroup of the *planitibia* species group, and is part of a large group that breed in araliaceous trees on all the islands. The wing pattern is strikingly different from nearly all other species except the sympatric *D. hemipeza*, from which it may be distinguished by having the crossveins of the wings and their corresponding marks staggered rather than in-line.

Ecology. The species occurs in wet to wet-mesic forest, where the larvae breed exclusively in decaying bark of trees in the family Araliaceae. They were reared from *Cheirodendron platyphyllum*, *C. trigynum*, and *Polyscias* (=*Tetraplasandra*) *oahuensis* by S. Montgomery. Based on its current and historic distribution, it appears to prefer taller stature, more open forest (Figure 12), while the related *D. nigribasis* occupies the same breeding niche in the stunted, boggy forest found at the summit of Kaala and the Koolau crest. *Cheirodendron trigynum* is the primary host in this habitat, which remains relatively abundant in both the Waianae and Koolau ranges but tends to occur on steep slopes where surveying is difficult.

Distribution. During the early collecting period (1968-75), most records of *D. substenoptera* were from the Koolau range, extending from the Castle Trail in the north to Wiliwilinui in the south. In the Waianae range, it was found from various sites around Kaala and from Palikea. Recent surveys have documented it from Kaala (just below the summit) and Palikea, but from only a single site in the Koolaus (though sampling there has been much less intensive than previously). The absence of *D. substenoptera* from many historic and suitable sites, its rarity at many of those where it is sometimes found, and the general abundance of *Cheirodendron* at those areas, suggests it is not primarily limited by the availability of host plants.

Management History. The stabilization plan for *D. substenoptera* calls for management of three PUs of at least 5 hectares per PU. There are currently only three PUs where it occurs – Palikea, Kaala, and Lower Opaeula. We plan to manage all three for this species, since all are accessible and managed for other taxa. The Kaala PU encompasses the belt of taller *Metrosideros–Cheirodendron* forest that rings Mt. Kaala and extends along the summit crest to Puu Kalena, and spans the Lihue and Kaala MUs.

Figure 10. *Drosophila substenoptera*, Palikea. This species often sits with its wings out to the side, which may increase its visibility to predators such as yellowjackets.

Current Status of *Drosophila substenoptera* Population Units

Population Unit	MFS	Management Unit	Action Area	Current Management
Palikea	Y	Puu Palikea	none	ungulate fence, weeding, outplanting
Kaala	Y	Kaala, Lihue, East Makaleha	SBW	ungulate fence (partial), weeding, outplanting
Lower Opaeula	Y	Opaeula Lower	KLOA	ungulate fence, weeding

Site Descriptions

Palikea

This MU consists of a roughly rhomboid fenced area enclosing wet and wet-mesic forest at the southern end of the Waianae range. The area enclosed by the MU fence is approximately 9.5 ha. It includes several ridge and gully systems; just below the summit crestline the gulch bottoms are relatively flat before becoming steeper below. Vegetation on the crest and upper ridges is dominated by *Metrosideros polymorpha*, with a significant presence of *Cheirodendron trigynum* and *Ilex anomala*. In gulches, the vegetation is more mesic, and much of the area is heavily invaded by *Schinus terebinthefolius, Psidium*

Figure 11. Population units of *Drosophila substenoptera* designated for management, with habitat management areas shown (area Kaala includes potentially habitable areas beyond current management plans due to inaccessibility).

cattleianum, and *Morella faya*. Weed control efforts by OANRP have significantly reduced alien cover over the past several years, primarily in the more mesic areas. Many rare plants are found wild or outplanted in the MU, including *Cyanea grimesiana obatae*, *Cyanea superba superba*, *Phyllostegia hirsuta*, *Cyanea membranacea*, *Lobelia yuccoides*, and *Exocarpos gaudichaudii*.

Cheirodendron trigynum occurs in the wetter areas near the summit crest and along ridges, extending down into some of the upper gulches. Seedlings are commonly observed. The area occupied or potentially habitable by *D. substenoptera* is approximately 5 ha; the rest of the MU is more mesic vegetation, much of which is dominated by *Schinus*. Some wet areas invaded by strawberry guava may be restorable, but these would require extensive weeding effort.

Although it is the driest of the three sites, and the smallest in total area, Palikea is the only place where *D. substenoptera* is reliably found; though sometimes in low numbers, it has been at every monthly monitoring survey since it was started in May 2013.

Kaala

This is a relatively large PU of approximately 85 ha, covering the band of taller forest just below the summit plateau of Kaala and extending along the upper reaches of Lihue to Puu Kalena. *Drosophila substenoptera* has been found at three locations – in "Trinerve Gulch" in South Haleauau Valley near Puu Kalena, on the Waianae-Kaala Trail on the west side of Kaala, and at the top of East Makaleha Gulch on

Figure 12. Typical forest habitat of *Drosophila substenoptera*, Lower Opaeula. Fallen *Cheirodendron* tree in the foreground.

the north side of Kaala. These are considered a single population across the area, since *Cheirodendron* occurs continuously throughout; *C. platyphyllum* dominates at the summit plateau, intermixing with and then changing fully to *C. trigynum* on the slopes. The full area is difficult to survey, since most of the area consists of steep terrain dissected with ravines. However, the particular gulches and ridges where *D. substenoptera* is known to occur make up about 5 ha.

The summit and near-summit areas consist largely of intact native vegetation, but become more invaded further downslope, particularly with blackberry (*Rubus argutus*). Kahili ginger (*Hedychium gardnerianum*) is a major target of weed control. Many rare plants occur in the area, including *Cyanea* spp., *Lobelia oahuensis*, *Labordia cyrtandrae*, and *Schiedea trinervis*.

Occurrence of *D. substenoptera* is sporadic here and it appears to be rare throughout the area. Each of the three records is of a single individual, except for a flush at Trinerve Gulch in 2009.

Lower Opaeula

This site, also known as Frog Pond for the two perched ponds found just below the main ridge, is unusual on Oahu for having relatively high-stature *Metrosideros-Cheirodendron* forest at middle elevation. It is located along the Peahinaia Trail about halfway between the trailhead and the summit, but the trail is now mostly overgrown and difficult or impossible to traverse. At the summit is another pair of MUs, Opaeula Upper/Helemano, which may form a contiguous area of habitat with Lower Opaeula, but has not been surveyed to date.

Only one *D. substenoptera* has been seen here in three survey trips, but as the only site in the Koolau range where it has been found recently, it is highly significant for the species. Furthermore, the forest type seems to be ideal, raising the question of why it is not more abundant. Although the suitable area within and adjacent to the MU is relatively small, about 2 ha, additional habitat may be present nearby.

Management Actions

Host Plant Restoration

Since *Cheirodendron* spp. maintains robust populations with visible reproduction, and *D. substenoptera* does not appear to be host-limited, augmentation of host plant populations with outplants is not planned as part of management.

Threats

Fire is generally a minimal threat, since most sites are wet and remote from ignition sources. However, Palikea has a steep moisture gradient from dry to wet forest, and a fire in Aug.–Sept. 2014 burned over 1000 acres about 2 km from Palikea, though it did not reach the forest reserve boundary. Mitigation of the threat of fire is done on a landscape level, though the Army's wildfire management plan and participation in cooperative fire management efforts with the State of Hawaii.

Feral ungulates, particularly pigs, are important indirect threats because they damage or destroy host plants, and can also alter the forest microclimate by opening frequent gaps. Of the known *D. substenoptera* sites, Palikea and Lower Opaeula are already ungulate-free and Lihue nearly so (except for the portion of Lower Opaeula outside the fence, which appears suitable but is not known to be occupied); East Makaleha and Waianae-Kaala Trail are not and likely will not be fenced in the near future.

Invasive weeds are a significant factor in suppressing the recruitment and growth of native host plants for *Drosophila*, particularly understory trees like *Urera*. Christmasberry (*Schinus terebinthefolius*), strawberry guava (*Psidium cattleianum*), and blackberry (*Rubus argutus*) are among the most problematic. Christmasberry forms enormous, sprawling growths that shade out all other vegetation and are capable of covering entire gulches; large individuals leave very large light gaps when removed, which can lead to a drier microclimate and increased growth of other weeds before native plants have a chance to recover. Strawberry guava often grows at a very high stem density and is capable of readily resprouting from cut stumps or roots, making removal difficult. Blackberry forms dense, thorny mats, excluding seedlings from wetter gulch bottoms.

The western yellowjacket, *Vespula pensylvanica*, is regarded as a major threat to picture wing *Drosophila* on Maui and Hawaii, particularly for species in the *planitibia* group. It is also present on Oahu, but is much less conspicuous than on other islands and its impacts have not been determined. The wing-waving behavior exhibited by *D. substenoptera* (even outside of courtship) may make it more conspicuous and therefore vulnerable to predation. Because they are strongly attracted to heptyl butyrate, *Vespula* numbers can be easily monitored. Determination of the range and abundance of *Vespula* at *Drosophila* sites on Oahu will be a focus of the upcoming year. If warranted and feasible, control measures may be implemented in the following years.

Jackson's chameleon (*Triceros jacksonii*), an invasive African lizard, is likely also a threat as it is known to consume large numbers of insects. Chameleons spend most of the time in trees, where they are usually difficult to spot. They are known to occur at Puu Hapapa, but are probably widespread, particularly in the Waianae range.

