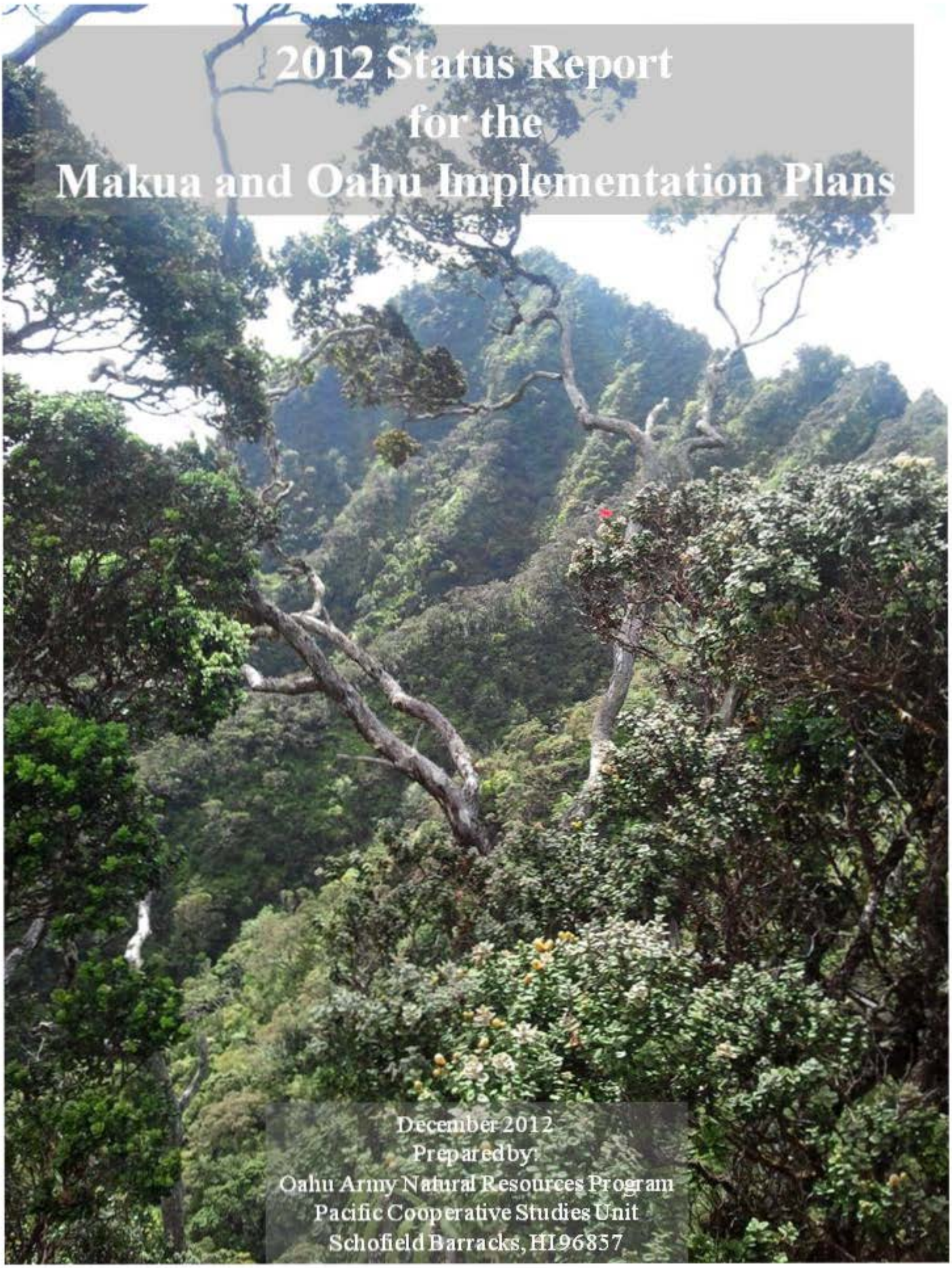
2012 Status Report for the Makua and Oahu Implementation Plans



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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 hired via a cooperating group 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) 2012 were similar to those in FY2011, though there has been staff turnover and replacement hiring is ongoing for several vacant positions. Funding increased in FY2012 with OANRP receiving $3.21 million for the Makua Implementation Plan (MIP) and $2.84 million for Oahu Implementation Plan (OIP), a 14% increase over FY11 funding (OIP: $2.35M, MIP: $2.94M). In FY 2012, OANRP did not receive funding for OIP Tier 2 and Tier 3 projects and continued to not impact 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 MIP and OIP. The reporting period for this report is October 1, 2011, to September 30, 2012 and covers Year 8 of the MIP and Year 5 of the OIP. This year, OANRP produced some preliminary cost figures for actual expenditures by program area and presented the data at the 2012 Hawaii Conservation Conference. Conference contributions can be found at http://manoa.hawaii.edu/hpicesu/dpw.htm. In the near future, the cost basis for the MIP and OIP needs to be revisited to ensure that OANRP budget requests are adequate. 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. OANRP changed the format of this report based on recommendations made in 2011 by the IT and USFWS. As a result, this 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 tracking database supplied on CD (See Appendix ES-2 for a tutorial of how to use this database).

OANRP just completed implementing the eighth year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the fifth year of the OIP (completed 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). Both issued by the USFWS, the original Makua Biological Opinion (BO) in 2007 and amended BO in 2008 require that the Army provide threat control for all Oahu Elepaio (*Chasiempis sandwichensis*) pairs in the Makua action area, stabilization for 28 plant 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.

Infrastructure

The new seed laboratory and OIP office building will be completed by early November 2012. OANRP plans to occupy these buildings in the Winter of 2012 for seed lab staff and the Spring of 2013 for field teams. With the addition of these buildings, OANRP will be able to function from one baseyard, which should improve daily communications between field crews and program managers and provide more support for the crews that are currently housed at the East Range facility and so staffing levels can be

increased as required under the Army's Biological Opinions. OANRP outreach and purchasing staff will remain at the East Range office for ease of access by volunteers and vendors.

Landowner/Agency Communications

OANRP continues to operate under a 20-year license agreement with Kamehameha Schools (KS) (expiring November 2030), a three-year license agreement with Hawaii Reserves Inc. (expiring Novemeber 2013) and a 4-year license agreement with the Honolulu Board of Water Supply (expiring November 2014). In addition, the Army signed a new six-month right of entry permit to monitor rare plant populations on Dole Food Company land (expiring June 2012). The Army also continues to work cooperatively under a MOU with the U.S. Navy for work in Lualualei Naval Magazine. In addition, the Army secured another one-year right of entry permit to protect Oahu Elepaio on Gill Olson Joint Venture property at Palehua (expiring May 2013).

In July 2011, a MOU was signed between the Army and the State of Hawaii (State), Department of Land and Natural Resources (DLNR). With this basic agreement in hand, the Army and State will continue to negotiate a more detailed real estate agreement, such as a right of entry or license. Currently, the Army holds five 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, and a Conservation District Use Permit, and has applied for a Protected Wildlife Permit. Issues pending negotiation under the real estate agreement include user fees and how to consolidate the content of each of the five separate annual state permits into one issued for a longer term. The Army and the State will continue to pursue this real estate agreement. The current delay in the process is on the Army's part. The Army is awaiting an appraisal and lease agreement from the Army Corps of Engineers for OANRP use of the State Pahole Mid-Elevation Nursery facility.

The Army continues to provide support for partner agencies including the Oahu Invasive Species Committee, Oahu Plant Extinction Prevention Program, and the Koolau and Waianae Mountains Watershed Partnerships. The Army is also an official member of the Koolau Mountains Watershed Partnership (KMWP), the Waianae Mountains Watershed Partnership, the Coordinating Group on Alien Pest Species, and the Hawaii Conservation Alliance.

Management Unit Protection

The OANRP fencing program completed construction of the 160-acre Koloa and 24-acre Opaeula Lower Management Unit (MU) fences this year. Lower Opaeula is pig free, and ungulate control is underway in Koloa. The 1,800-acre Lihue MU is nearly complete and must be finished before January 2013 when the Army resumes full training at Schofield Barracks. Ungulate removal from the Lihue MU is underway. In addition, OANRP has begun clearing the Kahanahaiki Subunit II and the Makaha Subunit II fencelines. OANRP is also partnering with the State of Hawaii and the KMWP to plan and execute a 652-acre "Rain Follows the Forest" Poamoho fence unit which will encompass three smaller (80 acres total) OIP management units(MUs): Poamoho Pond, Sanicula and Poamoho. OANRP is planning to contribute 3.5 kilometers of fencing towards completing the larger unit. This linear distance equals the perimeters of the three smaller units combined. It is likely that OANRP will construct the portion of the Poamoho fence that traverses KS property as a 20-year license agreement is currently in place to complete fencing on this parcel. Over the next year, construction is scheduled to begin on the Kawailoa, South Kaukonahua and Kamaili MUs. For more details about OANRP ungulate control see Chapter 1.

OANRP have adjusted the construction schedule (See the Ungulate Section of Chapter 1) for remaining MIP and OIP fences based on a few important factors. First, OANRP have not received funding for Tier 2 and 3 projects and thus OIP fences which protect only species in these tiers are postponed indefinitely.

The Army uses the Kawailoa and East Range training areas for helicopter overflight training and along Drum Road. The Army is not currently using trails in the upper portions of these ranges (triggers Tier 2 actions) nor are they hiking off trail (triggers Tier 3 actions). Until the Army begins using the Koolau ranges in this manner, Tier 2 and 3 will remain unfunded. In addition, OANRP are assisting with Koolau Mountains Watershed Partnership fencing at Poamoho which requires adjusting priorities. Lastly, OANRP are reassessing the feasibility of constructing and effectively managing the remaining large-scale Waianae fence units, namely the East and West Makaleha fences. Habitat contained in these units is extremely degraded and the terrain incredibly steep. OANRP are postponing construction of these until this challenge can be better assessed. OANRP will lead a discussion regarding MU threat control at the January IT meeting.

In total this year, OANRP spent 5,860 hours controlling weeds across 275.67 ha. Incipient Control Area (ICA) efforts accounted for 219.27 ha of this total. Staff spent 1,661 hours on ICA management and conducted 260 visits to 115 ICAs. Weed Control Area (WCA) efforts covered 56 ha. Staff spent 4,199 hours over 443 visits at 133 WCAs. See Chapter 1, 1.1.3 Weed Control Program, for a comparison to last year's control figures. Ecosystem Restoration Management Unit Plans (ERMUPs) were written this year for the following two MUs: Ohikilolo (Makua) and Waimano. OANRP now has 18 prepared ERMUPs for the highest priority and largest MUs (with the exception of Opaeula). The remaining 10 of 29 total ERMUPs will be prepared once OANRP initiates fencing for those MUs.

OANRP have increased communication with the Army's Range Division staff in order to reduce the inadvertent introduction of pest plant species to Army Ranges. OANRP discovered more incipient populations of new invasive plant taxa during this reporting period than in any previous. OANRP outreach staff have developed slides that will be included in a mandatory, Officer in Command, monthly training to soldiers prior to their use of Oahu training ranges. The briefing will address the importance of gear and vehicle cleaning, along with fire prevention. In addition, OANRP are involved in updating an Environmental Leader Awareness Field Card which is provided to soldiers before training events. OANRP are also advising contracting staff, who oversee washrack operation and maintenance, regarding the preferred destination for the sediment collected at these facilities. The recommendation is to deposit the sediment on Army training lands at designated locations so these can be monitored for invasive plants by OANRP staff. OANRP are also working with Range Control staff to restrict training access to areas infested with noxious weeds.

Rodent Control Program

OANRP rat control operations continue to change and improve as new technologies and information become available. Over this reporting period, OANRP decided to remove diphacinone rat bait from many of the rat control grids and alternatively increase the number of snap traps. The grids that were switched include all managed Elepaio territories and some of the smaller rat control grids at remote sites in the Waianae and Koolau Mountains. In addition, OANRP began a trial using new self-resetting traps manufactured in New Zealand. For more details regarding these topics refer to Chapter 6.

Rare Plant Conservation

The Executive Summary tables below 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 IP 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 "0" 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 was adjusted for this year's report and approximates the number of viable seeds initially received for stored collections. Viability rates for most collections were estimated or calculated at the timeof storage. For untested collections, seed viability was averagedfrom other collections within the same PU or taxon.

Overall, 57 of 100 MIP PUs (57%) are at or above stabilization goal for the minimum number of mature plants and 24 of 66 (47%) PUs for OIP plant species.

This year was a banner year for new plant discoveries including two taxa new to Army lands; *Lobelia oahuensis* and *Tetramolopium lepidotum*. Draft stabilization plans for these two taxa will be provided prior to the January IT Meeting to be discussed and reviewed. Presented in Chapter 2 of this report are new 5-year plans for *Abutilon sandwicensis* and *Phyllostegia hirsuta*. The USFWS listed 20 new plant taxa as endangered. Of these, 16 are found on Army training lands. The Army plans to consult with the USFWS on potential impacts to these taxa during the next reporting period. Mangement actions for these species will not begin until the consultation is complete and funding is secured. During this reporting period, OANRP outplanted a grand total of 2,780 individuals of MIP and OIP taxa which is the largest number planted in a single year by OANRP. Specifically, 790 individuals of ten Makua taxa, 879 individuals of four OIP taxa and 950 individuals of six taxa shared between both IPs were outplanted. In the last year, OANRP made 678 observations at in situ sites of IP taxa and 246 observations at outplanting sites.

Vegetation Monitoring

Vegetation monitoring transects were installed this year in the Kapuna MU; a total of eight MUs now have monitoring in place. In addition, OANRP re-monitored the Kahanahaiki MU this year, three years after the initial monitoring (See Chapter 3, Weed Section).

Fire

There were two major fires during this reporting period that occurred near MIP/OIP MUs. The first of these burned an area near the Keaau MU on 30 April 2012. Approximately 73 acres of dry grass and shrubland were burned, two subgulches to the south of the *Hibiscus brackenridgei* population (Appendix ES-3). The second major fire this year started in Lualualei Naval Magazine on 4 June 2012 and burned ~1,100 acres in total; including ~250 acres within the Waianae Kai Forest Reserve. This fire burned over a seven day period until it was finally extinguished on 11 June 2012 (Appendix ES-4). OANRP support to these fire fighting operations totaled $14,200 for Waianae Kai and $5,500 for Keaau. In addition, there was a fire in Waianae Kai which occurred in July. OANRP deployed contract helicopter support and one staff member to that fire for a total cost of $3,250 (Appendix ES-5). The total OANRP expenditure on fire response for this reporting period was $22,900.

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 42 of 100

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Alectryon macrococcus var. macrococcus	50											
		Central Kaluaa to Central Waieli	22	15	7	0	20	53	0%	27%	No	
		Kahanahaiki to West Makaleha	41	35	6	0	42	52	0%	9%	No	
		Makaha	86	85	1	0	86	75	0%	96%	Yes	
		Makua	20	20	0	0	21	15	5%	0%	No	
		Alectryon macrococcus var. macrococcus Total:	169	155	14	0	169	195				1 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	229	191	38	39	166	20	47%	100%	Yes	
		Kahanahaiki and Pahole	403	356	47	124	441	276	22%	99%	Yes	
		Makaha and Waianae Kai	13	13	0	0	13	12	46%	62%	No	
		Cenchrus agrimonioides var. agrimonioides Total:	645	560	85	163	620	308				2 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	75	43	32	0	39	0	100%	100%	No	
		North branch of South Ekahanui	147	44	103	0	73	5	100%	100%	No	
		Pahole to West Makaleha	106	38	68	0	98	46	86%	100%	No	
		Palikea (South Palawai)	142	111	31	15	138	63	48%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	470	236	234	15	348	114				1 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	60	40	20	0	59	66	45%	93%	No	
		Makaha and Waianae Kai	40	7	33	0	10	4	40%	100%	No	
		Pahole	114	61	53	3	115	114	38%	100%	No	
		Cyanea longiflora Total:	214	108	106	3	184	184				0 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	404	52	352	20	377	152	50%	100%	Yes	
		Makaha	125	2	123	0	105	0	0%	100%	No	
		Manuwai	0	0	0	0	0	0	0%	0%	No	
		Pahole to Kapuna	247	100	147	20	269	170	0%	100%	Yes	
		Cyanea superba subsp. superba Total:	776	154	622	40	751	322				2 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 42 of 100

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	240	64	176	0	240	97	10%	100%	Yes	
		Kawaiiki (Koolaus)	84	5	79	0	40	50	0%	0%	No	
		Opaeula (Koolaus)	101	35	66	0	101	26	0%	57%	No	
		Pahole to West Makaleha	1192	577	615	238	1192	300	4%	98%	Yes	
		Cyrtandra dentata Total:	1617	681	936	238	1573	473				2 of 4
Delissea waianaeensis	100											
		Ekahanui	277	175	102	0	277	58	100%	100%	Yes	
		Kahanahaiki to Keawapilau	336	183	153	0	223	34	81%	100%	Yes	
		Kaluaa	828	649	179	23	523	44	64%	100%	Yes	
		Manuwai	0	0	0	0	0	0	0%	0%	No	
		Delissea waianaeensis Total:	1441	1007	434	23	1023	136				3 of 4
Dubautia herbstobatae	50											
		Makaha	36	36	0	2	36	0	55%	0%	No	
		Ohikilolo Makai	358	358	0	0	358	700	0%	100%	Yes	
		Ohikilolo Mauka	424	415	9	0	424	1300	0%	100%	Yes	
		Dubautia herbstobatae Total:	818	809	9	2	818	2000				2 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	31	28	3	0	31	26	66%	0%	Yes	
		Kaena	1475	579	896	0	1475	300	4%	0%	Yes	
		Makua	127	125	2	0	127	40	34%	100%	Yes	
		Puaakanoa	148	132	16	0	148	157	15%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1781	864	917	0	1781	523				4 of 4
Euphorbia herbstii	25											
		Kapuna to Pahole	171	70	101	0	176	170	11%	94%	Yes	
		Makaha	64	8	56	0	91	0	0%	100%	No	
		West Makaleha	0	0	0	0	0	0	0%		No	
		Euphorbia herbstii Total:	235	78	157	0	267	170				1 of 3

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 42 of 100

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Flueggea neowawraea	50											
		Central and East Makaleha	6	6	0	0	5	6	43%	0%	No	
		Kahanahaiki to Kapuna	104	7	97	0	74	32	43%	86%	No	
		Makaha	64	11	53	0	43	4	55%	36%	No	
		Manuwai	0	0	0	0	0	0	0%		No	
		Flueggea neowawraea Total:	174	24	150	0	122	42				0 of 4
Gouania vitifolia	50											
		Keaau	61	60	1	1	61	0	22%	0%	Yes	
		Makaha	0	0	0	0	0	0	0%		No	
		Makaleha or Manuwai	0	0	0	0	0	0	0%		No	
		Gouania vitifolia Total:	61	60	1	1	61	0				1 of 3
Hesperomannia arbuscula	75											
		Haleauau	1	1	0	0	1	0	0%	100%	No	
		Makaha	29	2	27	0	6	13	0%	100%	No	
		Pahole NAR	58	0	58	0	59	8	0%	100%	No	
		Pualii	73	0	73	0	63	0	0%	100%	No	
		Hesperomannia arbuscula Total:	161	3	158	0	129	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	9	6	3	0	9	4	53%	0%	No	
		Kaimuhole and Palikea Gulch	64	17	47	4	166	8	49%	0%	No	
		Keaau	7	3	4	4	10	0	50%	0%	No	
		Makua	75	54	21	0	75	7	58%	100%	Yes	
		Hibiscus brackenridgei subsp. mokuleianus Total:	155	80	75	8	260	19				1 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	31	26	5	0	23	60	58%	81%	No	
		Central Makaleha and West Branch of East Makaleha	78	28	50	0	70	47	29%	0%	No	
		Kahanahaiki to Pahole	286	151	135	23	276	161	15%	100%	Yes	
		Kadua degeneri subsp. degeneri Total:	395	205	190	23	369	268				1 of 3

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 42 of 100

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Kadua parvula	50											
		East Makaleha	0	0	0	0	0	0	0%	0%	No	
		Halona	132	97	35	19	132	64	42%	23%	Yes	
		Ohikilolo	257	100	157	5	257	66	27%	100%	Yes	
		Kadua parvula Total:	389	197	192	24	389	130				2 of 3
Melanthera tenuifolia	50											
		Kamaileunu and Waianae Kai	1157	888	269	297	1152	880	0%	0%	Yes	
		Mt. Kaala NAR	300	300	0	0	300	250	0%	0%	Yes	
		Ohikilolo	1117	1109	8	0	1117	2009	1%	100%	Yes	
		Melanthera tenuifolia Total:	2574	2297	277	297	2569	3139				3 of 3
Neraudia angulata	100											
		Kaluakauila	164	164	0	0	118	0	0%	100%	Yes	
		Makua	39	24	15	1	74	29	18%	100%	No	
		Manuwai	0	0	0	0	0	12	29%	0%	No	
		Waianae Kai Mauka	20	16	4	0	20	46	27%	100%	No	
		Neraudia angulata Total:	223	204	19	1	212	87				1 of 4
Nototrichium humile	25											
		Kaimuhole and Palikea Gulch	35	32	3	0	57	54	89%	0%	Yes	
		Kaluakauila	233	198	35	0	233	200	0%	100%	Yes	
		Makua (south side)	53	50	3	0	41	138	0%	100%	Yes	
		Waianae Kai	259	205	54	0	257	200	1%	88%	Yes	
		Nototrichium humile Total:	580	485	95	0	588	592				4 of 4
Phyllostegia kaalaensis	50											
		Keawapilau to Kapuna	0	0	0	0	0	0	100%	100%	No	
		Makaha	0	0	0	0	0	0	0%	100%	No	
		Manuwai	0	0	0	0	0	0	0%		No	
		Pahole	0	0	0	0	0	10	50%	100%	No	
		Phyllostegia kaalaensis Total:	0	0	0	0	0	10				0 of 4
Plantago princeps var. princeps	50											
		Ekahanui	129	25	104	0	58	33	24%	100%	No	
		Halona	72	29	43	0	72	50	22%	0%	No	
		North Mohiakea	37	13	24	0	26	30	38%	0%	No	
		Ohikilolo	11	11	0	0	11	14	30%	100%	No	
		Plantago princeps var. princeps Total:	249	78	171	0	167	127				0 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 42 of 100

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Pritchardia kaalae	25											
		Makaleha to Manuwai	112	102	10	2	112	141	4%	0%	Yes	
		Ohikilolo	1151	78	1073	12	1138	473	0%	100%	Yes	
		Ohikilolo East and West Makaleha	307	0	307	0	249	75	0%	100%	No	
		Pritchardia kaalae Total:	1570	180	1390	14	1499	689				2 of 3
Sanicula mariversa	100											
		Kamaileunu	325	18	307	1	325	26	7%	100%	No	
		Keaau	311	11	300	40	311	141	1%	100%	No	
		Ohikilolo	35	0	35	0	35	162	0%	100%	No	
		Sanicula mariversa Total:	671	29	642	41	671	329				0 of 3
Schiedea kaalae	50											
		Kaluaa and Waieli	207	205	2	0	156	55	100%	100%	Yes	
		Maakua (Koolaus)	10	10	0	0	10	4	36%	0%	No	
		Pahole	84	72	12	1	76	3	100%	100%	Yes	
		South Ekahanui	100	100	0	0	102	85	72%	100%	Yes	
		Schiedea kaalae Total:	401	387	14	1	344	147				3 of 4
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	187	181	6	19	155	65	66%	100%	Yes	
		Kapuna-Keawapilau Ridge	0	0	0	0	0	4	50%	100%	No	
		Makaha	30	30	0	0	30	0	0%	100%	No	
		Schiedea nuttallii Total:	217	211	6	19	185	69				1 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	574	270	304	26	592	90	56%	100%	Yes	
		Keawapilau to West Makaleha	548	263	285	295	831	36	19%	97%	Yes	
		Makaha	0	0	0	0	0	0	0%	0%	No	
		Schiedea obovata Total:	1122	533	589	321	1423	126				2 of 3
Tetramolopium filiforme	50											
		Kalena	30	18	12	2	9	0	15%	0%	No	
		Ohikilolo	3143	2551	592	20	3143	2500	0%	100%	Yes	
		Puhawai	11	11	0	0	2	12	36%	0%	No	
		Waianae Kai	38	30	8	1	38	22	0%	0%	No	
		Tetramolopium filiforme Total:	3222	2610	612	23	3192	2534				1 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 42 of 100

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Viola chamissoniana subsp. chamissoniana	50											
		Halona	44	41	3	0	44	3	11%	0%	No	
		Makaha	71	59	12	0	71	50	0%	100%	Yes	
		Ohikilolo	425	403	22	1	425	0	0%	100%	Yes	
		Puu Kumakalii	44	44	0	0	44	20	27%	0%	No	
Viola chamissoniana subsp. chamissoniana Total:			584	547	37	1	584	73				2 of 4

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 15 of 67

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Strategy for stabilization of target plant taxa Tier: 1												
Abutilon sandwicense	50											
		Ekahanui and Huliwai	41	17	24	0	43	44	6%	71%	No	
		Kaawa to Puulu	110	55	55	1	121	124	0%	0%	Yes	
		Kahanahaiki	0	0	0	0	0	0	0%	0%	No	
		Makaha Makai	97	54	43	1	122	100	30%	0%	Yes	
		Abutilon sandwicense Total:	248	126	122	2	286	268				2 of 4
Cyanea acuminata	50											
		Helemano-Punaluu Summit Ridge to North Kaukonahua	72	59	13	7	72	72	6%	0%	Yes	
		Kahana and South Kaukonahua	2	2	0	0	2	2	0%	0%	No	
		Makaleha to Mohiakea	147	103	44	0	146	118	1%	23%	Yes	
		Cyanea acuminata Total:	221	164	57	7	220	192				2 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	84	68	16	6	80	76	0%	0%	Yes	
		Kaukonahua	16	14	2	0	16	12	0%	0%	No	
		Opaeula to Helemano	21	13	8	0	21	13	0%	77%	No	
		Cyanea koolauensis Total:	121	95	26	6	117	101				1 of 3
Cyanea st.-johnii	50											
		Ahuimanu-Halawa Summit Ridge	10	7	3	0	11	14	20%	100%	No	
		Helemano	5	4	1	0	5	6	50%	100%	No	
		Waiahole-Waiawa Summit Ridge	17	15	2	1	17	6	18%	0%	No	
		Waimano	66	14	52	0	19	19	17%	100%	No	
		Cyanea st.-johnii Total:	98	40	58	1	52	45				0 of 4
Eugenia koolauensis	50											
		Kaleleiki	230	27	203	0	284	55	0%	59%	No	
		Kaunala	131	38	93	54	162	141	0%	100%	No	
		Oio	21	16	5	7	39	74	4%	100%	No	
		Pahipahialua	57	36	21	379	83	291	5%	100%	No	
		Eugenia koolauensis Total:	439	117	322	440	568	561				0 of 4

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 15 of 67

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Gardenia mannii	50											
		Haleauau	3	3	0	0	3	2	43%	33%	No	
		Helemano and Poamoho	10	10	0	0	12	18	0%	0%	No	
		Lower Peahinaia	11	10	1	0	32	38	0%	0%	No	
		Gardenia mannii Total:	24	23	1	0	47	58				0 of 3
Hesperomannia arborescens	25											
		Kamananui to Kaluanui	246	133	113	45	167	99	0%	0%	Yes	
		Kaukonahua	132	76	56	124	132	127	0%	0%	Yes	
		Lower Opaeula	27	18	9	0	27	24	0%	0%	No	
		Hesperomannia arborescens Total:	405	227	178	169	326	250				2 of 3
Huperzia nutans	50											
		Kahana and North Kaukonahua	5	5	0	0	5	6	0%	0%	No	
		Koloa and Kaipapau	3	3	0	0	3	3	0%	0%	No	
		South Kaukonahua	1	1	0	0	1	1	0%	0%	No	
		Huperzia nutans Total:	9	9	0	0	9	10				0 of 3
Labordia cyrtandrae	50											
		East Makaleha to North Mohiakea	209	163	46	0	94	100	12%	75%	Yes	
		Manana	0	0	0	0	1	1	0%	0%	No	
		Labordia cyrtandrae Total:	209	163	46	0	95	101				1 of 2
Melicope lydgatei	50											
		Kaiwikoele-Kawainui Ridge	0	0	0	0	3	3	0%	0%	No	
		Kawaiiki and Opaeula	24	24	0	0	25	43	0%	58%	No	
		Poamoho	0	0	0	0	0	0	0%	0%	No	
		Melicope lydgatei Total:	24	24	0	0	28	46				0 of 3
Phyllostegia hirsuta	100											
		Haleauau to Mohiakea	13	6	7	0	18	18	37%	0%	No	
		Hapapa to Kaluaa	13	1	12	0	7	20	28%	0%	No	
		Laie & Puu Kainapuaa	5	2	3	1	4	0	17%	0%	No	
		Phyllostegia hirsuta Total:	31	9	22	1	29	38				0 of 3
Phyllostegia mollis	100											
		Ekahanui	226	225	1	0	2	35	50%	100%	Yes	
		Kaluaa	125	69	56	0	19	49	50%	100%	No	
		Pualii	204	20	184	0	0	0	100%	100%	No	
		Phyllostegia mollis Total:	555	314	241	0	21	84				1 of 3

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 15 of 67

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Pteris lidgatei	50											
		Helemano	2	0	2	2	2	2	0%	0%	No	
		Kaluanui	1	1	0	0	0	0	0%	0%	No	
		North Kaukonahua	0	0	0	0	0	0	0%	0%	No	
		Pteris lidgatei Total:	3	1	2	2	2	2				0 of 3
Schiedea trinervis	50											
		Kalena to East Makaleha	610	341	269	333	395	376	9%	90%	Yes	
		Schiedea trinervis Total:	610	341	269	333	395	376				1 of 1
Stenogyne kanehoana	100											
		Haleauau	1	1	0	0	1	1	100%	100%	No	
		Kaluaa	124	9	115	0	68	79	100%	100%	No	
		To be Determined (Makaha)	0	0	0	0	0	0	0%	0%	No	
		Stenogyne kanehoana Total:	125	10	115	0	69	80				0 of 3
Strategy for stabilization of target plant taxa Tier: 2												
Cyanea crispa	50											
		Kahana and Makaua	14	7	7	0	14	6	13%	0%	No	
		Kawaiiki	6	3	3	0	4	6	0%	0%	No	
		Wailupe	6	5	1	0	6	6	83%	0%	No	
		Cyanea crispa Total:	26	15	11	0	24	18				0 of 3
Cyrtandra viridiflora	50											
		Helemano and Opaeula	53	40	13	6	52	60	9%	95%	No	
		Kawainui and Koloa	20	16	4	0	20	26	5%	0%	No	
		South Kaukonahua to Kipapa summit	1	1	0	0	2	2	0%	0%	No	
		Cyrtandra viridiflora Total:	74	57	17	6	74	88				0 of 3
Euphorbia rockii	25											
		Helemano	23	22	1	0	23	8	0%	100%	No	
		Kawainui to Koloa and Kaipapau	57	41	16	2	50	73	0%	0%	Yes	
		Waiawa and Waimano	20	15	5	0	20	15	0%	0%	No	
		Euphorbia rockii Total:	100	78	22	2	93	96				1 of 3
Myrsine juddii	25											
		Kaukonahua to Kamananui-Koloa	486	486	0	0	486	455	0%	82%	Yes	
		Myrsine juddii Total:	486	486	0	0	486	455				1 of 1

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 15 of 67

= 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 2011	# Plant In Original Report	% Completed Genetic Storage	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Sanicula purpurea	100											
		North of Puu Pauao	21	0	21	0	21	21	0%	0%	No	
		Poamoho Trail Summit	28	3	25	2	28	12	0%	0%	No	
		Schofield-Waikane Trail Summit	79	3	76	10	40	27	0%	0%	No	
		Sanicula purpurea Total:	128	6	122	12	89	60				0 of 3
Viola oahuensis	50											
		Helemano and Opaeula	309	163	146	22	309	307	0%	99%	Yes	
		Kaukonahua	11	11	0	0	11	25	0%	0%	No	
		Koloa	72	60	12	6	70	45	0%	0%	Yes	
		Viola oahuensis Total:	392	234	158	28	390	377				2 of 3
Strategy for stabilization of target plant taxa Tier: 3												
Cyrtandra subumbellata	50											
		Kahana	15	8	7	0	15	15	0%	0%	No	
		Kaukonahua	0	0	0	0	0	2	0%	0%	No	
		Punaluu	203	202	1	0	201	200	0%	0%	Yes	
		Cyrtandra subumbellata Total:	218	210	8	0	216	217				1 of 3
Lobelia koolauensis	100											
		Kaukonahua	33	7	26	0	30	48	18%	0%	No	
		Kipapa	100	0	100	20	100	100	0%	0%	No	
		Waiawa to Waimano	200	0	200	0	200	200	0%	0%	No	
		Lobelia koolauensis Total:	333	7	326	20	330	348				0 of 3

Rare Snail Conservation

During this reporting period OANRP and partners conducted the largest reintroduction in history of a Hawaiian land snail. Hundreds of *Achatinella mustelina* were reintroduced into the Puu Hapapa snail exclosure and the effort was deemed successful. Over this period, OANRP have learned more about the impact of Jackson's chameleons (*Trioceros jacksonii*) as predators of tree snails, and the Puu Hapapa snail exclosure is operating effectively as a predator barrier. A summary of these efforts at Puu Hapapa are included in Chapter 3. In light of the successful reintroduction at Puu Hapapa, OANRP also presents a new approach to using the University of Hawaii Tree Snail Conservation Lab to more directly support short-term conservation efforts and minimize snail loss due to long-term holding in the lab.

Table 4 presents the status summary for the Waianae *A. mustelina* in the MIP and Table 5 presents the status summary for six species of Koolau *Achatinella* spp. in the OIP. The goal of all populations in both IPs is 300 total snails across all age classes in each Evolutionary Significant Unit (ESU) or Geographic Unit (GU). Populations of *A. mustelina* in the MIP have been genetically assigned to one of six ESUs. An analogous term, GU, is used for Koolau taxa because the same level of genetic analyses has not been done for those snail populations, and thus they are distinguished by geographic location rather than genetics.

Elepaio Management

In 2012, OANRP controlled rats to protect 97 pairs of Oahu Elepaio (*Chasiempis ibidis*) which is similar to our effort last year. The documented fledgings from managed pairs this year numbered 65 fledglings. This figure is smaller than the previous reporting year when 96 fledglings were observed. Reduction in fledgling success may have been a result of the late onset of winter weather and thus a late start of the breeding season (one month late), coupled with heavy rainstorms in March 2012 which resulted in nest failures. In 2011, twelve pairs double clutched and in 2012 this number dropped to two. Although this success rate is lower than the year previous, it remains the second best elepaio season for OANRP since 1998. The total population of monitored elepaio increased 12% since last year, 237 to 266 total birds. For more information see the Elepaio Chapter 4. During 2013, OANRP will be adjusting to the reopening of Schofield Ranges and may be required to work weekends in order to meet rat control and elepaio monitoring requirements.

Table 4. Makua Implementation Plan –Executive Summary – Snails

Achatinella mustelina Evolutionary Significant Unit (ESU)	Population	2012 Snails				# Snails in 2011	# Snails in 2003 MIP	# of Snails at University of Hawaii Lab	% of Snails in Population Protected from Ungulates	Is Population at Goal?	Overall Populations at Goal for Species
		# Adult	# Sub-adult	# Juvenile	Total						
ESU A	Kahanahaiki/ Pahole	135	49	24	208	293	105	2	100%	No	*5 of 8*
ESU B	B1: Ohikilolo	286	51	47	384	391	300	4	100%	Yes	
	B2: East Makaleha	287	107	68	462	453	40	1	0%	Yes	
ESU C	Lower Kaala NAR/ Schofield Barracks West Range	100	54	14	168	172	50	18	Partial	No	
ESU D	D1: North Kaluaa to Schofield Barracks South Range	203	175	287	665	380	86	17	Partial	Yes	
	D2: Makaha	132	35	21	188	188	17	3	100%	No	
ESU E	Ekahanui	258	61	39	358	178	12	12	100%	Yes	
ESU F	Puu Palikea	262	87	64	413	458	40	4	100%	Yes	
Totals					**2,846**	**2,513**	**650**	**61**			***5 of 8***

Table 5. Oahu Implementation Plan –Executive Summary – Snails

Snail Species	Geographic Unit (GU)	Population	# Snails in 2012	# Snails in 2011	# Snails in 2008 OIP	# of Snails at University of Hawaii Lab	Population Protected from Ungulates	Is Population at Goal?	Overall Populations at Goal for Species
Achatinella apexfulva	GU A	Poamoho Trail	0	0	0	1	No	No	*0 of 1*
Achatinella bulimoides	GU A	Punaluu Cliffs	5	5	2	10	No	No	*0 of 2*
	GU B	Punaluu/Kaluanui	15	0	0	0	No	No	
Achatinella byronii/ decipiens	GU A	East Range	6	6	6	0	No	No	*2 of 5*
	GU B	Puu Pauao	16	16	16	0	No	No	
	GU C	Poamoho	313	259	69	0	No	Yes	
	GU D	Punaluu Cliffs	7	7	3	0	No	No	
	GU E	North Kaukonahua	568	445	175	3	No	Yes	
Achatinella lila	GU A	Poamoho Summit	15	15	39	407	No	No	*0 of 3*
	GU B	Peahinaia Summit	11	11	11	0	Partial	No	
	GU C	Opaeula-Punaluu Summit	13	13	45	0	No	No	
Achatinella livida	GU A	Crispa Rock	86	86	60	0	No	No	*0 of 3*
	GU B	Northern	9	9	5	0	Yes	No	
	GU C	Radio	37	37	83	35	No	No	
Achatinella sowerbyana	GU A	Kawainui Ridge	0	0	2	0	No	No	*1 of 7*
	GU B	Kawaiiki Ridge	30	30	3	0	No	No	
	GU C	Opaeula-Helemano	390	357	344	9	Yes	Yes	
	GU D	Poamoho Summit and Trail	140	140	302	0	No	No	
	GU E	Poamoho Pond	35	35	90	0	No	No	
	GU F	Poamoho-North Kaukonahua Ridge	2	2	2	0	No	No	
	GU G	Lower Peahinaia	5	5	40	1	Partial	No	
Totals			**1,703**	**1,478**	**1,297**	**466**			***3 of 21***

Insect Conservation

Last year, OANRP finalized and submitted stabilization plans for two taxa of Hawaiian picture-wing flies (*Drosophila substenoptera* and *D. montgomeryi*). OANRP developed cost estimates and submitted them for funding in FY 2013. The first step in executing these plans will be to hire an entomologist to provide implementation oversight. OANRP expects to fill this position by the spring of 2013. In the meantime, OANRP cooperated with the Oahu Plant Extinction Prevention Program to reintroduce the host plant, *Urera kaalae,* into *D. montgomeryi* habitat in the Kaluaa MU. A total of 67 individuals were planted during this reporting period. Nineteen *Urera glabra*, another host plant of *D. montgomeryi*, were planted during the 2012 reporting period and more are being grown in the OANRP greenhouse for planting this winter. OANRP also continues to maintain habitat through ecosystem scale weed control in existing fences which benefits the habitat of these flies.