Ants are a serious problem for almost all native invertebrates. The sites where most *Drosophila* are currently found are generally outside the ranges of the worst invasive ant species, the big-headed ant (*Pheidole megacephala*) and long-legged ant (*Anoplolepis gracilipes*). However, the Papuan fire ant, *Solenopsis papuana*, is virtually ubiquitous in mesic and wet forests up to the highest summits. It is very small, generally cryptic and inconspicuous, and almost completely unstudied; its impacts are unknown. A project is currently underway by UH-Manoa researchers to test the effects of *S. papuana* on the native insect fauna, and *Drosophila* in particular.

Competition is not often considered a serious factor for saprophagous insects, but it may be for *D. substenoptera*. Since its discovery in 1997, an adventive crane fly, *Libnotes* nr. *trukensis*, has become extremely abundant in decaying *Cheirodendron* bark. It is most prevalent on Hawaii, where it is often the only species to emerge when rearing from *Cheirodendron* branches; previously, many species of *Drosophila* could readily be obtained by rearing, including some that had never been found through regular collecting. It is known from Oahu, but its prevalence and impact is uncertain. Rearing to determine the abundance of *Libnotes* will be part of threat evaluation.

Population Monitoring

Monthly monitoring will continue at Palikea, in order to obtain more data on the seasonal population fluctuations of this species. Kaala and Lower Opaeula will be monitored quarterly to track the populations there. Future work will include exploring different monitoring and surveying techniques, such as different lures.

Captive Rearing and Reintroduction

Many species of picture wing *Drosophila* have been reared in the laboratory, some for over 30 years. This involves inducing females to lay eggs on tissue paper soaked in an extract from the host plant; larvae then feed on a yeastless artificial medium. Due to the prodigious reproductive capacity of these flies, they are capable of producing several hundred individuals in one generation from a single female. Thus, it is an important technique that can be used to raise flies for reintroduction into sites where they have been extirpated, starting from relatively few wild individuals. While *D. substenoptera* has not been bred, we do not expect that it will be significantly more difficult than for other species. Experimental rearing will begin in 2015 by Dr. Kenneth Kaneshiro of UH-Manoa, in order to confirm the viability of this method.

Three Year Action Plan for *Drosophila substenoptera*

Population Unit	Area (ha)	MIP YEAR 11 October 2014 – September 2015	MIP YEAR 12 October 2015 – September 2016	MIP YEAR 13 October 2015 – September 2016
Palikea	5.0	• weed control • threat evaluation • monitor monthly	• weed control • threat control • monitor monthly	• weed control • threat control • monitor monthly
Kaala	~85	• weed control • threat evaluation • monitor quarterly	• weed control • threat control • monitor quarterly	• weed control • threat control • monitor quarterly
Lower Opaeula	2.0	• weed control • threat evaluation • monitor quarterly	• weed control • threat control • monitor quarterly	• weed control • threat control • monitor quarterly

CHAPTER 6: RODENT MANAGEMENT

OANRP has managed MIP and OIP species that are subject to rodent predation with various strategies since 1997. This chapter discusses rodent control methods utilized over the past reporting year and highlights recent changes. Specifically, this chapter has five main sections: Section 6.1 provides an overview of the current rodent control program and discusses recent changes; Section 6.2 discusses recently installed Goodnature® A24 automatic rat trap grids at Kahanahaiki and Ohikilolo; Section 6.3 provides results of an investigation into tracking tunnel data; Section 6.4 discusses on-going trap trials at Palikea and Ekahanui; and Section 6.5 lays out future plans for rat control.

6.1 OANRP RODENT CONTROL PROGRAM SUMMARY

OANRP manages rats threatening some rare species only seasonally (e.g., *Chasiempis ibidis* or 'Oahu Elepaio' during the nesting season), while other species are protected year-round (e.g. *Achatinella* spp.). The methods of rodent control that OANRP currently utilizes for rodent control are limited to using kill-traps (Victor® traps, Ka Mate™ traps, and Goodnature® A24 traps) and predator exclosures.

Rat control in 2014 consisted of deploying small Victor® snap trap and Goodnature® A24 trap grids around resources, maintaining large-scale trapping grids consisting of Victor® or Ka Mate™ traps, and installing and maintaining large-scale trapping grids of Goodnature® A24 traps. More Goodnature® traps will be installed across MUs and around additional population units over the next year. OANRP contracts Pono Pacific to conduct rat control during Elepaio nesting season (December – June) at Ekahanui, Kahanahaiki, Moanalua, Palehua, and Schofield Barracks West Range (SBW). Pono Pacific is also contracted to conduct year round rat control at Ekahanui and Palikea.

Table 1. Current rat control strategies utilized by OANRP as of October 2014.

MU/Area	Primary Spp. Protected	Control Method	Description	Trap Type	# Traps	Deployment	Check Interval
East Makaleha	*A. mustelina*	Trapping Grid	Two small grids	Victor® w/out boxes	30	Year-round	4-6 weeks
				A24 Automatic traps	15		
Ekahanui† *i*	*A. mustelina*	Trapping Grid	Many small grids	Victor® w/out boxes	47	Year-round	4-6 weeks
				A24 Automatic traps	30		
	C. ibidis	Trapping Grid	Large-scale grid	Victor® w/ & w/out boxes[i]	620	Annual: Dec-June	2 weeks
Kahanahaiki †+	*A. mustelina*	Predator Exclosure	Constructed 1998	--	--	Year-round	--
	A. mustelina, C. superba	Trapping Grid	Large-scale grid	A24 Automatic traps	83	Year-round	4 weeks
				Victor® w/ boxes	464		2 weeks

MU/Area	Primary Spp. Protected	Control Method	Description	Trap Type	# Traps	Deployment	Check Interval
Kamaohanui	*A. mustelina*	Trapping Grid	One small grid	Ka Mate A24 Automatic traps	47 10	Year-round	6 weeks
Kapuna	*H. oahuensis* *S. nuttallii*	Trapping Grid	Two small grids	A24 Automatic traps	5 4	Seasonal	6 weeks
Koiahi	*A. mustelina*	Trapping Grid	One small grid	A24 Automatic traps	8	Year-round	6 weeks
Makaha	*A. mustelina*	Trapping Grid	One small grid	Victor® w/out boxes A24 Automatic traps	29 6	Year-round	6 weeks
	H. oahuensis		Two small grids	A24 Automatic traps Victor® w/out boxes	13 24	Seasonal	6 weeks
	C. grimesiana		One small grid	A24 Automatic traps	6	Year-round	6 weeks
Moanalua†	*C. ibidis*	Trapping Grid	Many small grids*	Victor® w/out boxes	288	Annual: Dec-June	2 weeks
Ohikilolo	*A. mustelina, P. kaalae*	Trapping Grid	Many small grids	Victor® w/ boxes A24 Automatic traps	47 53	Year-round	6 weeks
Palehua†	*C. ibidis*	Trapping Grid	Many small grids*	Victor® w/out boxes	168	Annual: Dec-June	2 weeks
Palikea	*A. mustelina*	Predator Exclosure	Constructed 2012	--	--	Year-round	--
Palikea-Mauna Kapu	*A. mustelina*	Trapping Grid	One small grid	Victor® w/ boxes	15	Year-round	6 weeks
Palikea†	*A. mustelina*	Trapping Grid	Large-scale grid	Ka Mate	180	Year-round	2 weeks
SBW Haleauau‡†	*A. mustelina*	Trapping Grid	One small grid	Victor® w/out boxes	28	Year-round	6 weeks
	H. oahuensis	Trapping Grid	One small grid	Victor® w/out boxes A24 Automatic traps	3 3	Seasonal	6 weeks
	C. ibidis	Trapping Grid	Many small grids*	Victor® w/out boxes	364	Annual: Dec-June	2 weeks
W. Makaleha	*C. grimesiana*	Trapping Grid	One small grid	Victor® w/out boxes	28	Year-round	6 weeks
Waianae Kai	*N. angulata*	Trapping Grid	One small grid	Victor® w/out boxes	20	Seasonal	6 weeks

MU/Area	Primary Spp. Protected	Control Method	Description	Trap Type	# Traps	Deployment	Check Interval
Waieli-Hapapa	*A. mustelina*	Trapping Grid	One small grid	Victor® w/out boxes	35	Year-round	6 weeks
		Predator Exclosure	Constructed 2011	--	--	Year-round	--

* *Each managed Elepaio (*C. ibidis*) territory has 12 traps installed ~12 m apart in trees.*
† *Contracted Pono Pacific to maintain rat grids during Elepaio nesting season.*
‡ *N. Haleauau snail sites are included during Elepaio nesting season.*
i *The majority of traps have been removed from the wooden boxes and placed in trees.*
\+ *Victor® snap traps discontinued to run A24s.*

OANRP is continually researching and reassessing rat control methods to determine the most effective strategies for the protection of natural resources.

6.2 A24 GRIDS AT KAHANAHAIKI AND OHIKILOLO

In 2014, OANRP installed two large scale grids of A24s at two management units (MUs) in the Waianae mountain range, Kahanahaiki and Ohikilolo. Both MUs have had extensive rat control conducted in previous years, ranging from small grids of bait stations to large scale Victor® snap trap grids. Due to the difficult accessibility of Ohikilolo (helicopter access only), the A24s were a good option to test here. Kahanahaiki has long been a testing ground for new management techniques and was the first area with ecosystem scale rat control. It was decided to install the A24 grid in Kahanahaiki so that the results could be compared to other rat control strategies used there in the past. Additionally, easy access at this location allows for frequent monitoring and adjustments.