During this reporting period, three species of Hawaiian damselflies were granted endangered species status. These are *Megalagrion leptodemas*, *M. oceanicum* and *M. nigrohamatum* ssp. *nigrolineatum*. In the upcoming year, the Army will consult with the USFWS to determine if Army training may affect these damselflies.

Hawaiian Hoary Bats

OANRP began conducting Hawaiian Hoary Bat (*Lasiurus cinereus semotus*) surveys at the Army's Koolau Training ranges because of the recent bat detections at north shore windmill project sites. The purpose of these surveys was to gather information necessary to prepare a Biological Assessment under Section 7 of the Endangered Species Act assessing potential impacts to bats from Army activities. OANRP placed bat detectors at Kahuku and Kawailoa Training Areas and at Schofield Barracks, East Range. Bats were detected at all three sites at very low numbers per detection night compared to other islands. These Koolau baseline surveys were near completion when the Army received a report that the Navy had detected bats at Lualualei Naval Magazine. Based on this new information, OANRP will conduct surveys over the next six months at Waianae training areas in order to analyze impacts to bats at Waianae Army sites. Once these surveys are complete, the Army will prepare and submit a Biological Assesment. Until such time, the Army is avoiding impacts to roosting bats during the summer pupping season per the recommendation of USFWS Staff. Tree felling projects at Army training sites do not occur between July 1 and Oct 15 each year.

Research

During this reporting period, OANRP funded numerous research projects related to management of MIP and OIP taxa. The OANRP Research Specialist continued slug and ant research and management; slug work this year was focused on determining preferred buffer size and application frequency of Sluggo for protection of susceptible 'manage for stability' plant populations. OANRP's Propagule Management Specialist received her Ph.D for her research on the breeding biology of *Schiedea*. She is working on publishing her dissertation results in peer-reviewed journals. In support of this *Schiedea* research, OANRP contracted Bishop Museum to conduct genetic analyses. Their final report is included as Appendix ES-6. In addition, Richard Pender et al. (including the OANRP Monitoring Specialist) published work regarding the effect of large-scale trapping grids in protecting fruit of *Cyanea superba* ssp. *superba* in the journal *Biological Invasions* (see Appendix ES-7). Additionally, OANRP funded Dr. Robert Cowie to conduct a survey of snails present at Army propagation facilities. His recommendations to detect and monitor alien snails at the Pahole Mid-elevation facility are included in Appendix ES-8.

Funded research related to *Achatinella* over the last year included Dr. Norine Yeung's research on the invasive predatory garlic snail (*Oxychilus alliarius*). Her final report is included as as Appendix ES-9.

The intent of this research was to determine garlic snail distribution and abundance within native *Achatinella* tree snail habitat and to elucidate their role as a predator of *Achatinella* tree snails. Additionally, OANRP continued funding Dr. Brendan Holland's captive propagation of Achatinella and research regarding Jackson's chameleons. For a complete report of his findings, see Appendix ES-10.

Research funded by OANRP in support of Ecosystem management 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, snaptrap, rat control grids. For an update on the third year of this research refer to Appendix ES-11. Last but not least, the OANRP Ecosystem Restoration Program Manager co-authored a paper with Dr. James Leary on the effective application of herbicides to woody invasive plants in Hawaii which can be viewed at the PCSU website, http://manoa.hawaii.edu/hpicesu/dpw_oth.htm.

TABLE OF CONTENTS

CHAPTER 1: ECOSYSTEM MANAGEMENT

Notable projects from the 2011-2012 reporting year are discussed in the Project Highlights section of this chapter. Note that this reporting year is 12 months (1 October 2011 through 30 September 2012), while last year's report covered 13 months.

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 MIP and OIP.

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

Report Year	ERMUP Finalized
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

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. The ERMUPs detail 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 them on request. They will not be included in Status Reports until they need to be rewritten to cover another five years. This year, one new ERMUP was written for Waimano, and the ERMUP for Ohikilolo (Makua) was revised extensively. Both plans are included here, following the Weed Control Program highlights.

1.1 PROJECT HIGHLIGHTS

1.1.1 Ungulate Control Program

Summary

- OANRP was able to complete the Koloa (4,434 m) and Lower Opaeula (1,606 m) MU fences
- At this time, 11,200 m of 12,240 m of the Lihue fence has been completed. At Makaha Subunit II 1000 m of 2600 m has been cleared with materials on the line ready to be built. At Kahanahaiki Subunit II about 600 m of 1500 m have been partially cleared and about 200m built.
- All totaled, about 11,864 m of fence were built during the reporting year, enclosing approximately 210 acres (the acreage of partially completed units is not reported here).
- OANRP is working with the State to plan and build two large fence units within the proposed Poamoho NAR. This proposed NAR will be located in the Ewa Forest Reserve. These fences, when completed, would envelope five of the proposed smaller units in the area, eliminating the need to build them. These fences would also encompass larger amounts of habitat in which to conduct further management and eliminate the need for the Lower Poamoho and Poamoho II MU fences. The funding dedicated for these units would be used to assist with the construction of the larger units. Construction of the first of the two proposed fences will begin in the winter/spring of 2013.

- OANRP is proposing to finish Lihue, Kahanahaiki Subunit II and Makaha Subunit II and initiate and/or complete construction on at least one of the following fences; South Kaukonahua, or Kamaili by end of the next reporting period.

- OANRP proposes to complete the 106 cultural surveys for fence lines at Huliwai, Ohikilolo, and Waiawa during FY13.

- Pigs breached the fences at Ekahanui Kaluaa/Waieli, Kahanahaiki, and Pualii but were removed.

- OANRP has completed all of the retrofit of the assigned fence sections at Kapuna Upper, Kahanahaiki and Pahole with Fickle Hill Deer Fence to prevent the smaller piglets from breaching the fence.

- Hunting operations were conducted in the lower unit of the Manuwai MU for about eleven months before snaring commenced. A total of 35 pigs were removed, 14 males, 12 females and nine of unknown sex (the carcasses were never located). To date, two boars, two sows two unknown sex, and two goats have been removed in both the upper and lower units since the snares were set. Sign of ungulates in the lower unit is very low. It is believed that there are very few ungulates remaining.

- OANRP had to initiate eradication efforts prior to the completion of the Lihue fence due to the Army going back to full time training in this area in January 2013. Once training commences full time, access will be restricted. To date, a total of 372 pigs have been removed and sign in all portions of the unit has been dramatically reduced. Intense control effort is focused on keeping ungulates from entering via uncompleted sections of the perimeter and in getting complete coverage of the unit using snares and live traps.

OIP/MIP Management Unit Status

The MU status table below shows the current status of each proposed fence unit within each MU. Shading in any column indicates that ungulate management is needed for the MU and specific compliance documents are needed. The X's denote that compliance documents and authorizations (such as in columns 6, 7, 8, and 9) are complete. Column 1 lists the MU name. Column 2 lists the different fence subunits within each MU. Column 3 shows whether it is ungulate free. Column 4 is a list of the acres protected versus the acres proposed in the Implementation Plan. Column 5 is the year of completion or proposed construction. Column 6 indicates whether a CDUP is required for the unit and if it has been acquired. Column 7 lists whether cultural surveys for the 106 process have been completed and reviewed. Column 8 indicates whether a Memorandum of Understanding (MOU) and/or Right of Entry (ROE) and/or Rental Agreement (RA) are required for the unit and if they have been acquired. Column 9 indicates whether a License Agreement is required for the unit and if it has been acquired. Column 10 gives the number of Manage for Stability species for the MIP and OIP within each MU. Column 11 contains notes which give the highlights and status from each fence. Column 12 lists the current threats to each fence unit.

MIP Management Unit Status

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	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. Portions of the fence were retrofitted with fickle fence to stop ingress of small pigs.	None
	Kahanahaiki II	Partial	No	0/30	2013		X			6	0	Proposed for construction in 2013. Snaring is performed to reduce pig pressure. To date 150 pigs have been caught since 1998.	Pig
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002					3	0	Complete. Fence is in need of some modification but still pig-free.	None
Ohikilolo Lower	Ohikilolo Lower	Yes	Yes	70/70	2000					2	0	The Ohikilolo ridge fence and the strategic fence are both complete. Since July 2006, 11 goats have been able to breach the fence. All have been removed and the fence was modified to prevent more ingress.	Pig
Opaeula Lower	Opaeula Lower	Yes	Yes	26/26	2011	X	X		X	1	3	Fence is complete and ungulate free.	None
Ohikilolo	Ohikilolo	Partial	No	3/574	2002 2014					10	0	Ohikilolo ridge fence is complete, excluding goat ingress from south. Six smaller ungulate free PU fences are also complete. A route has yet to be determined for the closure of the Ohikilolo MU to exclude pigs.	Pig
Puu Kumakalii	Puu Kumakalii	No	-	-	-	-	-	-	-	2	0	None needed but will be partially included within the proposed Lihue fence.	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES													
East Makaleha	East Makaleha	No	No	0/231	TBD	X	X			7	3	Awaiting signing of Army-State real estate agreement. OANRP looking at alternatives to building the entire larger unit or partnership assistance.	Pig/Goat Cattle
	West of East Makaleha	No	No	0/3	TBD	X		X		1	0	A possible line has been scoped already. Awaiting completion of 106 surveys.and the signing of Army-State real estate agreement.	Pigs and Goats
Ekahanui	Ekahanui I	Yes	Yes	44/44	2001	X				6	3	Complete. Had several pigs breach the fence but all have been eradicated.	None
	Ekahanui II	Yes	Yes	165/159	2009	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	Predator proof fence installed by State	None
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999	X				4	3	Completed by TNCH. There have been several breaches and a total of 15 pigs have been removed. Skirting was installed around the existing fence to deter incursions. The completed fence is several acres larger than the original proposed MU fence.	None
	Kaluaa/Waieli II	Yes	Yes	25/17	2006	X				2	3	Completed by TNCH. The completed fence is several acres larger than the original proposed MU fence.	None

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
	Kaluaa/Waieli III	Yes	Yes	43/11	2010	X	X			1	0	Completed and ungulate free. The completed fence is larger than the original proposed MU fence. Repaired river crossing after large storm.	None
Keaau	Keaau	No	No	0/33	2014	X	X			2	0	Proposed fence for *Gouania vitifolia* and *Hibiscus brackenridgei* ssp. *mokuleianus*. Awaiting signing of Army-State real estate agreement and Cultural 106 surveys.	Pig/Goat/ Cattle
Keaau/Makaha	Keaau/Makaha	Yes	Yes	1/3	2009	X	X			1	0	Complete and ungulate free.	None
Manuwai	Manuwai I	Yes	No	166/166	2011	X	X			7	1	Complete. Ungulate removal is on-going, to date a total of 37 pigs and two goats have been removed	Pig/Goat
Napepeiaoolelo	Napepeiaoolelo	Yes	Yes	1/1	2009	X	X			1	1	Complete.	None
Pahole	Pahole	Yes	Yes	215/215	1998	X				16	0	Complete. Portions of the fence were retrofitted with fickle fence to stop ingress of small pigs.	None
Palikea	Palikea I	Yes	Yes	23/21	2008	X				2	0	Complete. Subunit II has been abandoned in favor of Napepeiaoolelo. The completed fence is a couple of acres larger than the original proposed MU fence.	None
	Palikea IV	No	-	-	-	X	-	-	-	1	0	None	None
	Palikea V	No	-	-	-	X	-	-	-	1	0	None	None
Kapuna Upper	Kapuna I/II	Yes	Yes	32/182	2007	X				1	0	Complete.	None
	Kapuna III	Yes	Yes	56/182	2007	X				5	0	Complete.	None
	Kapuna IV	Yes	No	342/224	2007	X				8	0	Complete, but NARS staff are continuing pig eradication campaign by alternating between volunteer hunts and snaring.	Pigs
Waianae Kai	Waianae Kai	Yes	Yes	9/9	2010	X	X			2	0	Complete and ungulate free.	None
	Gouvit	Yes	Yes	1/1	2008	X				1		Complete and ungulate free	None
	Nerang Mauka	Yes	Yes	1/1	2011	X	X			2		Complete and ungulate free.	None
West Makaleha	West Makaleha	Partial	No	7/93	TBD	X	X			7	0	Cultural 106 surveys are complete. OANRP is awaiting the signing of Army-State real estate agreement. Limited goat control has been conducted in the past. The *Schiedea obovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free.. OANRP is also looking at alternatives to building the entire larger unit or partnership assistance.	Pig/Goat
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	TBD	X			X	1	0	Need to scope. This fence was overlooked in the past but is slated for a MFS population of Lipten.	Goat

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
Makaha	Makaha I	Yes	Yes	85/96	2007					10	1	Complete and ungulate free.	None
	Makaha II	Partial	No	0/66	2013	X	X		X	4		Completed 106 surveys. Slated for construction in 2013. Completed *Cyanea longiflora* PU fence.	Pig/Goat
DOLE FOOD COMPANY, INC.													
Alaiheihe and Kaimuhole	Alaiheihe and Kaimuhole	No	No	0/100	2020	X				4	0	An ROE is complete for rare plant monitoring. OANRP has scoped out a line and a 106 survey is partially complete. At this time, Castle and Cooke is unwilling to discuss any fencing and are looking to sell the land. OANRP is hopeful that if there is a sale then the new landowner will be interested in working towards mutually beneficial goals.	Pig/Goat/ Cattle/ Donkeys

OIP Management Unit Status

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	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	Yes	Yes	183/183	2008		X			1	3			Strategic fences complete. No pigs have been caught nor any sign observed since 2010. A line has been scoped for the Waianae Kai side and 106 surveys complete but the State has opted to postpone construction since no sign has been observed. The proposed Lihue fence will connect to this unit.	None
Kaunala	Kaunala	Yes	Yes	5/5	2006		X				1			Complete.	None
Kawaiiki I/II	Kawaiiki I/II	No	No	0/11	TBD	X			X			2		OIP EA, CDUP and 20 year license agreement complete. Awaiting 106 cultural survey. OANRP is looking at alternatives to building smaller units by becoming involved in partnerships that are proposing larger units in the area.	Pig
Kawailoa	Kawailoa	No	No	0/7	TBD	X	X		X		1			OIP EA, 20 year license agreement, 106 cultural survey and CDUP complete. OANRP is looking at alternatives to building smaller units by becoming involved in partnerships that are proposing larger units in the area.	Pig
Lihue	Lihue	Partial	No	4/1800	2012		X			4	6			95% of the fence perimeter has been constructed. Six PU fences complete. Three hundred seventy-two pigs removed.	Pig/Goat
Poamoho	Poamoho Lower	No	No	0/156	TBD	X			X		1			OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey. OANRP is partnering with the State to build a larger unit encompassing large amounts of suitable habitat.	Pig
	Poamoho Upper	No	No	0/60	TBD	X			X			2		OANRP is partnering with the State to build a larger unit encompassing large amounts of suitable habitat.	Pig
Opaeula Lower II	Opaeula Lower II	No	No	0/24	TBD	X			X		1			OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey. OANRP is looking at alternatives to building smaller units by becoming involved in partnerships that are proposing larger units in the area.	Pig
Oio	Oio	Yes	Yes	4/4	2006	X					1			Complete.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	273/273	2007						1			Complete. Two pigs were able to breach Opaeula fence in 2010 but were promptly captured with assistance from KMWP.	None
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006	X					1			Complete.	None
South	South Kaukonahua I	No	No	0/95	2014		X				3	3	1	OIP EA and 106 cultural surveys complete. Snaring is performed to reduce pig pressure.	Pig

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
Kaukonahua	South Kaukonahua II	No	No	0/.5	TBD		X					2		OIP EA and 106 cultural surveys complete. OANRP is partnering with the State to build a larger unit encompassing large amounts of suitable habitat.	Pig
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES															
Huliwai	Huliwai	No	No	0/1	2013	X					1			OIP EA complete, awaiting 106 cultural surveys	Pig
Ekahanui	Ekahanui III	Yes	Yes	8/8	2010	X	X				1			Complete and ungulate free.	None
Kaipapau	Kaipapau	No	No	0/273	TBD	X	X				4	1		OIP EA and 106 surveys complete. Awaiting signing of Army-State real estate agreement OANRP looking at alternatives to building the entire larger unit or partnership assistance.	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	TBD	X	X				1			OIP EA and 106 surveys complete. Awaiting signing of Army-State real estate agreement. OANRP is look at alternative areas to manage the *Labordia cyrtandrae*.	Pig
Manuwai	Manuwai II	Yes	No	138/138	2011	X	X			1	1			Complete. Ungulate removal is ongoing with 12 pigs removed so far.	Pig/Goat
North Kaukonahua	North Kaukonahua	No	No	0/31	TBD	X	X				3	1		OIP EA and 106 cultural survey complete 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	2013	X					1	4		The new proposed Poamoho NAR fence will encompass this unit. The OANRP has proposed to assist the State with construction.	Pig
	Poamoho Pond	No	No	0/18	2013	X						1	1	The new proposed Poamoho NAR fence will encompass this unit. The OANRP has proposed to assist the State with construction.	Pig
	Kaukonahua-Punaluu	No	No	0/2	2013	X						1		The new proposed Poamoho NAR fence will encompass this unit. The OANRP has proposed to assist the State with construction.	Pig
Wailupe	Wailupe	No	No	0/22	TBD	X						1		OIP EA complete, awaiting 106 cultural surveys. Awaiting Army-State real estate agreement and 106 surveys. OANRP looking at alternatives to building the entire larger unit or partnership assistance.	Pig
Waimano	Waimano	Yes	Yes	4/4	2011	X	X				1			Complete and ungulate free.	None
North Pualii	North Pualii	Yes	Yes	20/20	2004	X				1	1			Complete.	None
	BOARD OF WATER SUPPLY														
Kamaili	Kamaili	No	No	0/7	2014	X	X		X		1			OIP EA, cultural resource surveys, license agreement and CDUP are complete.	Pig/Goat
	HAWAII RESERVES INC.														
Koloa	Koloa	Yes	No	0/160	2012	X	X		X		4	2		Complete. Ungulate eradication has begun.	Pig
	KAMEHAMEHA SCHOOLS														

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
Waiawa	Waiawa I	No	No	0/136	2017	X			X		2	1	1	OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
	Waiawa II	No	No	0/136	2019	X			X		2	1		OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION															
North Halawa	North Halawa	Partial	No	.5/4	TBD	X					1			Built small unit around *Cyanea st-johnii* PU. Larger unit still planned for area. Awaiting completion of 106 cultural survey for larger unit. OANRP looking at alternatives to building the entire larger unit or partnership with Hawaii State Department of Transportation.	Pig
KUALOA RANCH INC.															
Kahana	Kahana	Partial	No	1/23	TBD	X						1		Built small units around *Schidea kaalae* PU. OIP EA is complete. Awaiting completion of 106 cultural survey for larger unit. OANRP looking at alternatives to building the entire larger unit or partnership assistance.	Pig
U. S. FISH AND WILDLIFE SERVICE															
Kipapa	Kipapa	No	No	0/4	TBD	X							1	OIP EA is complete. Awaiting completion of 106 cultural survey. OANRP looking at alternatives to building the entire larger unit or partnership with U.S. Fish and Wildlife Service.	Pig

1.1.2 Environmental Outreach

Volunteers

During the reporting period 1 October 2011 – 30 September 2012 the OANRP Outreach Program focused on existing volunteer-based projects at appropriate sites within OIP and MIP management areas, and at the two OANRP baseyards. A significant amount of volunteer time was spent controlling the incipient moss, *Sphagnum palustre* within the Kaala Management Unit. Table 1 summarizes project trips. See Appendix 1-1 for photographs of project trips.

- Total volunteer hours for field days = 4,302.5
  (includes driving time to and from trailhead, safety briefing, hiking time to and from work site, and gear cleaning time at end of day)
- Total volunteer hours at work site =1,261.5
  (includes actual time spent weeding, planting, or monitoring)
- Total field volunteer trips = 78
- Total baseyard volunteer hours = 602.5
  - Baseyard projects:
    - Propagule processing
    - Nursery maintenance
    - Baseyard landscaping
    - Outreach material preparation and filing
- Maintained a volunteer database of 1,367 total volunteers and communicated regularly with active volunteers.
- Developed online sign-up system for volunteers to register for upcoming service trips using iVolunteer Online: www.oanrp.ivolunteer.com.
- Developed online evaluation form for volunteers to provide post-service trip comments and suggestions. Feedback is used to help outreach staff refine and improve service trip opportunities.

Volunteer service for FY 2012

Management Unit	Projects	Total Number of Field Days
Kahanahaiki	Invasive weed control	15
	School Group Stewardship Plots weeding	2
	Weeding and common native monitoring	1
	Common native/monitoring/seed collection only	4
Kaala	Common native plant monitoring	2
	Sphagnum moss control & boardwalk construction	4
	Sphagnum moss control only	18
	Sphagnum moss and other incipient weed control	5
	Other incipient weed control only	5
Palikea	Incipient weed control	1
	Invasive weed control	1
Makaha	Invasive weed control	7
	WHS Field Day	1
West Makaleha	Invasive weed control	3
Pahipahialua	Invasive weed control	2

	Common native monitoring	½
Kaluaa	Invasive weed control	2
Kaunala	Invasive weed control	1
	Common native monitoring	½
Hapapa	Invasive weed control	1
Ekahanui	Invasive weed control	1
Schofield Waikane	Trail Maintenance	1

Educational Materials

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

- Outreach Exhibits and Activities:
  - Kahuli (*Achatinella mustelina*) template for button making activity to use at outreach events;
  - Kahuli monitoring activity for classrooms—students learn hands-on field science techniques focused on protecting endangered Hawaiian tree snails. (Presented at the 2012 Hawaii Environmental Education Symposium);
  - Conservation-themed bingo card for the Next Generation of Conservation Leaders Reception scavenger hunt activity;
  - Tracking tunnel game: match the prints with the predator;
  - Insect aspirator activity for Project Learning Tree teacher workshop;
  - Schoolyard ant survey activity for Project Learning Tree teacher workshop.
- Signage:
  - "Rainwater Harvesting" – designed a sign with DPW Environmental staff that highlights the rainwater harvesting system at OANRP West Range Baseyard;
  - "Let the snails do the crawling…"– completed sign to explain importance of predator barrier/fence for the protection of *Achatinella* spp.; signs have been placed near predator barrier at Hapapa.
- Displays:
  - "Native Plants of Kahuku," –created canvas prints and placards to highlight native plants found at Kahuku Training Area (KTA), including akia (*Wikstromia oahuensis* var. *oahuensis*), ulei (*Osteomeles anthyllidifolia*), and the endangered nioi (*Eugenia koolauensis*). Display was installed in the KTA Range Control Building.
- Brochures & Flyers:
  - "Nioi (*Eugenia koolauensis*)" – a brochure describing cultural significance, threats, and management activities associated with this endangered species (brochures were distributed at KTA Community Open House and will be on-hand at KTA Range Control);
  - "Makaha Valley" – a flyer describing the rationale for building the Makaha Subunit II fence, highlighting cultural and natural resources in the area (flyers were distributed at hunter's check-in station at Kumaipo Trailhead).
- New PowerPoint Presentations:
  - "Field Science for the School Campus with the Oahu Army Natural Resources Program." Presented at the 2012 Hawaii Environmental Education Symposium;
  - "So you want to get paid to hike?" Presented at the "Trail Tales" series at SoulTrex, an outdoor gear store at Windward Mall.
- Other:

- Presenter at the Navigating My Course workshop, a three-day educational experience for young women interested in pursuing careers in conservation in Hawaii;
- Active participants on the planning committee for the 2012 Hawaii Conservation Conference;
- Planning Committee members, facilitators, and presenters for the Changing the Face of Conservation Leaders in Hawaii and the Pacific: Nahululeihiwakuipapa Workshop at the 2012 Hawaii Conservation Conference, a session targeting youth interested in conservation careers;
- Natural Resources Program talking points developed in coordination with the USAG-HI Public Affairs Office for Makua Public Access events.

Internships and Temporary Staff

Developed internships at OANRP and with cooperating agencies. Coordinated orientation, training and gear assignments for all interns and for temporary field technician staff. This year we hosted the highest number of interns and temporary hires to date, providing valuable natural resource management training for a total of eight interns, two temporary staff, and 20 Hawaii Youth Conservation Corp (HYCC) members.

- Hosted three teams of interns from HYCC, providing hands-on natural resource training for 20 youth. Together, HYCC interns contributed a total of 756 volunteer hours in June and July;
- Evaluated and scored 35 applicants, interviewed 10 applicants, and awarded five individuals with 3-5 month, paid OANRP summer internships. Interns were placed with field, nursery, and fence crews to gain valuable career skills and experience in the field of natural resource management;
- Hosted one HYCC Hana Hou intern for eight weeks;
- Evaluated and scored eight applicants, interviewed one applicant, and awarded one individual with a 12-month AmeriCorps Internship with OANRP. Intern has been placed with a natural resource field crew;
- Evaluated and scored 13 applicants, interviewed five applicants, and selected one individual for a temporary Natural Resources Data and Administrative Support position;
- Coordinated orientation, training and scheduling for one temporary field technician;
- Coordinated scheduling for one high school senior, who worked with field teams and specialists to satisfy volunteer requirements for his senior project.

Troop Education

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

- Delivered a one-hour presentation for the eight Environmental Compliance Officer (ECO) training courses held on Oahu in FY2012; approximate number of soldiers attending = 189 (presentation is constantly revised to relay current information on potential threats to natural resources on Army lands, such as the recently discovered *Cenchrus setaceus* in Makua);
- Delivered two briefings on protecting natural resources of Makua Military Reservation to approximately 75 and 60 soldiers on February 22 and June 2, respectively;
- Coordinated a tour of the West Base endangered plant nursery for Schofield soldiers;

- Coordinated and led an Earth Day volunteer trip for soldiers to control invasive weeds in the Kahanahaiki chipper site.

Outreach Events

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

- Total # of outreach activities = 34
- Total # of people served (approximated) = 3, 568

Outreach activities for FY 2012

Event	Approx. # of People Served	Audience
UH NREM Class IS489 Presentation	20	UH NREM Students
Leilehua HS Career Day	60	High school students
UH Conservation Biology Grad Class	10	UH grad students
Makua Public Access Brief	24	General public
Windward CC Presentation	16	College students
Makua Public Access Brief	18	General public
Navigating My Course Workshop	12	High school students
Kamehameha Schools Sustainability Fair	500	Middle and high school students
Makua Public Access Brief	15	General public
Oahu Ag and Environmental Awareness Day	180	Elementary students (5th grade)
Project Learning Tree workshop (hosted at OANRP West Range Baseyard)	7	Teachers
Live & Learn Event (Schofield)	50	Military families
Boy Scout Talk Story at East Base	30	Boy Scouts (ages 11-17)
Makua Public Access Brief	18	General public
Natural Resource Management & Conservation Career talk at HPU	20	College students
Earth Month Theater Presentation – Schofield Barracks	18	Military families
Family Fun Fest and Earth Day Celebration	400	Military families
Earth Month Theater Presentation-Aliamanu Military Reservation	18	Military families
Boy Scout Talk at Barber's Point	12	Boy Scouts (ages 11-17)
Windward Mall Earth Day	75	General public
Earth Month Theater Presentation-Schofield Barracks	50	Military families
WCC Botany 130 Class Presentation	15	College students
Makua Public Access	51	General public

Kahuku Training Area Community Open House	27	Kahuku residents
Earth Month Theater Presentation-Aliamanu Military Reservation	4	Military families
Fort Shafter Spring Fling-Earth Day Event	200	Military families
Endangered Species Day	200	General public/military families
Makua Public Access	20	General public
Makaha Hawaiian Civic Club Presentation	10	Makaha residents
Environmental Education Symposium	20	Teachers and Environmental Educators
HCC Emerging Professionals Session	150	High school and college students
HCC Next Generation of Conservationists Reception	200	High school and college students
HCC Open House Exhibit	100	General public
HCC Display in Exhibit Area	1000	Conference Attendees
SoulTrex Talk- Windward Mall	18	General public
Total Number of People Served:	**3568**	

Public Relations

Wrote articles, press releases, and bulletins; provided coordination and accurate information to the local, state, regional, and national media and agencies (see Appendix 1-1 for examples). The table below is a summary of all media featuring OANRP in 2012.

Media coverage of OANRP activities in FY 2012

Title	Publication	Date	Format
Forces combine to manage one of Oahu's rare natural gems	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2011/10/06/forces-combine-to-manage-one-of-oahu%E2%80%99s-rare-natural-gems/	06-Oct-11	Article
Natural Resources Team wins top Army Award	The Official Homepage of the United States Army http://www.army.mil/article/73133/Natural_Resources_Team_wins_top_Army_award/	03-Feb-12	Website Post
Army biologists release endangered snails into Waianae Mountains	Honolulu Star Advertiser http://www.staradvertiser.com/news/breaking/138995479.html?id=138995479	08-Feb-12	Article
U.S. Protects Critically Endangered Hawaiian Snails from Invasive Predators	Scientific American Blog http://blogs.scientificamerican.com/extinction-countdown/2012/02/15/army-protects-endangered-hawaiian-snails-invasive-predators/	15-Feb-12	Website Post

Audio: Snail release	Defense Media Activity—Hawaii News Bureau http://www.dvidshub.net/audio/29295/snail-release	21-Feb-12	Website Post
300 snails reintroduced to the Waianae mountains	KHON2 http://www.khon2.com/news/local/story/300-snails-reintroduced-to-the-Waianae-mountains/QWbFEzFpOEm-xPpBkSp5vA.cspx	21-Feb-12	Televised News
Rebuilding Rare Hawaiian Tree Snail Population	Hawaii News Now http://www.hawaiinewsnow.com/story/16987993/rebuilding-rare-hawaiian-tree-snail-population	21-Feb-12	Televised News
The return of the tree snails	Defense Media Activity—Hawaii News Bureau http://www.dvidshub.net/news/84106/return-tree-snails	21-Feb-12	Website Post
Video: Snail Release	Defense Media Activity—Hawaii News Bureau http://www.dvidshub.net/video/137985/snail-release http://www.dvidshub.net/video/137986/snail-release	21-Feb-12	Website Post
Snails Slip Back into Native Habitat on Waianae Mountain Range	KITV4 ABC http://www.kitv.com/Snails-Slip-Back-Into-Native-Habitat-On-Waianae-Mountain-Range/-/8906042/9658354/-/jmljomz/-/index.html	21-Feb-12	Televised News
Video: Army Now—Mar. 2nd on Army's reintroduction of tree snails	Army Broadcasting http://www.dvidshub.net/video/138684/army-now-mar-2nd	03-Mar-12	Website Post
Upscale living: Slimy residents fill gated community	Hawaii Army Weekly http://www.army.mil/article/75656/Upscale_living__Slimy_residents_fill_gated_community	06-Mar-12	Article
Snail re-introduction note	Midweek-Central Oahu Waha Nui http://www.midweek.com/waha-nui-9/	28-Mar-12	Article
Hail Snails!: Sometimes, you build a jail to keep bad guys out.	Honolulu Magazine http://www.honolulumagazine.com/Honolulu-Magazine/April-2012/Endangered-Kahuli-Snails-on-Oahu/	01-Apr-12	Article
Families invited to celebrate Earth Month, Fun Fest	The Official Homepage of the United States Army http://www.army.mil/article/77069/Families_invited_to_celebrate_Earth_Month__Fun_Fest/	2-Apr-12	Website Post
OANRP & Island Palms Community to host Planet Earth movie night	Hawaii Army Weekly http://www.army.mil/article/77404/OANRP__IPC_to_host__Planet_Earth__movie_night/	06-Apr-12	Article

Army, Marines in Hawaii receive 2012 Secretary of Defense Environmental Awards	Pacific Business News http://www.bizjournals.com/pacific/news/2012/05/01/army-marines-in-hawaii-receive-2012.html	01-May-12	Website Post
Oahu Army Natural Resource Team, Marine base in Hawaii recognized for environmental work	The Republic http://www.therepublic.com/view/story/078993d84dd24006adeadf9c77b4e15d/HI--Environ	01-May-12	Website Post
OANRP recognized for superior work	The Official Homepage of the United States Army http://www.army.mil/article/79881/OANRP_recognized_for_superior_work/	17-May-12	Website Post
Division of Forestry and Wildlife and the Oahu Army Natural Resources program: Growing, Teaching and Learning Naturally!	Malama Hawaii http://malamahawaii.org/blog/tag/project-learning-tree/	17-May-12	Website Post
Army Conservationists Lauded for Environmental Stewardship	Midweek-Central Oahu News http://www.midweek.com/army-conservationists-lauded-for-environmental-stewardship/	30-May-12	Website Post
Army Conservationists Protect Hawaii Rainforest	YouTube http://www.youtube.com/watch?v=csnS4jpe924	29-Sept-12	Website Post

- Edited/produced/distributed the Ecosystem Management Program (EMP) Bulletin, a quarterly newsletter highlighting achievements made by the Army Environmental Division both on Oahu and Hawaii Island. The EMP is 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.
    - Volume 54: Winter 2011-Spring 2012 (this issue combined two quarters)
    - Volume 55: Summer 2012

<u>Outreach Program Recognition</u>

Received national recognition of OANRP Outreach program and volunteers.

- Registered and planned volunteer work day in Kaala, Schofield Barracks West Range (SBW) on September 29, 2012 for National Public Lands Day. Received cash award totaling $2650 to purchase supplies including: volunteer saws, loppers, and gloves; hand pump sprayers (for *Sphagnum palustre* moss control at Kaala); and Garlon 4 Ultra herbicide. Volunteer work day was promoted on National Public Lands website;

- Nominated two OANRP volunteers for the President's Volunteer Service Award. Both volunteers were eligible for the Silver Level Award (serving 456.5 and 268 hours within the reporting year) and will receive presidential pins and certificates of appreciation.

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

1.1.3 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 5,860 hours controlling weeds across 275.67 ha, a program record. This includes both incipient and ecosystem control efforts by staff and volunteers. Last year, 5,778 hours were spent sweeping 259 ha. This year's increase is primarily due to increased effort on incipient control projects, specifically *Sphagnum palustre* and *Chromolaena odorata* control. Staff also conducted surveys on all primary training range roads and MU access roads, military landing zones (LZs), and all secondary training range roads in SBE. In the coming year, secondary training range roads in KTA and SBW will also be surveyed.

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 and around MUs. Those not located within oradjacent to a MU were selected for control either because they occur in an Army training range (for example, *Rhodomyrtus tomentosa* in SBE), or are particularly invasive (*Morella faya* in Kaluaa). Many ICAs are quite small, but a few, like those for *Angiopteris evecta* in Kapuna or *Chromolaena odorata* in Kahuku, are quite large. Typically, ICA areas are swept over and over again, until eradication has been achieved and staff are reasonably confident that there is no remaining seed bank. The goal of ICA efforts is to achieve local eradication of the target species. OANRP currently manages about 60 taxa in approximately 190 ICAs.

Of the total 275.67 ha swept, ICA efforts covered 219.27 ha. Staff spent 1,661 hours on ICA management and conducted 260 visits to 115 ICAs. In contrast, last year, 164 ha were swept, 665.5 hours were spent, and 281 visits were made to 130 ICAs. The expansion in effort this year is largely due to *C. odorata* control and volunteer work on *Sphagnum palustre*. Note that in some areas, several small ICAs can be treated in one field day. 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.

ICA Effort in MUs

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Kaala Army	7	*Anthoxanthum odoratum* *Crocosmia* x *crocosmiifolia* *Diplazium esculentum* *Elaeocarpus grandis* *Festuca arundinacea* *Juncus effusus* *Sphagnum palustre*	63	781.56	The majority of time and effort was spent on *S. palustre* control. Almost every moss control trip was run by the outreach program. Volunteers provide the majority of labor for *S. palustre*, *C. crocosmiifolia*, and *J. effuses.*
KTA No MU	6	*Acacia mangium* *Cenchrus setaceus* *Chromolaena odorata* *Melochia umbellata* *Miscanthus floridulus* *Rhodomyrtus tomentosa*	49	473.7	Efforts on *C. odorata* expanded greatly this year, and account for most of the time spent. In the coming year, staff hope to use aerial sprays to treat some *C. odorata* and most *M. floridulus* plants.
SBE No MU	8	*Buddleja madagascariensis* *Cenchrus setaceus* *Heterotheca grandiflora* *Rhodomyrtus tomentosa* *Schizachyrium condensatum* *Senecio madagascariensis* *Smilax bona-nox* *Vitex trifolia*	22	131.35	SBE is heavily used for training, and is close to residential Wahiawa. It has a particularly high diversity of alien plants. Most time is spent on *R. tomentosa* and *S. condensatum*, which was just found this year.
Ohikilolo Lower	1	*Cenchrus setaceus*	10	66.65	Control on *C. setaceus* is discussed below. It is a priority for control.
Makaha II, Makaha No MU	2	*Leptospermum scoparium* *Morella faya*	2	57	These species pose a threat to Makaha and Kaala. Staff will continue to work with NARs on eradication.
Lihue	1	*Erythrina poeppigiana*	3	35	This is the first year of control.
Kahanahaiki	6	*Acacia mearnsii* *Angiopteris evecta* *Ehrharta stipoides* *Pterolepis glomerata* *Sphaeropteris cooperi* *Triumphetta semitriloba*	28	22.03	This is the first year *E. stipoides* has been controlled in Kahanahaiki. It was likely introduced to the area via staff or contractors. It has been controlled for years just outside the Kahanahaiki fence, in Pahole.
Palikea	3	*Crocosmia* x *crocosmiifolia* *Dicliptera chinensis* *Setaria palmifolia*	13	14.85	All *C. crocosmiifolia* control is done with volunteers & accounts for most of the time spent on ICAs in Palikea
Ekahanui	2	*Acacia mearnsii* *Ehrharta stipoides*	3	12.5	These are newly established ICAs.
Manuwai	2	*Caesalpinia decapetala* *Pterolepis glomerata*	6	11.65	Control has just begun on these incipients; both have limited ranges.

While the goals for all ICAs are the same, the rate of visitation required to achieve this 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 take a while to mature. In general, ICA efforts are considered successful if visits are frequent enough to detect and control plants before they mature and if there is a downward trend in total numbers of plants found on each visit.

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

ICA Target Taxa

Taxa	Effort	Comments
Sphagnum palustre	641.1	Volunteers provide the majority of hours. Most time is spent in Kaala Army MU, but some time is also spent in Kaala NAR
Chromolaena odorata	430	Effort includes OANRP and partner agency time. Not included is effort spent conducting surveys only. See discussion below.
Crocosmia x *crocosmiifolia*	106.25	Volunteers conduct the majority of control on this species.
Rhodomyrtus tomentosa	84.2	This is a priority target in SBE.
Cenchrus setaceus	77.15	This taxon is discussed below. It is a high priority for control.
Leptospermum scoparium	57	This taxon is an eradication target in the Waianae Mountains. Staff has and will continue to partner with NARS on control. Wind-dispersed, long-lived seed and rapid growth to maturity mean consistent control will be needed for many years.
Juncus effusus	38	Volunteers conduct the majority of control on this species.
Erythrina poeppigiana	35	Found only on SBW, access to treat this tree may be limited in future
Schizachyrium condensatum	23	This taxon is discussed below. It is a high priority for control.
Acacia mangium	21	Regular control of this species will be needed for years, as the seeds are long-lived and appear to disperse widely.
Acacia mearnsii	20.5	This tree is only targeted at select MUs. It has long-lived seeds and will require regular control on an annual basis.
Pterolepis glomerata	17.2	This taxon is only a target in the Waianae Mountains.
Melochia umbellata	15.75	Restricted to KTA, this taxon has long-lived seeds. Regular control will be needed for many years.

In the OARNP database, specific reports can be generated which detail this information at each ICA; these reports include the dates of the last mature and non-mature plants found, overall effort spent, and population trend graphs. Please see these reports for a more complete picture of ICA status.

In the coming year, it is expected that *C. odorata* effort will decrease slightly, as actions have been split between OANRP and OISC (see *C. odorata* discussion in the Invasive Species Updates below). This weed will continue to be of highest priority. Effort is expected to increase for *C.setaceus, S. condensatum*, and *Miscanthus floridulus* (swordgrass) as control efforts ramp up at these new ICAs. Aerial control options will be used for *C. setaceus*, *C. odorata*, and *M. floridulus* to treat large, hard-to-access infestations and improve efficiency. Efforts on *R. tomentosa, E. poeppigiana*, *A. mangium*, and *A. mearnsii* should remain constant in the coming year, as all have long-lived seeds. It is hoped that increased use of pre-emergent herbicides will decrease the amount of effort needed to treat other ICAs, including *P. glomerata*, *M. umbellata* and *E. stipoides*.

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 based on a variety of factors including, presence of rare taxa, potential for future rare taxa reintroductions, integrity of native forest, invasive species presence, and fire threat. Different WCAs have different goals, depending on the MIP/OIP taxa present, the state of existing native forest, and fire threat. 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 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 Makua and Oahu Implementation Plans, 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/FWS for review. It can be difficult to compare effort spent between WCAs/MUs, and to judge whether the effort spent was sufficient. Goals for each site vary, and estimating the effort needed for each WCA is very challenging. Staff will work towards creating meaningful estimates of effort needed/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 2011 report is included for reference. This year's data is 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).

Fenceline clearing in Kahanahaiki II

MU WCA Weed Control Summary, 2011/10/01 through 2012/09/30

Management Unit	2012 Report Year					2011 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Alaiheihe and Kaimuhole	79.14	2.44	**0**	**0**	**0**	0.52	1	4	The 2011 effort is due to road maintenance. Fence construction is awaiting landowner permission. No comprehensive weed management plan in place yet.
Alaiheihe No MU	N/A	108.5m^2	**0**	**0**	**0**	101 m^2	1	3	No control was conducted around this year. This area is not a priority for control.
Ekahanui	87.50	76.88	**3.44**	**24**	**175.75**	1.64	11	136.5	Additional WCAs were drawn in this MU to accommodate trail-clearing for rat control and new rare plant reintroductions. Control efforts focused around rare species locations.
Ekahanui No MU	N/A	10.07	**573 m^2**	**2**	**4.25**	1.08	1	10	Total WCA area was expanded from 2011. Limited weed control is conducted outside the MU. This year, staff assisted a State-sanctioned volunteer group with control of *Pimenta dioica*, which poses a threat to the exclosure.
Haili to Kealia I and II	12.8	2.14	**453 m^2**	**1**	**1**	0	0	0	Minimal weed control was conducted around one of the *Hibiscus brackenridgii* sites. This area is alien-dominated. Long term goals need to be evaluated.
Helemano	60.62	61.01	**78 m^2**	**2**	**2.3**	11.36	13	141	Due to difficulty in flying to the Koolau summit, little weed control was accomplished this year. Staff focused on treatment of *Setaria palmifolia* outliers, an activity which could be done on short day trips.
Helemano South No MU	N/A	46.24	**0**	**0**	**0**	0.46	1	15	No control conducted this year. This area is not in an MU, and is not a top priority. Staff will participate in partner-led activities in this area.
Huliwai No MU	N/A	1.75	**0.18**	**1**	**1.5**	50.22 m^2	1	0.5	Staff assisted a State-sanctioned volunteer group with control of *Chrysophyllum oliviforme*. This weed is locally established in Huliwai, but it would be good to prevent it's movement into nearby MUs.
Kaala Army	50.03	50.58	**5.89**	**31**	**513.7**	13.42	13	420	*Hedychium gardnerianum* continues to be the primary weed target at Kaala. Staff targeted plants located on the slopes of Kaala, in steep terrain. This area is inherently more time-consuming to cover.

Management Unit	2012 Report Year					2011 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaena	10.06	2.97	**1.7**	**3**	**50**	1.02	3	67.5	The MU at Kaena was modified to include additional plants found. Weed control focused around rare taxa.
Kaena East of Alau	14.51	0.14	**0.14**	**2**	**23.5**	0.18	4	116	Last year, the high number of hours were due to one large volunteer trip. This year, control focused directly around the rare plant site, and also on woody weed removal, as this area is at high risk from fire.
Kahanahaiki	37.70	27.35	**6.66**	**110**	**1,150.9**	10.47	71	997.25	The MU area was expanded from last year to include Kahanahaiki II. Much weed control work here is around rare species sites and large native forest patches. This year the chipper project was resumed, and another 1.5 acres were cleared. This, and volunteer trips account for the high effort here.
Kaleleiki	0.11	0.80	**660m²**	**2**	**15.5**	1536 m²	1	19.5	Control was conducted in the exclosure. The area of the MU needs to be increased to include all known *Eugenia koolauensis* plants, and a larger management plan is needed.
Kaluaa and Waieli	80.97	82.9	**3.18**	**42**	**287.35**	3.43	35	262.6	Control efforts focused around rare plant locations and around the Hapapa snail exclosure. Some volunteer trips as well.
Kaluaa No MU	N/A	3.87	**0.44**	**3**	**45**	0.96	4	39	Limited weed control is conducted outside the MU. Control is targeted around rare taxa that fall outside the Kaluaa and Waieli MU and the access road to the Kaluaa trailhead.
Kaluakauila	41.68	9.64	**3.89**	**14**	**118.75**	3.45	15	99	Control efforts focused on grass control and *Leucaena leucocephala* control around rare taxa. Control was expanded to include *Nototrichium humile* sites. The ridgeline fuelbreak was maintained.
Kamaileunu I	0.41	0.49	**0.18**	**2**	**18**	0	0	0	Woody weed and grass control was conducted in and directly around this small exclosure
Kapuna Upper	172.35	179.24	**0.95**	**18**	**105**	2.22	23	240.5	Control efforts continued to focus around rare taxa and reintroductions, including new *Flueggea neowawarea* planting sites.
Kaunala	1.98	1.99	**0.42**	**3**	**31.5**	0.18	3	65.4	Staff efforts focused around rare taxa, and volunteer efforts continued in areas with no *E. koolauensis*.

Management Unit	2012 Report Year					2011 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
KTA No MU	N/A	1.25	**224 m²**	**2**	**4**	0	0	0	Weed control was conducted around a small *E. koolauensis* site in East Oio.
Lihue	710.93	708.27	**4.33**	**13**	**129.75**	1.83	9	105.5	All of Lihue was divided into WCAs to facilitate data tracking. OANRP increased weed control efforts in the Lihue area to take advantage of increased availability of SBW. Efforts centered around rare taxa exclosures, snail sites, and along the fenceline.
Makaha I	60.87	35.26	**1.66**	**30**	**244.75**	2.54	27	253.3	Weed control efforts focus around rare plant sites in the southern part of the exclosure and *Toona ciliata* control. Volunteer trips were conducted here also.
Makaha II	26.69	2.65	**0.57**	**4**	**19**	0	0	0	Clearing was conducted for the Makaha II fenceline. Some control was performed around *Cyanea longiflora* as well, in preparation for outplanting.
Makaha No MU	N/A	7.85	**0**	**0**	**0**	2.18	3	8	No control was performed outside the MU this year.
Manuwai	122.49	124.91	**0.74**	**13**	**222.5**	0.47	5	17.5	Regular weed control began in Manuwai this year. Efforts focused around rare taxa and potential reintro sites. Some grass control was performed on the northern fenceline.
MMR No MU	N/A	28.17	**0**	**0**	**0**	4.44	4	56	No control was performed outside the MU this year.
Nanakuli No MU	N/A	4.04	**0**	**0**	**0**	0.81	1	2	This is the Halona ridgeline, an area between the Palikea and Palikea IV MUs. *Sphaeropteris cooperi* control will be targeted here in the coming years.
Napepeiauolelo	0.75	0.93	**0.11**	**1**	**3**	0	0	0	This exclosure was weeded as a potential reintroduction site.
Ohikilolo	273.59	149.06	**3.64**	**16**	**258**	5.35	20	464	In the Ohikilolo Ridge (upper) half of this MU, control efforts continued across native dominated forest and around rare taxa, and were also expanded into new areas. In the Lower Makua half of this MU, weed control was conducted in native dominated forest and around *Neraudia angulata* sites.
Ohikilolo Lower	28.75	4.44	**4.07**	**13**	**159**	3.72	15	274	Staff were able to reduce the number of visits to Lower Ohikilolo, but maintaining fire breaks around the rare taxa here continues to be labor-intensive.

Management Unit	2012 Report Year					2011 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Oio	1.33	1.63	**0**	**0**	**0**	0	0	0	No control was done at this site this year. Due to the poor health of the *E. koolauensis* population at this site, OANRP continues to be hesitant to commit resources to this site, although it is designated Manage for Stability.
Opaeula	49.55	48.07	**0**	**0**	**0**	0	0	0	Almost all of the Opaeula exclosure has been swept once. Staff continue to focus on Helemano instead.
Opaeula Lower I	10.15	10.15	**88 m²**	**1**	**4.25**	0.14	3	39.25	The Opaeula Lower fence is complete. Some control was performed around rare taxa and on grass. Weed control will begin on an MU scale next year. See the MU plan at the end of this chapter.
Pahipahialua	5995 m²	5995 m²	**423 m²**	**3**	**30**	1263 m²	4	65	Staff efforts focused around rare taxa, and volunteer efforts continued in areas with no *E. koolauensis*.
Pahole	88.02	30.78	**3.03**	**23**	**194**	2.36	21	256.5	Control efforts continue to focus around rare taxa sites and grass sprays.
Pahole No MU	N/A	8.65	**5.33**	**4**	**8**	7.78	5	77.1	Staff continue to control weeds along the Pahole road and around the Nike greenhouse.
Palawai No MU	N/A	1.45	**0.25**	**1**	**1.5**	1.41	6	37.6	This area immediately abuts the Palikea MU. Control efforts here focus on *Sphaeropteris cooperi*, to remove mature plants seeding into the adjacent MU.
Palikea	9.95	10.59	**2.29**	**28**	**197**	2.64	49	457.65	The Palikea snail exclosure is complete. Last year, it accounted for a large portion of weed control effort. This year, efforts focused on controlling weeds around it, as well as other rare taxa sites. Grass was targeted along the trails and fences.
Poamoho No MU	N/A	94.67	**0**	**0**	**0**	9.18	2	49.5	No control was conducted along the Poamoho access road this year
Puaakanoa	10.70	0.70	**0.29**	**1**	**10**	0.51	6	82	Weed control efforts focus on fuel reduction around the *Euphorbia celastroides* var. *kaenana*. Fire is a major threat to the MU. Efforts in previous years have successfully repressed grass in this rocky area.
Pualii North	7.99	3.30	**673 m²**	**3**	**14**	0.51	4	34.5	OANRP focused control efforts around rare taxa sites and reintroductions.

Management Unit	2012 Report Year					2011 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Puu Kumakalii	5.63	4.83	**0**	**0**	**0**	0	0	0	Little weed control is possible in this steep, cliff-dominated MU. Some may be conducted to facilitate future reintroductions.
SBE No MU	N/A	4.1	**0**	**0**	**0**	0.1	1	.5	No control reported at the East Base this year.
SBW No MU	N/A	1.55	**0.64**	**4**	**8.25**	1	3	10	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	1.15	**0.13**	**1**	**2.5**	0.31	5	18.2	Conrol efforts focused around rare taxa at the mouth of the gulch.
Waianae Kai Neraudia Mauka	0.53	2.59	**0.30**	**4**	**20**	0	0	0	This MU fence is now complete. Control efforts centered around *Neraudia angulata* and potential outplanting sites. The forest in this area is degraded.
Waianae Kai NoMU	N/A	3.31	**438 m²**	**2**	**2.25**	85 m²	3	1.34	Weed control focused on the *Gounia vitifolia* exclosure.
Waimanalo to Kaaikukai No MU	N/A	0.64	**0.27**	**1**	**1**	0	0	0	This area encompasses the Palikea access trail. Control focuses on trail maintenance and grass repressesion.
Waimano	3.95	4.06	**313 m²**	**2**	**7.75**	0	0	0	The fence around this exclosure was recently completed. Most of the MU is native forest. Control efforts targeted the weedy gulch bottom, and the few canopy weeds. See the Waimano MU plan at the end of this chapter for a discussion of weed strategy.
West Makaleha	38.04	1.51	**1.29**	**13**	**114.5**	1.28	12	177.25	Most weed control efforts focused around rare taxa in the Three Points fence, but some effort was also spent in the *Schiedea obovata* fence on the north side of the MU.
West Makaleha No MU	N/A	0.32	**0**	**0**	**0**	0	0	0	Control is conducted here to keep the access trail open, as needed.
TOTAL	N/A	1868.39	**56.41**	**443**	**4199**	99.26	409	5123.4	See discussion below.

This year, WCA efforts covered 56 ha, a decrease over last year (99 ha). Also, staff spent 4,199 hours over 443 visits at 133 WCAs. This is a decrease from the 2010-2011 report year (5,123 hours, 409 visits) but an increase over the 2009-2010 report year (3,255.9 hours, 353 visits) and the 2008-2009 report year (2,652.4 hours, 267 visits). While part of the difference between the 2011-2012 and 2010-2011 report years is likely due to the longer than usual report period in 2011 (thirteen months), some of it is due to a real decline. There is still an overall trend of increasing effort on weed control, as efforts have not dipped below 2008 numbers. Staff recognize 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.

Less time was spent conducting control in WCAs in 2012 than in 2011, but more visits were made; this reflects an effort to partner control with other activities. A much smaller area was weeded in 2012 than in 2011. This decrease is not attributable to work in any one MU, but reflects a small decline in many MUs, although at some locations, efforts were intensified, with several re-treatments in the same area. These retreatments are not reflected in the area total, as no new area was managed. Effort and area weeded actually increased in some MUs. The following table highlights the changes in effort and area for the twenty or so MUs where the most effort was spent. The MUs vary in size, habitat quality, and number of IP taxa present. However, they do comprise the largest and most diverse MUs where OANRP works. The table is sorted by 2012 effort. Decreases are noted in italics.

Changes in Effort and Area in Select MUs, 2011/10/01 through 2012/09/30

Management Unit	2012 Effort (hrs)	2011 Effort (hrs)	Change in Effort	% Change from 2011	2012 Area (ha)	2011 Area (ha)	Change in Area	% Change from 2011
Kahanahaiki*	1150.9	997.25	153.65	15.4%	6.66	10.47	*-3.81*	*-36.4%*
Kaala Army*	513.7	420	93.7	22.3%	5.89	13.42	*-7.53*	*-56.1%*
Kaluaa and Waieli*	287.35	262.6	24.75	9.4%	3.18	3.43	*-0.25*	*-7.3%*
Makaha I and II*	263.75	253.3	10.45	4.1%	2.23	2.54	*-0.31*	*-12.2%*
Ohikilolo	258	464	*-206*	*-44.4%*	3.64	5.35	*-1.71*	*-32.0%*
Manuwai	222.5	17.5	205	1,171.4%	0.74	0.47	0.27	57.4%
Palikea*	197	457.65	*-260.65*	*-57.0%*	2.29	2.64	*-0.35*	*-13.3%*
Pahole	194	256.5	*-62.5*	*-24.4%*	3.03	2.36	0.67	28.4%
Ekahanui*	175.75	136.5	39.25	28.8%	3.44	1.64	1.8	109.8%
Ohikilolo Lower	159	274	*-115*	*-42.0%*	4.07	3.72	0.35	9.4%
Lihue	129.75	105.5	24.25	23.0%	4.33	1.83	2.5	136.6%
Kaluakauila	118.75	99	19.75	19.9%	3.89	3.45	0.44	12.8%
West Makaleha*	114.5	177.25	*-62.75*	*-35.4%*	1.29	1.28	0.01	0.8%
Kapuna Upper	105	240.5	*-135.5*	*-56.3%*	0.95	2.22	*-1.27*	*-57.2%*
Kaena	50	67.5	*-17.5*	*-25.9%*	1.7	1.02	0.68	66.7%
Kaluaa No MU	45	39	6	15.4%	0.44	0.96	*-0.52*	*-54.2%*
Kaunala*	31.5	65.4	*-33.9*	*-51.8%*	0.42	0.18	0.24	133.3%
Pahipahialua*	30	65	*-35*	*-53.8%*	0.04	0.13	*-0.09*	*-69.2%*
Kaena East of Alau	23.5	116	*-92.5*	*-79.7%*	0.14	0.18	*-0.04*	*-22.2%*

Management Unit	2012 Effort (hrs)	2011 Effort (hrs)	Change in Effort	% Change from 2011	2012 Area (ha)	2011 Area (ha)	Change in Area	% Change from 2011
Waianae Kai Neraudia Mauka	20	0	20	N/A, +	0.3	0	0.3	N/A, +
Puaakanoa	10	82	*-72*	*-87.8*	0.29	0.51	*-0.22*	*-43.1%*
Pahole No MU	8	77.1	*-69.1*	*-89.6*	5.53	7.78	*-2.25*	*-28.9%*
Helemano	2.3	141	*-138.7*	*-98.4*	0.01	11.36	*-11.35*	*-99.9%*
Totals	4110.25	4814.55	*-704.3*	*-14.6*	54.5	76.94	*-22.44*	*-29.2%*

* = areas where volunteers contribute to control efforts

The MUs with the greatest declines in area swept are, in order, Helemano, Kaala Army, Kahanahaiki, Pahole No MU, Ohikilolo, and Kapuna Upper. Little work was done at Helemano due to weather and helicopter difficulties; this MU is dominated by native taxa, and delays to weed sweeps are unlikely to cause long-term damage. At Kaala Army MU, large volunteer sweeps were conducted across the flat part of the bog in 2011. These sweeps are scheduled to occur every 3-5 years and thus were not repeated in 2012, decreasing the total area swept. Instead, the field team focused on mature stands of *Hedychium gardnerianum* on the slopes of Kaala, where large groups of volunteers are not as effective and more time is required to sweep smaller areas. In Kahanahaiki, the decline in area swept can be attributed to large sweeps for *Grevillea robusta* conducted in 2011, which were not needed in 2012. Chipper work, while intense, occurred over a relatively small area. Work in Pahole No MU was limited to road and Nike site maintenance in 2012 and did not include weeding around rare taxa sites, as it did in 2011. At Ohikilolo, part of the decline in area covered is due to reduced effort in the Makua valley section of the MU. This area does not have many MIP taxa and is considered to be lower in priority than many other MUs. In 2011, staff assisted NARS with State-led weed control trips in Kapuna Upper. This year, staff assisted NARs staff with weed control in other MUs instead. Small increases in area swept were seen in Lihue, Ekahanui, Kaena, Pahole, and Kaluakauila MUs. These increases are primarily due to the expansion of control efforts around rare taxa sites.

Effort declined in Palikea, Ohikilolo, Helemano, Kapuna Upper, and Ohikilolo Lower (in that order). In 2011, effort in Palikea was particularly high due to clearing for the new snail enclosure. Effort declined in Ohikilolo, Helemano, and Kapuna Upper for the same reasons area swept declined (see above). Also, less time was spent conducting weed control on the ridge portion of Ohikilolo, although crews did expand efforts into new WCAs. Effort in Kapuna Upper centered around small reintroductions. Ohikilolo Lower was monitored quarterly, but spray efforts were not needed in some quarters, resulting in the decline in effort in 2012. This decline in effort needed may have been due to a dry summer, resulting in little grass growth, or the use of pre-emergent herbicides in portions of the fuel breaks, or reduced invasive taxa germination. Hopefully this trend continues at Ohikilolo Lower.

Fewer MUs had increases in effort spent in 2012. The MUs with the greatest increases are, in order, Manuwai, Kahanahaiki, Kaala Army, Ekahanui, and Kaluaa and Waieli. In 2011, all effort in Manuwai was spent on fenceline clearing. Since the completion of the ERMUP efforts in Manuwai have dramatically increased, and include site preparation for rare taxa reintroductions. Efforts are expected to continue to increase in the coming year, as new weed control techniques facilitate large sweeps for alien canopy weeds. Kahanahaiki continues to be the MU where most weed control is performed. This year, work on the chipper project contributed to the high number of hours spent here, 691 of 997 hours spent. Volunteer efforts continue to be an important contribution to Kahanahaiki effort as well. Field crews targeted remote *H. gardnerianum* patches at Kaala Army; these were labor-intensive to treat, requiring more effort to cover a smaller area. Efforts at Ekahanui were expanded to include new reintroduction

sites and clear trails for the rat control grid. The increase in effort at Kaluaa and Waieli can be attributed in part to weed maintenance around the new snail enclosure.

Also noteworthy are increases in Waianae Kai Neraudia Mauka, Waimano, and Lihue. The fences around Waianae Kai Neraudia Mauka and Waimano were completed in the last year, triggering increased attention and time for weed control. Rare taxa reintroductions are scheduled for Waianae Kai and will require regular weed maintenance. This year, an ERMUP was written for Waimano. This native dominated MU requires little weed control; staff plan to front load efforts and sweep the entire MU in the coming year. The Lihue fence is still under construction; however, efforts in this MU have been higher than normal to take advantage of easy access to SBW. In January, Range construction is scheduled to be complete and access to Lihue will be limited once again. Despite this, staff hope to continue to conduct weed control around rare taxa locations in the coming year.

OANRP is concerned that overall WCA efforts declined from 2011 to 2012, and will push to increase efforts at all MUs in the coming year. In particular, staff will focus on, in no particular order: Manuwai, Opaeula Lower (fence and ERMUP completed in 2012), Pahole, Kaluaa and Waieli, Makaha, Ohikilolo, and Kapuna Upper. It is hoped that new tools, like Incision Point Application, will increase efficiency and allow staff to conduct canopy control over large areas. In the coming year, it is expected that efforts will decrease slightly at Kahanahaiki, as the chipper project is complete. Follow-up weed control will continue however, and control efforts will be expanded into the gulch portion of the MU to address concerns detailed in the Kahanahaiki Vegetation Monitoring section below. Staff hope to expand *Hedychium gardnerianum* control efforts in Kaala Army and Lihue through the use of Herbicide Ballistic Technology.

Contemplating challenging terrain in the *Cenchrus setaceus* infestation at MMR.

1.1.4 Vegetation Monitoring: Kahanahaiki Three-Year Analysis

This year, vegetation monitoring was conducted in the Kahanahaiki MU for the second time. The following write-up is intended to serve as a stand alone document; the inclusion of detailed background information, which may appear repetitive here, is intentional

Habitat Restoration at Kahanahaiki (Subunit 1) Management Unit Vegetation Monitoring

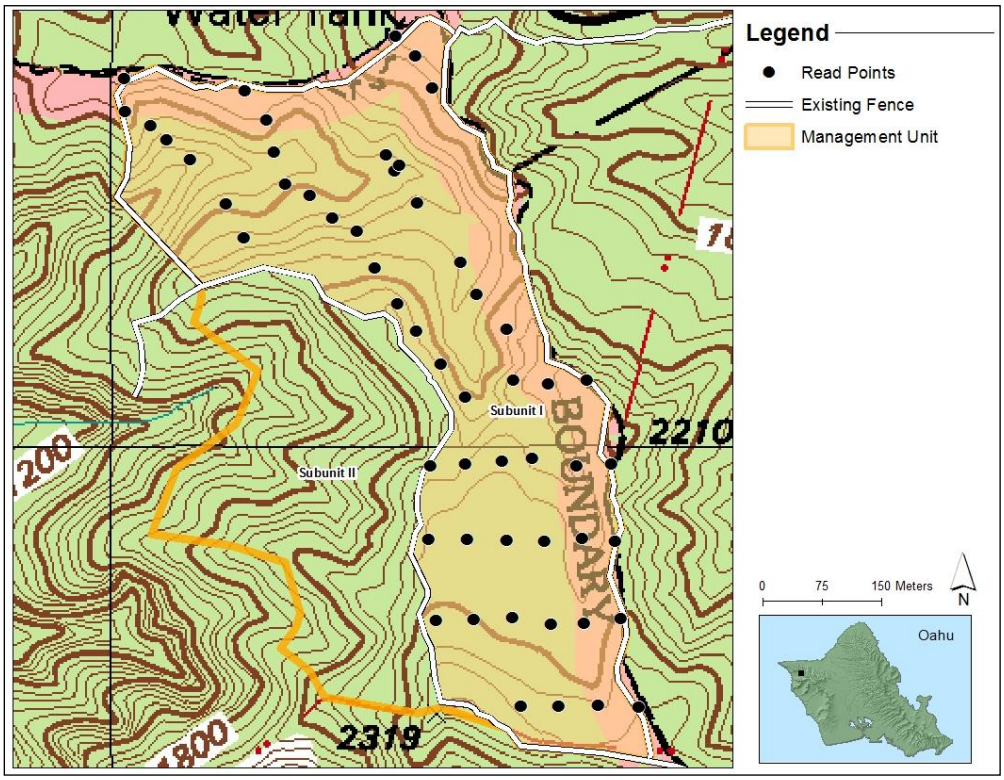
Brief History and Purpose

Oahu Army Natural Resources Program's (OANRP) primary management objective is to stabilize federally endangered species impacted by military training on the island of Oahu. Recognizing the importance of providing appropriate habitat for rare species stabilization, management units (MUs) were designated for recovery actions to occur in and monitoring objectives were created. Designation of MUs for stabilization were chosen by a team of expert biologists representing multiple organizations including the Army, USFWS, State of Hawaii, Honolulu Board of Water Supply, and The Nature Conservancy of Hawaii. The guidelines used for selection of these areas were based on the following criteria: 1) relatively high densities of in situ Population Units (PUs) of target taxa, 2) large areas of relatively intact native-dominated vegetation which would provide habitat for in situ PUs as well as for reintroduction sites, and 3) as far as possible, locations in areas accessible for management (Makua Implementation Plan 2003). To ensure the success of long-term protection of these MUs (required action in the MIP) monitoring goals were developed. The primary MU level vegetation monitoring goal was to reach and maintain 50% or less non-native percent cover in the canopy and understory. Two additional monitoring objectives recommended by the group were to assess change over time in both native and non-native plant geographic distribution and track change over time for native vegetation percent cover. To assess percent cover, ocular estimations of native and non-native percent cover were recorded for plots along belt-transects. Analyses for these goals are reported in Section 1 of this report. To track the geographical distribution of species found within the MU, frequency data was recorded. Analyses for this goal are reported in Section 2 of this report. This report assesses these MU level ecosystem restoration goals for the Kahanahaiki MU from 2009 to 2012.

Kahanahaiki Management Unit is part of the Makua Military Reservation, located in the Waianae Mountain Range, on the eastern border of Makua Valley. Since the MU was fenced in 1996, OANRP has spent considerable effort on habitat restoration. In 1998 it was declared ungulate free and by 1999 large-scale weed control had been implemented. Due to its accessibility, relatively intact ecosystem, and high number of rare species, Kahanahaiki has also been used for numerous weed control trials and served as a primary volunteer outreach site.

In the spring of 2009, baseline vegetation monitoring was collected for Kahanahaiki and in the spring of 2012 those plots were re-monitored and trend analysis was conducted. Since the vegetation monitoring protocol was designed to address multiple MU level management goals (as mentioned above), the following trend analysis was separated into sections. The goals, monitoring objectives, and statistical thresholds used for analysis came from the Makua Implementation Plan (2003).

Vegetation Monitoring Transects



Section 1: Percent Cover Vegetation Management Goal

Primary Management Objective:

- Assess if the percent cover for both the alien understory and canopy is 50% or less across the entire management unit (MIT 2003).
- If non-native species cover is not below the 50% threshold, determine if this value is decreasing significantly toward that goal based on repeated monitoring of the MU.

Secondary Management Objective:

- Assess if the percent cover for both the native understory and canopy is 50% or more across the entire management unit (MIT 2003).
- If native species percent cover is not met, determine if this value is increased significantly toward that goal based on repeated monitoring of the MU.

Sampling Objective:

- Be 90% confident of detecting a 10% change in both non-native and native understory vegetation in the understory and canopy.
- The acceptable level of making a Type 1 error (detecting a change that did not occur) is 10% and a Type 11 error (not detecting a change that did occur) is 20%.
- Minimum detected change between two samples being compared is 10% over the sampling period.

Vegetation Monitoring Protocol:

Refer to the monitoring section of the OANRPs 2008 Year End Report.

Analysis:

To determine if non-native and native vegetation met the primary MU level management goal in 2009 and 2012, percent cover values were calculated. The median statistic was used to describe percent cover for all variables since the distributions were non-normal. To assess percent cover change over time, the 2012 data was subtracted from the 2009 baseline data. As the sampled plots were permanent, a matched pairs design was used for analysis. A negative value indicated a decrease in percent cover, a positive value indicated an increase, and zero indicated no significant trend. The data was collected in ten percent interval ranges but for reporting purposes the average was calculated (e.g. 20-30% cover interval was reported as 25%).

Non-Native Percent Cover:

The non-native understory goal was met in 2009 and 2012. There was a median percent cover for both years was 25% and there were no significant changes in the percent cover over time (Wilcoxon = 345.0, p = 0.422). The non-native canopy cover goal was met in 2009, but not in 2012. The median percent non-native canopy cover was 45% in 2009 and 55% in 2012. There was an increase in non-native cover as indicated by the significant positive value detected (W = 549.0, p = 0.010; Figure 1).

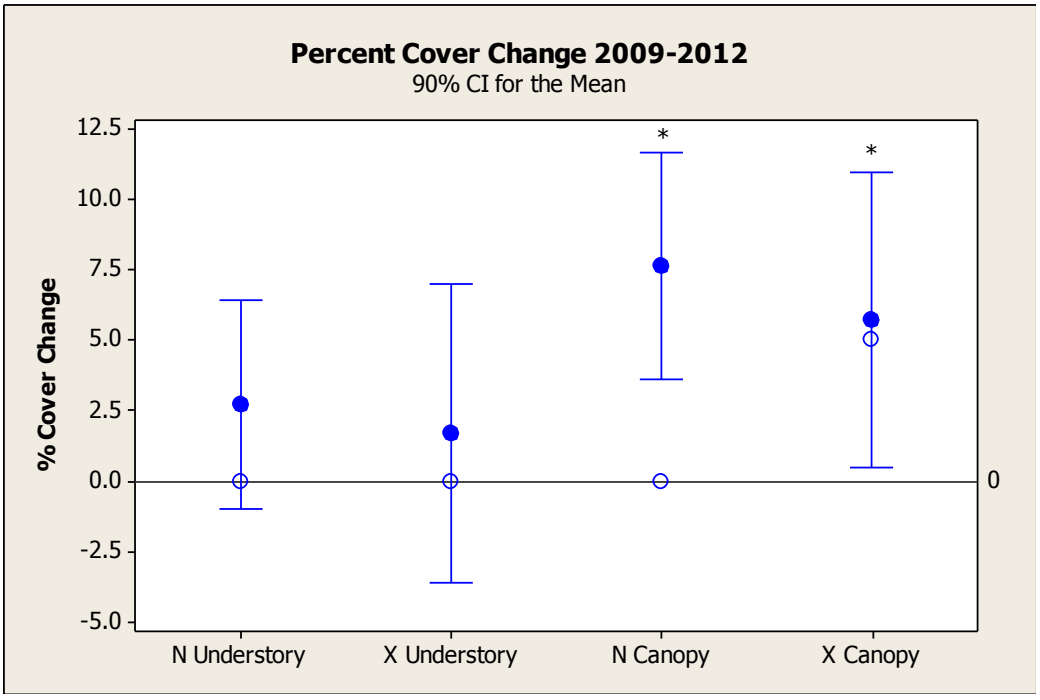


Figure: The open circles represts the median and the solid circles represent the mean. N = Native and X = Non-Native. Percent cover change over time (at p<0.10) are represented by an asterisks.

Native Percent Cover:

The median percent native understory was 15% in both years and the percent cover change over time was not significant (W=345.0, p = 0.422). The median percent canopy cover was 15% in 2009 and was 25% in 2012. There was an increase in native canopy cover as indicated by the significant positive value detected (W = 595.5, p = 0.004) (refer to Figure 1).

In order to better understand the increase of non-native canopy cover from 2009 to 2012, further analysis was warranted. Because the MU has a patchy distribution of native canopy cover, it was prudent to investigate whether there were any within MU differences in percent cover trends over time for native dominated areas versus non-native dominated areas. Therefore, the 2009 dataset was divided into two groups based on if the plots were more than 50% non-native cover or less than 50% non-native cover. 50% non-native vegetation cover was used as the division point because it represented the ultimate MU level goal. The sample sizes for these two groups were 25 and 28 plots respectively.

Between 2009 and 2012, there was an increase in non-native canopy in the non-native dominated areas as indicated by a significant positive value (W = 135.5, p = 0.007) (refer to Figure 2). In the native dominated areas, there was an increase in native canopy as detected by a significant positive value (W = 140.5, p = 0.018) (refer to Figure 3).

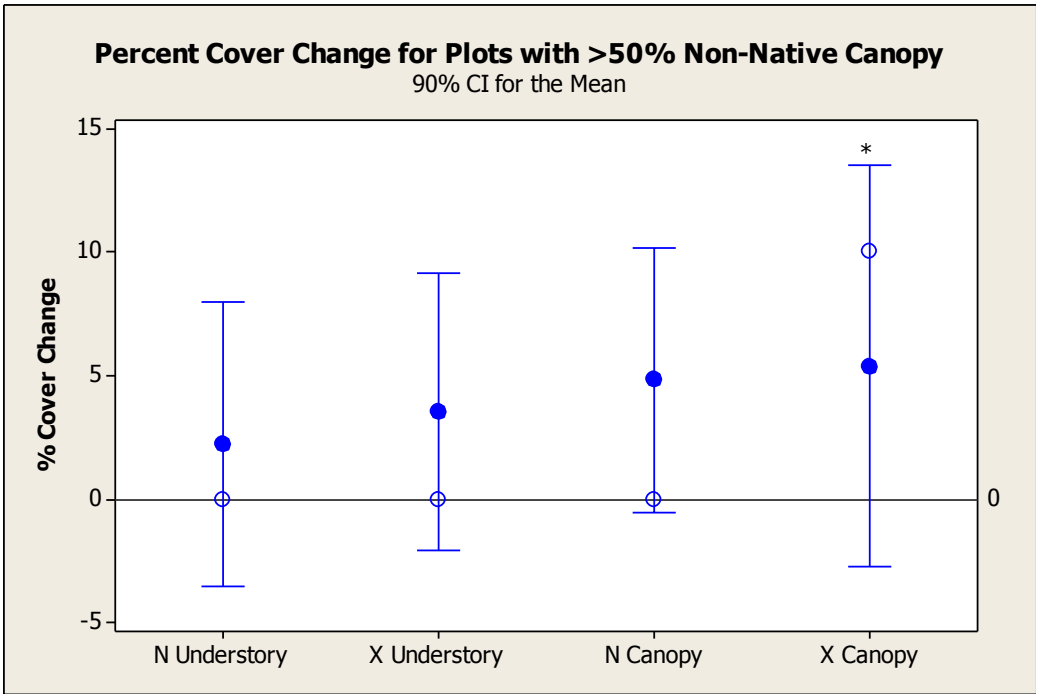


Figure: The open circles represts the median and the closed circles represent the mean. N = Native and X = Non-Native. Percent cover change over time (at p<0.10) are represented by an asterisks.