6.2.1 Kahanahaiki Trapping Grid

The Kahanahaiki grid is designed for large-scale lethal trapping for rats (*Rattus* spp.) across the MU. The overall goal is to reduce rat activity within an MU to a level that benefits the endangered plants, *A. mustelina* (Oahu tree snail), native insects, and the native ecosystem as a whole.

On June 9, 2014, OANRP installed a grid of 83 Goodnature® A24 automatic rat traps across the 26 ha Kahanahaiki MU, equating to 3.2 A24s per ha. The A24 grid will be used instead of maintaining the existing snap trap grid of 464 Victor® ® snap traps, equating to 17.8 Victor snaps per ha. The snap traps will be left in place while the success of the A24 grid is assessed. The A24 grid was laid out using 50x100m spacing with some traps placed at 25x100m based on prior snap catch data. From past snap catch data we have observed, the gulch area in general accounts for more rat catches than other areas of the MU, so additional traps were placed here based on this information.

The previous grid setup of snaps were housed in protective wooden boxes on the ground; the perimeter consisted of 234 traps spaced 12.5 meters apart and the interior contained 246 traps on transects and trails at a spacing of 25 meters apart. Snaps were generally checked on a 2-week interval, requiring the use of 4 personnel. A24s were checked monthly, requiring 3 personnel, thus resulting in a sixty percent reduction in labor. The A24s were checked for presence of carcasses, re-baited with Goodnature® preservative peanut butter and the CO_2 canister was tested. Due to a limited number of counters, only 17 of the 83 traps were fitted with counters to monitor hits.

A total of 38 tracking tunnels were monitored inside the grid and 24 tunnels were monitored at a nearby site (Kapuna Gulch, within Pahole Natural Area Reserve) as a control with no active trapping being conducted. Tunnels were monitored one month prior to installation of the A24s and then monthly

thereafter for both sites, Kahanahaiki has been monitored since 2009 and results from 2013 monitoring have been included for comparison (Figure 1). Tunnel data show that percent rat activity at the Kapuna site remains much higher than at Kahanahaiki.

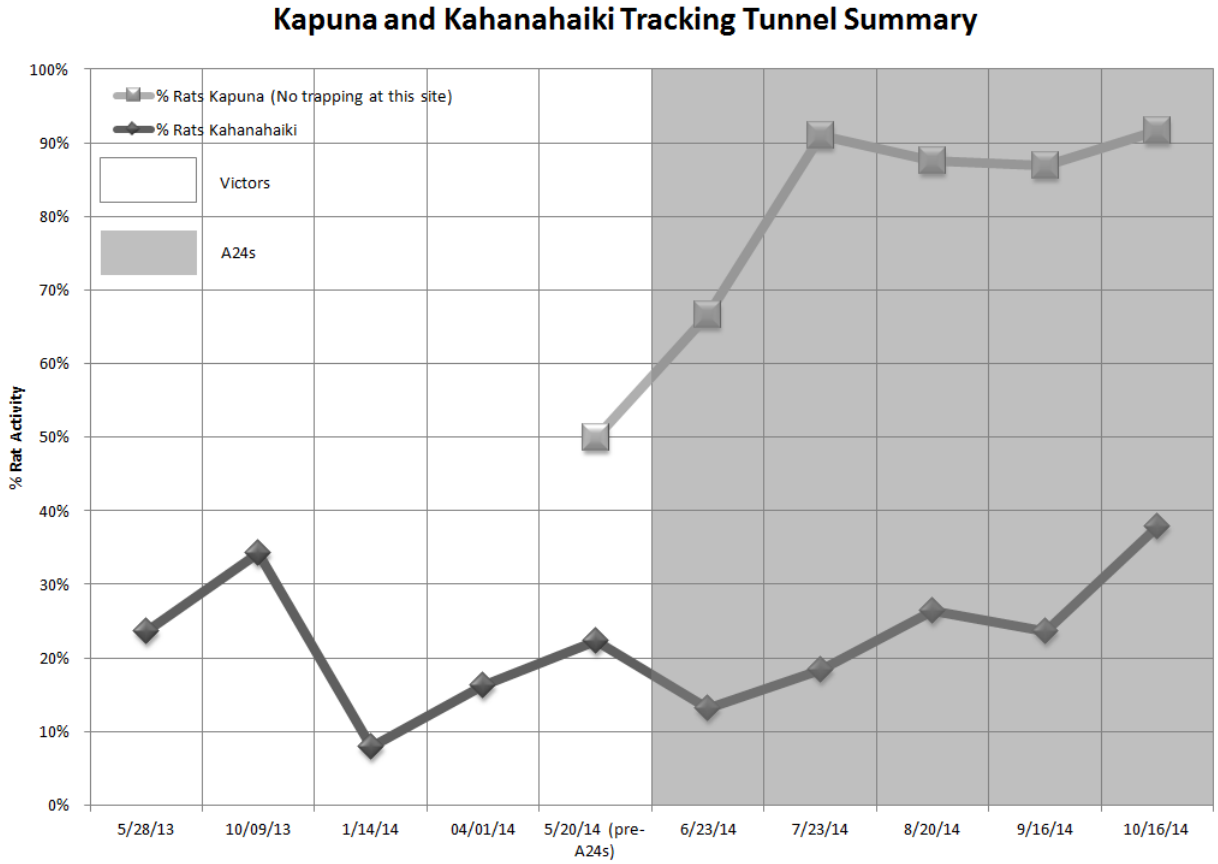


Figure 1. Percent of rat activity each month at Kahanahaiki and Kapuna (No trapping at this site).

Management Considerations for 2015

One of the OANRP goals for the A24s is to eventually reduce trap checking interval from to quarterly. Because this is a multi kill trap and costs more than traditional traps, a balance of staff time and trap cost needs to be achieved to meet program objectives. One of the ways to accomplish this is by increasing the bait longevity and attractiveness in the A24s at Kahanahaiki. A study developed to do this involves constructing custom counters that record the date and time of each hit. This will allow us to determine how effective the bait is over a three month period. From bait trials last year, we have found that the Goodnature Preservative peanut butter and our home made beeswax peanut butter bait seem to be most promising at this point and thus will be used for the trial. Both of these baits seem to be relatively resistant to mold and are not rapidly consumed by slugs.

A second OANRP goal is to reduce rat activity to less than 10%. A trial will be conducted using a 50x50m grid for trap spacing replacing the current trap spacing grid of 100x50m. The checking interval and bait used will be determined by the results of the bait longevity study. Future plans for this MU would depend on results from the bait longevity study. If bait is not palatable for a period of one to two months then other trap options may be considered. We have observed the bait lasting several months at Kahanahaiki with little to no mold and very little scavenging from slugs or ants. Therefore, the checking

interval can be reduced from once a month to every two months. If observations show continued bait retention and attractiveness, the interval can be reduced to quarterly.

OANRP has considered reducing the size and scope of this grid to only protect small populations of rare species within the MU. However, since labor for this site can be potentially only 2 people once every two months or even quarterly we recommend continuing to bait this grid for MU wide protection. The Kahanahaiki MU will be used as the location to develop best practices of grid size, trap density, bait attractiveness, CO_2 canister changing intervals, and check intervals. The development of the trial at Kahanahaiki may be used as a standard for future trials on bait longevity at other MUs to guide check intervals. Once established, best practices will be used across other MUs.

6.2.2 Ohikilolo Trapping Grid

The Ohikilolo grid was established in 2009 to protect two endangered species, *P. kaalae* and *A. mustelina*. The grid has been modified in the past from a combination of Ramik bait stations and Victor® snap traps to just snap traps and now to A24s exclusively. Ohikilolo is only easily accessible via helicopter; therefore, the baiting interval has been every 6 weeks. The use of A24s at this site could potentially decrease the checking interval to quarterly, which would save valuable helicopter time and money.

On March 10, 2014, 53 A24s were installed at Ohikilolo. These traps were spaced approximately 10-25 meters apart on ridge and gulch trails throughout the MU, and re-baited on a 6-week interval. The existing Victor® snap traps were left in place while the success of the A24 grid is assessed. Counters were installed on all traps and bait trials are currently being conducted. Unlike Kahanahaiki, bait at this site has been observed to become very moldy with significant bait loss due to slug consumption. Different combinations of preservatives and wax are being assessed at this site as part of the bait trial.

Tracking tunnels have been used to monitor rat activity within the grid. A total of 27 tracking tunnels are placed throughout the MU and have been monitored on a semi-annually to quarterly interval starting in July 2009 through October 2013, monitoring did not occur between October 2013 through March 2014. Starting in March 2014, tunnels were monitored on a 6-week interval (Figure 2).

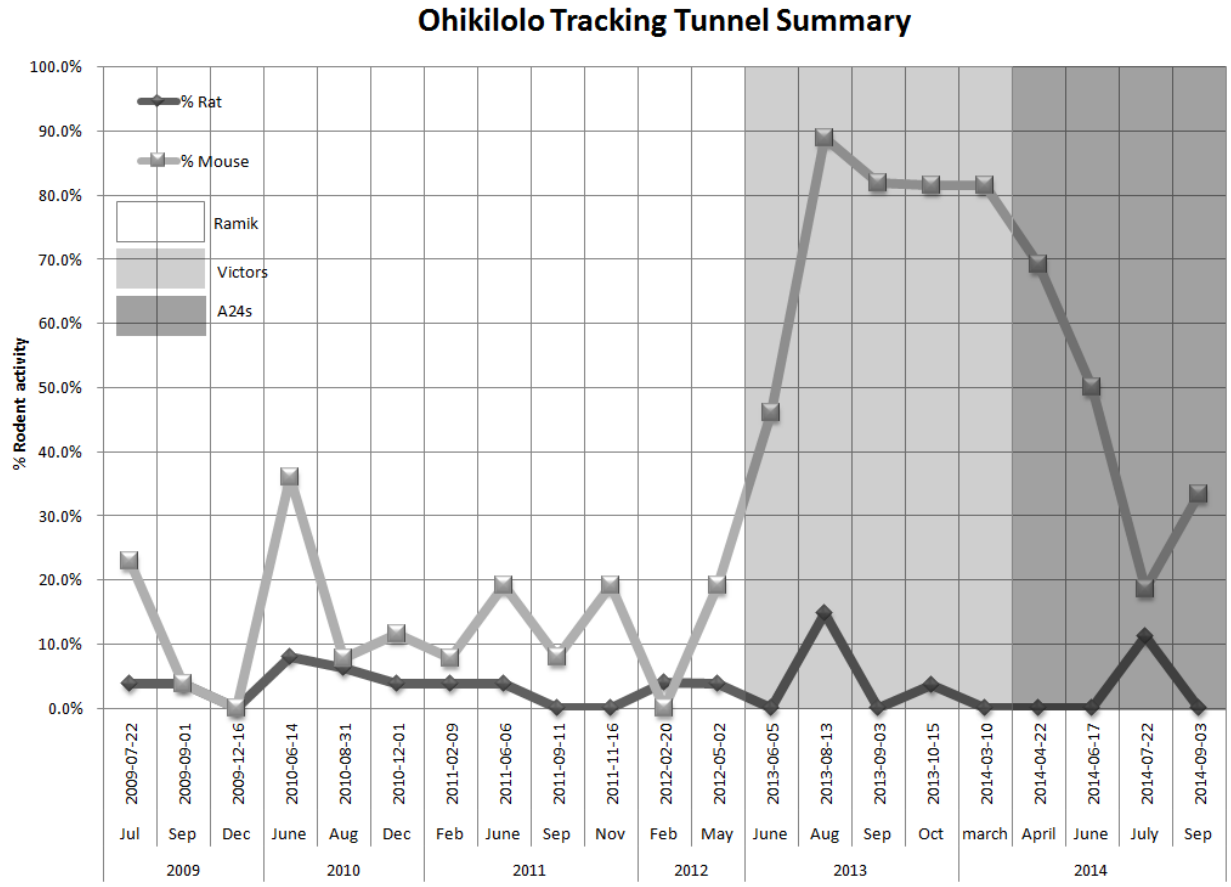


Figure 2. Percent of rodent activity among tracking tunnels by month at Ohikilolo showing when Ramik, Victors and A24s were used. Ramik was last used on May 13th, 2013.

Rodent control at Ohikilolo is designed to specifically target rats because they are the largest rodent threat to the natural resources OANRP protects (Mosher 2010, Shiels 2010). Mice have a significantly smaller home-range size than rats and OANRP believed that the grid was not effective at reducing mouse populations. Data from the tracking tunnels indicate changes in mouse activity levels in association with rodent control methods. Mouse activity levels were relatively low with the use of Ramik and A24s as compared with the use of victors. Victor® snap traps are larger in size than mouse traps and therefore catch very few mice. This suggests that although the grid was designed to target rats, Ramik and A24s also reduced local mouse populations.

6.3 EVALUATION OF TRACKING TUNNELS

In New Zealand, Department of Conservation uses tracking tunnels inside and outside of large trapping areas (> 200 ha) to assess efficacy of rodent control. They have also defined a 'damage threshold' of 5% rat activity in which tracking tunnels must remain below in order to achieve management goals for a species (Hill pers. comm. 2011). To date, OANRP has not been able to determine a damage threshold for rat activity in tracking tunnels that corresponds to management goals because activity levels have been so variable. Initially, OANRP hypothesized that this is because the existing trapping grids are too small or are otherwise unable to maintain a reduced population of rats inside the grid.

A thorough review of our tracking tunnel data has revealed another possible explanation for large fluctuations of percent rat tracking at some of our MUs. Historically, a small amount of peanut butter has

been added to a leaf that is then placed on the tracking card. This setup allows for easy removal of bait by the first species to encounter the tunnel, therefore not attracting any other species. For example, if cats, mice or mongoose are tracked and remove the bait, rat tracks are generally not observed. When percent of cats tracked is high, percent of rats tracked is low. One possible explanation is that rats are showing avoidance to the tunnels because of high cat presence in the area. However, after putting a larger amount of peanut butter directly on the tracking cards at our Kapuna site we observed three cards with both cat and rat tracks with some peanut butter remaining. We have also documented this in other sites over the years. This leads us to believe that rats are not avoiding tunnels near cats; rather, they are not being tracked due to absence of bait in the tunnels. Both Ekahanui and Kahanahaiki tracking tunnel data have been analyzed to explore this possible relationship (Fig. 3).

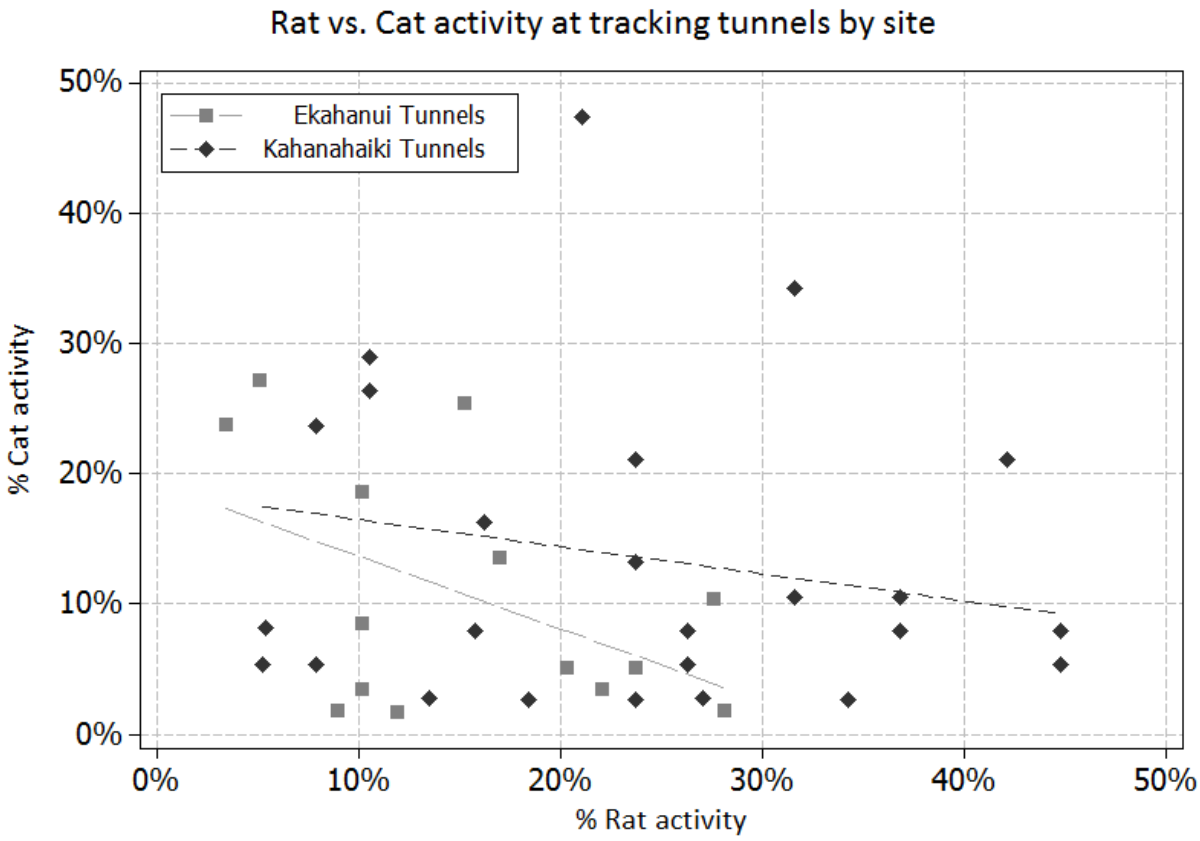


Figure 3. Percent of rat vs. cat activity at tracking tunnels by site.

After looking at the percent tracking data we do see a negative relationship for both sites. It appears that there is a pattern there, but a Pearson Correlation is not significant when looking at both sites combined ($p = 0.182$). However, when looking at each site individually, Ekahanui is approaching significance ($p = 0.08$). Kahanahaiki was not significant ($p = 0.269$), but, with the removal of three outliers in 2010 that had both high percentages of cats and rats, becomes significant ($p = 0.010$).