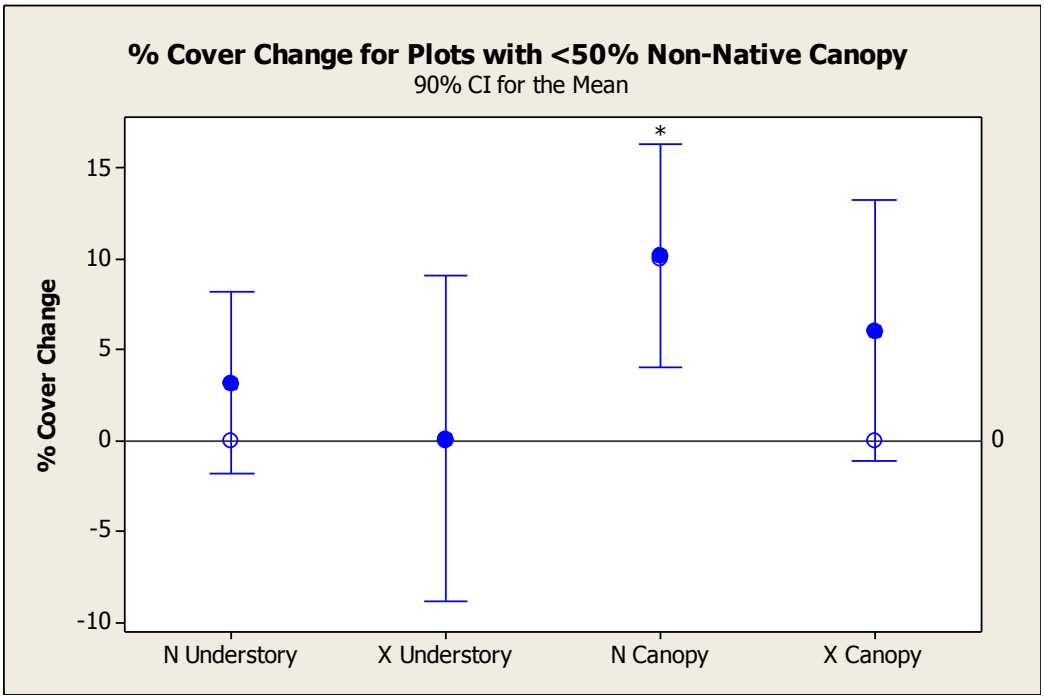
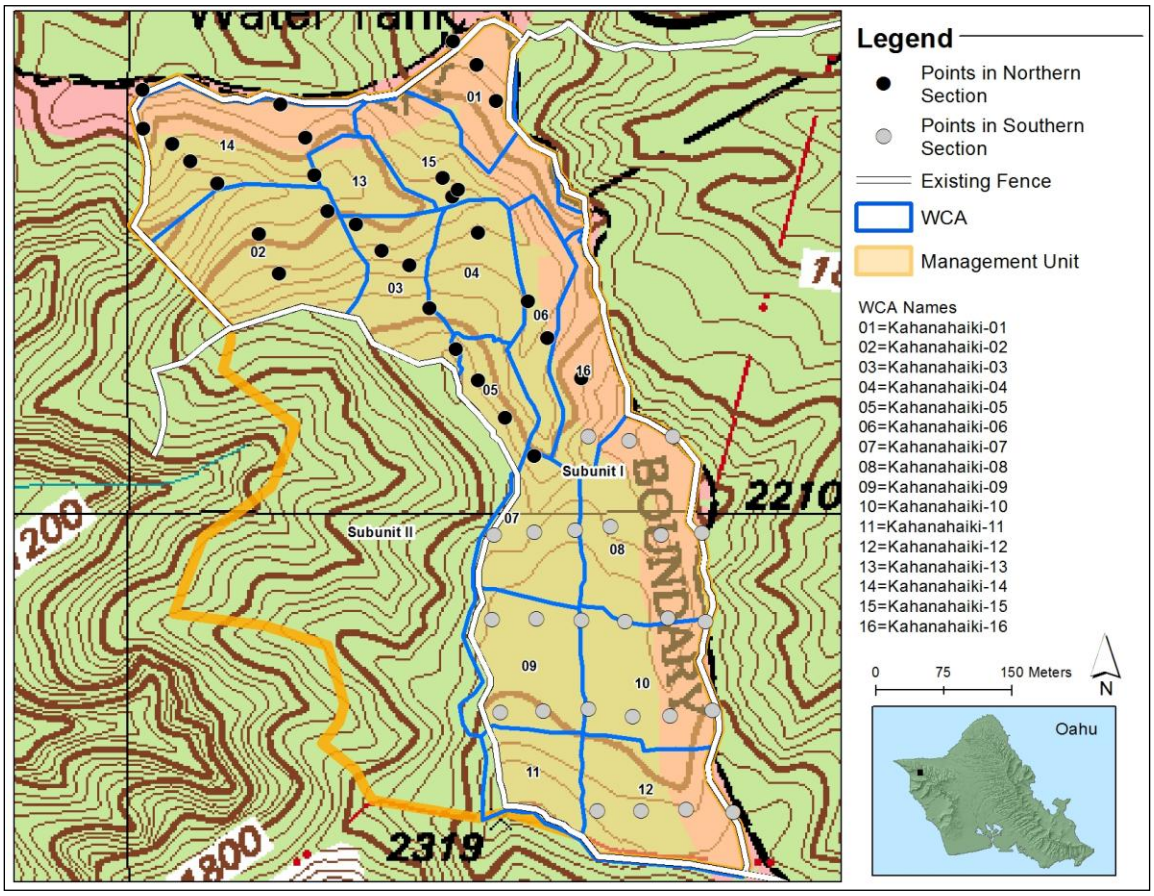


Figure: The open circles represts the median and the solid circles represent the mean. N = Native and X = Non-Native. Percent cover change over time (at p<0.10) are represented by an asterisks.

Management Strategy Analysis:

Percent cover trends indicated that canopy cover weed control efforts need to increase in order to obtain the MU level non-native canopy cover goal. Additional analysis indicated that the native dominated areas of the MU were sustaining goal but the non-native dominated section was getting further away from goal. Therefore, the most effective way to reverse the negative non-native cover trend would be to continue existing management in the native dominated areas while increasing weed control in some of the more degraded areas. Since large scale weed control strategy and planned actions are based on weed control areas (WCAs), the most effective way of reversing the negative trend on an MU scale would be to increase weed control planned actions in degraded WCAs. For this reason, further analysis was done to identify the WCAs that had the highest and lowest levels of non-native cover (refer to the below map). It was determined that the northern WCAs were significantly non-native dominated (W = 889.5, p = 0.0278) than the southern WCAs (refer to the map below and Figure 4). The 2009 median non-native percent cover for the northern WCAs was 65% and 35% for the southern WCAs. The sample sizes for these two groups were 28 and 25 plots respectively. The percent cover change over time for those two areas mimics the trend detected within the non-native and native dominated areas described above. In the northern WCAs there was an increase in non-native canopy (W =177.0, p = 0.008). In the southern WCAs there was an increase in native cover (W = 227.0, p = 0.007) (refer to figure 5).

Plot Locations in the Northern and Southern Sections



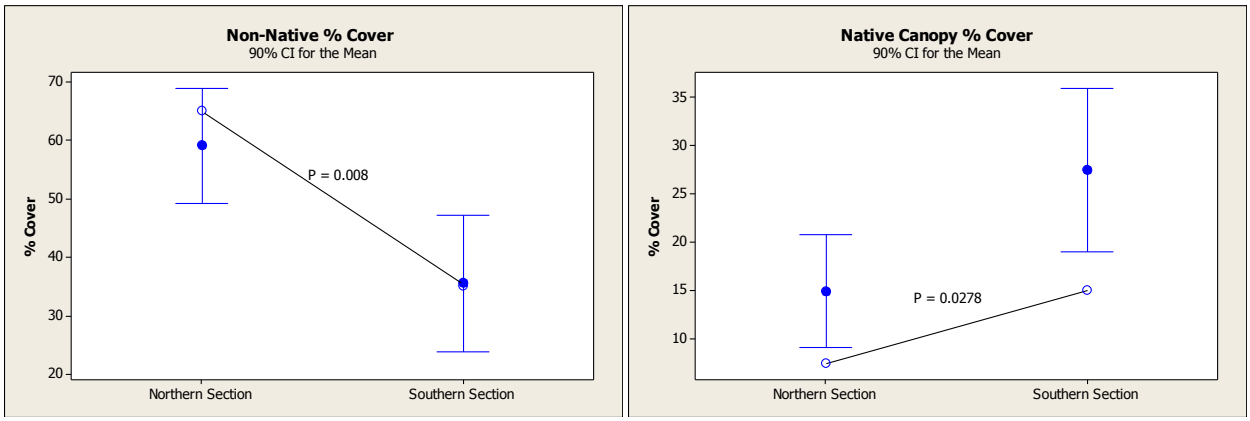


Figure: The open circles represent the median and the solid circles represent the mean. The median percent cover between the northern section and southern section of the MU were significantly different (at $p<0.10$).

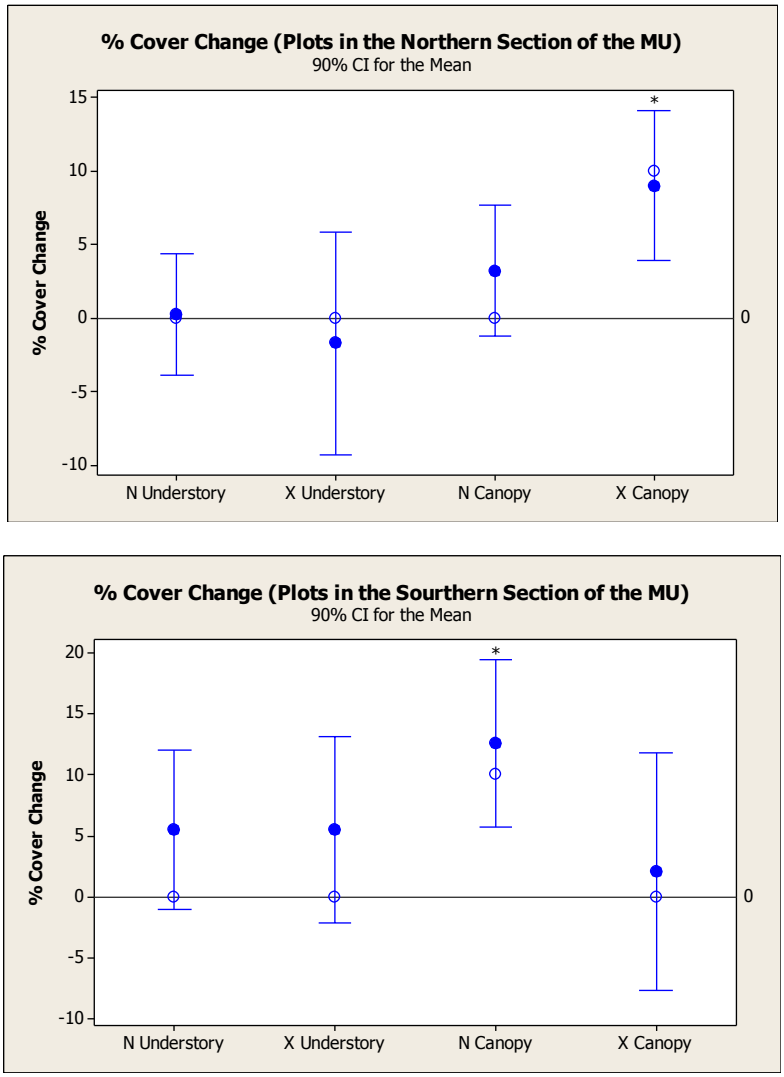


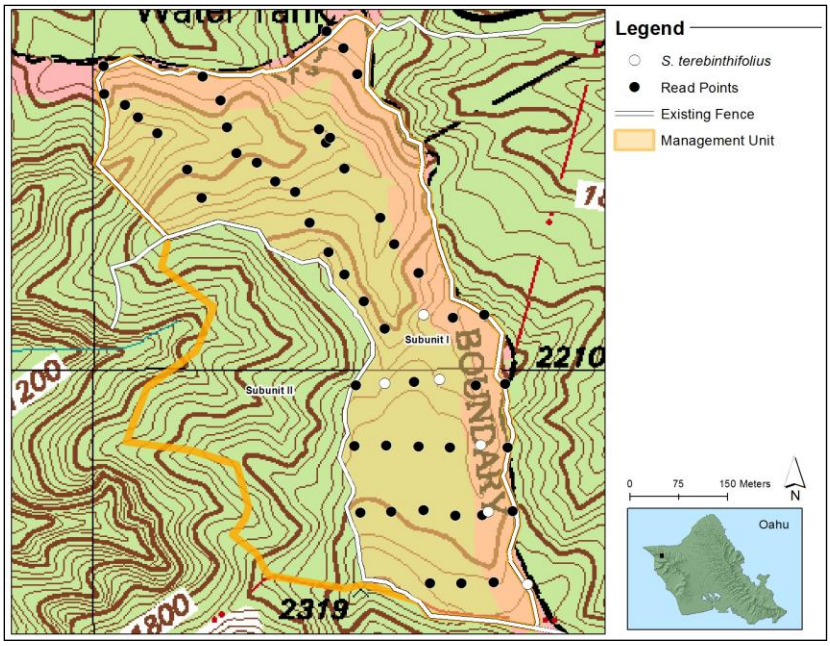
Figure: The open circles reprists the median and the solid circles represent the mean. Percent cover change over time (at p<0.10) are represented by an asterisks.

In order to identify what species significantly changed in percent cover over time, additional analysis was conducted for common non-native and native species in the northern and southern areas. In the northern section, the only taxon that significantly increased in percent cover over the three-year period was *P. cattleianum* (W = 49.0, p = 0.03).

In the southern section, *S. terebinthifolius* was the only non-native taxon that significantly changed in percent cover over time. From 2009 to 2012, a significant increase in the percent cover was detected (W = 10.0, p = 0.045). Quantitative analysis using percent cover data and mapped GPS coordinates indicated that *S. terebinthifolius* increased in plots located in the gulch bottom and ridge crest (refer to the *S. terebinthifolius* map below). For native species, *Acacia koa* was the only taxon that significantly changed in percent cover over time. Analysis detected a significant positive value (W = 97.5, p = 0.005), indicating an increase in percent cover. Quantitative analysis using percent cover data and mapped GPS coordinates for each plot showed an increase in percent cover in sections of the MU where aggressive *P. cattleianum* control had occurred (refer to the *A. koa* map below). This control occurred in two main locations: along the eastern fence line where canopy cover weed control had taken place in 2009 and in a

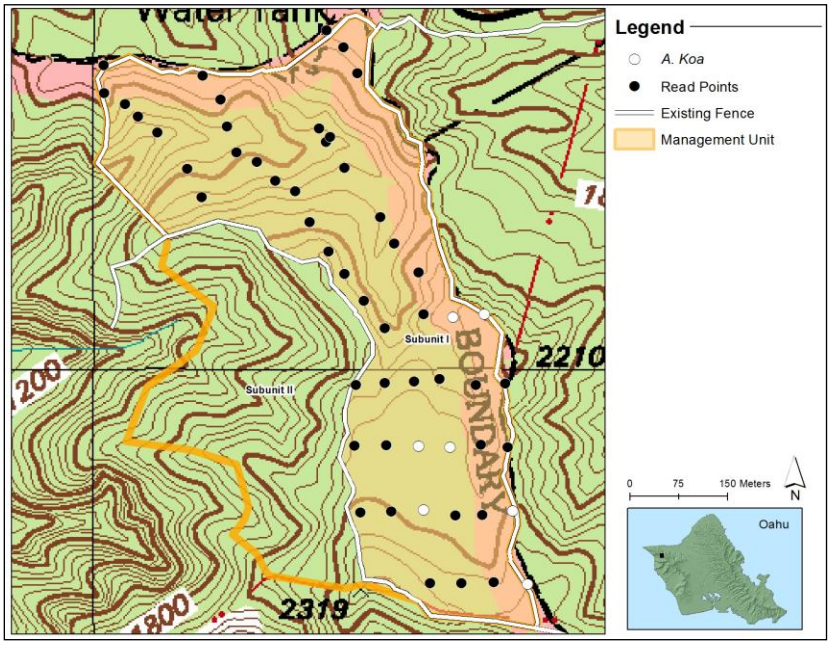
section where there was complete removal of *P. cattleianum* in 2009 known as the 'chipper site'. During past weed control trials, it was documented that *A. koa* responded favorably to light gaps and can reach 2 to 3 meters tall within three years (Chipper Site Monitoring, OANRP unpublished data). This evidence supports the qualitative observation that *A. koa* increased the most in sections of the MU were there was aggressive weed control.

Plots that increased in S. terebinthifolius % cover in the Southern Section



White dots indicate an increase in percent cover.

Plots that increase in A. Koa % cover in the Southern Section



White dots represent an increase in percent cover.

Section 2: Frequency of Occurrence Goal

Management Objective:

- Assess the spatial distribution and frequency for both native and non-native species.
- Provide an updated priority weed species list for the Kahanahaiki MU.
- Identify any non-native vegetation that was not previously considered to be a threat on an MU scale.

Sampling Objective:

- Detect expansion or contraction in geographical distribution of native and non-native species on an MU scale.

Vegetation Monitoring Protocol:

- Refer to the monitoring section in the 2008 annual status report.

Analysis:

To determine if there had been a significant change in the geographical distribution over time for species found in Kahanahaiki, frequency of occurrence data was recorded. To test for significant difference from 2009 to 2012, the total number of plots that contained each taxon (out of the total number of plots sampled) was calculated for each year. Significant differences over time were detected using a Chi-square test. The most common non-native species in the MU were *Psidium cattleianum* and *Schinus terebinthifolius*. In 2012, *P. cattleianum* occurred in 74% of the plots and *S. terebinthifolius* occurred in 66% of the plots. The next most common non-native was *Aleurites moluccana*, which occurred in 13% of the plots. Both *P. cattleianum* and *S. terebinthifolius* have been extremely successful at invading Kahanahaiki and tend to create monotypic stands over time (qualitative field observation), if not controlled. For this reason, it is particularly important to control these species in order to reach the primary non-native canopy cover goal on an MU scale. From 2009 to 2012, neither of these species significantly expanded in geographical range (*P. cattleianum* Chi-Square = 0.204, p = 0.65, *S. terebinthifolius* Chi-Square = 0.04, p = 0.836). It is important to note that the percent cover for *P. cattleianum* did, however, increase in the northern section of the MU. One explanation for these results is that *P. cattleianum* did not expand across the MU but the density increased within sections of the MU where it already occurred in 2009.

There were several species detected in 2009 that were targeted for large scale control due to their distribution, density, and invasive characteristics. The main target from 2009-2012 was *Grevillea robusta*. The weed control strategy for *G. robusta* was large scale weed sweeps, targeting mature plants. Within the three year period there was a significant difference in the distribution of mature *G. robusta* (Chi-Square value = 4.16, p = 0.04), with a decrease in the frequency by 60%. The only non-native species that significantly increased in distribution were *Aleurites moluccana* (Chi-Square value = 2.83, p = 0.09) and *Passiflora edulis* (Chi-Square value = 4.16, p = 0.04, refer to the figure 6).

The only significant difference detected in native taxa was a decrease in the distribution of *Melicope oahuensis* (Chi-Square = 4.16, p = 0.04).

Strata	Species	Occurrence in 2009	Occurrence in 2012	Chi-square value	P Value	Change
Non-Native						
Alien Understory	*Aleurites moluccana*	1	5	2.83	0.09	Increase
Alien Canopy	*Grevillea robusta*	10	4	2.96	0.09	Decrease
Alien Understory	*Passiflora edulis*	0	4	4.16	0.04	Increase
Native						
Native Understory	*Melicope oahuensis*	4	0	4.16	0.04	Decrease

Figure: Frequency of occurrence for species that significantly change in their geographical range between 2009 and 2012. The sample size was 53 plots. Occurrence refers to the number of plots the species were present in.

Species Richness Analysis and Vegetation Monitoring Checklist:

A species checklist of vascular plants found within the Kahanahaiki MU was updated using the 2012 monitoring datasets (refer to the Species List and Frequency tables below). Within the canopy, a total of 37 plant species were recorded. Of all the species that were documented in the canopy, 28 (76%) were native and 9 (24%) non-native. In the understory a total of 99 species were recorded; 56 (57%) were native and 43 (43%) were non-native. For a complete list refer to the vegetation monitoring checklist at the end of this document. In addition to updating the species list, analysis was conducted to determine if there had been a change in species richness between 2009 and 2012. Within the three-year time period, there was no significant difference detected for any of the strata.

Management recommendations:

The monitoring results indicate that the most effective way of achieving MU level non-native canopy cover goals is to continue with the current management strategy for the northern section of the MU. In addition, WCA level weed control efforts in the southern section of the MU should be increased. In particular, it is critical to target *P. cattleianum.* Additionally, *P. edulis* should be aggressively targeted during WCA level weed sweeps in order to prevent further invasion. For *A. moluccana*, frequency analysis indicated an increase in immature trees. After mapping these plot locations and comparing notes from 2009, it became clear that all of the plots, except for one, already had established *A. moluccana* in the canopy in 2009. The detected "increase" actually reflected recruitment in previously established stands of *A. moluccana*. For *G. robusta*, analysis indicated that the weed control strategy used over the last 3 years successfully reduced the geographic distribution of this species and therefore implementation of this strategy should continue. For the southern section of the MU, analysis indicated the overall weed control strategy was sufficient at maintaining MU goals. It also indicated that there was a significant increase for native canopy cover with *A. koa* being the species with a significant increase. The only recommendations for changes in weed control strategy for this area would be for *S. terebinthifolius* and *P. edulis*. Since there was a significant increase in the percent cover of *S. terebinthifolius,* control of this species should be increased. Based on the qualitative observation from the distribution maps, priority control should target gulch bottoms and ridge crests.

2012 Species Check Lists:

Non-Native Canopy	
Species Name	**Percent Occurrence (out of 53 plots)**
Psidium cattleianum	74%
Schinus terebinthifolius	66%
Aleurites moluccana	13%
Cordyline fruticosa	9%
Grevillea robusta	8%
Syzygium cumini	8%
Clidemia hirta	2%
Passiflora edulis	2%
Psidium guajava	2%

Non-Native Understory	
Species Name	**Percent Occurrence (out of 53 plots)**
Psidium cattleianum	96%
Schinus terebinthifolius	72%
Clidemia hirta	70%
Blechnum appendiculatum	38%
Lantana camara	36%
Melinis minutiflora	28%
Oplismenus hirtellus	25%
Paspalum conjugatum	23%
Stachytarpheta dichotoma	23%
Conyza bonariensis	21%
Christella parasitica	19%
Ageratina riparia	17%
Phlebodium aureum	13%
Rubus rosifolius	13%
Grevillea robusta	11%
Oxalis corniculata	11%
Aleurites moluccana	9%
Passiflora suberosa	9%
Syzygium cumini	9%
Christella dentata	8%
Cordyline fruticosa	8%
Passiflora edulis	8%
Emilia sonchifolia	6%
Montanoa hibiscifolia	6%
Nephrolepis multiflora	6%
Psidium guajava	6%
Adiatum hispidulum	4%
Ageratum conyzoides	4%
Andropogon virginicus	4%
Buddleia asiatica	4%
Chamaecrista nictitans	4%
Crassocephalum crepidoides	4%
Deparia petersenii	4%
Acacia mearnsii	2%
Casuarina equisitifolia	2%
Desmodium incanum	2%
Leucaena leucocephala	2%

Non-Native Understory	
Species Name	**Percent Occurrence (out of 53 plots)**
Melinis repens	2%
Panicum repens	2%
Pluchea carolinensis	2%
Rivina humilis	2%
Spathodea campanulata	2%
Youngia japonica	2%

Native Canopy	
Species Name	**Percent Occurrence (out of 53 plots)**
Psydrax odorata	70%
Alyxia oliviformis	42%
Acacia koa	36%
Metrosideros polymorpha	32%
Coprosma foliosa	23%
Diospyros sandwicensis	13%
Psychotria mariniana	13%
Hedyotis terminalis	11%
Nestegis sandwicensis	9%
Antidesma platyphyllum	8%
Pouteria sandwicensis	8%
Cocculus orbiculatus	6%
Diospyros hillebrandii	6%
Cibotium chamissoi	4%
Dodonaea viscosa	4%
Hibiscus arnottianus subsp. arnottianus	4%
Lepisorus thungbergianus	4%
Pisonia sandwicensis	4%
Pittosporum glabrum	4%
Psychotria hathewayi	4%
Santalum freycinetianum var. freycinetianum	4%
Xylosma hawaiiense	4%
Bobea brevipes	2%
Charpentiera tomentosa	2%
Leptecophylla tameiameiae	2%
Pipturis albidus	2%
Sapindus oahuensis	2%
Streblus pendulinus	2%

Native Understory	
Species Name	**Percent Occurrence (out of 53 plots)**
Psydrax odorata	79%
Alyxia oliviformis	66%
Nephrolepis exaltata subsp. hawaiiensis	51%
Cocculus orbiculatus	43%
Coprosma foliosa	40%
Doodia kunthiana	40%
Microlepia strigosa	36%
Hedyotis terminalis	34%
Metrosideros polymorpha	34%
Acacia koa	32%
Dianella sandwicensis	32%

Native Understory	
Species Name	**Percent Occurrence (out of 53 plots)**
Bidens torta	30%
Carex meyenii	30%
Diospyros sandwicensis	23%
Wikstroemia oahuensis var. oahuensis	21%
Sphenomeris chinensis	19%
Antidesma platyphyllum	17%
Carex wahuensis	15%
Lepisorus thungbergianus	15%
Psychotria mariniana	15%
Asplenium kaulfussii	13%
Cibotium chamissoi	13%
Cyperus hypochlorus var. hypochlorus	11%
Scaevola gaudichaudiana	11%
Nestegis sandwicensis	9%
Pisonia sandwicensis	9%
Psilotum nudum	9%
Chamaesyce multiformis	8%
Dodonaea viscosa	8%
Hibiscus arnottianus subsp. arnottianus	8%
Leptecophylla tameiameiae	8%
Pouteria sandwicensis	8%
Pteridium aquilinum	8%
Dicranopteris linearis	6%
Diospyros hillebrandii	6%
Psychotria hathewayi	6%
Xylosma hawaiiense	6%
Asplenium horridum var. horridum	4%
Cibotium glaucum	4%
Elaphoglossum aemulum	4%
Myrsine lessertiana	4%
Bobea elatior	2%
Cenchrus agrimonioides var. agrimonioides	2%
Charpentiera tomentosa	2%
Delissea waianaeensis	2%
Gahnia beecheyi	2%
Korthalsella cylindrica	2%
Myrsine lanaiensis	2%
Peperomia tetraphylla	2%
Pipturis albidus	2%
Pisonia brunoniana	2%
Pisonia umbellifera	2%
Pittosporum glabrum	2%
Rumex albescens	2%
Santalum freycinetianum var. freycinetianum	2%
Sapindus oahuensis	2%

1.1.5 Weed Survey Updates: New Finds

Oahu Early Detection (OED) and Bishop Museum continue to provide species identification services to OANRP. This support facilitates the prompt identification of unknown species, and aids in determining whether control work is necessary. Over the past year, OANRP has submitted 57 samples for identification. Appendix 1.2, *Identification of invasive plant species on U.S. Army lands, Base Year October 2011 to July 2012*, summarizes the results of these submissions, which include a new state, island, and adventive records. OED and Bishop Museum staff are in the process of publishing some of these new records in the Bishop Museum Occasional Papers.

The table below summarizes the results of surveys and incidental observations over the past year, not including those noted in Appendix 1.2 . When evaluating a new discovery, staff consider distribution and invasive potential to determine whether control is warranted. The Hawaii Weed Risk Assessment (WRA) provides a valuable indicator of invasive potential.

Summary of Alien Taxa Survey Results

Survey Type	Survey Code	Significant Alien Taxa Seen	Discussion
Camp/ Other	none	none	No significant weeds found at campsites
Weed Transect	WT-Kaluaa-01*, Kaluaa Access Trail	*Dicliptera chinensis*, *Schefflera actinophylla*	Both taxa pose a threat to the MU, but are not incipient. They will be controlled in the course of regular trail maintenance to prevent them from moving into the exclosure.
Weed Transect	WT-Kaluaa-02*, Kaluaa Gulch Trail	*Ardesia elliptica*, *Heliocarpus popayensis*, *Mallotus philippensis*, *Schefflera actinophylla*	All are important targets in the exclosure, and should be controlled in the course of regular maintenance work. None are incipient.
Weed Transect	WT-Kaluaa-03*, Hapapa Access Trail	*Schefflera actinophylla*	This is an important target and will be controlled in the course of regular maintenance work. It is not incipient.
Weed Transect	WT-Kaala-01, Kaala Boardwalk and Transect	*Begonia foliosa*, *Crocosmia x crocosmiifolia*, *Hedychium gardnerianum*, *Sphagnum palustre*	This survey hadn't been conducted in several years. Control is already being conducted for all these species except *B. foliosa*, which is somewhat well-established.
Weed Transect	WT-Kapuna-01, Mokuleia Trail	*Angiopteris evecta*, *Falcataria moluccana*, *Schefflera actinophylla*, *Pinus luchuensis*	All of these species are uncommon in the MU and will be controlled when seen. More of the Mokuleia trail was surveyed this year, which accounts for some of these new finds.
Landing Zone	LZ-KLOA-017, Puu 1652	*Leptospermum scoparium*	One small plant was controlled on the LZ. Since this area is west of a known infestation of *L. scoparium* on the Poamoho trail, it is likely that wind-dispersed plants may continue to be found in the future.
Landing Zone	LZ-KLOA-21, Elephant's Foot; LZ-KLOA-33, Red; LZ-KLOA-35, Puu Kapu	*Rhyncospora caduca*	This sedge was found on all three of these LZs for the first time. While it is possible it was not accurately identified in previous surveys, it also is possible that it was introduced via training, since *R. caduca* is present across the SBE LZs. It thrives in open areas. Given that these LZs are not close to any rare resources, no control will be conducted.

Survey Type	Survey Code	Significant Alien Taxa Seen	Discussion
Landing Zone	LZ-SBE-170, Ku Tree; LZ-SBE-173, Upper 36	*Crocosmia x crocosmiifolia*	While this taxon can be invasive in native forest and is controlled by OANRP elsewhere, it is a common garden plant, and is not a high priority for control in the alien forests of SBE.
Road	RS-KTA-01, Charlie 1 Gate to Foxtrot Gate	*Datura stromonium*, *Solanum torvum*	Although both weeds are widespread, they are not common in KTA. Staff should continue to note locations of these species in KTA in the future, in particular *S. torvum*.
Road	RS-KTA-06, Kaunala Road	*Pinus luchuensis*	A forestry planting, this pine has naturalized in other locations. No control is recommended at the current time, but any other plants found should be mapped and monitored.
Road	RS-Kuaokala-01, Kuaokala Road	*Nephrolepis brownii*	OED recently identified this sample as *N. brownii*, which is widespread across Oahu. However, it has characteristics similar to *N. biserrata*. No control will be conducted now, but if taxonomic experts indicate at a later date that it is the uncommon *N. biserrata*, control options will be evaluated.
Road	RS-LKN-01, Lower Kaala NAR Road	*Callitris* spp.	Some *Callitris* taxa are known to naturalize and disperse widely. It is likely this species either dispersed from plantings on SBE or SBW, or was introduced to the area via forestry plantings. Control will only be conducted in MUs.
Road	RS-Palikea-01, Palehua Road	*Coffea arabica*, *Heliocarpus popayanensis*	If these taxa are found in or directly around the MU, they will be controlled.
Road	RS-SBE-01, East Range Roads	*Angiopteris evecta*, *Callitris columellaris*, *Cenchrus setaceus*, *Cryptomeria japonica*, *Cupressus lusitanica*, *Dovyalis hebecarpa*, *Heterotheca grandiflora*, *Hedychium* spp., *Polyscias nodosa*, *Pyrostegia venusta*, *Schizachyrium condensatum*, *Sphaeropteris cooperi*, *Terminalis myriocarpa*	SBE is located directly adjacent to residential Wahiawa, and has always been home to a variety of ornamental species not typically seen in other training areas. This year, staff conducted an extended survey at SBE, monitoring every drivable road/trail. A number of unusual species were found. Control is being conducted on *C. setaceus* and *S. condensatum* (discussed below), and also *H. grandiflora*. This aster was found in two separate sand piles and requires little effort to control. It typically prefers higher elevations, but apparently thrives here as it was seen flowering. All other species will be monitored annually, and controlled only if they move into native forest.
Road	RS-SBS-01, South Range Roads	*Sphaeropteris cooperi*	Little management is done in SBS, which is heavily used for training and dominated by alien forest. No control is currently planned for *S. cooperi*.
Road	RS-SBW-01, South Firebreak	*Callitris endlicheri*	This species has been seen the road survey before, but was only recently identified to species level. It is a candidate for control within the Lihue fence.
Road	RS-SBW-03, North Firebreak	*Albizia lebbeck*	While this taxon does have some invasive potential, it does not appear to be naturalizing at this time. No control is planned.
Road	RS-WaiKai-01, Waianae Kai Access Road	*Pimenta dioica*	This tree can be habitat-altering. Its distribution in Waianae Kai is unknown, but the forest there is very degraded. If seen in an MU, control will be conducted.

Survey Type	Survey Code	Significant Alien Taxa Seen	Discussion
Incidental	SBE	*Alstonia macrophylla*	Several trees were found at different sites around SBE. Although this taxon does have a WRA of 13, it is widely scattered, sparse, and no immature were observed. Staff will continue to monitor and control it incidentally during other field work.
Incidental	SBW	*Ilex cassine*	One large plant was found. This taxon was seen once before in SBW. It will be controlled wherever seen in the Lihue exclosure.
Incidental	SBW	*Solanum capsicoides*	One plant was found and removed within the Lihue fence. This uncommon species is controlled in nearby Kaluaa. It will be targeted whenever seen.
Incidental	Kaluaa and Waieli	*Morella faya*	One large tree was seen near Puu Hapapa. This is one of the most northerly sites known for *M. faya*. It will be controlled as an incipient.

* Three new weed transects were established in the Kaluaa and Waieli MU this year. All of them run along major access trails used by staff.

Alien Taxa Identified by Bishop Museum and OED

Albizia adianthifolia, new State record

Brachiaria decumbens, new island record

Sisyrinchium exile, new island record

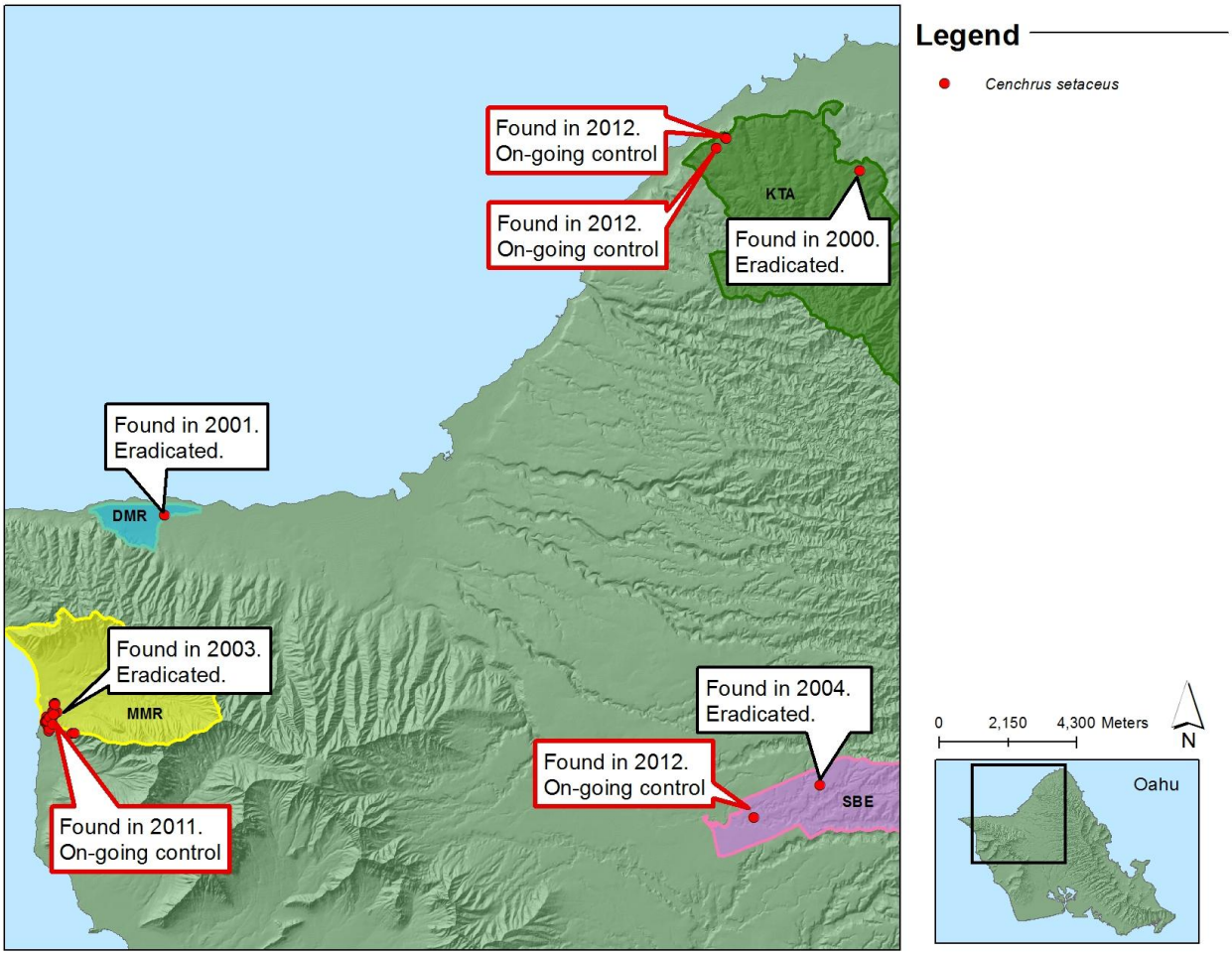
Entolasia marginata, new island record

1.1.6 Invasive Species Updates

<u>*Cenchrus setaceus*, Fountain Grass</u>

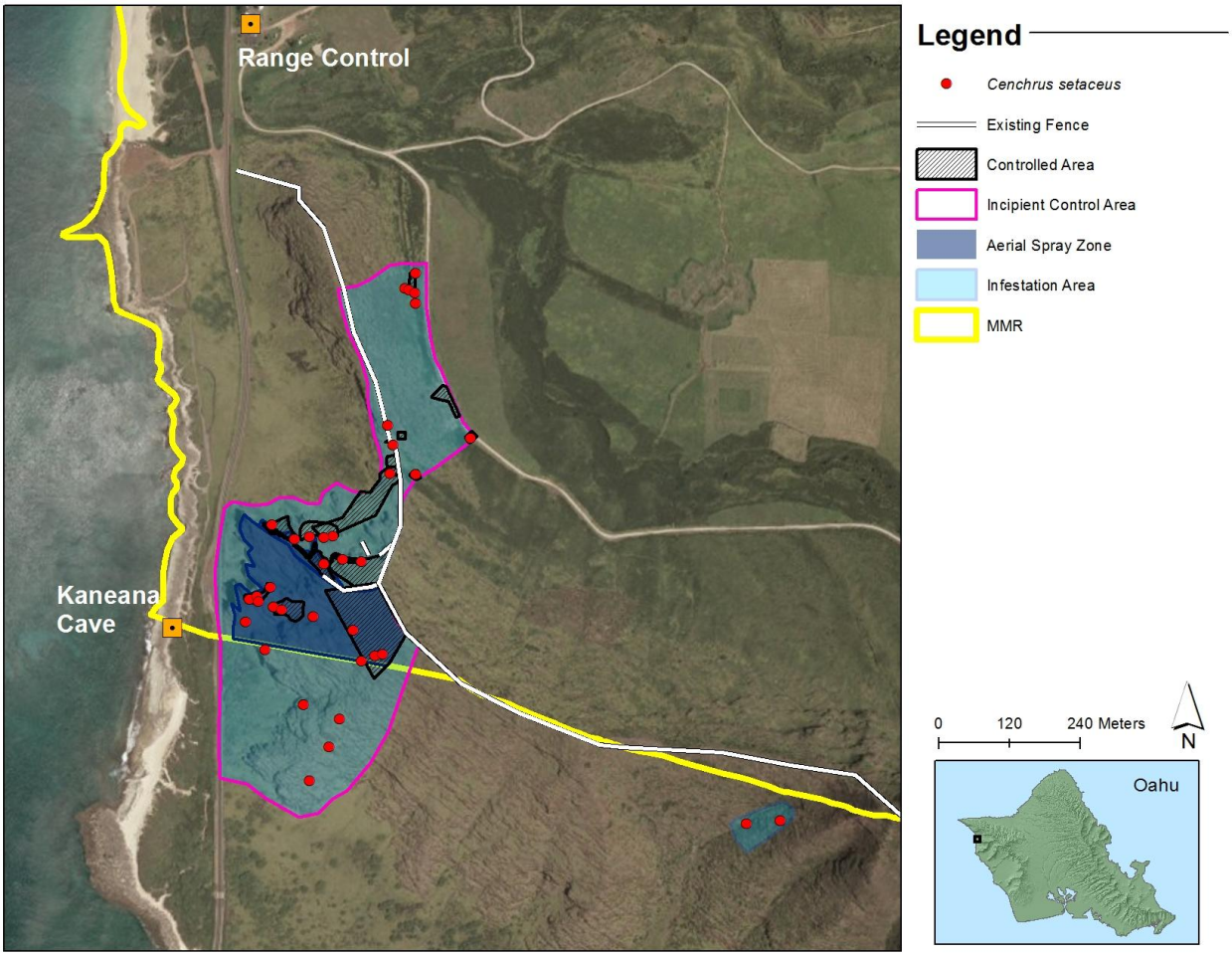
- In this reporting year, staff identified four new *C. setaceus* sites: two in KTA, one in SBE, and one in MMR, see map below. The boxes outlined in red indicate sites found this year, with control ongoing, while the black outlined boxes note sites found in previous years and now considered eradicated.
- *C. setaceus* is a state listed Noxious Weed and received a WRA 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.