We also analyzed the relationship between mice and rat percent activity at both sites combined (Fig. 4). We found a significantly positive correlation with mice and rat activity ($p = 0.024$). It is possible that both mice and rats could be responding to a resource together (where rat abundance is high so is mice abundance). This would suggest that rats are not defending territories against mice, thus, removal of rats would not cause an explosion of mice. It is impossible to distinguish rat versus mice kills using counter data on the A24s.

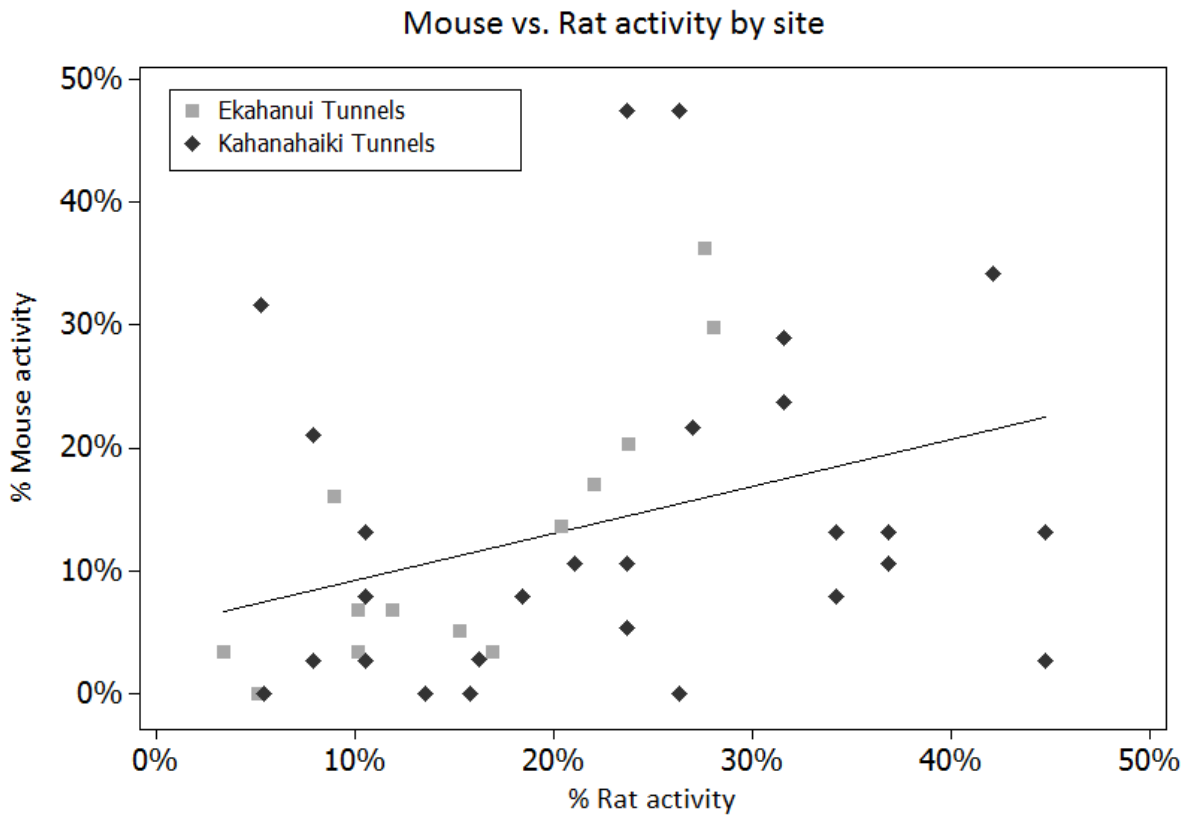


Figure 4. Percent of Mouse vs. Rat activity at tracking tunnels by site

6.4 ON-GOING TRIALS AT PALIKEA AND EKAHANUI

Although the significant amounts of data and research conducted on traps and bait in New Zealand is helpful for implementation in Hawaii, OANRP has documented difficulties and conditions that are not experienced in New Zealand. For example, bait removal by slugs and other invertebrates is a major issue that is not experienced to the same degree in New Zealand. Additionally, it is possible that black rats (*R. rattus*) in Hawaii spend more time in trees than black rats in New Zealand (Peters, pers. comm. 2013). Two questions OANRP asked over past years is whether or not rat control is improved by housing snap traps inside a protective box (typically placed on the ground) or whether uncovered snap traps mounted directly to trees is more effective. It is thought that perhaps the rats would encounter the traps more easily if they were in trees while the slugs would not encounter them as easily, reducing bait loss. DOC's best practice includes housing Victor® traps inside wooden boxes placed on the ground in order to exclude non-target species, guide target species, prevent accidental triggering, and maintain the integrity of the trap from weather (NZ DOC 2005).

At Ekahanui a trial is being conducted to assess if putting Victor® traps uncovered in trees is better than putting Victor® traps in trees with two different trap coverings: wooden boxes or greenhouse plant pots. This study will also look at catch of non-targets and determine whether covered traps will catch fewer non-targets relative to uncovered traps while maintaining the same efficacy for rats. The entire Ekahanui grid covers an area of 177 acres (72 ha). The grid consists of 620 Victor® snap traps that are housed in protective wooden boxes on the ground or placed in trees without boxes; there are 225 traps on the perimeter of the MU and 394 traps in the interior of the MU, all spaced 25 meters apart. For this trial, only a subset of traps (150) was used. 80 Victor® traps were placed in trees with no covering, 36 were

placed in boxes in trees, and 34 were placed in greenhouse plant pots in trees. Traps were checked every two weeks and catches were recorded.

At Palikea a trial was conducted to compare two different trap types, Victor® versus Ka Mate™, and to conduct a cost benefit analysis. The Palikea grid covers an area of 21 acres (9 ha). The grid consists of 180 Ka Mate™ traps: there are 98 traps on the perimeter of the MU spaced 12.5 meters apart and 82 traps in the interior of the MU spaced 25 meters apart along trails. Ka Mate™ traps were deployed in order to experiment with that style of trap and compare the trapping efficacy to Victor® snap traps. On June 5, 2014, staff replaced every other Ka Mate™ trap with a Victor® trap uncovered in a tree, for a total of 91 Ka Mate™ and 84 Victor® traps. Both trap types were then baited every two weeks using small pieces of coconut and observations were recorded. Peanut butter was not used for this trial as Ka Mate™ traps require the use of hard bait for proper trap function. Ka Mate™ traps are set by wedging coconut underneath the trigger. The bait is held in place by tension and the trap cannot trigger until the bait is removed. Victor® traps are set by placing the coconut securely on the yellow pan in-between the plastic triangle or by smashing into the little box on the trigger. Results of these trials will be included in next year's report.

6.5 FUTURE PLANS

Currently, OANRP is conducting limited small grid rat protection at several different rare plant populations. These consist of Victor® traps, A24 traps, or both. Visitation to these sites is often inconsistent and based on plant needs. Some sites get visited frequently while others sometimes only are visited once every couple of months. Control is usually conducted during the fruiting season for most species. Seasonal control, however, has morphed into year round control on some populations that have had basal girdling by rats, such as the *Schiedea* and *Hesperomannia* populations see figure 5.

Figure 5. Rat damage on *Hesperomannia arborescens* at Kapuna/Keawapilau.

Large scale grids of A24s may prove to be more cost effective and beneficial for MU wide rat control compared with large scale grids of victors. OANRP will use counter trials and tracking tunnel results from Kahanahaiki to determine future rat control at other MUs. Possible new sites for MU wide control include Makaha and Kaluaa. MU wide rat control at these areas would provide benefits for multiple species. For either site, tracking tunnels would be placed within the MU and a control site. Spacing would be determined from results at Kahanahaiki and would probably be approximately four A24s per hectare.

Over the next year, OANRP will continue using peanut butter beeswax more extensively. To maximize longevity and bait attractiveness to rats, OANRP will experiment with using the peanut butter beeswax as

supplemental bait; all Victor traps will be baited with a piece of the wax and also a fresh dab of peanut butter or other bait, such as Nutella®. This way, the traps will be highly attractive to rats while the first bait (e.g., peanut butter) is present and will remain baited with the wax after the peanut butter has been removed by insects or slugs.

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CHAPTER 7: INVERTEBRATE CONTROL PROGRAM

Summary

This chapter describes the status and outcome of actions carried out under the direction of the Oahu Army Natural Resources Program (OANRP) Research Specialist which, this year, focused on increasing effenciency in the control of invasive slugs, surveying for and controlling the newly introduced Coconut Rhinoceros Beetle (*Oryctes rhinoceros*) and Little Fire Ant (*Wasmannia auropunctata*), as well inspecting high risk areas for invasive ants (Hymenoptera, Formicidae). We also discuss our efforts to limit or prevent native snail exposure to slug bait.

7.1 SUMMARY OF SLUG CONTROL ACTIONS OCT. 2013-SEPT. 2014

Background: Slugs can cause dramatic declines in the survival of rare native Hawaiian plants (Joe & Daehler 2008). Control of slugs using the organic molluscicide Sluggo® (trademark omitted from the rest of this document) (Neudorff, Germany) was shown to encourage seedling germination and recruitment of certain rare plant species (Kawelo *et al*. 2012), in particular those within the genera *Cyanea* and *Schiedea*. In 2010, Sluggo was approved for forest use by the Hawaii Department of Agriculture (HDOA) under a Special Local Needs (SLN) permit. We are currently working with the manufacturer and the HDOA to ensure all research and documentation is completed to allow for renewal of this important product upon its expiration in Oct. 2015. This SLN has made slug suppression possible around rare plants in the wild. In response, OANRP has expanded its slug control program every year since 2010. Over the past year we controlled slugs in order to protect eight endangered species in six Management Units (MUs) across an area equal to 3.2 acres, a 40% increase in area from the previous year. Rare plant species which received Sluggo treatments at a rate of 1 lb. Sluggo per 184 m^2 per month (half the maximum label rate) appear in Table 1. Portions of Ekahanui and Palikea were not treated every month as they were part of an experiment on setting reduced intervals for application of Sluggo discussed later in this section.

Table 1. List of rare plant species treated monthly with Sluggo. Treatment areas are not necessarily contiguous.

MU	Plant species treated (Population Reference Code)	Treatment area (m^2)	Sluggo required per treatment (lbs.)
Ekahanui	*Cyanea grimesiana* subsp. *obatae* (EKA-C) , *Delissea waianaeensis* (EKA-D), *Phyllostegia mollis* (EKA-D), *Schiedea kaalae* (EKA-D)	4,232	23
Palikea	*C. grimesiana* subsp. *obatae* (PAK-A & PAK-B)	2,220	12
Kahanahaiki	*C. superba* subsp. *superba* (MMR-E & MMR-H), *S. nuttallii* (MMR-E), *S. obovata* (MMR-C & MMR-G)	1,650	9
Upper Kapuna	*S. kaalae* (KAP-A)	706	4
West Makaleha	*C. longiflora* (LEH-B), *S. obovata* (LEH-A & LEH-C)	1,196	6.5
Pahole	*S. nuttallii* (PAH-D & PAH-E), *C. superba* subsp. *superba* (PAH-A)	3,000	16

Pest species monitoring:
Relative slug abundance was measured using baited pitfall traps (McCoy 1999) consisting of ten 9-oz. glass jars, placed in holes so that their openings were level with the soil surface and baited with six oz. of beer. This year, we switched from Guinness (Diageo Brewing Co., Ireland) to a less expensive brand of beer, Pabst Blue Ribbon (Pabst Brewing Co., CA). Results from a trial in Kahanahaiki comparing the two beers demonstrated they are equally attractive to slugs (Fig. 1). A repeated measures ANOVA showed beer type did not significantly influence catch when controlling for time ($F_{1, 119} = 0.25$, $p = 0.618$).

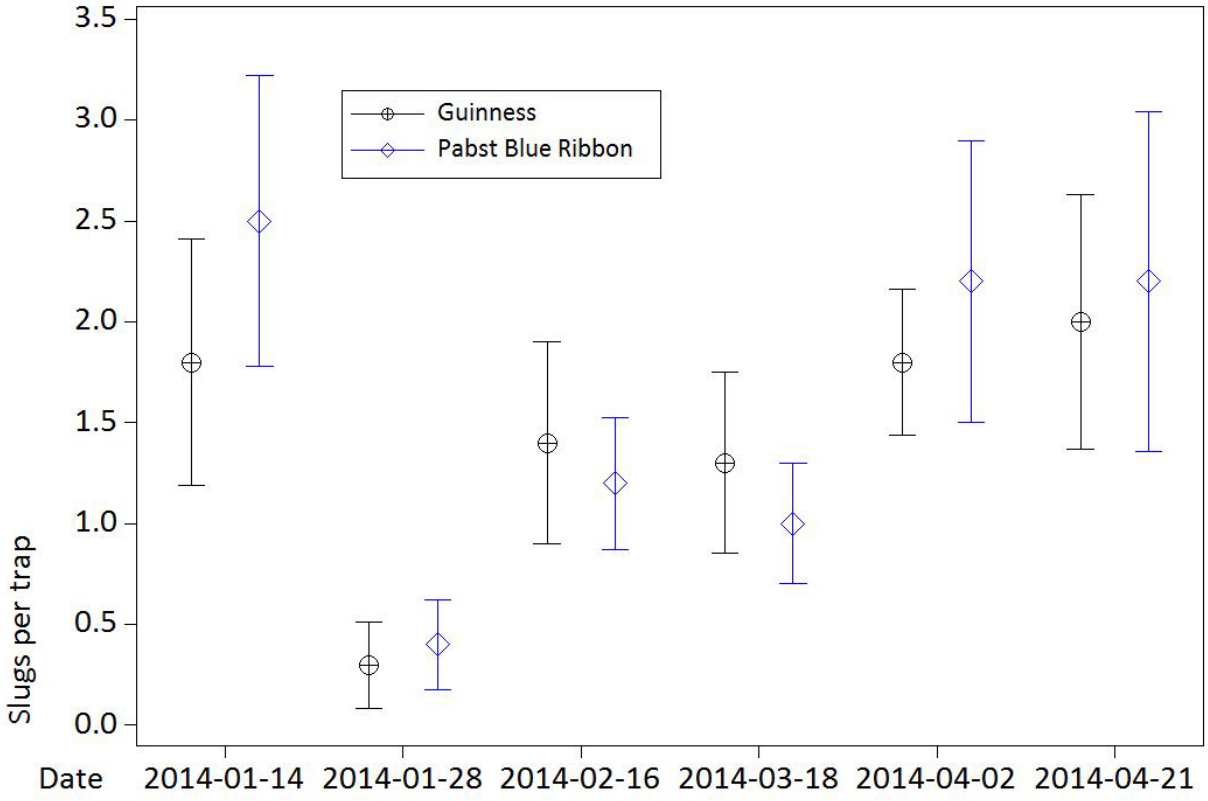


Figure 1. Slugs captured per trap by beer type (bars are ± 1 SEM).

Due to constraints on time and labor, relative slug abundance could not be monitored at all slug control sites. Our strategy was to use abundance data from two sites (Palikea and Ekahanui) to determine slug control at other sites. This is an imperfect strategy however, as slug abundance can differ by MU. This coming year, we plan to monitor slugs at all sites but less frequently than in the past.

Methods: Within Palikea and Ekahanui, treatment and control sites were established no closer than 30 m and no farther than 100 m from one another. Traps were scattered throughout each treatment site at least two meters from their nearest neighbor and at least two meters from the edge of the Sluggo application area. Traps were set for two weeks, after which any captures were recorded. In previous years, Sluggo application was halted when slugs dropped to one slug per trap in the control sites. Slug abundance at untreated sites this year never dropped below this- admittedly subjective- threshold so monthly treatments were continuous for all except areas included in the optimal Sluggo application trial. The control data which informed our decision to continue treatments appears as part of a later figure (Figs. 7a & b, see "No Sluggo" group specifically). Calibrating the start and end times for Sluggo application requires multiple visits to set and check traps. This is time which could be better spent simply applying Sluggo continuously. We will transition to this latter strategy in the upcoming year.

Native snail monitoring: Native snails may be adversely impacted by Sluggo. The label cautions: "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 must not be applied within 20 m of any tree known to harbor endangered Hawaiian tree snails (*Achatinella* spp.)." Accordingly, all areas which currently receive Sluggo have been extensively searched by our rare snail conservation specialist. Even a thorough survey does not garuntee detection. Snails can be hidden deep in foliage, move into or out of an area, or occur in such low numbers that an encounter would be improbable. Regular, periodic monitoring is necessary to ensure native snails are not present and do not move *into* areas where they would be exposed to Sluggo. This occurred at two sites, one at West Makaleha (Fig. 3) and one at the bottom of Kahanahaiki gulch (Fig. 4). Sluggo has not been applied at either of these sites since snails were found. The timeline of activities by MU related to native snails at these sites appears in Table 2.

Table 2. Discovery of native snail species in former Sluggo application sites.

MU	Date	Finding	Action
West Makaleha	April 2011	No native snails found	Sluggo application begins at *Cyanea longiflora, Schiedea obovata* and *C. grimesiana* sites
	April 2013	Six *A. mustellina* were found within 20 m of *C. grimesiana* Sluggo application site	Snails moved to suitable tree outside of slug control area. Sluggo halted at *C. grimesiana* site
	April 2014	No native snails found	No action taken
	Oct. 2014	Two *A. mustellina* were found in an *Antidesma* tree in the former Sluggo application area	Snails moved to suitable tree outside of slug control area. Sluggo resumed at *C. grimesiana* > 20 m from the original *Antidesma* host
Kahanahaiki	March 2010	*Cyanea superba* seedling survival with slug control investigated under an Experimental Use Permit for Sluggo	Sluggo applied experimentally at two week and one month intervals
	Dec. 2010	*Leptachatina* spp. (Amastridae) found within Sluggo area	Sluggo halted at *Cyanea superba* near snails
	Sept. 2014	*Leptachatina* spp. (Amastridae) found within former Sluggo area	No action taken, Sluggo application not resumed

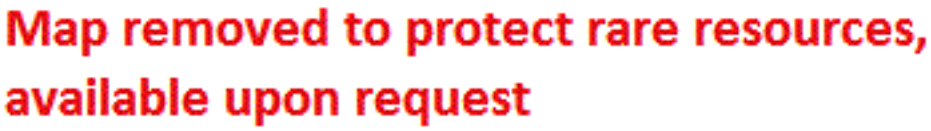


Figure 3. *Achatinella mustellina* location and translocation in relationship to slug control areas in West Makaleha. Translocated snails are shown in red. Due to eight snails found on two occasions in the vicinity of some of *Cyanea grimesiana* subsp. *obatae* plants Sluggo has not resumed for plants within 20 m of the original host tree.