C. setaceus *Sites on Army Training Ranges*



- **KTA**: Both *C. setaceus* locations were found during surveys for *Chromolaena odorata*, discussed below. Given that this area is heavily used for both military training and recreational motocross, the source of the *C. setaceus* is difficult to pinpoint. However, *C. setaceus* is widespread at PTA, and dispersal via training is possible. Both sites are relatively small, with 80 plants at one site and 125 at the other. Treatment is on-going.
- **SBE**: Twelve plants have been controlled at one location, next to a major road. Training is the most likely source for this small site.
- **MMR**:
    - Staff discovered this infestation in November 2011, during a routine check of the Ohikilolo fence. Most of the plants found were located on the makai- and Keaau-facing slopes of Ohikilolo ridge, on the edge of MMR (see map). Much of this area is very steep and rocky, punctuated by cliffs, although plants have also been found on the mauka side of Ohikilolo, in areas with easily traversable terrain.

C. setaceus Control Efforts at MMR



    - OANRP partnered with Oahu Invasive Species Committee (OISC) to develop a control strategy for this infestation. Joint surveys conducted early in 2012 determined that the infestation is limited to a 19.83 ha core and a 0.4 ha outlier. OISC is conducting control and surveys on private land south of MMR, including the outlier. OARNP is managing the MMR portion of the infestation, including the core.

- OANRP has used a combination of ground-based spraying, aerial spraying, and Herbicide Ballistic Technology (HBT) to treat plants. Areas where HBT and aerial sprays are critical are noted on the map above. One aerial spray of the cliff-dwelling plants was conducted in May, and additional sprays are planned in the coming rainy season. *C. setaceus* does not respond to herbicide treatment during dry periods; perfecting the timing of sprays will be a challenge in the coming year. Although the map above indicates that little of the infestation area has been swept, this does not take into account intial surveys. Most plants are clustered in the aerial spray zone, with widely scattered plants found through the rest of the infestation area.

Staff find the first *C. setaceus* in November

Aerial spray rig


Aerial spraying on the cliffs of Ohikilolo Ridge. The blue dye of the herbicide mix is visible in both pictures. On the left, the spray ball is directly in a patch of *C. setaceus*, visible as distinct tufts.

- To date, OANRP has spent 184.5 hours on control, at a cost of $5,107. This does not include OISC's time.

- Several Gigapan photopoints were installed to assist in surveys and tracking the success of control efforts. Gigapan is a robotic unit that captures high resolution panoramas. To capture the images, a camera is mounted onto the robot, which in turn is mounted on a tripod, and the desired panoramic boundaries are manually programed. Then the robot automatically captures a series of images in a systematic fashion. The total number of images needed for the panorama depends on the desired resolution (the more zoomed in the camera is the more pictures are required). Once the images have been captured they are stitched together using post processing Gigapan software. All the photopoints are located on the makai side of Farrington Highway, and look directly at the steepest portion of the infestation. These photopoints have not been analyzed yet. The photos below demonstrate the power and resolution of the Gigapan images.

Gigapan Views of C. setaceus at MMR

Above: Complete Gigapan photopoint of the *C. setaceus* on the makai-facing slope of Ohikilolo ridge. The red circle at the top of the photo indicates the location of the zoomed in view, below.
Below: Two large *C. setaceus* plants are distinctly visible in the zoomed-in view, despite some blurriness.

Chromolaena odorata, Devil Weed

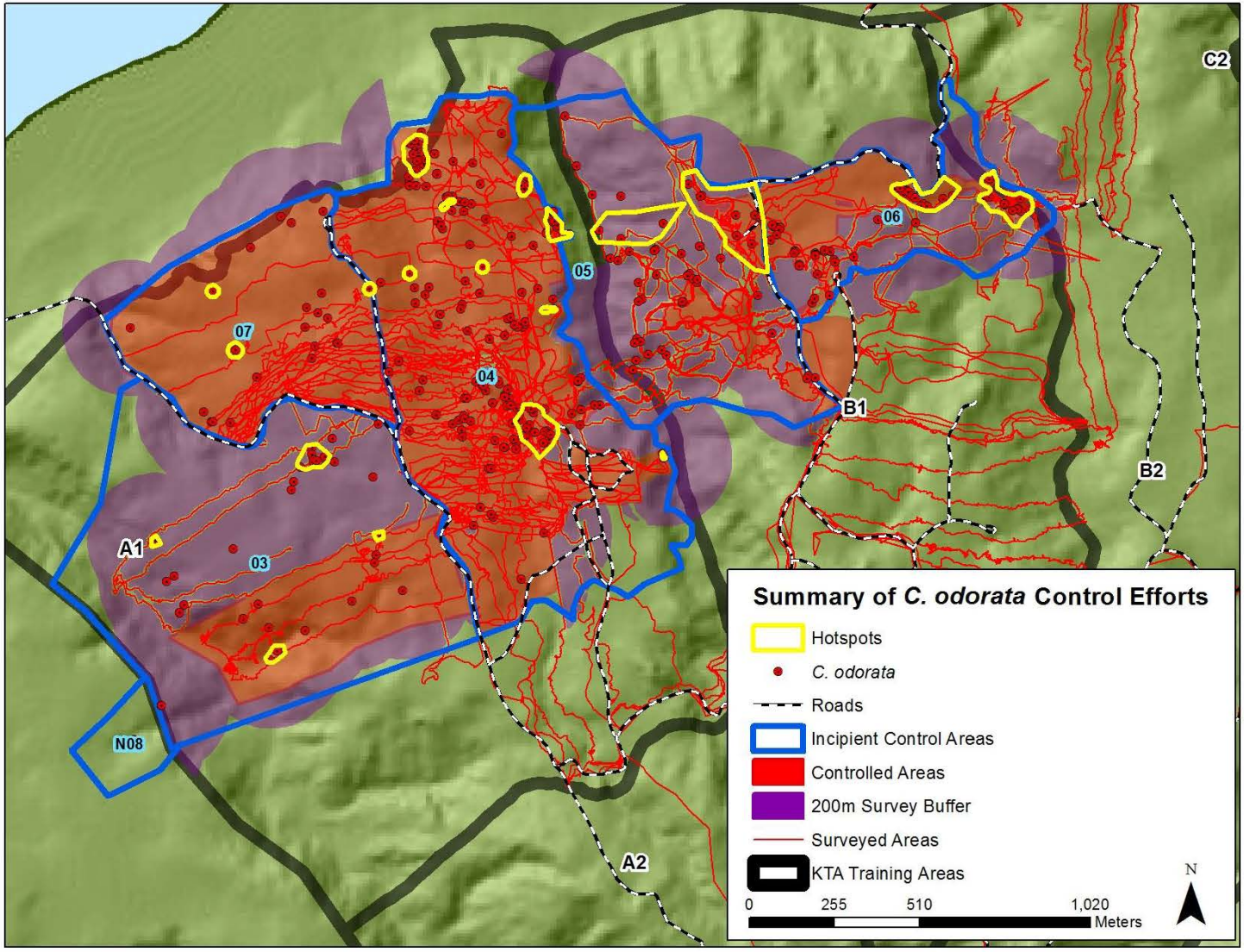
- Please see the 2011 Year End Report, Appendix 1-2 to view the draft management plant for *C. odorata* control. It will be revised in the coming year.
- OANRP and OISC have continued to partner on *C. odorata* control over the past year. From the discovery of *C. odorata* till now, OANRP alone has spent 878 hours and $25,955 on survey and control efforts. This figure does not include hours spent on data analysis, strategy development, and coordination. Over this same time period OANRP, OISC, and other partners controlled *C. odorata* over 160.26 ha and surveyed approximately another 162 ha across which no plants were found. Staff controlled 1,867 mature plants, 3,898 immature plants, and 557 seedlings over 32 visits.
- In the coming year, OANRP has contracted OISC to conduct control across two-thirds of the infestation. The remainder will be managed directly by OANRP staff. This arrangement will allow the entire infestation area to be swept annually. This level of control is necessary as *C. odorata* can mature within a year. OANRP and OISC also plan to complete a 200m buffer sweep around all known *C. odorata* locations in the next year. This buffer is 151.76 ha.
- There are eight ICAs to track control work. The table and map below summarize control efforts.

ICA Control Notes

ICA	Status
WaimeaNoMU-ChrOdo-01	OANRP to manage in 2013. Outlier. Only 1 immature plant found here. No additional plants seen despite multiple visits.
KTA-ChrOdo-02	OANRP to manage in 2013. Outlier. Only 1 immature plant found. No additional plants seen when driving by site. More thorough surveys needed.
KTA-ChrOdo-03	OISC will manage in 2013. Large area. Surveys and control needed across most of the ICA. Boundaries yet to be finalized.
KTA-ChrOdo-04	OISC will manage in 2013. Large area. Surveys and control 99% complete. Boundaries need to be finalized on south eastern corner. Hotspots were treated more than once.
KTA-ChrOdo-05	OANRP will manage in 2013. Large area. Surveys and control needed across most of the ICA. Boundaries yet to be finalized on northern and souther ends. Hotspots within this ICA have already been treated. Aerial survey planned for one large hotspot far off road.
KTA-ChrOdo-06	OANRP will manage in 2013. Large area. Surveys and control close to complete across ICA. Boundaries yet to be finalized. Hotspots have been treated multiple times. Power sprayer and preemergent herbicide have been effective at hotspots.
KTA-ChrOdo-07	OISC will manage in 2013. Large area. Surveys and control complete. Several hotspots need to revisited. Northern boundary needs to be confirmed.
AimuuNoMU-ChrOdo-08	OISC has done all work here and will continue to do so in 2013. Large area, on private land. Control and surveys already partially complete. Boundaries yet to be finalized.

Power-spraying *C. odorata*

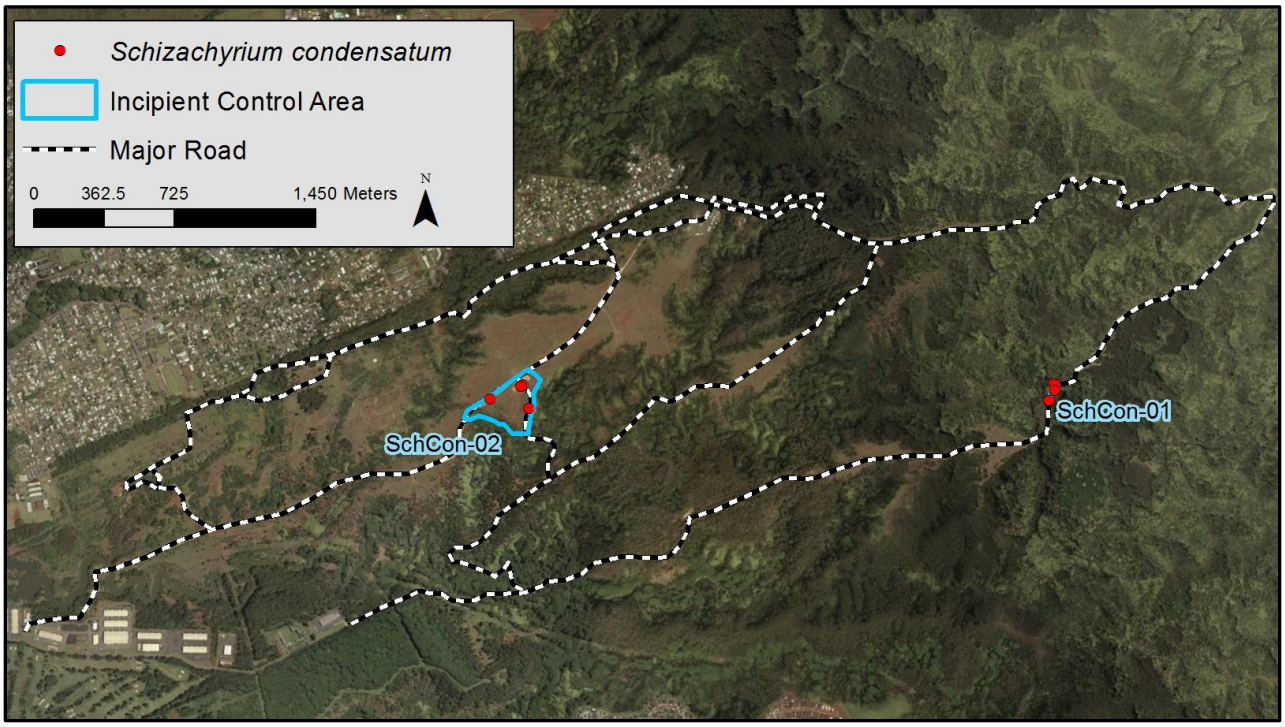
***C. odorata* Control Efforts Across KTA**



***Schizachyrium condensatum*, Bush Beardgrass**

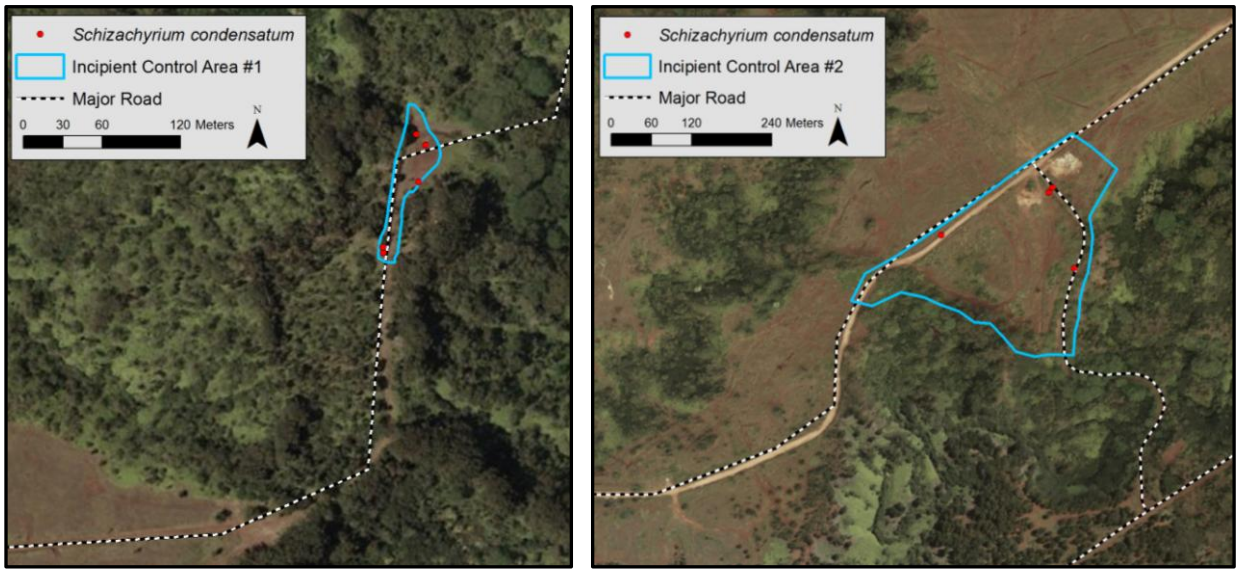
- In February 2012, staff identified one location of *S. condensatum* on an infequently used road in SBE. This is the first-ever record of true *S. condensatum* on Oahu, but it is a major habitat threat at Hawaii Volcanoes National Park (Big Island) and on Kauai. Bush beardgrass is well-adpated to fire and regenerates even after high-intensity burns; this results in a self-perpetuaing system, as fire promotes denser infestations, which in turn further increase fire potential. It is fast-growing, can become reproductive within a year, produces tiny wind-dispersed seeds, and degrades both natural areas and pastures. It prefers mesic to wet habitat, is easily spread by human activity, and colonizes disturbed areas and roadsides. Although there is some evidence that *S. condensatum* does not compete well with species which form dense ground cover, such as *M. minutiflora*, it received a WRA score of 13, is a significant threat to training at heavily used SBE, and if left unchecked could threaten other areas on Oahu. (HPWRA,2012).
- Later, a second *S. condensatum* site was discovered in SBE, this time along a heavily trafficked road. While the taxon does have distinct seed heads, it can be cryptic when mixed in with other grasses. This contributed to the late discovery (in September 2012) of the second site.

S. condensatum *Infestation at SBE*



- At ICA Site #1, staff partnered with Oahu Early Detection on intial control. 184 mature plants, 280 immature plants, and 4,040 seedlings were removed during initial control. This site is surrounded by dense uluhe cover, which appears to have limited the spread of this grass (see Site #1 map, below left). However, a large, open landing zone, visible on the map, is very close to the infestation. Staff from Range Control scraped the road at the infestation site during road repairs. While this did assist in control, OANRP is concerned about possible spread via the large machinery used. Staff re-established communication with Range Control and ITAM to better avoid situations like this in the future.

Site #1 ***Site #2***



- ICA site #2 unfortunately is located directly adjacent to an open area used by the Army Engineers for large machinery training. Over 750 mature and 50 immature plants have been controlled to date. More surveys are needed to finalize the infestation boundaries. Staff have already communicated with the Engineers, Range Control, and ITAM, highlighting the need for proper sanitation protocols.
- In the coming year, all roads in SBE will be driven again and surveyed for additional *S. condensatum*.

1.1.7 Invasive Species Spread Prevention on Training Ranges

Over the past two years, OANRP has found several highly invasive weeds on Army land, particularly those described in the Invasive Species Updates above. The Army's potential to move weeds from training area to training area has been amply demonstrated. This year, OANRP took steps 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 Control, Integrated Training Area Management (ITAM), and various branchs of DPW. The following is a list of highlights.

- The Federal Biologist and Natural Resource Manager submitted a memo to the Director of Mission Support Element regarding the recent discoveries of *C. odorata* and others on Army training lands. This memo stressed the importance of sanitation and prevention, and asked that all vehicles leaving KTA, the *C. odorata* infestation site, be required to use the new wash rack.
- Federal and OANRP staff have established a positive working relationship with the Range Office and ITAM, which has increased awareness of invasive weed issues.
- Staff attended the Officer In Command/Range Safety Office (OIC/RSO) brief. This class is required for all soldiers; without it, they cannot schedule any training activities. OANRP received permission to add slides relating to sanitation and natural resources issues to the brief. The slides will be completed and sent to the trainer by the end of the year. The slides will highlight the need to schedule and use the wash racks, as well as the high cost of controlling noxious pests, and the negative impact noxious pests can have on training activities.

- Staff successfully requested Range Control to close a 3.84 ha portion of KTA to training activities. This area is the largest concentration of *C. odorata* found next to a road, and is often used for staging training activities.
- OANRP reviewed ITAM plans for vegetation clearing in SBE, and shared the location of the *S. condensatum* infestations. ITAM advised OANRP on proper signage to post at the sites, and agreed to leave dirt on-site during road maintenance activities.
- OANRP sent information to the Engineers division regarding *S. condensatum*, since the infestation directly borders an area used by them for large machinery training. They were asked to wash all machinery in the wash rack when leaving the Range.
- The KTA wash rack was completed and will be open for use in the next month. The SBE wash rack was closed for repairs for one month, but has since reopened with partial functionality (only the high-flow hoses are operational). A new washrack on SBW is under construction.
- The Federal Biologist worked with DPW and the Range Office to determine the best location for disposal of sediment collected at the SBE wash rack. Ideally, the material will either be sent to H-Power or spread on a designated site at SBE that OANRP can then monitor.
- ITAM provided staff with a report showing what training areas and LZs were scheduled for use last year. OARNP will request this report again in the coming year and use it to ensure that heavily used road and landing zones are surveyd.

In the coming year, staff will continue to build relationships with Range Control, ITAM and DPW, and will reach out to Natural Resources staff at Pohakuloa Training Area to facilitate invasive species prevention measures.

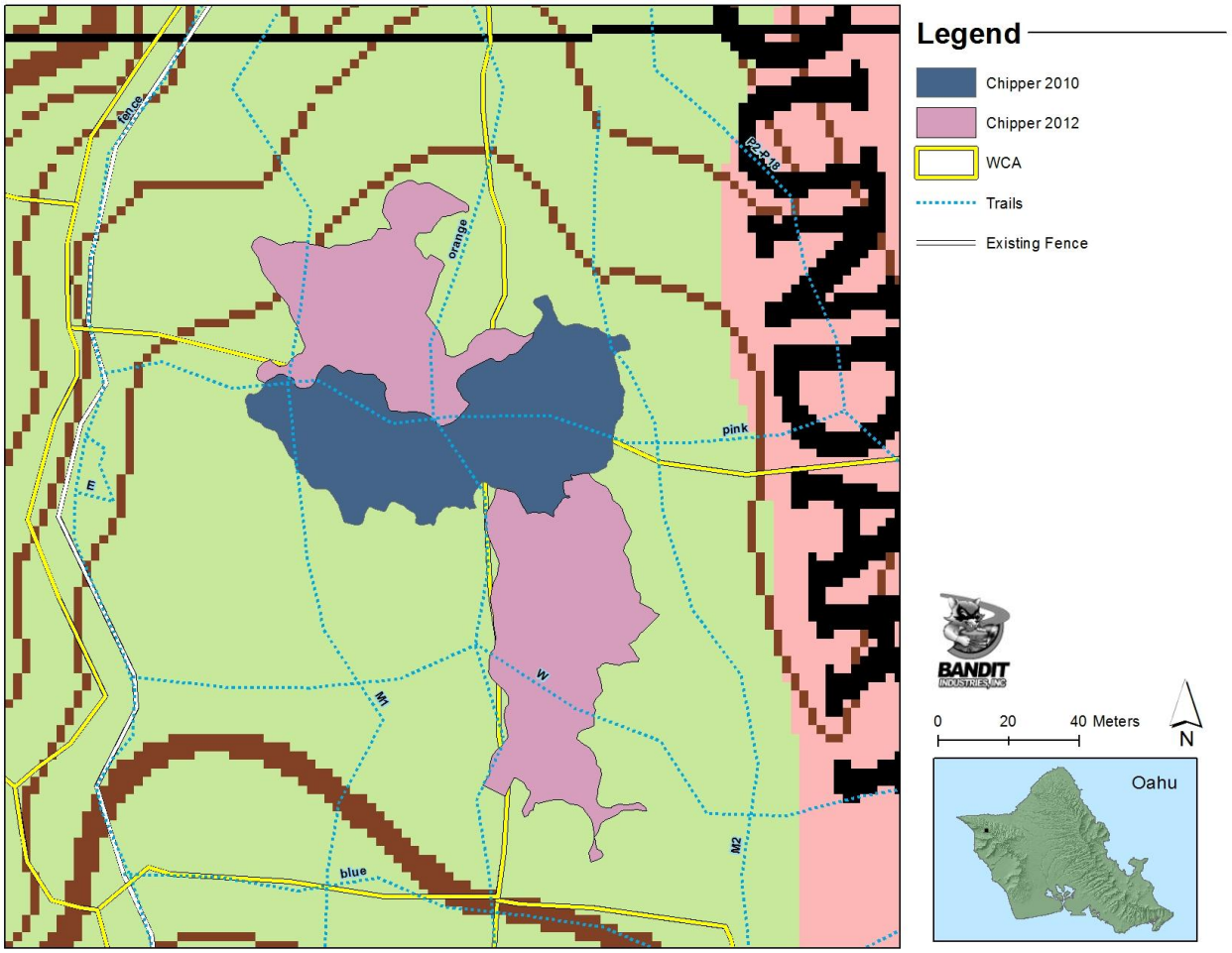
1.1.8 Weed Control Projects: Chipper

In 2010, staff began a very aggressive *Psidium cattleianum* control in Kahanahaiki MU, using a chipper to mulch slash from dense monocultures. A description of the project can be read in Appendix 1-5 of the 2010 Year End Report, and a status update is provided in Chapter 1 of the 2011 Year End Report. The goals of this project are to reduce alien vegetation cover, make headway towards meeting the <50% alien cover MIP goal in Kahanahaiki, foster recruitment of native pioneers, restore the area to native-dominated vegetation, and restore habitat for rare taxa.

This year, the chipper project was expanded. Working between April and September 2012, a combination of full-time staff and temporary hires cleared 0.63 ha. Logistically, having a temporary crew dedicated to the chipper project assisted in day-to-day efficiency and relieved permanent field crews busy with other tasks. Often, field days consisted of only two staff, who combined chainsawing, herbiciding, chipping, and data keeping with chipper maintenance and repair. The chipper project area was located in the southern (Maile Flats) portion of Kahanahaiki. The map below depicts the clearing efforts in both 2012 and 2010.

Prior to the commencement of work in 2012, several night snail surveys were conducted in the proposed clearing area. Snails were found at one site on the edge of a small gulch; this area was flagged off and was not cleared. In 2010, clearing efforts were timed to coincide with the senescence of the *P. cattleianum* seed bank, 3-6 months after fruiting. This year, staff decided to continue control even after ripe *P. cattleianum* fruit was observed, since very little area remained. In the coming year, it will be valuable to note whether seedling beds arise in areas with ripe fruit, as this will provide an unofficial trial of the efficacy of timing efforts with the *P. cattleianum* seed bank.

Kahanahaiki Chipper Project Area



The table below summarizes the effort and costs required for this project. In 2010, all work was conducted with permanent staff, while in 2012 at least half the work was carried out by temporary staff. Person hours do not include volunteer time. All clearing and chipping time is accounted for in the table, along with a few follow-up control trips in both 2010 and 2012. Follow-up work conducted in 2011 is not included. The table does not attempt to separate out the cost of initial clearing with the cost of follow-up, although this would be a useful metric for future analysis. Costs do not include gear, herbicide, the chipper itself, fuel, helicopter (used for slinging in diesel and chainsaws), or bringing a mechanic into the field to perform repair work on the chipper on two occasions. Comparing the 2010 and 2012 efforts, staff were able to clear a much greater area in 2012, at a lower price per unit area and per hour. This indicates a large learning curve for running efficient clearcut/chipper operations. Overall, almost $26,000 was spent clearing 0.90 ha of *P. cattleianum.*

Kahanahaiki Chipper Project Effort and Time

	2010 Effort	**2012 Effort**	**Total**
# of Trips	21	34	55
Person Hours	446.5	691.5	1,138
Area Cleared	0.36 ha or 3,584 m²	0.54 ha or 5,377 m²	0.90 ha or 8,961 m²
Staff Time Cost	$12,775	$13,030	$25,805
Price per m²	$3.55/ m²	$2.42/ m²	$2.88/ m²

Price per hour	$28.61/hour	$18.84/hour	$22.68/hour

OANRP plan to calculate a total cost for the chipper project next year, after the chipper is flown out of the site and a full year of follow-up control has been conductedin the 2012 cleared area. This total cost will include all factors described above, not just staff time. The cost of initial clearing versus the cost of follow-up will also be compared. Together with the results of the Chipper Vegetation Monitoring study described at the end of this section, the total cost estimate will provide a complete picture as to the utility and success of this intensive project.

Picture: Volunteers conducting follow-up control in the 2010 chipper area. Note the native *Carex, Pipturus, Nephrolepis* and *Acacia koa* hidden in thick *Rubus rosifolius*. Hopefully, as the *A. koa* canopy fills in, herbaceous weeds such as *R. rosifolius* will be suppressed and native understory plants will continue to thrive.

Photopoints were installed throughout the chipper area to document vegetation change. The following three series of photos show the drastic change the area chipped in 2010 underwent and the progress of recovery efforts.

Photopoint Series 1:

This photo series highlights the quick regeneration of *Acacia koa* in the chipped area. Within two years, some *A. koa* had reached 1.5m or more in height.

Photopoint Series 2:

In this series, the success of *Bidens torta* seed broadcasts is evident; *B. torta* is the dominant cover by July 2012. Also noteworthy is the recovery of *Nephrolepis exultata*, which died back dramatically immediately following clearing.

Photopoint Series 3:

Continued weed control efforts have been necessary in the chipped area. While native taxa thrive in the area, so do *P. cattleianum* and other weeds. Staff have since removed the *P. cattleianum* in the fourth photo. Without consistent follow-up, many of the gains of the project would be lost.

Next year, OANRP plans to continue regular weed control throughout the chipped area. No new areas will be clear-cut and chipped, as very little monoculture *P. cattleianum* remains. Instead, efforts will focus on invasive grass control, woody and herbaceous weed control, and broadcasts of native seeds. Plant taxa preferred by *Achatinella mustelina* snails may be outplanted to supplement natural native recruitment.

Vegetation Monitoring of Chipper Project Area

Vegetation monitoring was conducted in the chipper project area this year to look at the behavior of native and alien species following removal of *P. cattleianum*. Only the results of this small study are discussed here; please contact OANRP directly for a description of methodology used. The three sites sampled for this study are described in the table below. All sites were considered to have similar vegetation and management history prior to 2010.

Chipper Vegetation Monitoring Treament Site Description

Treatment Site	Description of Management.
Before Control	No *P. cattleianum* clearcut/chip control conducted. Some understory weed control conducted within the last ten years, but very little effort spent.
<1 Month After Control	*P. cattleianum* stands clearcut and chipped less than a month prior to reading plots. Other canopy weeds, such as *Schinus terebinthifolius*, were also cut and chipped. While canopy weeds were the primary target, understory weeds (*P. cattleianum*, *Clidemia hirta*) were also removed. No seed sows were conducted.
Two Years After Control	*P. cattleianum* stands clearcut and chipped in the summer of 2010, two years ago. At the same time, other canopy weeds and understory weeds were also controlled. Starting in late 2010 and continuing to the present, understory weed control was conducted through the chipped zone, alien grasses were sprayed, and *B. torta* seed was broadcast across the area.

Management Goal:

- Reduce and maintain the non-native understory cover below 50% vegetation cover and connect native forest patches surrounding the chipper area.
- Restore habitat to native dominated and increase the overall percent cover and diversity.

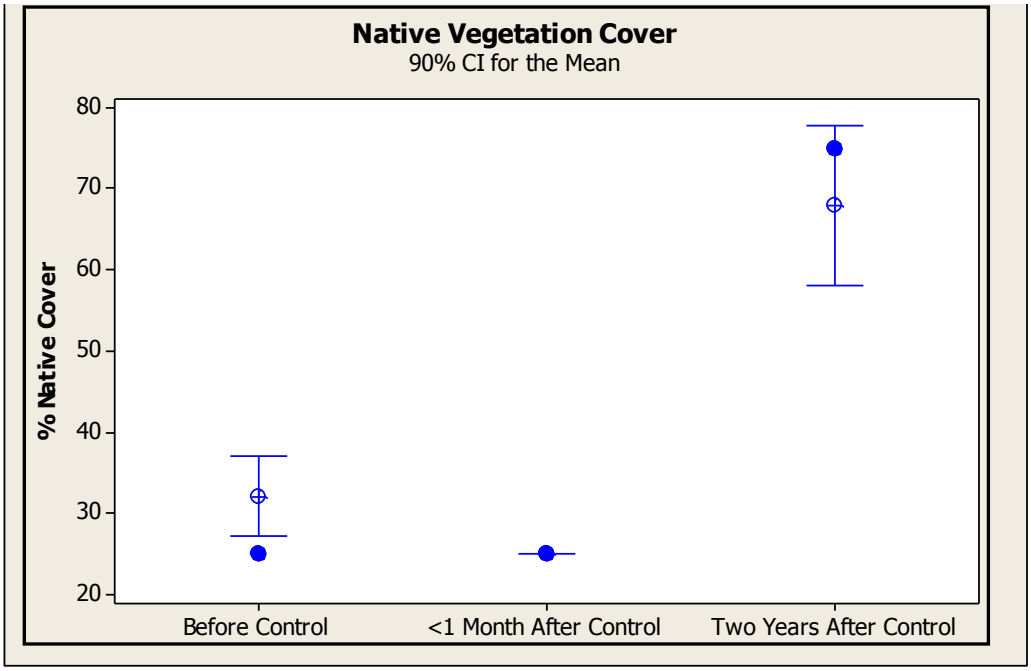
Monitoring Goal:

- Track percent cover change over time for native in the understory and canopy
- Track species richness for both native and non-native vegetation

Percent Cover Analysis:

Before any weed control was conducted, the mean native vegetation in the understory was in the 25-50% cover range. Less than one month after the initial weed control was conducted, the mean alien vegetation cover dropped from 100% to 0-25%. Two years after initial weed control the mean native vegetation percent cover increased dramatically, from 0-25% to 50-75%. A pairwise comparison analysis detected a significant difference in vegetation cover for the "Two Year" group. These results indicate that there was a significant increase in the percent cover of native vegetation in the understory two years after the initial *P. cattleianum* control (R-Sq = 53.75, P = 0.00).

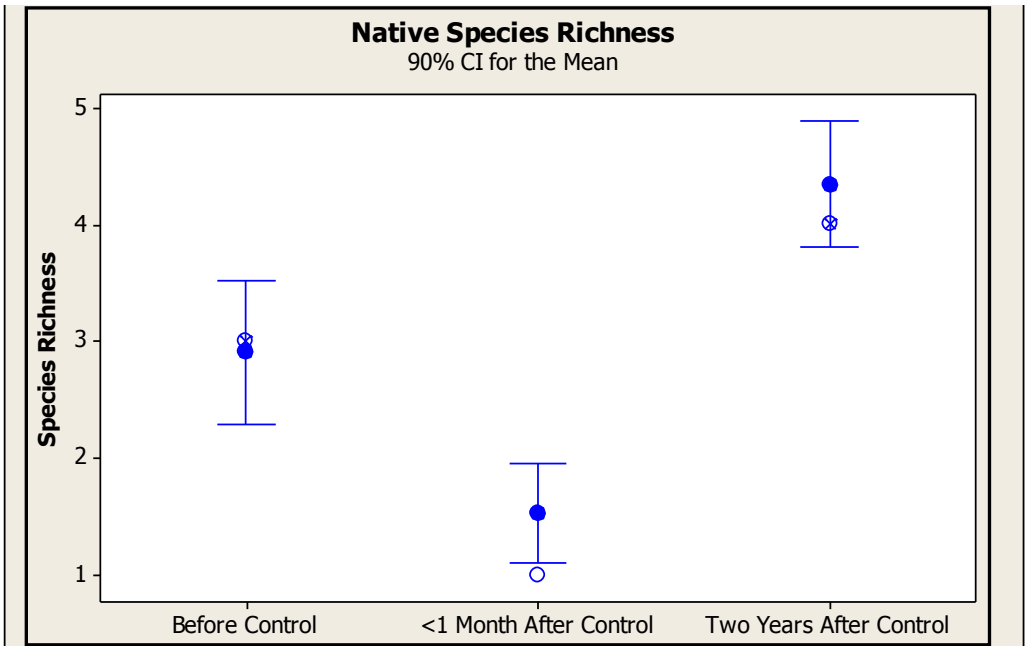
Native Vegetation Percent Cover



Species Richness Analysis:

Species richness decreased from a mean of 2.9 species per plot to 1.5 species one month after treatment, and increased to 4.4 species after two years. All three groups were significantly different from each other (R-Sq = 40.21%, P = 0.00). Note, between groups significance was determined by conducting an ANOVA test and a Tukeys pairwise comparison test. These results indicate that after the initial control, native species richness decreased, but after only two years it recovered, surpassing initial native species richness.

Native Species Richness



These results indicate a positive response in both native percent cover and species richness to the management conducted for the chipper project, including initial clearcutting and chipping, follow-up control, and *B. torta* seed broadcasting. It is impossible to separate out the effects of follow-up weeding and seed broadcasting from natural recruitment and growth. This study will be continued to further examine the status of the chipper project area over time. Monitoring will be conducted every two years. Once canopy cover starts to fill in, analysis will be conducted to determine if there is a correlation between species richness and percent vegetation cover.

1.1.9 Interagency Coordination

Oahu Invasive Species Committee (OISC)

- OANRP continues to participate actively with OISC, attending OISC planning, strategy and control meetings, sharing data and updates on incipient species of interest found on Army land, and occasionally conducting work swaps.

- This year, OANRP assisted in reviewing the OISC Draft Management Plan. This document is intended to guide OISC activities over the next five years.

- OISC underwent staff turnover at the end of the year. Both the Operations Manager and Field Coordinator resigned from the program, leaving on positive terms; their expertise and professionalism will be missed. The OANRP Ecosystem Restoration Program Manager served on the hiring committee for the new Operations Manager. Since OISC is such an important partner, it was important to be a part of this process. In the coming year, OANRP looks forward to strengthening relationships with new OISC staff.

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

- OARNP 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, and 2011 MIP and OIP Status Reports.

- Highlights from work over the past year:
    - Dr. Leary, with assistance from OANRP and NARS staff, produced a CTAHR technical report titled "Practitioner's Guide for Effective Non-Restricted Herbicide Techniques to Control and Suppress Invasive Woody Species in Hawaii," Appendix 1-3. Staff reviewed the document, provided information regarding commonly used weed control techniques, and assisted with IPA trials.
    - HBT was used to treat *Cenchrus setaceus* in MMR. One day was spent treating 54 plants located on cliffs in narrow gulches, where aerial spraying could be dangerous and accessing the plants requires being on rappell. While it is unclear if the treatment was completely effective, further studies are merited, as HBT provides the safer and more time-efficient control method.
    - On-going IPA trials installed by Dr. Leary, OANRP, and NARS staff were monitored. The trials tested five active ingredients: triclopyr/Garlon 4, glyphosate/Round-up, imazapyr/Polaris, aminopyralid/Milestone, and aminocyclopyrachlor/MAT 28. Results are summarized in the table below; since MAT 28 is not currently available for purchase, it was not included in the table.