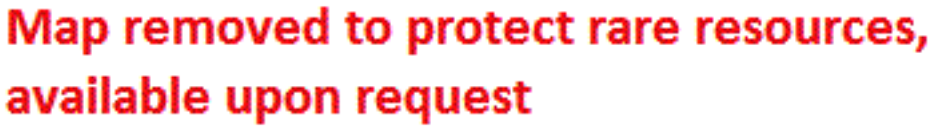


Figure 4. *Leptachatina* spp. (Amastridae) locations in relationship to slug control areas in Kahanahaiki. Due to multiple finds of snails in the vicinity of some *Cyanea superba* plants Sluggo is no longer applied there.

7.2 EFFICACY OF REDUCED SLUGGO APPLICATIONS

Background: In 2011 we set up an experiment to determine whether Sluggo applied at the label rate (once every four weeks) provides equal slug suppression as when applied every two weeks. These two rates were chosen because the label states (italicized emphasis my own): "Apply at higher rates if the infestation is severe or if the area is heavily watered or after long periods of heavy rain. Reapply as the bait is consumed or *at least* every two weeks." OANRP manages sites that are fairly remote. The cost of slug control is doubled if crews must treat plants every two weeks when only a single application per month is required to reduce slug numbers. The cost of the bait itself is also a factor. A 25 lb. bag retails at $70 (http://www.groworganic.com/sluggo-25-lb-bag.html).

Results indicated that a month interval between Sluggo applications provided adequate slug control in the two largest sites (Ekahanui and Palikea; OANRP 2012) but was insufficient at West Makaleha where the treatment area measured only 144 m^2. The following year, doubling the treatment area significantly improved slug suppression and allowed for a longer interval between treatments (OANRP 2013). This year we tested whether slug control can be achieved when Sluggo is applied even less frequently. We refer to this latest study as the Extended Interval Treatment (EIT) as compared to the Monthly Interval Treatment (MIT), which took place prior to the EIT in the early months of 2012.

Methods: We delimited treatment areas measuring 2000 m^2 and control sites at least 30 m away from the treatment areas in two MUs: Ekahanui and Palikea (Figs. 5 & 6). From January 2014 through July 2014 we applied Sluggo once every 8 weeks at Ekahanui and once every 6 weeks at Palikea. Except when relevant, we will refer to both of these as the EIT at that site.

Figure 5. Slug treatment and control sites in Ekahanui. Under the EIT the shaded area received Sluggo once every 8 weeks.

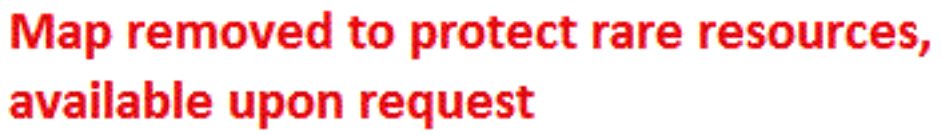


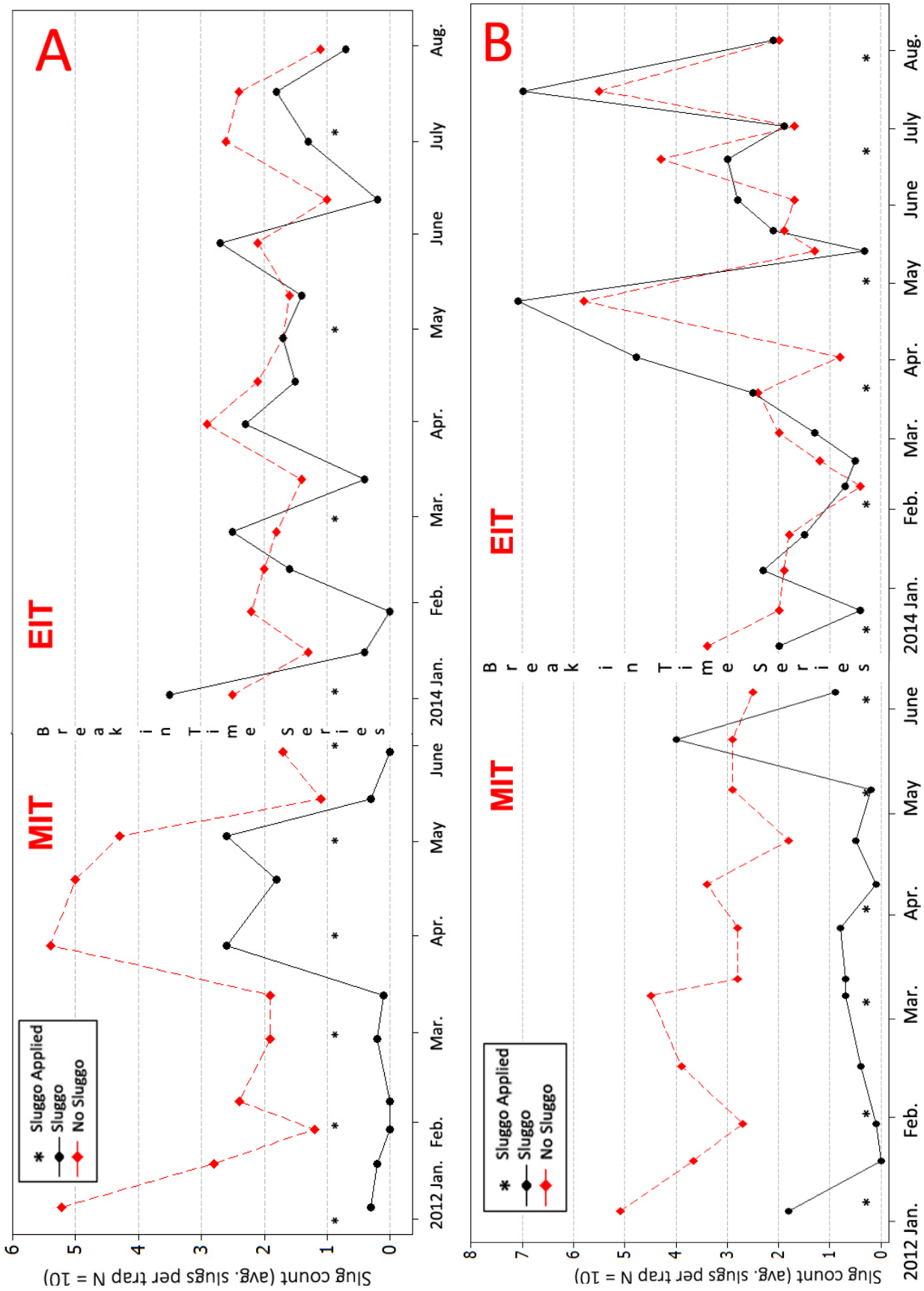
Figure 6. Slug treatment and control sites in Palikea. Under the EIT the shaded area received Sluggo once every 6 weeks.

We used counts of slugs at baited traps once every two weeks in treatment and control sites as a measure of relative slug abundance (see Pest Species Monitoring this document).

Analysis post-treatment relied upon the counts of slugs at the control traps subtracted from counts of slugs at the treatment traps. Thus a value of 0 indicated no difference between each trap pair, a positive number indicating an increase in slugs and a negative number a decrease in slugs due to treatment. The dataset for the EIT relied upon data collected this year, while that for the MIT relied upon data gathered from January through June 2012. Both the EIT and MIT occurred in the same areas, with the same baited beer traps, the only difference was that the former took place in 2012 and the latter in 2014.

Analysis: Statistical analyses were performed with Minitab Release 16 software of Minitab Inc. (Ryan *et al.* 2005). Significance during hypothesis testing was characterized by p-values less than 0.05. Datasets did not deviate greatly from normal so a repeated measures ANOVA was used to investigate the effect of treatment independent of time. Differences between the treatment and control groups within EIT treatments by MU were analyzed using a two sample T test. While reductions in the number of slugs between the MIT and EIT as well as between the control and treatment groups were compared statistically, direct comparisons between the two EIT treatments (6 weeks at Palikea vs. 8 weeks at Ekahanui) were not possible because of lack of replication within the other MU.

Results: The mean number of slugs recorded at the treatment and control sites in the MIT vs. the EIT group at Ekahanui is shown in Figure 7a. The same data for Palikea is shown in Figure 7b.


A
EIT
MIT
Break in Time Series
Sluggo Applied
Sluggo
No Sluggo
Slug count (avg. slugs per trap N = 10)
2012 Jan.
Feb.
Mar.
Apr.
May
June
2014 Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
B
EIT
MIT
Break in Time Series
Sluggo Applied
Sluggo
No Sluggo
Slug count (avg. slugs per trap N = 10)
2012 Jan.
Feb.
Mar.
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May
June
2014 Jan.
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June
July
Aug.

Figure 7. A: Ekahanui MIT and EIT groups vs. the control. B: Palikea MIT and EIT groups vs. the control**.**

A repeated measures ANOVA showed a significant slug reduction in the MIT group over the EIT group in Ekahanui ($F_{1, 244} = 28.38$, $p < 0.000$). This was also true for Palikea where the MIT group outperformed the EIT group ($F_{1, 271} = 49.27$, $p < 0.0005$) (Fig. 8).

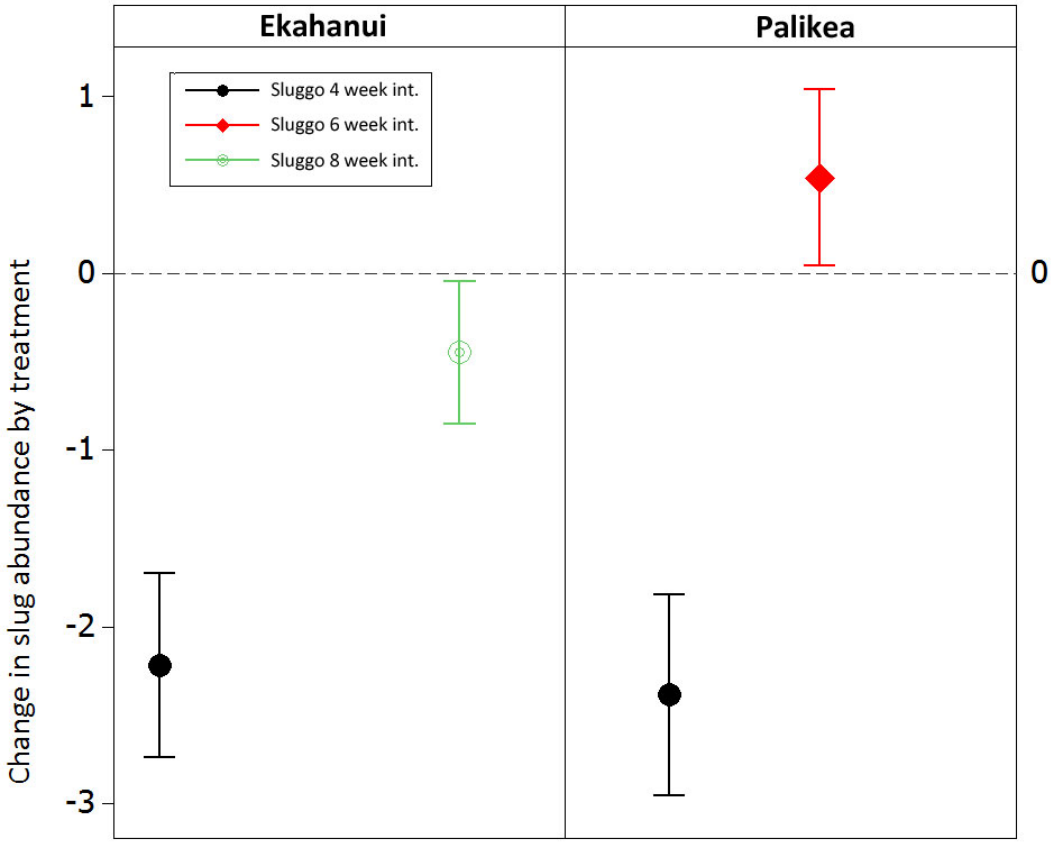

Figure 8. Interval plot (bars are 95% Confidence Interval for the Mean (CIM)) of the EIT at both sites showing a greater reduction in slugs in the MIT group.

In fact, a two sample T test failed to show a difference between the EIT group and its control at Ekahanui ($t(15) = 1.50$, $p = 0.149$) or Palikea ($t(17) = -0.21$, $p = 0.835$) indicating the Sluggo treatment was ineffective.

Conclusion: Despite fluctuations in slug numbers from year to year, when Sluggo is applied at intervals longer than 4 weeks apart, slug reduction is indistinguishable from no treatment. Sluggo should be applied at least every month to protect rare plant species.

7.3 Survey of Invasive Ant Species

New ant species: In December 2013, the Little Fire Ant (LFA) arrived in Waimanalo from infested material from the Big Island. It is a serious threat both ecologically and economically. To prevent accidental transport of this pest, we surveyed several new sites, including suppliers of our greenhouse media and the garden supply shop at Schofield Barracks. These are areas where, if LFA were found, they could easily contaminate our greenhouse and by extension get into natural areas where we work. We plan

to repeat these surveys at least annually if not more frequently. A list of sites and the dates they were surveyed appear in Table 3. LFA was surveyed according to methods recommended by the Hawaii Department of Agriculture on their website (http://hdoa.hawaii.gov/pi/files/2014/05/LFASurvey.pdF) with the exception that baited vials rather than chopsticks were used to better preserve any specimens.

Table 3. High risk sites targeted for periodic LFA surveys.

Date, time	Location	Area searched	Positive samples
March 6 2014, 1:30-2:30 pm	New housing 1875 Lyman Road, Schofield Barracks	Approximately 4 household blocks	0 of 20
March 12 2014, 3:30-4:30	OANRP storage warehouse, Higgins Road, Wahiawa	0.5 acre warehouse and yard	0 of 20
March 24 2014, 9-10 am	BEI Honolulu	Pesticide warehouse	0 of 20
March 24 2014, 11-12 pm	Niu Nursery, Sand Island	Soil and cinder outdoor loading area	0 of 20
March 24 2014, 1-2 pm	Pacific Agricultural Sales	Warehouse	0 of 50
May 28 204, 10-11 am	Schofield PX Garden Shop	Outdoor patio with plants measures 75 m^2	0 of 20
July 31 2014, 8-9 am	Green Thumb Community Garden, Schofield Barracks	Mulch piles and garden entrance	0 of 20
July 31 2014, 12-2 pm	Mililani Mauka greenwaste transfer station	0.5 acre greenwaste pile	0 of 100

Other ant surveys: In Hawaii, ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads (OANRP 2010). As stated in previous reports (OANRP 2011), OANRP conducts annual surveys of invasive ants in high-risk areas using a standard protocol developed by University of Hawaii entomologists (OANRP 2010). These areas include trailheads, cabins and landing zones, where accidental introductions of ants are more likely to occur as well as in areas where rare resources may prove vulnerable to ant attack. Careful monitoring will increase our chances of early detection and eradication. Due to the increased burden of LFA surveys, not all samples collected this year have been sorted. The results from completed current surveys appear in Table 4.

Table 4. List of ant species found in each MU. Results for the majority of MUs are not yet available.

Management Unit	Ants recorded prior to 2014	Ants recorded 2014	Action needed?
Kaala	*Solenopsis papuana, Ochetellus glaber, Tetramorium simillimum, Cardiocondyla venustula, C. wroughtoni, C. minutior*		No ants detected in 2014
Kahuku	*Pheidole megacephala,*	*Pheidole*	Both species present are

Training Area	*Anoplolepis gracilipes*	*megacephala, Anoplolepis gracilipes*	considered a medium threat and are too widespread for control
Makaha	*Anoplolepis gracilipes, S. papuana, Pheidole megacephala, Technomyrmex albipes*	*Solenopsis papuana*	All species widespread at parking lot. No ants detected at outplanting sites
Ekahanui	*Solenopsis papuana, Plagiolepis alluaudi, Technomyrmex albipes*	*Solenopsis papuana*	Species present are abundant and widespread. Control in certain areas under consideration

Ant Control Actions: Three infestations of the *Solenopsis geminata* (tropical fire ant or TFA) were identified and treated in 2011 by State and OANRP staff (infestations were at Pahole Mid Elevation Nursery, Puu 2210 and Peacock Flats Campground). Follow up monitoring in 2013 shows TFA has not recurred at Puu 2210, but was detected at the Peacock Flats Campground and at the Pahole Mid-elevation nursery. In the past TFA has responded well to insecticidal baits containing the active ingredient hydramethylnon. We will reapply this bait as needed with cooperation from the State DLNR who manages the campground and greenhouse areas. Further monitoring in 2014-2015 is needed to assure successful eradication.

7.4 COCONUT RHINOCEROS BEETLE

Background: In December 2013, CRB, was confirmed as being present near the Honolulu International Airport and a large breeding site was found in mulch piles at Joint Base Pearl Harbor – Hickam (JBPH). OANRP has fully cooperated with the joint USDA and HDOA Task Force to prevent its spread by removing potential breeding sites on Army installations, maintaining traps and looking for signs of CRB damage to plants. Of particular concern to OANRP is CRB's likely impact to an endangered palm we manage, *Pritchardia kaalae.* In addition to its devastating effects on palms, CRB is known to attack a number of agricultural crops including sugar cane and taro.

Actions: CRB is detected and caught using a combination pheromone and light trap developed by the USDA (Fig. 9). Twenty of these traps were deployed on Schofield and Wheeler AFB in Feb. 2014 and they are checked twice a month. Lures are changed every two months. No CRB has yet been detected at any of our traps. In Sept. 2014 OANRP carried out a survey of potential breeding sites in the Fort Shafter area after USDA informed us that CRB was recently detected there. We found three mulch piles, which we surveyed but could not confirm were free of CRB. We contacted the landscapers responsible for the mulch and were successful in getting two of the three removed. We will continue our efforts in the coming year.

Figure 9. Photo of a CRB trap.

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