IPA Trial Results

Species	Site	Recommended Herbicide	Notes
Toona ciliata	Kaluaa	Milestone, Polaris	All trees treated with Milestone and Polaris were completely defoliated. Although some still had green cambiums, these trees are expected to die. Monitoring will continue until either death or recovery is observed.
Acacia confusa	Kaluaa	Milestone	Milestone was most effective. Higher doses may be needed for moderate to large sized trees.
Corymbia citriodora	Kaluaa	More study needed	These trees were very large, and no defoliation was seen. If future trials are carried out, they should target smaller trees or use higher doses.
Schefflera actionphylla	Kapuna	Milestone, Polaris, Roundup	This taxon was surprisely responsive to a variety of herbicides. This is significant, as staff have had trouble controlling this taxon with other means.
Syzigium cumini	Kapuna	More study needed	Results were inconsistent for this species. While Milestone had some potential, more experimentation with dosages is necessary.
Araucaria columnaris	Peacock Flats	Milesone	These trees took almost a year to show dramatic effects from the herbicides. Milestone was most effective, but more study is needed.
Leucaena leucocephala	Kaena	Milestone,	All herbicides were effective, but only Milestone achieved complete defoliation.
Callitris columellaris	SBE	More study needed	None of the herbicides achieved dramatic defoliation. Roundup had the most promising results. Future trials should include higher doses.
Casuarina glauca	SBE	More study needed	All of the herbicides had some effect, but none defoliated all treated plants. Future trials should include higher doses.

- Dr. Leary submitted research proposals for 2012 and 2013 to OANRP. The purpose of these proposals is to further research and development of IPA and HBT weed treatment techniques. The 2012 proposal allowed Dr. Leary to purchase six IPA gear set-ups and two HBT gear set-ups. This equipment will be used in 2013 to conduct species trials and operational trials. These include:
    - IPA:
        - Continuing species trials to match herbicide with target weed. This also will involve experimenting with dosage.
        - Conducting operational field trials, in which staff use IPA gear to control weeds for several field days. This will allow Dr. Leary to study efficiency by examining the amount of time needed to control a certain number of weedy trees. It will also allow staff to test the gear and determine if any modifications are necessary to improve the ease of use and minimize leaks. Since IPA uses undiluted herbicide, avoiding spills is very important for staff safety.
    - HBT:
        - Efforts will continue to focus on two species, *P. cattleianum* and *H. gardnerianum*. Work may also be continued on *Cenchrus setaceus*.
        - *P. cattleianum*: work will build on trials conducted in previous years. HBT using triclopyr is not yet 100% effective on this taxa. Trials will be conducted to determine if herbicide delivery to basal bark is improved by having a high angle treatment point. If the trial is successful, this method may be used to treat *P. cattleianum* on the Koolau summit.

- *H. gardnerianum*: This taxa is a major threat to the Kaala and Lihue MUs. Dr. Leary and staff will conduct a trial to look at the efficacy of imazapyr projectiles on cliff-dwelling plants. A previous trial was deemed inconclusive, as it was impossible to definitively identify the area treated due to steep terrain. In the coming year, staff hope to overcome this issue via Gigapan photopoints, which will enable close examination of the cliffs pre- and post-spraying. The area sprayed will be tightly defined, and all *H. gardneriaum* patches within that area will be treated. Gigapan technology is described in the Invasive Weed Update, *C. setaceus* section above. Gigapans have already been taken of the treatment area.

Gigapan Views of H. gardnerianum at Kaala

Pictures: The upper picture shows the landscape scale of the Gigapan. Some *H.gardneriaum* patches are visible on the right side of the photo, but are much harder to make out on the left. The red circle at the upper left of the photo indicates the location of the zoomed in photo, below. *H. gardneriaum* is easily identifiable in the zoomed picture.

1.2 ECOSYSTEM RESTORATION MANAGEMENT UNIT PLANS

The Ecosystem Management Unit Plans (ERMUPs) included here follow the same format as ERMUPs included in the 2010 Status Report for the MIP and OIP. Each plan includes a summary of rare resources as well as a discussion of all threats to the MU. Each plan includes a table of proposed actions at the end of the document. The ERMUPs are designed to be stand-alone, technical documents which guide OARNP field crews. Some repetitive verbiage is intentional.

1.2.1 Ohikilolo (Makua)

MIP Year 9-14, Oct. 2012 – Sept. 2017

MU: Ohikilolo (Makua)

Overall MIP Management Goals:

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

Background Information

Location: Leeward side of Northern Waianae Mountains, Southern base of Makua valley

Land Owner: U.S. Army Garrison Hawaii

Land Managers: Oahu Army Natural Resources program

Acreage: 676 acres

Elevation Range: 1200-2200 ft.

Description: Ohikilolo (Makua) MU is located in the Makua Military Reservation (MMR). The area is accessed at the mouth of the valley, or by helicopter to LZs throughout the valley. The terrain of the lower portion of the MU includes deep gulches with steep walls, and broad ridges of mixed mesic to dry forest. The upper portion, above the steep sided walls of Makua Valley, is comprised mostly of steep slope to the crest of the ridge.

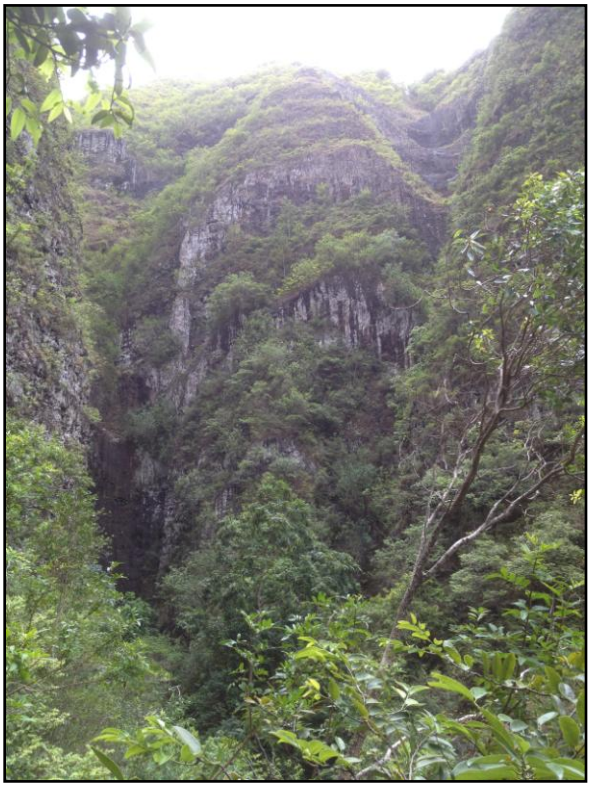
The Ohikilolo Management Unit (MU) is one of the larger MIP MUs. Management for this MU has long been divided informally among OANRP staff as the two following areas; Ohikilolo (Upper) and Lower Makua. The division is useful for management purposes because the access issues to each of the areas vary; large cliffs run approximately along the 2000 ft contour between the two. Due to unexploded ordinance issues (UXO), Lower Makua also requires contract support from UXO specialists. The two 'areas' have been treated separately in past reports because they are managed by two different field teams. For the purposes of the year end report, they have been reported in Ecosystem Restoration Management Plans as two separate areas within the same MU.

There are many challenges to management in Makua. Access is limited, and scheduling with Range Control and UXO specialists is required, due to the large amount of UXO present in the valley. Additionally, there are ungulates in the MU, and eradication is difficult without a complete perimeter fence. Constructing a large MU fence would be difficult because of the presence of UXO.

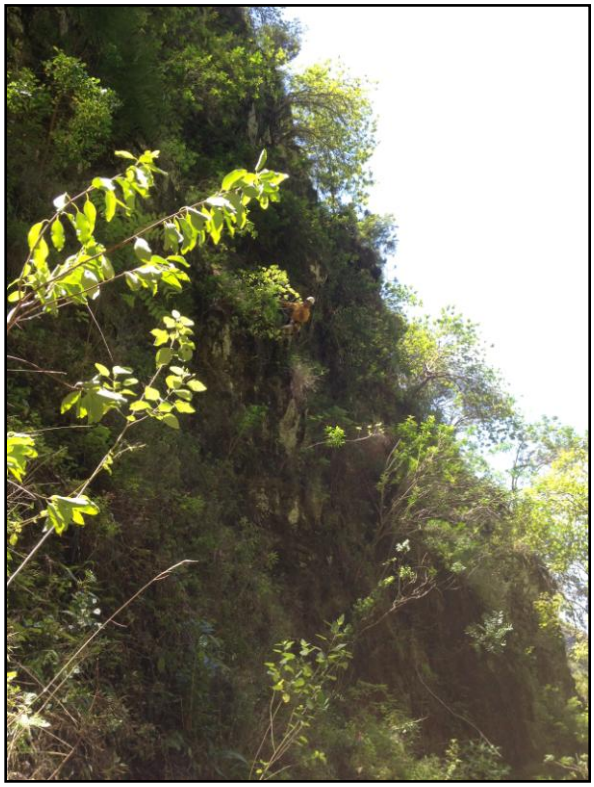
Native Vegetation Types

Waianae Vegetation Types
Dry Forest
Canopy includes: *Diospyros* sp., *Psydrax odoratum*, *Nestegis sandwicensis*, *Myoporum sandwicense*, *Erythrina sandwicensis*, *Reynoldsia sandwicensis*, *Rauvolfia sandwicensis*, *Santalum ellipticum*, and *Myrsine lanaiensis*. Understory includes: *Dodonaea viscosa*, *Sida fallax*, *Bidens* sp., *Microlepia strigosa*
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

Vegetation Types at Makua



Makua valley floor looking South.



Steep cliffs of Koʻiahi gulch looking East towards cliffs abo.

Photo taken from the Kahanahaiki overlook looking south to Makua**.**

MIP Rare Resources

Organism Type	IP Species	Population Reference Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Alectryon macrococcus* var. *macrococcus*	MMR- A,D,E, F, O-R	Makua	MFS	Wild
Plant	*Flueggea neowawraea*	MMR-C, D, E	Ohikilolo	GSC	Wild
Plant	*Melanthera tenuifolia*	MMR-C, I, J	Ohikilolo	GSC	Wild
Plant	*Neraudia angulata*	MMR- A, D, E	Makua	MFS	Both
Plant	*Nototrichium humile*	MMR-D,E,H,I	Makua (S. side)	MFS	Both
Bird	*Chasiempsis ibidis*	N/A		Manage	Wild

MFS= Manage for Stability GSC=Genetic Storage Collection

Other Rare Taxa at Ohikilolo MU- Makua

Organism Type	**Species**	**Status**
Plant	*Alphitonia ponderosa*	Species of concern
Plant	*Bobea sandwichensis*	Species of concern
Plant	*Bonamia menzesii*	Endangered
Plant	*Ctenitis squamigera*	Endangered
Plant	*Diellia falcata*	Endangered
Plant	*Korthalsela degneri*	Endangered
Plant	*Lobelia niihauensis*	Endangered
Plant	*Ocrosia haleakalae**	Endangered
Plant	*Pleomele forbesii*	Endangered
Plant	*Pteralyxia macrocarpa*	Endangered
Plant	*Sideroxylon polynesicum*	Endangered
Bat	*Lasiurus cinereus semotus*	Endangered

*****Further taxonomic and/or genetic research is needed to determine if certain individuals found in Makua are in fact *O. haleakalae* as preliminary and anecdotal information suggests.

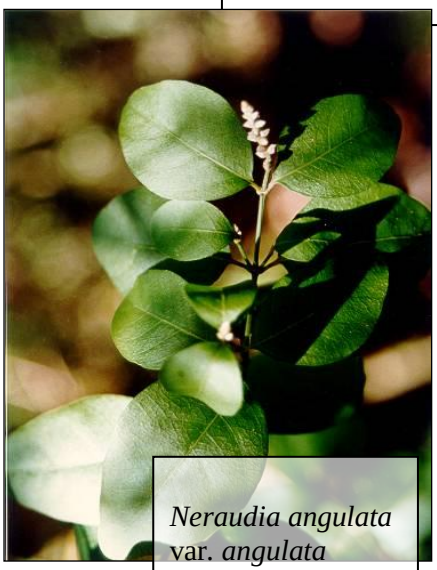
Locations of rare resources at Ohikilolo MU- Makua

Rare Resources at Makua

Chasiempsis ibidis

Alectryon macrococcus var. *macrococcus* fruit

Flueggea neowawraea



Neraudia angulata var. *angulata*

Nototrichium humile

Sideroxylon polynesicum

MU Threats to MIP MFS Taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes
Rats	All	Unknown for rare plants	No	Yes
Slugs	Potential threat to *N. angulata* and *N. humile*	Yes	No	Yes
Ants	Unknown	Yes	No	Some available, depends on species
Black Twig Borer	*A. macrococcus, F. neowawraea* and *N. angulata*	Yes	No	No practical method available. Heavy watering and fertilizing of targeted plants sometimes successful.
Weeds	All	Yes	Yes	Yes; No for species that occur on cliffs
Fire	All	No	Yes	Yes

Management History

- 1929: Army began taking parcels of land for military training.
- 1943: Military gains control of entire valley
- 1995-1997: Ground hunts were started with the use of contract hunters from the U. S. Department of Agriculture Wildlife Services while plans to install a perimeter fence to enclose MMR along the ridge crest were finalized.
- 1996-1997: The first stretch of fencing (3 km) separating MMR from the Keaau game management area was completed by the National Park Service and ~8 km of fencing was erected around the eastern perimeter of the valley.
- 1998: Large fire in Makua, live fire training is halted.
- 1999: Contract and Staff ground hunts continued from 1997-1999 to control numbers of goats. OANRP began to employ neck snares as a management tool.
- 2001: The last portion of the fence was completed separating the valley from the core populations of goats to the south and OANRP staff employed aerial shooting and "Judas goats" as management tools.
- 2001-2004: Army resumes live fire training on a limited basis.
- 2002: NRS completed a small fence around a single *F. neowawraea* at MMR-C.
- 2003: A breach in the fence allowed at least three goats to cross over from Makaha Valley into Makua Valley. These three goats were subsequently caught and no more sign was observed in the area of the breach. NRS completed a strategic fence protecting *N. angulata* MMR-D, after which the *N. angulata* MMR-E reintroduction population was established to augment the existing MMR-D population.
- 2004: OANRP eradicated feral goats from the entire MU.
- 2005: OANRP completed two strategic fences in the back of Koiahi gulch; they protect *N. angulata.*
- 2006: Four goats breached perimeter fence, all were caught.
- 2009: Last two mating pairs of elepaio observed.
- 2011: Forest tree line mapped from helicopter using GPS to establish accurate weed control boundaries.

Ungulate Control

Identified Ungulate Threats: Pigs and Goats

Threat Level: Medium

Primary Objective:

- To maintain all areas of the MU as goat-free and the fenced areas as pig-free.
- Decide best plan for completing MU fence (fence in UXO area or completion of ridgeline fence along Kuaokala boundary). Initiate construction and eradicate all ungulates from within.

Strategy:

- Sustained levels of eradication for goats throughout the MU, and pigs within fences.

Monitoring Objectives:

- Conduct fence checks.
- Note any pig sign while conducting day to day actions within fenced MU.

Management Responses:

- If any goat activity is detected in the MU, implement hunting and/or snaring program.
- If any pig activity is detected in fenced units, implement hunting and/or snaring program.

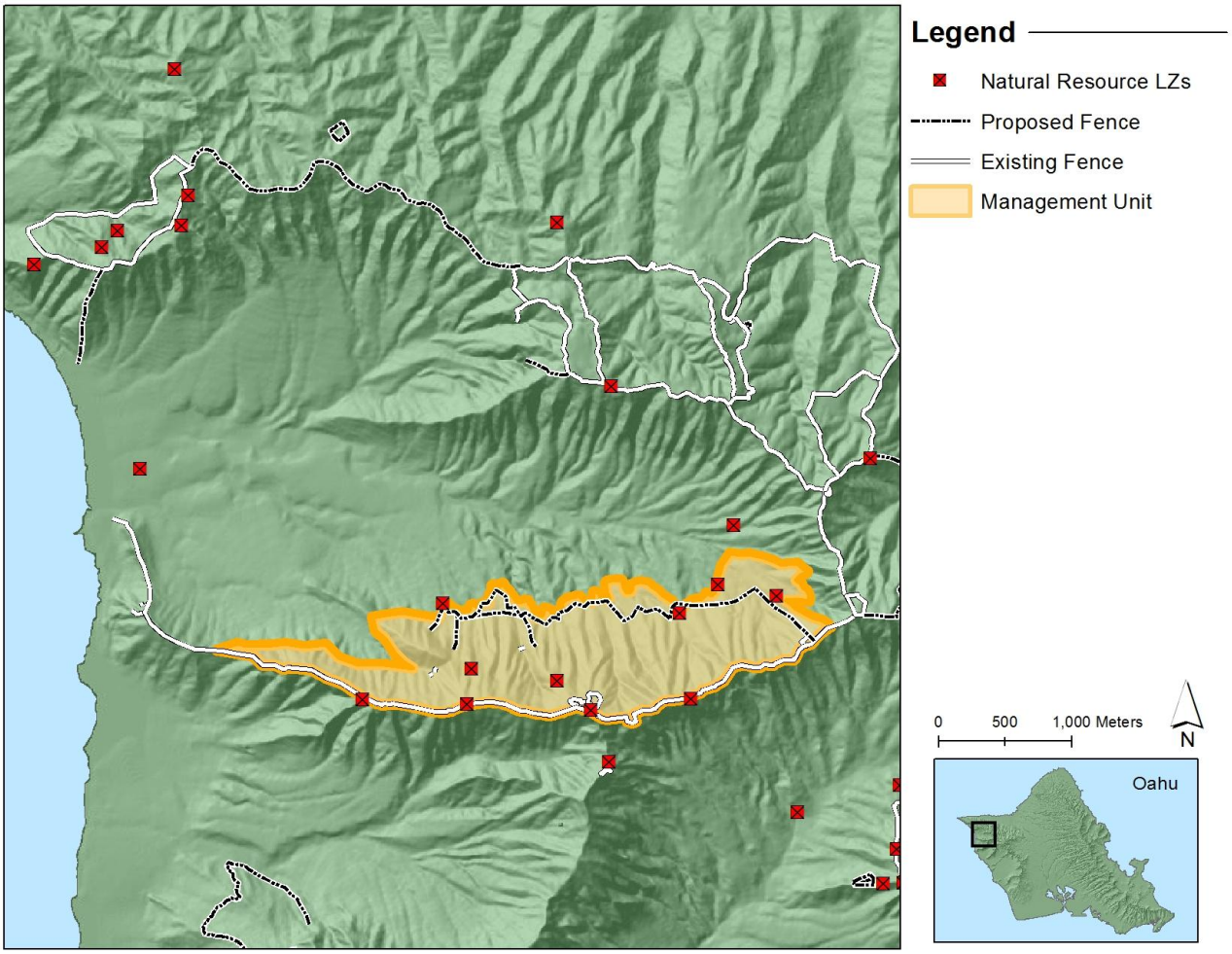
Fence Completions:

- 2002: *F. neowawraea* fence (1), Makua
- 2003: *N. angulata* fence (1), Makua
- 2005: *N. angulata* fences (2), Koiahi

Maintenance Issues:

There are four fences in this portion of the MU, with a fifth fence planned near the Lower Makua campsite LZ for protection of a new *Neraudia angulata* outplanting. The major threats to the fences include erosion, fallen trees and rocks, fire and vandalism. No incidences of vandalism have been observed. Special emphasis will be placed on checking the fence after extreme weather events.

Makua Ungulate Map



Weed Control

Weed Control actions are divided into 4 subcategories:

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

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

MU Vegetation Monitoring

As previously discussed, this large MU has been divided into different regions to facilitate management. Vegetation cover across the Ohikilolo (Upper) section was monitored in 2010. The steep cliffs dividing

Ohikilolo (Upper) from Ohikilolo (Makua) cannot be monitored for vegetation cover at the current time. Remote monitoring technologies are being considered and if a feasible methodology becomes available, vegetation cover monitoring may take place in this cliff community. This document focuses on the lowest elevation section of the MU, Ohikilolo (Makua). As defined by the MIP, the major vegetation cover goals are as follows:

Primary Management Objective:

- Assess if the percent cover for both the alien understory and canopy is 50% or less across the entire management unit (Oahu Implementation Team et al. 2008). If alien species cover is not below the 50% goal, use repeated MU monitoring to determine whether or not the value of alien species is decreasing significantly toward that goal.

Secondary Management Objective:

- Assess if the percent cover for both the native understory and canopy is 50% or more across the entire management unit (Makua Implementation Team et al. 2003). If native species cover is not above the 50% threshold, use repeated MU monitoring to determine whether or not the value of native species is increasing significantly toward that goal.

Sampling Objective:

- Be 95% confident of detecting a 10% change in both non-native and native understory vegetation in the understory and canopy.
- The acceptable level of making a Type 1 error (detecting a change that did not occur) is 10% and a Type 11 error (not detecting a change that did occur) is 20%.
- Minimum detected change between two samples being compared is 10% over the sampling period.

Given the low number of MIP taxa (5) located in the Makua portion of the MU, OANRP has decided that investigating the primary and secondary management objectives at this time is not the highest priority for monitoring staff. Also, since Makua is entirely in an UXO area and entry requires an UXO escort, ground-based monitoring would be very expensive. This decision will be revisited either in five years, or upon the completion of the fence planned to encompass the bottom portion of the MU.

Weed Control Monitoring:

In the meantime, the following vegetation management related questions will be investigated.

1. Is the forest/grassland interface changing over time? In particular, is the forest line receding and is fire-carrying grass expanding up ridges?
    - Propose looking at this through the establishment of a long-term photopoint, or aerial imagery. May use gigapan technology.

2. What is the distribution of *Toona ciliata* across Makua? Are weed control efforts directed towards *T. ciliata* sites?
    - If feasible, propose looking at this via gigapan or other remote sensing technologies. Results will be used to direct weed control efforts on the ground.

Surveys

Army Training: Yes

Other Potential Sources of Introduction: NRS, pigs, poachers

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

Management Objective:

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

Monitoring Objectives:

- Monitor/install transects to detect alien species ingress along trails and roads, particularly *Cenchrus setaceus*
- Quarterly surveys of LZs (if used).
- Annual surveys of trails
- Note unusual, significant, or incipient alien taxa during the course of regular field work.

Management Responses:

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

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Roads, landing zones, fencelines, and other highly trafficked areas are inventoried regularly; Army roads and LZs are surveyed annually, non-Army roads are surveyed annually or biannually, transects are surveyed at least annually, while all other sites are surveyed quarterly or as they are used. At Makua, only landing zones and transects are currently surveyed regularly.

Incipient Taxa Control (ICAs)

Management Objective:

- Identify new incipient weed threats in the MU

Monitoring Objectives:

- Locate new ICA's when doing general weed control and surveys

Management Responses:

- Designate ICA's and control new weed threats

No incipient species have been identified by OANRP in the MU, therefore there are currently no ICAs. OANRP will continue to monitor and conduct incipient control when appropriate.

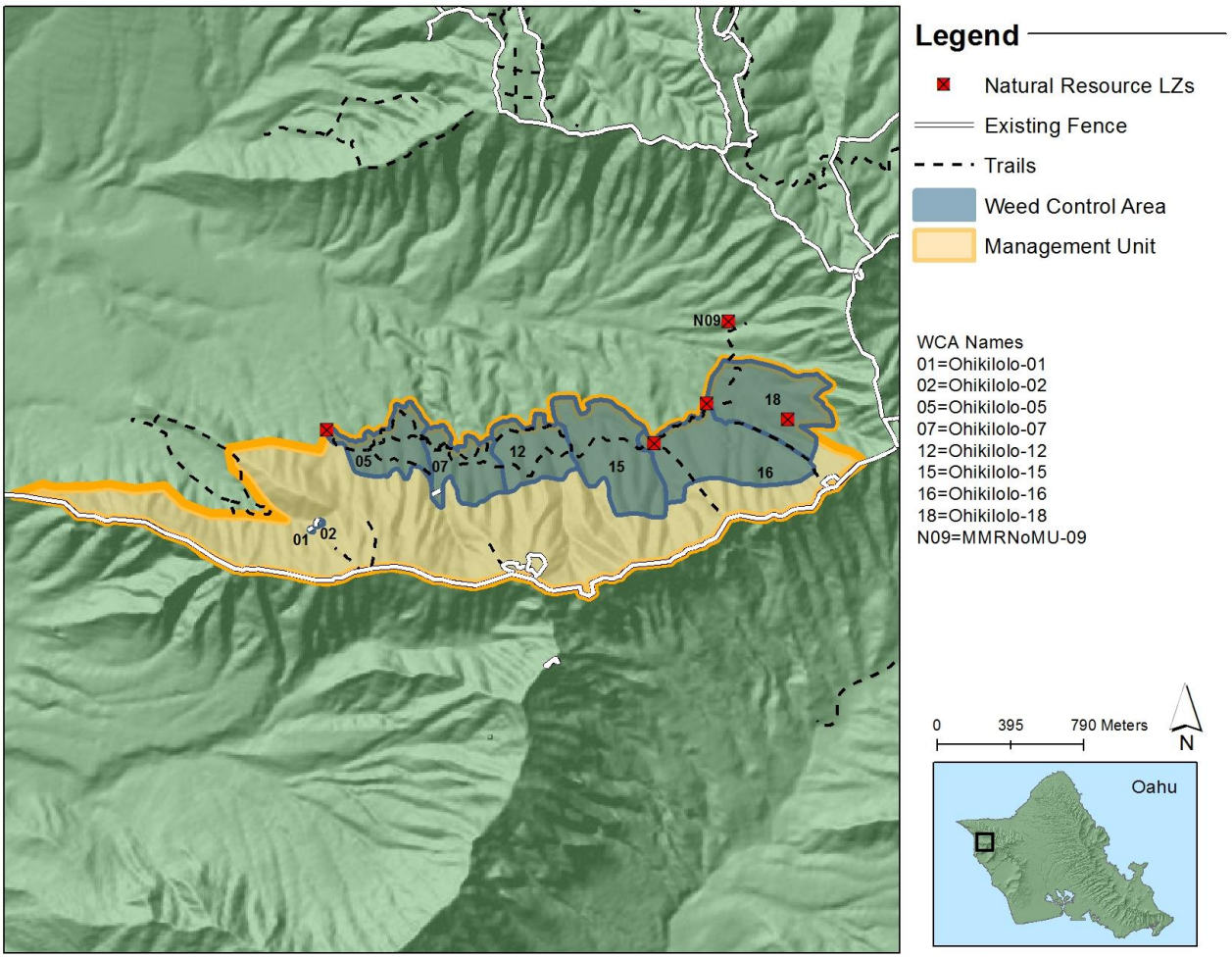
The table below summarizes invasive taxa at Makua. Appendix 3.1 of the MIP lists significant alien species and ranks their potential invasiveness and distribution. Each species is given a weed management code: 0 = not reported from MU, 1 = incipient (goal: eradicate), 2 = control locally. If no code is listed in the 'original' column, the species was not evaluated by the IT but was added later by OANRP. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in an MU. OANRP supplemented and updated Appendix 3.1 with additional target species identified during field work. In many cases, the weed management code assigned by the MIP has been revised to reflect field observations. ICAs are not designated for species in the table below; however, occurrences of all species in the table should be noted by field staff.

Summary of Target Taxa

Taxa	MIP weed man. code		Notes	No. of ICAs
	Original	Revised		
Araucaria columnaris	1	1	No *A. columnaris* is known from the Makua portion of the MU, but it is known from Ohikilolo (Upper). It has wind-dispersed seed, and immature trees have been found more than 300m from the now-dead source tree. If found in Makua, it should be controlled. No herbicide is required for control of immature; they can be pulled or simply cut down.	0
Blechnum occidentale	2	2	This invasive fern should be target in areas directly around rare taxa. It forms thick mats that may inhibit successful establishment of seedlings	0
Caesalpinia decapetala	0	1	This thorny vine, once established, is horrendous to walk through and control. Any locations found should be GPSed, controlled, and possibly designated as ICAs.	0
Coffea arabica	0	2	While common in Koiahi gulch, *C. arabica* is not known from areas east of Koiahi ridge. It should be a priority for early detection and rapid control.	0
Fraxinus uhdei	0	1	One large mature tree was known from Ohikikilolo (Upper), but none are currently known from Makua. If found, this is a high priority for control.	0
Grevillea robusta	2	2	*G. robusta* has wind dispersed seeds, colonizes cliffs, and is alleleopathic. It should be controlled during WCA sweeps. Incision Point Application (IPA) is effective.	0
Heliocarpus popayensis	0	1	Uncommon in the MU, *H. popayensis* was seen and controlled once in the past 10 years. Trees are large, soft-wooded, with wind-dispersed seed. It can form large stands. This is a high priority target.	0
Leucaena leucocephala	2	2	Common in the MU, this is a target whenever seen near native forest patches. It is best controlled with Garlon 4 in a 40% mix or with IPA Milestone.	0
Melia azedarach	2	2	This tree is widespread, but not very common. It is a target in WCAs.	0
Melinis minutiflora	2	2	Grasses are a high priority target for control in WCAs, particularly (but not only) around native forest.	0
Montanoa hibiscifolia	0	1	This shrubby tree grows quickly, thrives in dry, steep habitats, and produces wind-dispersed seed. It should be controlled wherever seen.	0
Myrica faya	1	1	One *M. faya* was controlled in Ohikilolo (Upper) years ago. If any plants are found, they should be controlled immediately and monitored as an ICA.	0
Psidium cattleianum	2	2	By far the most common canopy weed, *P. cattleianum* is the primary target of WCA control. Trees in and near native forest patches are highest priority. Care should be taken not to open large stands of *P. cattleianum*, creating light gaps optimal for grasses.	0
Schinus terebinthifolius	2	2	Widespread across the MU, *S. terebinthifolius* becomes the dominant vegetation as the ridges climb in elevation. It	0
Spathodea campanulata	2	2	While this tree has a wide distribution, it is not common in the MU. It should be treated wherever seen. IPA should be used once trials are complete.	0
Syzygium cumini	2	2	With its thick bark, *S. cumini* is difficult to control. Chainsaw girdling and Garlon application are most effective. IPA trials are needed. This tree should be targeted around native forest patches.	0
Toona ciliata	2	2	No large monotculture stands of *T. ciliata* are currently known from Makua. If left unchecked, this tree would likely behave as it has in Makaha and Kaluaa. It is a priority target and should be controlled whenever seen. IPA with Milestone and Polaris is effective.	0

Triumfetta semitrilobata	2	2	This shrub should be controlled around rare taxa and along trails.	0
Urochloa maxima	2	2	Formerly *Panicum maximum*. This grass has a very high burn index. Any patches in/near native forest patches are a high priority for control.	0

Weed Control Areas



Ecosystem Management Weed Control (WCAs)

MIP Goals:

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

Management Objectives:

- In lieu of any vegetation monitoring, goal is to focus efforts within 50m of rare taxa and through forest patches, and in these areas work towards reducing alien cover to 50% or below.

Management Responses:

- No monitoring is in place for any of the MIP goals for this portion of the MU. Instead, gigapan photo points will be installed to detect novel alien canopy weeds, which will be a priority for control.
- If monitoring for any MIP goal is installed, and if results suggest goals are not being met, staff will increase/expand weeding efforts.

The Lower Makua dry forest is unique, with impressively tall native canopy and numerous *O. compta.* There are large groves of native-dominated dry forest, and qualitative observations of weeded areas suggest that these areas are recovering well. However, there is continued pressure at the forest edge from encroaching alien grasses.

WCAs are divided by a series of ridges and gulches and need to be GPSed to aid weed data tracking. The WCA numbers are not sequential as Ohikilolo (Makua) and Ohikilolo (Upper) together make up the Ohikilolo MU. WCA's are prioritized based upon rare resources and the status of each WCA based upon staff observations. Large scale weed sweeps often include the use of chainsaws to girdle large trees before applying herbicide.

This year OANRP altered the northern border of the MU to follow the forest edge. Areas that contained solid *Urochloa maxima* were avoided. This change did not involve any major increase or decrease in MU area. This change facilitates weed control and streamlines data management.

UXO is a major safety concern. If an area is deemed unacceptably dangerous, NRS will not conduct weed management in it. This is particularly true for specific types of UXO that can be obscured by dense grass, and areas where dense grass obscures the ground.

WCA: Ohikilolo-01 (Koiahi, South Nerang)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *S. campanulata, T. ciliata, Ageratina adenophora, Buddleia asiatica, Melinis minutiflora*

Notes: This area is degraded with few native species remaining, and work is focused tightly around plants/base of cliff in hopes of fostering recruitment. *N. angulata* are present at the back of the gulch on cliffs. There are a few *N. humile* at the foot of the cliffs. Weeding may improve native recruitment now that the area surrounding these rare plants is fenced. Fence repairs are periodically needed due to large boulders washing down the gulch and cliffs above. Weeding should be prioritized around *Microlepia strigosa* as it fills in after weed removal and provides a dense understory. Invasive grasses and invasive ferns can be hand pulled or clipped and dripped around native plants.

WCA: Ohikilolo-02 (Koiahi, North Nerang)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *M. minutifolia, Blechnum appendiculatum, A. adenophora, Psidium cattleianum*

Notes: This area is degraded with few native species remaining, and work is focused tightly around plants/base of cliff in hopes of fostering recruitment. There are a few *N. angulata* at the foot of the cliffs. Weeding may improve native recruitment now that the area surrounding these rare plants is fenced. Fence repairs are periodically needed due to large boulders falling from cliffs above. Weeding should be prioritized around *Microlepia strigosa* as it fills in after weed removal and provides a dense understory.

Invasive grasses can be hand pulled around native plants, but eliminating large patches of grass is difficult because water has to be hiked in for herbicide.

WCA: Ohikilolo-05 (Firebreak Road to Banana Gulch)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *S. campanulata, Montanoa hibiscifolia, Melia azedarach, Syzygium cumini, P.cattleianum*

Notes: Two populations of *Bobea sandwichensis* are present in this gulch. Continued non-native canopy removal may help with the re-establishment of native seedlings. Grass control is needed on the western end of the WCA to minimize ingress into the native forest. *M. strigosa* was noted filling in the gaps after weed control. Spraying grass below *Dodonaea viscosa* at the top of ridges will perhaps aid native recruitment. Some gulches are fairly native-dominated in the understory and canopy, with *Diospyros sandwicensis* being the most common species. Large overstory of invasive trees like *Aleurites moluccana* and *Syzygium cumini* are encroaching into gulch areas and towards the base of cliffs. The ridges are largely unforested at the north end of the WCA, where the grass encroaches to the forest edge. At the edge of the grassy ridges there is a border of *P.cattleianum* that prevents grass from moving upslope of the gulch. Most weeding efforts are concentrated on the eastern part of the WCA, close to the border of WCA 7, due to the presence of native-dominated forest nearby.

WCA: Ohikilolo-07 (Nerang to Well Ridge)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *B. appendiculatum, M. hibiscifolia, T. ciliata, S. terebinthifolius, A. adenophora*

Notes: The majority of weeding efforts in this WCA occur in an area known as "Banana gulch", where populations of *Melanthera tenuifolia, Nototrichium humile,* and *Neraudia angulata var. angulata* are located. They are protected by a small strategic fence in the back of a slot gulch on the west end of the WCA. Additional weeding efforts have been focused along the trails within this WCA. Continued non-native canopy removal may help native seedlings get re-established. Large overstory invasive trees like *Aleurites moluccana* and *Syzygium cumini* are encroaching on gulches and farther back into slot gulches towards the base of cliffs. The ridges are largely unforested at the north end of the WCA where the grass encroaches to the forest edge. Continuing off the grassy ridges toward the gulch bottoms there is a border of *P.cattleianum* that limits grass ingress upslope of the gulch.

WCA: Ohikilolo-12 (Ron's Rock to Dividing Ridge)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *P. cattleianum, G. robusta, S. campanulata, T. ciliata, S. cumini, S. terebinthifolius*

Notes: Continued non-native canopy removal may help native seedlings re-establish in the gulches. Large overstory of invasive trees like *Aleurites moluccana* and *Syzygium cumini* are encroaching into gulches and farther back into slot gulches towards the base of cliffs. The ridges are largely unforested at the north end of the WCA where the short grasses encroach to the forest edge. At the edge of the grassy ridges, there is a border of *P.cattleianum* to slow its progress further into the slopes of the gulch. This WCA is somewhat unique, in that there are archeological sites as well as *Sideroxylon polynesicum*, a rare tree/shrub found in dry forest areas. Unfortunately access to this WCA is limited due to its remote location. It is almost halfway between the makua firebreak road and the Lower Makua Campsite/LZ.

WCA: Ohikilolo-15 (Dividing Ridge to Campsite)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *P. cattleianum, G. robusta, S. campanulata, T. ciliata, S. cumini, S. terebinthifolius*

Notes: This is one of the largest WCAs in Makua. Due its location, just a few ridges over and west of the Lower Makua Campsite DZ, accessibility allows for more frequent plant monitoring and weeding. Along with hosting an Elepaio territory, this large area is home to several managed taxa including *F. neowawraea* (fenced), *A. macrococcus*, and *B. sandwicensis*. Additional native plants present in this area include *D. sandwichensis*, *P. odoratum, Sapindus oahuensis*, *Nestegis sandwicensis*, and the rare *Alphitonia ponderosa* Continued non-native canopy removal may help native and endangered seedlings re-establish. Luckily there is not much grass under the very tall native and non-native canopy. Preventing grass on the ridge from entering the gulches is a priority, so leaving monotypic stands of *P. cattleianum* is necessary to form a barrier to grass ingress.

WCA: Ohikilolo-16 (Campsite to Arch site)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *P. cattleianum, G. robusta, S. campanulata, T. ciliata, S. cumini, S. terebinthifolius*

Notes: Commonly referred to by staff as "The Nicest Patch Ever," this is area has an abundance of common and rare natives, as well as endangered taxa including, Elepaio territories makes this a priority weeding area. Future efforts will focus on sweeps up towards steep cliffs, due to the close proximity of Campsites/LZs to weeding areas. Large, monotypic stands of *P. cattleianum* will be avoided, and weeding will focus on chainsaw girdling and herbicide application to *P. cattleianum* that is intermixed with natives. Although the highest concentrations of *Alectryon macrococcus* var. *macrococcus* reside here, there has been a steady decrease possibly due to rat predation, disease, andthe black twig borer (*Xylosandrus compactus*). In the past, extensive weed control focused on this intact native forest due to the presence of native tree canopy. The WCA is responding well to weeding efforts, with increasing amounts of native understory plants. Continued follow-up weeding will prevent alien overstory species from establishing.

WCA: Ohikilolo-18 (CteSqu to FluNeo)

Veg Type: Dry forest

MIP Goal: Less than 25% non-native cover

Targets: *G. robusta, S. campanulata, T. ciliata, P. cattleianum, S. cumini, M. hibiscifolia*

Notes: This WCA contains elepaio, as well as rare and endangered taxa such as, *A. macrococcus* var. *macrococcus, Pteralyxia macrocarpa, A. ponderosa,* and *Ctenitis squamigera*. Continued non-native canopy removal may help native seedlings re-establish. There are several native patches within this area that are threatened by dense stands of *P. cattleianum.* One the most effective weed control efforts to combat this weed involves chainsaw girdling. In doing so, it is important to prevent large light gaps that could allow invasive weeds to establish in the understory. The priority for this WCA is to concentrate weeding efforts in the flat area below *A. ponderosa*.

WCA: MMRNoMU-09 (Elepaio 15 LZ)

Veg Type: Dry forest

MIP Goal: None

Targets: *G. robusta, S. campanulata, T. ciliata*

Notes: This LZ was created to assist the monitoring of Elepaio in the gulches upslope. This small area is rarely used. It was cleared of weeds and overhanging vegetation in 2011 to ensure a safe and appropriate LZ. If access to this part of the valley is needed in future, additional maintenance be performed.

Rodent Control

Species: *Rattus rattus, Mus musculus*

Threat level: High

Current control method: At this time no MU wide rodent control is being considered.

Seasonality: Year round.

Number of Control Grids: 1

Acceptable Level of Activity: Less than 20% predation on endangered plants

Primary Objective:

- To maintain rat populations to a level that facilitates stabilized or increasing rare plants by the most effective means possible.

Monitoring Objective:

- Monitor *A. macrococcus* var. *macrococcus* to determine the occurrence of fruit/plant predation by rats.

Management Objective:

- Install and maintain a small rat control grid around *A. macroccus* MMR-X and *F. neowawarea* MMR-X to facilitate collection of fruit. The grid will be maintained seasonally until collections are complete. Either snap traps or automatic resetting traps will be used.

Slug Control

Species: *Deroceras leave, Limax maximus*

Threat level: Unknown

Current control method: Localized

Seasonality: Wet season

Number of sites: 3 (*Neraudia angulata* and *Nototrichium humile* MMR-D/E/I)

Acceptable Level of Activity: Unknown

Primary Objective:

- Reduce slug population to levels where germination and survivorship of rare plant taxa are optimal.

Monitoring Objective:

- Annual census monitoring of *Neraudia angulata* and *Nototrichium humile* seedling recruitment following fruiting events.
- Annual census monitoring of slug densities during wet season.

Management Objectives:

- Determine by the fall of 2014 whether slugs have an adverse impact on *Neraudia angulata* and *Nototrichium humile* survival.

Slugs have not, to date, been observed feeding on *Neraudia angulata* and *Nototrichium humile*. Both taxa occur in habitat frequented by slugs making contact possible. Slug control using Sluggo is not recommended until impacts to target plants have been determined.

Ant Control

Species: *Plagiolepis alludi, Anoplolepis gracilipes*

Threat level: Unknown

Control level: Only for high risk species or new incipients

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

Number of sites: One, Lower Makua Landing Zone

Acceptable Level of Activity: Unknown

Primary Objectives:

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

Monitoring Objective:

- Sample ants at human entry points a minimum of once a year. Use samples to track changes in existing ant densities and to alert NRS to any new introductions.

Management Objective:

- If incipient species are found and deemed to be a high threat and/or easily eradicated locally (<0.5 acre infestation) begin control.
- Determine extent of *A. gracilipes* infestation, if small, eradicate locally using Safari 20 SG
- Ant populations will be kept to a determined acceptable level across the MU to maintain ecosystem health.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. The distribution and diversity of ant species across the lower Makua MU has not yet been sampled.

Black Twig Borer Control

Species: *Xylosandrus compactus*

Threat level: High

Control level: Localized

Seasonality: Peaks elsewhere have been observed from October to January

Number of sites: 11 (*Alectyron macrococcus* var. *macrococcus* and *Flueggea neowawraea* sites)

Acceptable Level of Activity: Unknown

Primary Objectives:

- Reduce BTB populations to a level optimal for *Alectyron macrococcus* var. *macrococcus* and *Flueggea neowraea* survival.

Monitoring Objective:

- Annual or every other year census monitoring of *Alectyron macrococcus* var. *macrococcus* and *Flueggea neowawraea* populations to determine BTB damage.

Management Objective:

- There are no effective control methods available. Heavy watering and fertilization of targeted plants has been successful at reducing BTB damage in agricultural settings, but is not practical here on the wild plants, and there are currently no reintroductions planned.

Fire Control

Threat Level: High

Available Tools: Fuelbreaks, Visual Markers, Helicopter Drops, Wildland Fire Crew, Aerial spraying.

Management Objective:

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

Preventative Actions**:**

The Makua portion of the Ohikilolo MU is at high risk from fire. The Army has instituted several control measures to reduce the likelihood of fires starting in the valley during training exercises. These include regular maintenance of the firebreak road, limitation of training to within the firebreak road, and the establishment of a weather-based index to guide training activities. The index evaluates rainfall, temperature and wind conditions to produce a color-coded fire condition rating. Live fire-training may occur during 'green' conditions, but not during 'amber' or 'red' conditions. In addition, the Army maintains an Army Wildland Fire crew who are trained in fighting wildfires, and has two dip ponds on site. The Army has a grass cutting contract to maintain low fuels around select areas within the firebreak road, and has also conducted controlled burns to reduce fuel loads.

In 2010-2011, OANRP participated in fuels management work conducted by CALIBRE. This project, funded through the Garrison, looked at novel herbicide combinations, aerial spraying, and remote fuel breaks. Through this project, some remote fuel breaks were sprayed outside of the firebreak road, adjacent to several different MUs in MMR, including Ohikilolo (Makua). If CALIBRE obtains further funding, OANRP will continue to collaborate with them.

No live-fire training has occurred in the past ten years, but arson fires and out-of-prescription burns have threatened portions of the MU. Live-fire training appears unlikely to resume in the next five years.

OANRP will continue to focus on maintaining good communication with the interagency Wildland Fire Working Group to facilitate positive on-the-ground fire response throughout the Waianae range. OANRP will support fire fighting with helicopters and staff. In WCAs, grass patches will be controlled and no canopy weeding will be done on the edge of the grass/forest line to suppress grass incursion into forested areas.

In the future, staff will continue to consider whether any of the following fuel suppression options are feasible, productive, and cost-effective for the grassy slopes between the forest line and the firebreak road: aerial spraying of grass, fuel suppression via planting of trees that produce heavy shade (such as mango), fuel suppression via planting of common natives (such as *Dodonea viscosa* or *Osteomeles anthyllidifolia*).

Action Table

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Evaluate what type of monitoring useful																				
	Install Gigapan at C-Ridge, looking towards Makua; for purposes of monitoring grass area boundary, forest edge boundary.																				
General Survey	Survey Lower Makua campsite LZ (#8) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Upper Lower Makua LZ (#69) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Lower Makua trailhead LZ (#75) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Arch Camp LZ (#146) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Arch Camp LZ (#147) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	WT-Ohikilolo-01: Install weed transect along Koiahi access trail. GPS trail and mark route in field to ensure same trail can be walked in future years.																				
	WT-Ohikilolo-01: Survey Koiahi transect annually; transect begins at trailhead and ends at Neraudia fences.																				
	WT-Ohikilolo-02: Install weed transect along Makua access trail. GPS trail and mark route in field to ensure same trail can be walked in future																				

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	years.			▨																	
	WT-Ohikilolo-02: Survey Makua trail transect annually; transect begins at trailhead and ends at camp.			▨				▨				▨				▨				▨	
	Aerial survey Makua Valley portion of MU to identify large canopy weeds, particularly TooCil, but including any other uncommon and significant targets, which need to be controlled. Use info to direct selection of weeding areas.			▨				▨				▨				▨				▨	
Ohikilolo-01 (South Nerang)	Conduct understory and canopy weed control across WCA annually. Focus around Nerang and native species patches. Target understory weeds, Spacam, gradual control of canopy weeds.			▨				▨				▨				▨				▨	
	Control alien grasses across WCA, annually, or as needed.			▨				▨				▨				▨				▨	
Ohikilolo-02 (North Nerang)	Conduct understory and canopy weed control across WCA annually. Focus around Nerang and native species patches. Target understory weeds, Spacam, gradual control of canopy weeds.			▨				▨				▨				▨				▨	
	Control alien grasses across WCA, annually, or as needed.			▨				▨				▨				▨				▨	
Ohikilolo-05 (Firebreak Road to Nerang Gulch)	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches as first priority. Target TooCil, MonHib, Grerob, SzyCum, PsiCat, etc. Avoid creating large light gaps. Avoid killing thick Psicat/weed stands on edge of grass, as don't want to open more areas to grass. Sweep entire WCA once every 3-5 years. Always GPS	▨												▨		▨					

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	weeding areas.																				
Ohikilolo-07 (Nerang to Well Ridge)	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches as first priority. Target TooCil, MonHib, Grerob, SzyCum, PsiCat, etc. Avoid creating large light gaps. Avoid killing thick Psicat/weed stands on edge of grass, as don't want to open more areas to grass. Sweep entire WCA once every 3-5 years. Always GPS weeding areas.																				
	Control all weeds within fenced Nerang zone every 6 months. Focus around Nerang/Nothum plants and potential reintro spots. Target Bleapp, Agerip, Chrsp, Monhib, Helpop, understory weeds. Remove canopy weeds gradually.																				
	Control weedy grasses within Nerang exclosure every 6 months, as needed. Exercise care when working around rare taxa.																				
Ohikilolo-12 (Ron's Rock to Dividing Ridge)	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches as first priority. Target TooCil, MonHib, Grerob, SzyCum, PsiCat, etc. Avoid creating large light gaps. Avoid killing thick Psicat/weed stands on edge of grass, as don't want to open more areas to grass. Sweep entire WCA once every 3-5 years. Always GPS weeding areas.																				
	Control weedy grasses within Nerang reintro/exclosure every 6 months, as needed.																				

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Exercise care when working around rare taxa.																				
	Prep reintro zone. Control all weeds within fenced Nerang reintro zone every 6 months. Focus around potential reintro spots. Target Bleapp, Agespp., Chrsp, Monhib, Helpop, understory weeds. Remove canopy weeds gradually.																				
Ohikilolo-15 (Dividing Ridge to Campsite)	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches as first priority. Target TooCil, MonHib, Grerob, SzyCum, PsiCat, etc. Avoid creating large light gaps. Avoid killing thick Psicat/weed stands on edge of grass, as don't want to open more areas to grass. Sweep entire WCA once every 3-5 years. Always GPS weeding areas.																				
Ohikilolo-16 (Campsite to Arch site)	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches as first priority. Target TooCil, MonHib, Grerob, SzyCum, PsiCat, etc. Avoid creating large light gaps. Avoid killing thick Psicat/weed stands on edge of grass, as don't want to open more areas to grass. Sweep entire WCA once every 3-5 years. Always GPS weeding areas.																				
Ohikilolo-18 (Ctesqu to Fluneo)	Control canopy weeds and selected understory weeds across WCA. Focus on native forest patches as first priority. Target TooCil, MonHib, Grerob, SzyCum, PsiCat, etc. Avoid creating large light gaps. Avoid killing thick Psicat/weed stands on edge of grass, as don't want to open more areas to grass. Sweep entire																				

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	WCA once every 3-5 years. Always GPS weeding areas.																				
MMRNoMU-09 (Elepaio 15 LZ)	Clear and maintain LZ as needed.																				
Ungulate Control	Conduct post-storm fence monitoring trips.																				
	Select a route to complete the fencing of the MU.																				
	Monitor Lower MakuaPU fences MMR-H and G																				
	Construct Nerang outplanting fence																				
Rodent Control	Elepaio territory grids, restock every 2 weeks																				
	Create a grid using self resetting traps around the fruiting A. macrococcus var. macrococcus																				
	Maintain grid of self resetting traps																				
Ant Control	Conduct survey for ants at lower Makua Landing Zone																				
	If any high risk species are present begin control																				
Slug Control	Monitor rare plants for signs of slug damage																				
	If slugs found to exceed acceptable levels during monitoring, maintain slug bait at sensitive plant population(s)																				
Fire Control	Maintain LZs																				

Hatching=Quarter Scheduled

1.2.2. Waimano

Ecosystem Restoration Management Plan

OIP Year 6-10, Oct. 2012 – Sept. 2017

MU: Waimano

Overall OIP Management Goals:

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

Background Information

Location: Central Koolau Mountains/ Ewa Forest Reserve

Land Owner: State of Hawaii

Land Managers: Hawaii Department of Land and Natural Resources

Acreage: 8.92 acres

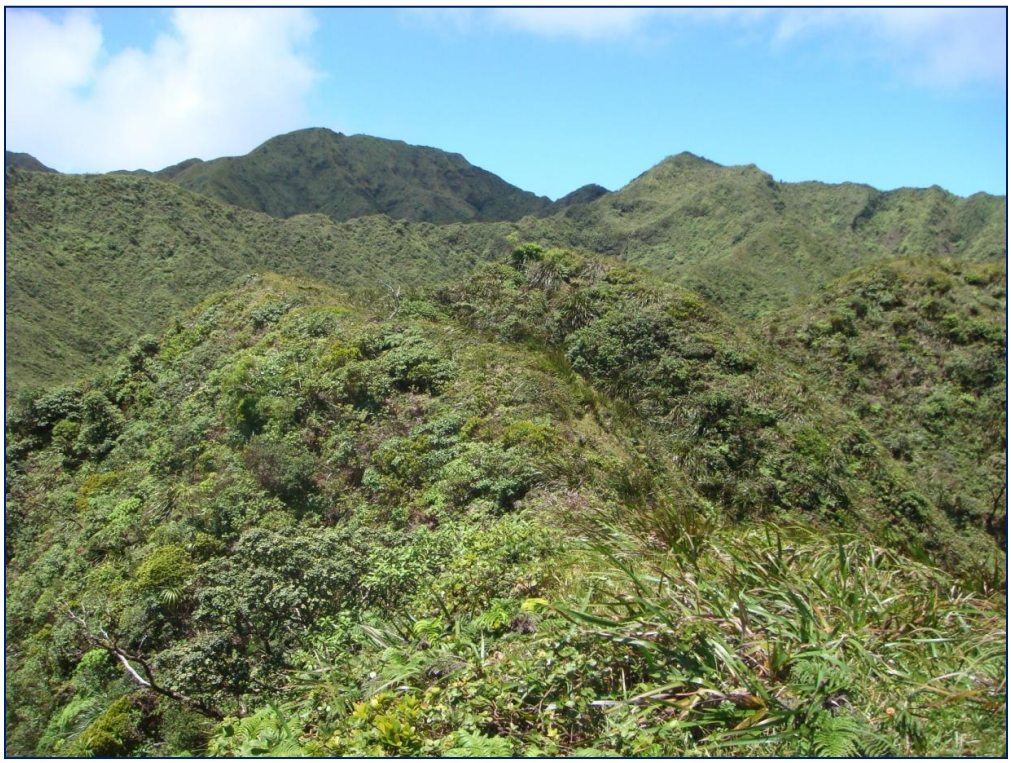
Elevation Range: 1,880ft.-2,320ft.

Description: The Waimano Management Unit (MU) is on the leeward side of the central Koolau Mountains within the Ewa Forest Reserve. The MU is located off the summit on the north facing slope of a deep drainage between the Manana trail to the north and the Waimano trail to the south. The fence rides the top of a ridge and drops down on two sub-ridges into the gulch. The lower line of the fence is located just above the gulch bottom. Most of the terrain within the fence is steep and is composed of three sub-ridges and four shallow drainages. This relatively small MU contains vegetation that is predominantly native and contains a diverse host of rare IP species which include: *Cyanea st.- johnii*, *Cyanea koolauensis*, *Euphorbia rockii.*

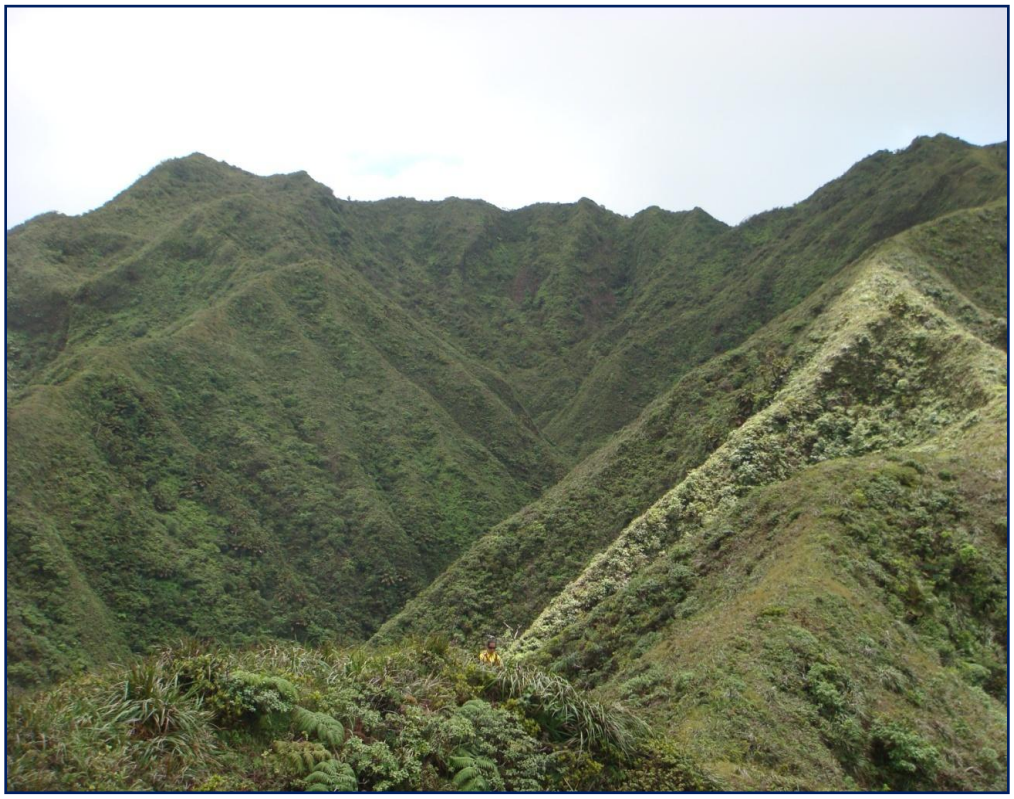
Native Vegetation Types

Koolau Vegetation Types
Wet forest
Canopy includes: *Metrosideros* spp., *Cheirodendron* spp., *Cibotium* spp, *Ilex anomala*, *Pritchardia martii*, *Myrsine sandwicensis*, and *Perrottetia sandwicensis*. Understory includes: A variety of native fern and moss species; may include *Dicranopteris linearis, Melicope* spp., *Cibotium chamissoi, Machaerina angustifolia*, *Nertera granadensis, Kadua centranthoides*, *Dryopteris rubiginosa*, *Sadleria sp.* and *Broussaisia arguta*.
NOTE: For future MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

Wet Forest Vegetation and views of Waimano



Waimano Ridge Top.



Ridge showing deep gulch in Waimano MU.

OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Cyanea koolauensis*	ANO-B,C, D	Waimano	GSC T3	Wild
Plant	*Cyanea st.-johnii*	ANO-A, B	Waimano	MFS T1	Wild/ Reintroduction
Plant	*Euphorbia rockii*	ANO-A, B	Waimano	GSC T2	Wild
Plant	*Lobelia gaudichaudii/ koolauensis* (sp. still needs to be determined)	ANO-A,B	Waimano	MFS T3	Wild

MFS= Manage for Stability *= Population Dead T1 = Tier 1
GSC= Genetic Storage Collection †=Reintroduction not yet done T2 = Tier 2
MRS = Manage Reintroduction for Genetic Storage

Other Rare Taxa in the Waimano MU

Organism Type	Species	Federal Status	Notes
Plant	*Cyanea humboldtiana*	Endangered	One known plant within MU
Plant	*Platydesma cornuta* var. *cornuta*	Endangered	

Locations of rare resources and the fence at the Waimano MU

Map removed to protect rare resources

Rare Resources at Waimano

MU Threats to MIP/OIP MFS Taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes, MU is fenced
Slugs	*Cyanea koolauensis, C. st.- johnii C. humboldtiana* and *Euphorbia rockii Lobelia koolauensis*	Yes	No	Yes, Sluggo is available for local control if area has been surveyed by an experienced malacologist to determine whether rare snails are present
Ants	Unknown	Yes	No	Some available, depends on species
Weeds	All	No	Yes	Yes
Fire	None	N/A	N/A	Yes. Fire unlikely at this MU, but fires have been set on Koolau trails in the past.
Rats	All	Unknown	Unknown	Multiple options are available in the form of snaps, bait stations and self resetting traps. Techniques employed would have to be adapted to Waimano.

Management History

- Oct 1994: Hawaii Biodiversity Mapping Program observation record for *Cyanea st.-johnii* from Joel Lau
- 2005-2008: Oahu Plant Extinction Prevention Program (OPEPP) makes collections from *C. st.-johnii* that go to Lyon Arboretum
- Feb 2008: Initial fenceline scope with OPEPP
- October 2008: OANRP scope fenceline to determine line
- July-Dec 2010: Fence construction and determined pig free in December
- March 2012: First outplanting of *C. st.-johnii*

Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Primary Objectives:

- Maintain MU fence as ungulate free.

Strategy:

Maintain the fenced area as ungulate-free by maintaining fence and monitoring for pig signs throughout the MU when monitoring rare plants or conducting other management actions.

Monitoring Objectives:

- Conduct fence checks. GPS and mark the fence at ten meter intervals so that the fence will be one large transect.
- Monitor for pig signs while conducting other management actions in the fence.

Management Responses:

- If any pig activity detected in the fence area, implement snaring program. Snares still remain within the MU. If ungulate sign is detected they will be reset.

Maintenance Issues:

There is a perimeter fence around the MU. The MU fence is small (9 acres). The largest threat to the perimeter fence is landslides. Vandalism is not a major threat due to the remote location of the fence. The fence crosses no major gulches. Monitoring for ungulate signs will occur during the course of other field activities. The fence will be kept clear of vegetation (especially grasses) to facilitate quarterly monitoring.

Weed Control

Weed Control actions are divided into 4 subcategories:

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

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

MU Vegetation Monitoring

The goals for MU level vegetation monitoring are as follows:

Primary Management Objective:

- Assess if the percent cover for both the alien understory and canopy is 50% or less across the entire management unit (Oahu Implementation Team et al. 2008). If alien species cover is not below the 50% goal, use repeated MU monitoring to determine whether or not the value of alien species is decreasing significantly toward that goal.

Secondary Management Objective:

- Assess if the percent cover for both the native understory and canopy is 50% or more across the entire management unit (Makua Implementation Team et al. 2003). If native species cover is not above the 50% threshold, use repeated MU monitoring to determine whether or not the value of native species is increasing significantly toward that goal.

Sampling Objective:

- Be 95% confident of detecting a 10% change in both non-native and native understory vegetation in the understory and canopy.
- The acceptable level of making a Type 1 error (detecting a change that did not occur) is 10% and a Type 11 error (not detecting a change that did occur) is 20%.
- Minimum detected change between two samples being compared is 10% over the sampling period.

Vegetation Monitoring Protocol Discussion:

Vegetation monitoring protocols used by OANRP in other MUs to look at the above objectives are not feasible for use at Waimano due to its small size, steepness and delicate native ecosystem. However, OANRP staff have observed qualitatively that this MU clearly meets the non-native canopy percentage goals of the OIP. Since this MU is native dominated, conducting MU level monitoring is not a priority action within the next five years and will not be conducted.

Within 50 m of rare taxa, the MIP states that staff should work towards a goal of <25% alien vegetation cover. Waimano is a small MU with widely scattered rare taxa; analysis will be conducted to see if the majority of the MU falls within a 50 m buffer around rare taxa. If so, staff will discuss the priority for monitoring this goal.

Weed Control Monitoring:

Gigapan photo points will be taken of Waimano MU. This relatively low-effort technology is a useful tool to visually document the MU. This methodology will not a replace MU level monitoring but will be used to document change over time and to help guide weed control efforts.

Objective:

- Document emerging new canopy weeds, ungulate impact (in the case of a fence breach), and significant changes to the canopy structure.

Planned Actions:

- Setup permanent Gigapan photo points in Q1 of 2012
- Re-monitor yearly

Surveys

Army Training?: No

Other Potential Sources of Introduction: OANRP staff, public hikers, rats, wind, and birds.

Survey Locations: Landing zones, camp sites, fenceline

Management Objective:

- Prevent the establishment of any new invasive alien plant or animal species through regular surveys along the fenceline, LZs, and campsites

Monitoring Objectives:

- Quarterly surveys of LZs (if used)
- Quarterly survey of campsite (if used)

- Note unusual, significant or incipient alien taxa seen during the course of regular field work.

Management Responses:

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

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Waimano currently remains unaffected by highly invasive weed species that affect other areas of the central Ko'olaus.

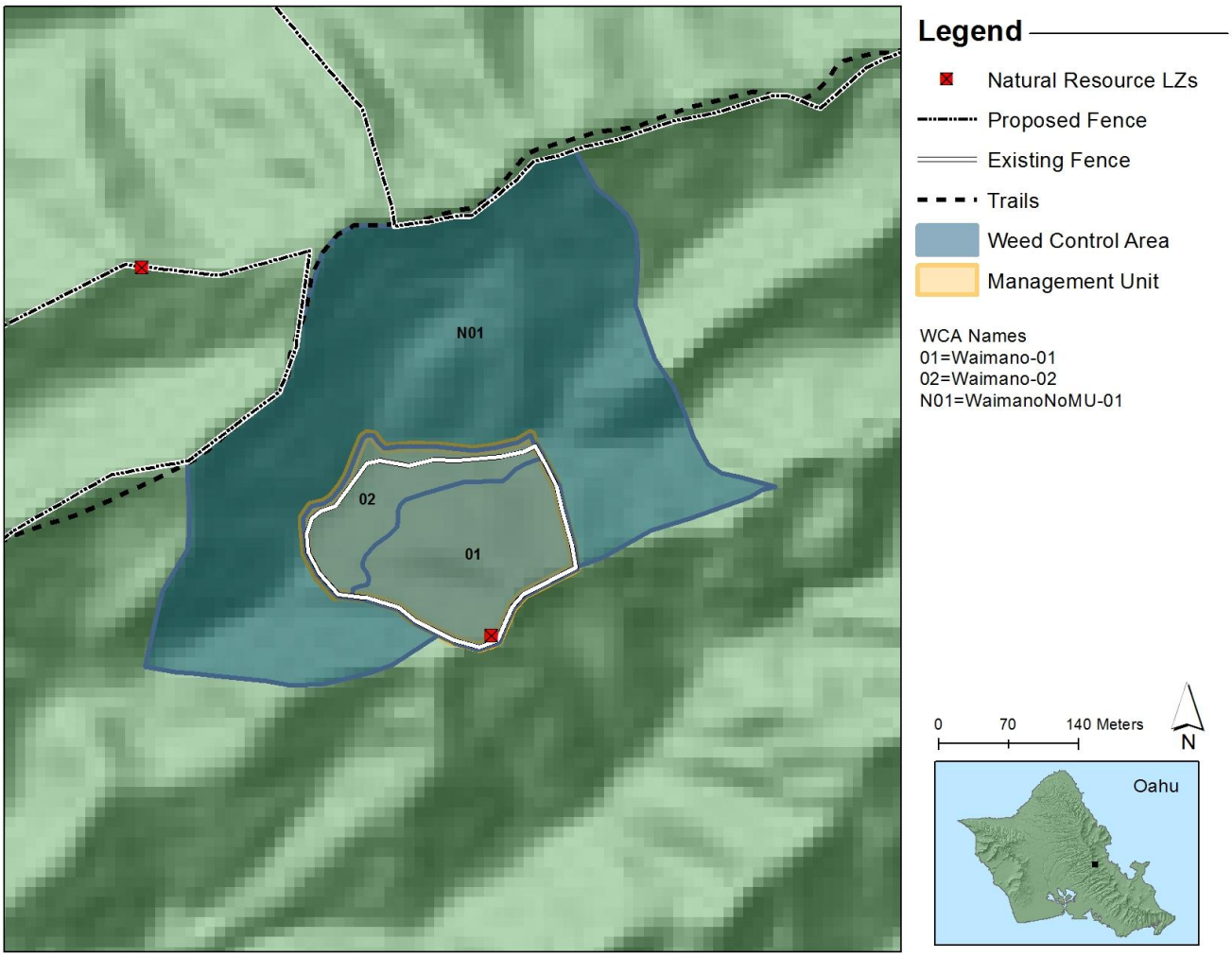
Incipient Taxa Control (ICAs)

No incipient species have been identified by OANRP in the MU, therefore there are currently no ICAs. OANRP will continue to monitor and consider regular control of novel weeds when appropriate. Additionally, a list of target weed taxa has been identified for control based on what has been found within the MU and outside the MU in the greater Waimano drainage. The table below summarizes invasive taxa at Waimano. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in the MU. Three management designations are possible: Incipient (small populations, eradicable – none identified here), Control Locally (significant threat posed, may or may not be widespread, control feasible at WCA level), and Widespread (common weed, may or may not pose significant threat, control feasible at WCA level).

Summary of Target Taxa

Taxa	Management Designation	Notes
Axonopus fissifolius	Control locally	Threat to rare plant populations will be evaluated, control options and conduct some control in the vicinity of the rare plant populations.
Citharexylum caudatum	Control locally	Several large trees found in the lower portion of the MU. Target for control when conducting WCA weeding.
Citharexylum spinosum	Control locally	Several observed by Koolau Mountains Watershed Partnership within Waimano NoMU-01. Target for control when conducting WCA weeding.
Clidemia hirta	Widespread	*C. hirta* is a well established part of the Koolau vegetation type. OANRP do not currently target it for control, except in the vicinity of rare taxa.
Ficus microcarpa	Control locally	A couple individuals observed by Koolau Mountains Watershed Partnership within Waimano NoMU-01. Target for control when conducting WCA weeding.
Heliocarpus popayanensis	Control locally	Trees have been found within Waimano NoMU-01. Target for control.
Psidium cattleianum	Control locally	Patches scattered along lower portion of MU. This is a primary target during weed sweeps. The largest and thickest stands are in gulches and draws.
Psidium guajava	Control locally	Several large trees found in the lower portion of MU with one individual found in Westernmost gulch within MU. Target for control when conducting weed sweeps.
Schefflera actinophylla	Control locally	This is a high priority for control. Several small plants found in the lower portion of the MU.
Spathodea campanulata	Control locally	Trees have been found within the MU. Target for control with the primary focus on mature individuals.
Sphaeropteris cooperii	Control locally	One small plant found in MU. If found, target during weed sweeps.

Weed Control Areas



Ecosystem Management Weed Control (WCAs)

OIP Goals:

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

Management Objectives:

- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Maintain 50% or less alien canopy cover across the MU.
- In WCAs within 50m of rare taxa, maintain 25% or less alien vegetation cover in understory and canopy.

Management Responses:

- No monitoring is in place for any of the OIP goals. Instead, gigapan photo points will be installed to detect novel alien canopy weeds, which will be a priority for control.

- If monitoring for any OIP goal is installed, and if results suggest goals are not being met, staff will increase/expand weeding efforts.

Waimano is dominated by native taxa, and most likely meets the goal of < 50% cover of alien vegetation across the MU. It may also meet the < 25% alien cover goal, but this is uncertain. The major canopy weed threat in the MU is *P. cattleianum*, which has the potential to form dense monotypic stands and is a dominant presence in other areas of the Koolau Mountains. In order minimize impact to the native ecosystem, the MU will be comprehensively and carefully swept utilizing low impact techniques. Weed control will focus on conducting short ground sweeps from the gulch up to the steep uluhe (*Dicranopteris linearis*) band (Waimano-02). The upper portion (Waimano-01) will be surveyed by traveling down the subridges using binoculars to spot target weeds. Any targets detected, including shrubs such as *C. hirta*, will be located and killed. The entire MU has been divided into two Weed Control Areas (WCAs) to assist in tracking and scheduling control efforts. It is not clear whether Waimano meets the < 25% alien cover around rare taxa goal.

WCAs: Waimano-01

Veg Type: Wet Montane

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

Targets: *Axonopus fisifolius, Citharexylum caudatum, Psidium cattleianum, Psidium guajava, Spathodea campanulata, Schefflera actinophylla, Sphaeropteris cooperii*

Notes: Waimano-01 encompasses the upper area of the MU including the upper fence line. It is predominantly native and is comprised of three steep subridges and four steep subgulches. The wild and reintroduced *C. st.- johnii* populations are found in this WCA. Some control has been conducted but no comprehensive sweeps have been done. The WCA will be swept by traversing down the subridges using binoculars to scan the drainages for target weed species and to avoid unnecessary trampling through sensitive vegetation. Understory weeding may be conducted around the reintroductions as needed. Since management began in this MU, one *S. cooperii* and one *P. guajava* were found and controlled in the westernmost drainage.

WCA: Waimano-02

Veg Type: Wet Montane

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

Targets: *A. fisifolius, C. caudatum, P. cattleianum, P. guajava, S. campanulata, S. actinophylla, S. cooperii*

Notes: Waimano-02 encompasses the lower portion of the MU from the gulch bottom to the steep uluhe band about 50m above. The WCA includes the lower fenceline. This area was impacted by pigs before fencing and was invaded by some target weeds, primarily *C.hirta*. Organized sweeps will be conducted to achieve the OIP goal of 25% or less alien cover as *E. rockii* and *C. koolauensis* are found in this WCA. Some *P. guajava, P. cattleianum,* and *C. caudatum* were controlled in WCA-02 while conducting rare plant monitoring. Special care needs to be made when controlling these targets as the cut stems will re-root if they are left to make contact with the ground.

WCA: WaimanoNoMU-01

Veg Type: Wet Montane

OIP Goal: N/A

Targets: *C. caudatum, H. popayanensis , P. cattleianum, P. guajava, S. campanulata, S. actinophylla, S. cooperii*

Notes: Waimano No MU is about three times the size of the managed Waimano unit. It was created as a buffer around the MU to assist in data tracking of incidental weed control that takes place outside the MU boundaries. Target weeds may be controlled opportunistically in this buffer to keep them from spreading into the MU where there is a zero tolerance for their occurrence. This WCA is of secondary priority.

Rodent Control

Species: *Rattus rattus, Mus musculus*. Plant species vulnerable to rodent predation may include: *C. koolauensis, C. st.- johnii, C. humboldtiana,* and *E. rockii*. Rodent damage on IP taxa at Waimano is undetermined.

Threat level: Where rodent predation on IP taxa is detected, threat may be high. More investigation is necessary to determine threat level. OANRP will respond with rodent control if predation is observed to be a significant threat.

Current control method: Currently no rodent control is conducted at Waimano. If rodents are deemed a threat to IP taxa, rodent control will likely be localized around the resource being protected and extend slightly beyond the boundaries of the population. Possible localized rodent control methods include the use of rodenticide baiting grids, snap trap grids, or automatic self-resetting traps.

Seasonality: Year round or during susceptible species' fruiting season.

Number of control grids: None at this time.

Acceptable Level of Activity: No control program planned currently. If IP taxa are threatened, 20% or less predation is acceptable.

Primary Objective: To limit rodent predation on susceptible IP taxa to less than 20% by the most effective means possible.

Monitoring Objective: To detect rodent predation on IP taxa where it occurs. Monitor rodent predation on resources to help determine management needs.

If rodent control is deemed necessary, the following monitoring tools may be implemented:

- Monitor changes in the rat population via tracking tunnels, chew tabs, bait take, or catch data.
- Monitoring positive effects on rare resources via census counts, sampling, incidental observations, etc.
- Monitoring changes of other ecosystem parameters, such as arthropod diversity/abundance, seedling diversity/abundance, plant composition in various vegetation types.

Management Objective: If rodent predation on IP taxa is discovered to be a high threat, a management plan that includes localized rodent control around impacted populations or individual plants will be instituted. MU wide rodent control is often desirable to protect the ecosystem as a whole but this is not feasible due to funding limitations, steep terrain and dense vegetation. Automatic self-resetting traps may be the best tool to control rats at Waimano due to accessibility limitations. Automatic traps require less

frequent maintenance and kill up to 24 rats per trap. Protocols for using automatic rat traps in Hawaii are currently being developed.

Slug Control

Species: Slugs (multiple species assumed present but no collections to date)

Threat level: High

Current control method: Localized

Seasonality: Wet season (September-May)

Number of species affected: *C. koolauensis, C. st.- johnii, C. humboldtiana, E. rockii* and *L. koolauensis*

Acceptable Level of Activity: No control program planned currently and threshold not determined for threats.

Primary Objective:

- Reduce slug population to levels where germination and survivorship of rare plant taxa are unimpeded.

Monitoring Objective:

- During annual plant monitoring, record whether slug damage is present (chewed leaf margins, slime trails on vegetation).

Management Objectives:

- If slug numbers are high enough to damage native plants, survey areas for the presence of rare snails. If no rare snails are present, begin slug control using Sluggo at the label rate.
- Additional threats will be assessed and control options weighed.

Ant Control

Species: No collections to date

Threat level: Unkown

Control level: Only for new incipient species

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

Number of sites: No ants have been observed at Waimano. Suggested sites to survey in the future are the Waimano LZ, Waimano campsite, the *C. st-johnii* reintroduction site, and the Waimano watertank.

Acceptable Level of Activity: Unknown

Primary Objectives:

- Determine what ant species are present and monitor these sites over time.

Monitoring Objective:

- Sample ants at human entry points at the LZ and campsite. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions. Ants are unlikely to be a problem here due to wet conditions.

Management Objective:

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

Fire Control

Threat Level: Low

Available Tools: Fuelbreaks, visual markers, helicopter drops, wildland fire crew.

Management Objective:

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

Preventative Actions**:**

Waimano is a wet montane forest with a very low threat of fire. No preventative actions are needed.

Action Table

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
General Monitoring	Set-up permanent Gigapan photo points in Q1																				
General Survey	Survey Manana Crestline LZ (#118) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Waimano Manuka site LZ (#117) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Waimano Water tank LZ (#156) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey Waimano St. johnii LZ (#157) whenever used, not to exceed once per quarter. If not used, do not need to survey.																				

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Survey within exclosure to ground-truth locations of WCAs and identify possible ICAs.																				
Waimano-01	Control weeds along fencelines whenever fence is walked/twice a year. Fence is primary ingress point for weeds to the high quality native forest within.																				
	Conduct weed sweeps for Psicat, Helpop, SphCoo and any other weedy trees. Sweep entire WCA in a year. Resweep every 3-5 years.																				
Waimano-02	Conduct weed sweeps across gulch bottom for Psicat, Helpop, SphCoo and any other weedy trees. Control Clihir as second priority. Control weeds along fencelines whenever fence is walked. Sweep entire WCA annually.																				
Waimano No MU-01	Control significant target weeds found while working in area. Signifcant target weeds include but are not limited to: HelPop, SphCoo, AngEve,																				

Action Type	Actions	MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016				MIP Year 13 Oct 2016-Sept2017			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	other habitat altering taxa. Prevent these weeds from invading Waimano MU fence.																				
Ungulate Control	Quarterly monitoring of fence line																				
Rodent Control	Survey rare resources for rat damage																				
Ant Control	Annual monitoring for ants at Waimano LZ and Waimano campsite.																				
Slug Control	Monitor rare plants for signs of slug damage																				
	Deploy slug bait around susceptible plant population(s) during wet season																				

Hatching=Quarter Scheduled

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CHAPTER 2: FIVE YEAR RARE PLANT PLANS

2.1 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.
- **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.
- **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.
- **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.
- **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.
- **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

Abutilon sandwicense

- **Scientific name:** *Abutilon sandwicense*
- **Hawaiian name:** Ko`oloa
- **Family:** Malvaceae
- **Federal status:** listed endangered on October 29, 1991
- **Requirements for OIP Stability**
  - 4 Population Units (PU) (4 due to presence in both Makua and Oahu AAs)
  - 50 reproducing individuals in each PU (short-lived perennial)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
  - Tier 1 stabilization priority

- **Description and biology:**
  - **Habit**- *Abutilon sandwicense* is a large shrub or a tree. Its branches grow to up to 10 m (33 ft) long (Degener 1932). The plant is covered with white to yellowish stellate hairs and glandular tomentulose pubescence. For the purposes of the OIP, *A. sandwicense* is categorized as a short lived plant (<10 year life span).
  - **Leaves**- The leaf blades are cordate-ovate to cordate-orbicular in shape, and measure 8-22 cm (3.1-8.7 in) in length.

Modified from: Oahu Implementation Plan, 2008. Oahu Army Natural Resource Program.

Abutilon sandwicense

- **Description and biology continued:**
  - **Flowers-** The pendulous flowers are solitary in leaf axils. The petals are 4-5 cm (1.6- 2 in) long and 1.4-2 cm (0.55-0.79 in) wide at the distal end, yellowish green to reddish in color, and extend beyond the calyx. The flowers of *A. sandwicense* are large and showy, suggesting that the original pollinating agent of the species may have been nectar-feeding birds. Currently, introduced honeybees can be observed visiting flowers. Flowering can be observed at any time of the year, but the peak flowering months are April through June. Petals can be bright green to reddish brown with green veins.

  - **Fruit-**The fruits are vase-shaped capsules 17-25 mm (0.7-1.0 in) long comprised of 8-10 mericarps. Each mericarp contains several seeds.

  - **Seeds**-The dull brown seeds are sparesely pubescent, up to 3 mm (0.1 in) long, and are triangular-reniform in shape. The seeds are probably viable for years, as are many Hawaiian Malvaceae species. Dispersal agents for this species are unknown. Reproduction in this species is primarily by seed . Cultivated plants usually take at least 3-4 years to reach maturity (Lau pers. comm.).

  - **Distribution:** *Abutilon sandwicense* is endemic to the Waianae Mountains of Oahu between Puu Palehua and Kahanahaiki Valley. It occurs on both the windward and leeward sides of the range, from 293-732 m (960-2,400 ft) in elevation.

Modified from: Oahu Implementation Plan, 2008. Oahu Army Natural Resource Program.

Abutilon sandwicense

- **Population trends:** Only a few population sites have been tracked for more than a few years. Some have increased in population size, and others have decreased. Initial observations of plants at the Huliwai (HUL-A), North Mikilua (MIK-A), and Halona (HAL-A) sites in 1994 were of just a few individuals. Subsequent observations have documented an increase in the number of immature plants at these sites suggesting that reproduction was continuing or new plants continued to emerge from the soil seed bank. Population trends have been difficult to determine due to intermittent monitoring, infrequent flowering and inconsistent observers which can make it difficult to differentiate increases in known sites from increases due to finding new plants. As monitoring of sites becomes standardized and regular, population trends may be able to be determined. Also, seedlings observed within these PUs may have been misidentified as *A. sandwicense* but actually be *A. grandifolium*. Pictures of the two taxa are included below to help staff discriminate between them in the future.

  Population estimates of the Kaawa to Puulu PU shown in the Population Estimate History Table below show that the total number of mature and immature individuals known in 2005 (118) had declined by about 6% by 2012 (110). However, these data do not fully reflect the decline from initial estimates at most known sites, a reclassification of immature plants to mature plants based on size class, and the discovery of several new sites. These are significant as little reproduction has been observed within the PU and the transition from immature to mature plants is only based on size class. This suggests that the plants noted as immature may actually be mature, meaning that there may be population structure may be even less than the current data suggest. At nine of the thirteen sites known before 2010, the number of plants has been documented to decline. Only a single site known before 2010 (ALI-B) has the number of plants been observed to increase. Since 2010, three new sites with a total of seven plants have been discovered increasing the total for this PU by 6%.

Modified from: Oahu Implementation Plan, 2008. Oahu Army Natural Resource Program.

Abutilon sandwicense

- **Habitat:** *A. sandwicense* grows on gulch slopes and in gulch bottoms in dry to dry-mesic forests, which are commonly dominated by the native trees lama (*Diospyros sandwicensis*), lonomea (*Sapindus oahuensis*), and/or wiliwili (*Erythrina sandwicensis*). Other common associated species include mehame (*Antidesma pulvinatum*), nioi (*Eugenia reinwardtiana*), kokio keokeo (*Hibiscus arnottianus*), kolea (*Myrsine lanaiensis*), olopua (*Nestegis sandwicensis*), mamaki (*Pipturus albidus*), papala kepau (*Pisonia sandwicensis*), hoawa (*Pittosporum* spp.), halapepe (*Pleomele forbesii* and *P. halapepe*), alahee (*Psydrax odorata*), hao (*Rauvolfia sandwicensis*), and ohe makai (*Polyscias sandwicensis*).

- **Taxonomic background:** There are four species of *Abutilon* native to Hawaii. Three are endemic to Hawaii (*A. sandwicense*, *A. menziesii* and *A. eremitopetalum*), and one also occurs naturally outside Hawaii (*A. incanum*). Two of the endemic species (*A. menziesii* and *A. sandwicense*), are listed as endangered. Three of the native *Abutilon* are known to occur on Oahu: *A. sandwicense*, *A. menziesii,* and *A. incanum*.

Modified from: Oahu Implementation Plan, 2008. Oahu Army Natural Resource Program.

Selected Historic Collections of *A. sandwicense*

Area	Year	Collector	Pop. Reference Code/Notes
Kauhiuhi	1932	Christophersen, E.	"var. welchii"
Manuwai	1932	Russ, G.W.	E. slope at FR fence, (Near ANU-D)
Manuwai	1932	Degener, O.	Holotype (near ANU-D). "Weed covered rocky partly forested slope"
Makaha	1933	Russ, G.W.	Makaha Makai PU
Ekahanui	1939	Bush, W.	EKA-A
Kanehoa	1939	Caum, E.L.	May be HUL-A
Kaomokunui Gulch	1955	St.John, H.	Green petals
Kamaohanui-Pane	1969	Herbst, D.R.	Dark Yellowish petals
Makaleha	1975	Herbst, D.R.	
Makaha	1986	Lau, J.	Makaha Mauka PU
Palikea Gulch	1986	Obata, J.	
Nanakuli	1987	Perlman, S.	
Palikea Gulch	1987	Perlman, S.	
Waianae Kai (Kawiwi)	1987	Perlman, S.	WAI-A
Waianae Kai (Kawiwi)	1992	Obata, J.	WAI-A. Red petals
Palikea Gulch		Degener, O.	#6040

Data compiled from Bishop Museum Herbarium Records provided by Clyde Imada 2011.

Habitat and wild plants in the Kaawa to Puulu PU

Plants grown from clones of the single wild plant from the Kahanahaiki PU


Flowering plants in the Makaha Makai PU
Seedling
Seeds
Mature Fruit
Mature Fruit


A. sandwicense vs. A. grandifolium (weed)
Forest & Kim Starr
Kaluaa Outplanting of Huliwai Stock

Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
Kaawa to Puulu	Feb	No Obs.	Sep	Hermaphroditic	Insect or Bird	Unknown	PY+PD
Kahanahaiki	No Obs.	No Obs.	No Obs.	Hermaphroditic	Insect or Bird	Unknown	PY+PD
Ekahanui and Huliwai	Apr-Jul	Jul-Sep	Jul-Oct	Hermaphroditic	Insect or Bird	17 ± 5 (EKA) 11 ± 5 (HUL)	PY+PD
Makaha Makai	Apr-Jul	Jul-Oct	Jul-Oct	Hermaphroditic	Insect or Bird	19 ± 9	PY+PD

- The Kahanahaiki founder (MMR-A-1) has only been observed to be reproductive in the nursery. Neither the wild plant nor any outplanted clones were observed to flower. We have, however, observed plants of this stock flowering in the nursery in March. No fruit were produced.
- It is currently assumed that the breeding system, suspected pollinator, and seed dormancy would be consistent regardless of PU. If future data indicate otherwise, the table will be updated accordingly.
- PY+PD = Physical and physiological dormancy. Seeds are water impermeable and require scarification prior to germination. Seeds, however, do not germinate immediately following scarification. It is uncertain if it is a physiological, morphological, or combinational mechanism inhibiting germination. Studies continue to determine the length of time in storage that will yield maximum germination following scarification, as well as whether or not the mechanism is morphological (the embryo is not fully developed at the time of seed maturation).

Habitat Characteristics for *In Situ* Sites in MFS PU

PU	*in situ* PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)	Average Annual Max. Temp. (F)
Kaawa to Puulu	AAW-A	1700	Moderate	Open – Closed	Lower - Mid Slope	NW	1665	75
	ALI-A,B,C,D	900-1600	Moderate	Open – Closed	Lower - Mid Slope	NE, WNW, E, NW, NW	1265-1347	76.33-77
	ANU-A,B, C,D,E,F,G, H,J	1000-1500	Mod. - Steep	Open - Closed	Lower - Upper Slope	Varies: N, E, W NE, NW, WNW	1304-1416	77-78
	IKI-A	1100	Steep	Open	Mid Slope	NW	1345	78
	IMU-A	1500-1700	Mod. - Steep	Intermediate	Mid Slope - Gulch Bottom	NW	1358	77
	KIH-A	1100	Mod. - Steep	Intermediate	Lower - Mid Slope	N	1191	78
Kahanahaiki	MMR-A	1160	Steep	Closed	Lower Slope	NW	1490	78
Ekahanui & Huliwai	EKA-A	1900	Mod. - Steep	Intermediate	Mid Slope	NW	1154	76
	HUL-A	1900	Mod. - Steep	Closed	Mid Slope	SE	1193	76.33
Makaha Makai	KAM-A	2500	Flat	Closed	Gulch Bottom - Lower Slope	N	1366	75
	MAK-B	1600	Moderate	Intermediate	Upper Slope	N	1648	76.80
	MAK-C	1800	Moderate	Open	Lower Slope	NW	1707	75
	MAK-D	2000	Flat - Mod.	Intermediate	Gulch Bottom	NW	1826	77

Information was compiled from OANRP observation forms & GIS data; Temperature and rainfall data complied from PRISM Climate Group (PRISM 2004). PRC = Population Reference Code.


Map removed,
available upon request

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Kaawa to Puulu	in situ	OIP	Manuwai
Kahanahaiki	extirpated and reintroduction*	MIP	Kaluakauila & Kahanahaiki II
Ekahanui and Huliwai	in situ and augmentation	None	Ekahanui I & III
Makaha Makai	in situ	None	Makaha Makai
Genetic Storage Population Units			
Kaluakauila	Reintroduction	MIP	Kaluakauila MU
Keaau	in situ	MIP	None
East Makaleha	in situ	None	None
Halona	in situ	None	Navy PU fence
Makaha Mauka	in situ	None	None
Nanakuli	in situ	None	None
North Mikilua	in situ	None	Navy PU fence
South Mikilua	in situ	None	None
Waianae Kai	in situ	None	Some in Waianae Kai MU
West Makaleha	in situ	None	None

*= outplanting not started yet

Population Structure

- Some population structure has been observed at the larger PUs. Small and large immature plants have been observed at the Makaha Makai, Makaha Mauka, Kaawa to Puulu and Ekahanui and Huliwai PUs. These are the PUs with many mature plants, but seedlings are rarely seen at any of the PUs. It is not known how long an individual plant will take to mature. See Population Trend notes above for more background on the Population Structure observed in each PU.

- The Kaawa to Puulu PU has rarely been observed flowering and it is unknown what influence this has had on the lack of population structure at this PU. OANRP has one record of the plants in Palikea Gulch flowering in February 1999. Hawaii Biodiversity and Mapping Program records indicate that Steve Perlman observed plants with flowers and fruits in Palikea Gulch in June 1987. Management at this PU has not been as frequent compared to OANRP observations of plants in other PUs and this lack of data makes the phenology more uncertain. It is also uncertain if infrequent and/or low flowering is a recent phenomenon or has always occurred in these populations. As management in this area increases, we are hopeful that observations of flowering will be made. These will be used to guide collection times and help to determine the likelihood that sufficient population structure will develop as ungulate threats are removed from the Manuwai MU.

Population Estimate History

Population Monitoring History							
	2005	2006	2008	2009	2010	2011	2012
Manage For Stability Population Units (number of matures/immatures/seedlings)							
Kaawa to Puulu	34/84/0		36/88/6	31/77/5	47/72/2	52/69/2	55/55/1
Kahanahaiki	0/0/0						0/0/0
Ekahanui and Huliwai	17/15/0	16/31/0	14/30/0	16/28/0	14/27/11	14/29/0	17/24/0
Makaha Makai	50/7/0		73/27/6			71/51/1	54/43/1
Genetic Storage Population Units (number of matures/immatures/seedlings)							
Kaluakauila	0/6/0	0/22/0	0/21/0	0/19/0	0/13/0	0/7/0	0/7/0
Keaau	1/0/10						1/0/10
East Makaleha	2/2/40						0/0/0
Halona	1/4/0						No data
Makaha Mauka	40/100/0		5/58/4				10/51/0
Nanakuli	30/0/0						No data
North Mikilua	2/39/0						9/11/0
South Mikilua	4/0/0						No data
Waianae Kai	15/17/0	2/0/0					2/1/0
West Makaleha	0/2/0						0/0/0

Monitoring Plan

- All *in situ* sites in MFS PUs will be monitored 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 seedlings and all new juvenile plants 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 will be monitored annually in the winter (January-March) 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. The total number of mature recruits per total number of plants outplanted will be used to guide the number of outplants needed to establish 50 mature recruits. The goal is to be able to have continual replacement of at least 50 mature plants in the hopes that stable population structure will be reached. Additional monitoring may be needed to observe the plants in flower or fruit since this is not expected during the winter census monitoring.

- Plants in the Kaawa to Puulu MFS PU will be monitored quarterly until flowering is observed and phenology can be documented. A select group of *in situ* sites will be selected and visited while conducting other management in the area.

- Several of the genetic storage PUs have not been observed in many years and will be visited over the next few years to determine if any plants are extant. These sites are a lower priority and will be visited while conducting other management as much as possible.

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 Banking: -18C & 20% RH	5*	Yes	In situ and Reintroductions

*No decline in viability after four years of storage. This is the longest known time period that this taxon has been stored. The congener, *A. menziesii*, also shows a similar storage trend.

Genetic Storage Plan Comments:

- Seeds are water impermeable and require scarification to germinate. Seeds likely show combinational dormancy, as seeds do not germinate immediately after scarification and often rot when seeds are collected, scarified, and sown within several weeks. Germination rates have never been greater than 20% within the first year after collection, and are often 0%. Due to some level of combinational dormancy, current protocols include storing seeds dry and frozen for one year prior to sowing to promote increased germination within a shorter time period so seedlings can be propagated in cohorts.
- There is concern of hybridization with *A. grandifolium* (alien) as both species occupy similar habitat and can be seen growing together at most PUs. Concern should be had for collecting fruit where *A. grandifolium* could have been flowering in the vicinity at the same time. Hand-pollination crosses could be performed to quantify possibility for hybridization. No hybridization has yet been detected in plants grown from seed collected from sites with both taxa. Weed control will be directed at removing *A. grandifolium* from sites with *A. sandwicense*.
- An insect, *Niesthrea louisianica* Sailer (Rhopalidae), introduced for bio-control on *Abutilon theophrasti*, is known to reduce seed viability by 98% in this taxon (Patterson et. al. 1987). While we have seen substantial damage to seeds of *Hibiscus brackenridgei* subsp. *mokuleianus* in Makua from *N. louisianica*, we have yet to observe damage to seeds of *A. sandwicense*. OANRP seed lab staff will continue to monitor fruit collections for this insect.
- A living collection in the nursery and at gardens will be established to secure clones of the single Kahanahaiki plant and be used as stock for cuttings and hand-pollination attempts.

Reintroduction Plan

Manage for Stability Population Units	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
Kaawa to Puulu	TBD*	TBD	Immature Plants	AAW, ALI, ANU, IKI, IMU, KIH	~50	25-100cm	6 inch or ½ gallon
Kahanahaiki	MMR-D*	100	Mature Plants	MMR-A-1	1	25-100cm	6 inch or ½ gallon
Ekahanui and Huliwai	EKA-C*	100	Immature Plants	EKA-A, HUL-A	~20	25-100cm	6 inch or ½ gallon
Makaha Makai	MAK-F*	100	Immature Plants	KAM-A, MAK-B, MAK-C, MAK-D	~50	25-100cm	6 inch or ½ gallon

*=reintroduction not started yet

- Outplantings will be conducted using nursery plants grown from wild collected seeds and cuttings from the Kahanahaiki plant. Seeds from stored collections from the Makaha Makai PU and the Ekahanui and Huliwai PU will be used to augment those PUs. Since only a single plant has ever been observed in the Kahanahaiki PU, clones of that individual will be used to establish that PU. In order to secure more founders for this PU, efforts will be made to locate additional plants to incorporate into the Kahanahaiki outplanting. If no additional founders are discovered and reproduction on plants in outplantings or living collections is not observed within the next five years, other strategies will be proposed to achieve stability goals.
- The Kaluakauila outplanting of the Kahanahaiki stock was initially established in 2005 with six plants. It was supplemented with additional plants annually from 2006 to 2008. None of the plants were observed to flower at the outplanting site and most have been noted to be in 'Poor' or 'Moderate' health since being planted. There are currently seven of the 22 outplants remaining at the sites and two were observed to be healthy in 2012. Since the outplanting sites occur in areas that are lower in elevation and drier than the original wild site, the decision was made to postpone additional planting here in favor of another site with more favorable conditions.
- Outplantings at the Kaawa to Puulu PU and Makaha Makai PU may be needed if population structure fails to develop once ungulates are controlled. The need for outplanting to achieve and sustain stability goals will be determined in OIP Year 8. Data from census monitoring of the tagged mature and immature plants and observations of seedlings will be used to determine if these PUs will require outplanting to meet and sustain stability goals. Population data will be revised as individual plants are revisited and determined to be mature or immature.
- Outplantings will be conducted in the winter (January-March) in sites selected by staff from OANRP, Board of Water Supply and State of Hawaii where applicable. Planting holes will be made with an auger where possible. Follow-up watering will be done as needed through the summer following planting and then stopped.

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	Black Twig Borer	Are Genetic Storage goals met?
Kaawa to Puulu	Yes	No	No	No	No	No	No	No	No
Kahanahaiki	No	No	No	No	No	No	No	No	Yes
Ekahanui and Huliwai	No	No	Partial (71%)	No	No	No	No	No	No
Makaha Makai	Yes	No	No	No	No	No	No	No	No

5 Year Action Plan

	Proposed Actions for the following years:				
Manage for Stability Population Units	OIP YEAR 6 October 2012 – September 2013	OIP YEAR 7 October 2013 – September 2014	OIP YEAR 8 October 2014 – September 2015	OIP YEAR 9 October 2015 – September 2016	OIP YEAR 10 October 1 2016- September 2017
Kaawa to Puulu	•Monitor/Collect	•Monitor/Collect	•Monitor/Collect •Determine if augmentation is needed	•Monitor/Collect •Begin augmentation if needed	•Monitor/Collect •Complete augmentation if needed
Kahanahaiki	•Construct fence •Begin reintroduction •Monitor annually	•Continue reintroduction •Monitor annually	•Complete reintroduction •Monitor annually	•Monitor annually	•Monitor annually
Ekahanui and Huliwai	•Continue augmentation •Monitor/Collect	•Continue augmentation •Monitor/Collect	•Complete augmentation •Monitor/Collect	•Monitor/Collect	•Monitor/Collect
Makaha Makai	•Monitor/Collect •Construct Fence	•Monitor/Collect	•Monitor/Collect •Determine if augmentation is needed	•Monitor/Collect •Begin augmentation if needed	•Monitor/Collect

5 Year Action Plan

	Proposed Actions for the following years:				
Genetic Storage Population Units	**OIP YEAR 6 October 2012 – September 2013**	**OIP YEAR 7 October 2013 – September 2014**	**OIP YEAR 8 October 2014 – September 2015**	**OIP YEAR 9 October 2015 – September 2016**	**OIP YEAR 10 October 1 2016- September 2017**
Keaau		•Monitor/Collect		•Monitor/Collect	
East Makaleha			•Survey		
Halona	•Monitor/Collect		•Monitor/Collect		
Makaha Mauka		•Monitor/Collect		•Monitor/Collect	
Nanakuli	•Monitor/Collect		•Monitor/Collect		
North Mikilua			•Monitor/Collect		•Monitor/Collect
South Mikilua			•Monitor/Collect		•Monitor/Collect
Waianae Kai		•Monitor/Collect		•Monitor/Collect	
West Makaleha			•Survey		

Management Discussion for *Abutilon sandwicense*

To date, OANRP management has focused on securing collections in *ex situ* storage and on constructing fence units (Ekahanhui III and Manuwai MUs) to allow for threat control and habitat management. Genetic storage collections have been prioritized for the MFS PUs with lower numbers of mature plants that may consequently need outplanting to meet OIP stability goals (Ekahanui and Huliwai, Kahanahaiki), but collections will continue from all PUs. Initial estimates for the number of plants in the Makaha Makai PU and the Kaawa to Puulu PU have been revised as management has begun in those areas and more plants are being discovered. However, observations at the known sites indicate a decline in the number of mature plants and a lack of population structure to replace mature plants. As the threats are controlled, conditions for recruitment may improve and outplanting may not be needed to meet stability goals. The next three years of monitoring data will be used to adapt management plans for outplanting in these PUs.

Outplantings have been conducted by TNC and OANRP staff in the past and the methods developed at these sites (planting technique, plant size, watering) will be used to establish outplants in the Ekahanui and Huliwai PU and Kahanahaiki PU. Construction of the MU fences needed for the Kahanhaiki PU and the Makaha Makai PU is expected within the next five years. The stability goal for the number of mature plants may be met in the next five years for all PUs if outplants survive to maturity as expected (based on monitoring of the past TNC and OANRP outplantings). Genetic storage collections will continue at all PUs as staff time allows. Priority will be given to the MFS PUs, PUs with a high fire threat, and PUs with low numbers of remaining plants.

References

- OIP 2008. Oahu Implementation Plan. United States Army Garrison, Hawaii, Directorate of Public Works, Environmental Division, Schofield Barracks, HI.
- Patterson, D.T., R.D. Coffin and N.R. Spencer. 1987. Effects of Temperature on Damage to Velvetleaf *Abutilon theophrasti* by the Scentless Plant Bug *Niesthrea louisianica*. Weed Science: 35: 324-327.
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Phyllostegia hirsuta

- **Scientific name:** *Phyllostegia hirsuta*
- **Hawaiian name:** none known
- **Family:** Lamiaceae
- **Federal status:** Listed Endangered on October 10, 1996
- **Requirements for MIP Stability**
  - 3 Population Units (PU)
  - 100 reproducing individuals in each PU (short-lived perennial)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
  - Tier 1 stabilization priority

- **Description and biology:**
  - **Habit**- *Phyllostegia hirsuta* is an erect subshrub or a vine with oppositely arranged leaves. Some of the reproduction in *P. hirsuta* is by vegetative means. The plant produces stolons that run along the ground for several centimeters. This allows a small plant to eventually form a larger clonal patch of several plants. The species is categorized as a short-lived plant (< 10 year life span) for the purposes of the Implementation Plan.
  - **Leaves**- The leaf blades are ovate, measure 17-30 cm (6.7-12 in) long and 7.3-18 cm (2.9-7.1 in) wide, and are covered with long hairs on both surfaces.

Modified from OIP 2008

Phyllostegia hirsuta

Description and biology continued:

- **Flowers-** The flowers are born in a compound inflorescence usually 10-20 cm (3.9-7.9 in) long that usually consists of a principal axis and two to several secondary, rarely tertiary, lateral branches. The corollas of the flowers are white and 7-11 mm (0.43 in) long. The flowers are presumably insect pollinated.
- **Fruit**-The nutlets are about 2.5-3 mm (0.10-0.12 in) long. Flowering occurs mainly from January through June. Seed dispersal may be effected by fruit eating birds.
- **Distribution-** *Phyllostegia hirsuta* is endemic to both the Waianae and Koolau Mountain Ranges on Oahu. The range of the species included almost the entire length of both mountain ranges. It has been found from 305-1,100 m (1,000-3,610 ft) in elevation. *Phyllostegia hirsuta* appears to be extirpated in parts of its recorded range. In the Koolau Mountains, no plants of *P. hirsuta* are known today south of South Kaukonahua Gulch in SBMR East Range. The currently known range of the species in the Waianae Mountains extends only from the Kaala area in the north to Ekahanui Gulch in the south.

- **Population trends:** There are some indications that populations of *P. hirsuta* may fluctuate in size, but more data gathered over long periods of time are needed for a confirmation of this. Population trends of most *P. hirsuta* population units (PUs)are not clear since most of the known plants have been located fairly recently, and many PUs that have been known for a long time have not been well tracked. However in the case of a colony of plants in North Palawai Gulch, the population size has definitely declined in size. When first observed in 1991, the plants were estimated to number 10-20. When the site was revisited in 1998 only two plants could be found. In several visits from 2000 on, no plants could be found at the site (Lau pers. comm. 2005).

Modified from OIP 2008

Phyllostegia hirsuta

- **Habitat:** *Phyllostegia hirsuta* in the Koolau Mountains occurs primarily in wet forests dominated by ohia lehua *(Metrosideros polymorpha)* and uluhe *(Dicranopteris linearis).* In contrast, the species in the Waianae Mountains occurs primarily in mesic forests. In both mountain ranges the species is found in gulch bottoms and on gulch slopes.
- **Taxonomic background:** There are currently 32 recognized Hawaiian species in the genus *Phyllostegia*. There are also two non-Hawaiian members of the genus, one in Tahiti and the other in Tonga (Wagner et al. 1999). *Phyllostegia hirsuta* is closely related to *P. parviflora,* which *is* also an endangered species endemic to Oahu (Wagner et al. 1999).
- **Outplanting considerations:** Herbarium specimens that appear to represent hybrids between *P. hirsuta* and *P. glabra* have been collected from the Koolau and Waianae Ranges (Wagner et al. 1999). *Phyllostegia hirsuta*'s geographical and ecological ranges broadly overlap those of several other listed endangered species of *Phyllostegia* in the Waianae Mountains, namely *P. mollis, P. kaalaensis, and P. parviflora* subsp. *lydgatei,* and the non-endangered *P. glabra* and *P. grandiflora*. Also potentially occurring with *P. hirsuta* in the Waianae Range is *P. micrantha*, which is represented by only a single herbarium specimen that was collected in 1910 in the area of Kaluaa Gulch in the southern Waianae Mountains (Wagner et al. 1999). In the Koolau Mountains, *P. hirsuta* potentially occurs with the listed endangered *P. parviflora subsp. parviflora*, as well as the non-endangered species *P. glabra, P. grandiflora,* and *P. lantanoides*. Since it is natural for these *Phyllostegia* species to co-occur with *P. hirsuta,* their presence in a given area should not preclude the outplanting of *P. hirsuta*, as long as they are not outplanted adjacent to any pre-existing wild populations of the other endangered taxa of *Phyllostegia*.

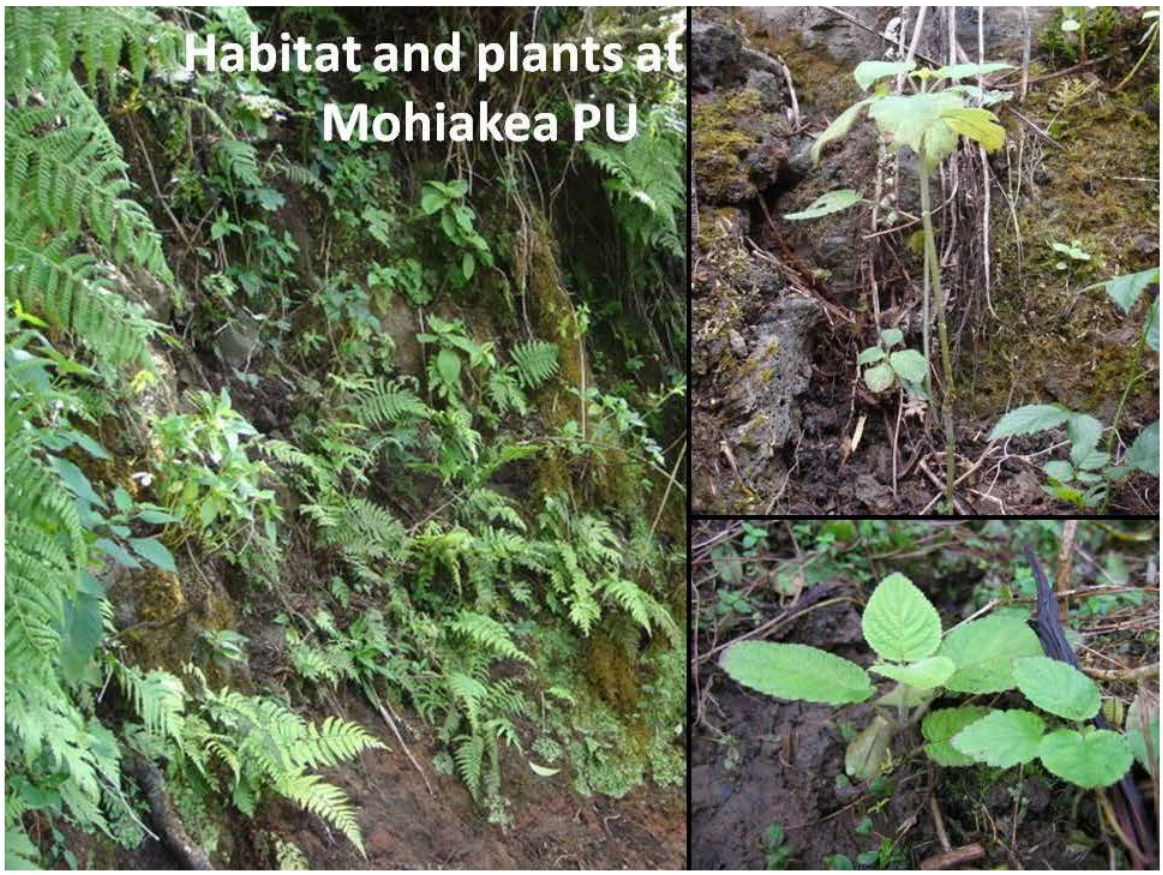
Modified from OIP 2008

Historic Collections of *P. hirsuta* in the Waianae Mountains, Oahu

Area	Year	Collector	Pop. Reference Code/Notes
Makaha	1909	Forbes, C.N.	
Makaleha	1912	Forbes, C.N.	
Haleauau	1930	Meebold, A.	
Hapapa	1930	Christophersen, E.	
Mt. Kaala	1932	Hosimoto, E.Y.	
Hapapa	1934	St.John, H.	Popouwela Ridge
Pahole	1934	St.John, H.	
Makaha	1935	St.John, H.	
Mohiakea	1936	Fosberg, F.R.	
Haleauau	1951	Degener, O.	South Haleauau
Huliwai	1960	Pearsall, G.A.	
Kaluaa (Puu Hapapa)	1970	Montgomery, S.	
Kaluaa	1982	Obata, J.	ELI-B
Huliwai	1987	Perlman, S.	HUL-A

Historic Collections of *P. hirsuta* in the Koolau Mountains, Oahu

Area	Year	Collector	Pop. Reference Code/Notes
Kipapa	1933	Hosaka, E.Y.	
Halawa	1927	Degener, O.	
Punaluu (Castle Tr.)	1931	Degener, O.	
Poamoho Trail	1993	Obata, J.	
Waikakalaua Gulch	1930	Hosaka, E.Y.	
Pupukea-Kahuku Tr.	1929	Degener, O.	Open woods near summit
Punaluu	1908	Rock, J.F.C.	
Maakua-Papali Ridge	1948	St.John, H.	
Nuuanu		Hillebrand, W.	
Palolo	1920	Garber, D.W.	
Waiahole	1919	Rock, J.F.C.	
Waikane	1931	Degener, O.	Schofield Trail
Kaluanui	1932	Hume, E.P.	
Waimano	1938	Hosaka, E.Y.	
Konahuanui		Mann, H.	
Punaluu	1932	Meebold, A.	

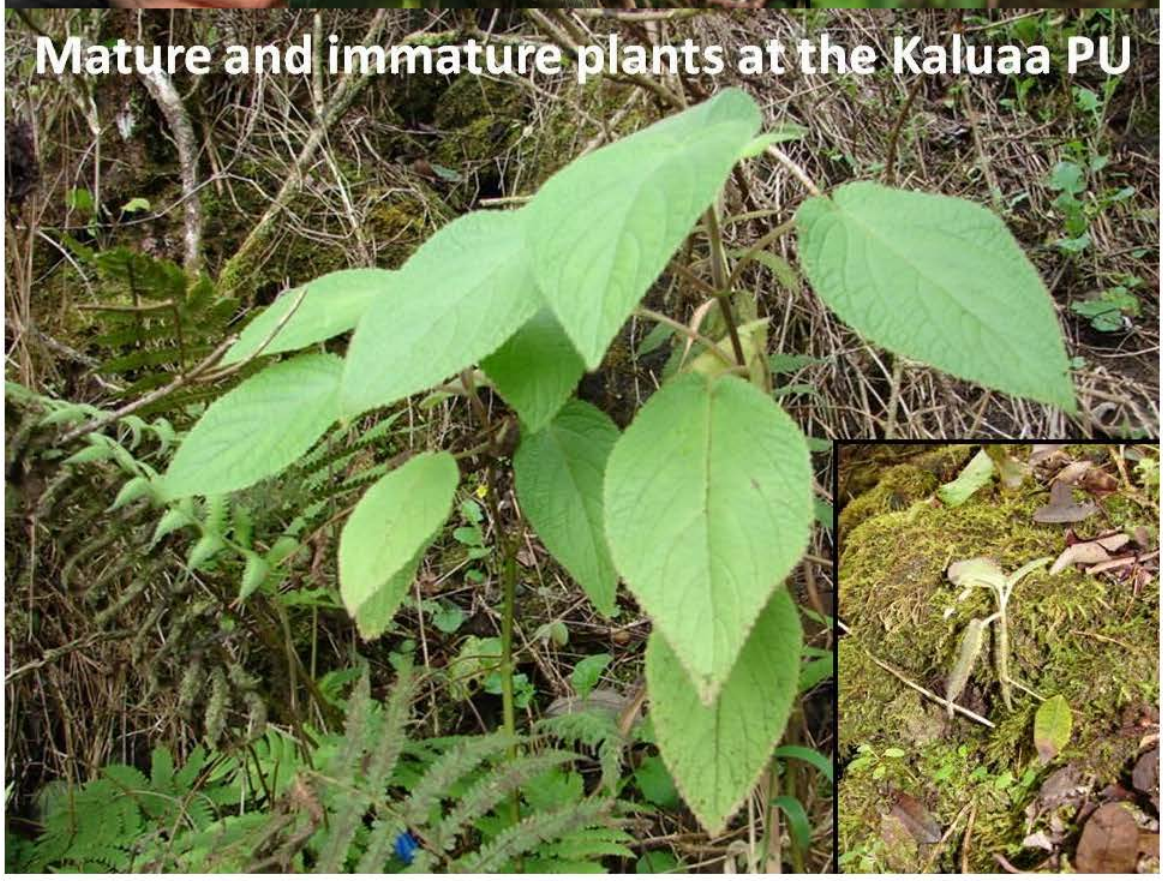


Flowering plants at the Opaeula PU

P. grandiflora, hirsuta and *lantanoides* coexist in the Opaeula PU

Photo below showing *P. grandiflora*, *hirsuta* and *lantanoides* (Left to Right)

Photo below showing *P. grandiflora*, *hirsuta* and *lantanoides* (top to bottom) contrasting the hairiness of the undersides of the leaves



Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
ALL	Jan-Mar	Mar-May	Mar-Jun	Hermaphroditic	Insect	0-4	None

- Phenology observations are consistent across all PUs. Most PUs did not have observations of reproductive plants. Plants are reproductive from January through June and there were no observations of any flowers and fruit outside this range.
- Isolated, mature plants (other vegetative plants may have been in close proximity) have had fruit that contained viable seeds, suggesting that these plants are capable of selfing. Species in the genus *Phyllostegia* have floral morphology indicative of insect pollination (Lindqvist et al. 2003).
- There is 1 seed per nutlet and 4 seeds per nut (fruit). However, seeds are not always filled.

Habitat Characteristics for Extant Sites

PU	*in situ* PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)	Average Annual Max. Temp (F)
Haleauau to Mohiakea	SBW-D	3020	Steep-Vertical	Intermediate	Mid Slope	N	1428	71
	SBW-E	3180	Steep	Intermediate	Mid Slope	N	1428	71
Laie & Puu Kainapuaa	ELE-A	2180	Moderate	Closed	Gulch Bottom	N	5086	75
	KOL-E	2280	Steep	Intermediate	Gulch Bottom	N	5196	75
	KOL-H	2160	Steep	Intermediate	Gulch Bottom	N	5208	75
Hapapa to Kaluaa	ELI-B	2620	Moderate	Intermediate	Upper Slope	NE	1233	75
	ELI-C	2700	Moderate	Intermediate	Upper Slope	NE	1244	73
	KAL-A	2520	Steep	Closed	Upper Slope	NE	1245	73
	SBS-A	2550	Steep	Open	Upper Slope	E	1244	73
	SBS-B	2500	Steep	Intermediate	Upper Slope	N	1244	73
Helemano & Opaeula	KLO-B	2750	Flat	Intermediate	Upper Slope	E	5453	73
	KLO-C	2450	Moderate	Intermediate	Gulch Bottom	N	6004	73
	KLO-E	2160	Moderate	Intermediate	Mid Slope	N	5847	75
Helemano to Poamoho	KLO-A	2440	Flat	Intermediate	Gulch Bottom	NW	5209	73
	KLO-F	2540	Steep	Open	Upper Slope	Unknown	5103	73
Kaipapau & Kawainui	KLO-J	2480	Flat	Closed	Flat	E	5690	75
	PAP-A	2220	Vertical	Intermediate	Vertical	N	5891	75
	PAP-C	2510	Moderate	Intermediate	Gulch Bottom	East	5891	75
Kaluanui & Punaluu	NUI-B	2220	Moderate	Intermediate	Upper Slope	NW	5556	73
	UNA-A	2300	Moderate	Intermediate	Upper Slope	NE	5453	73
Makaha -Waianae Kai Ridge	MAK-A		Steep	Intermediate	Upper Slope	W–NW		71

Information was compiled from OANRP observation forms and GIS data; rainfall and temperature data compiled from PRISM Climate Group (PRISM 2004).

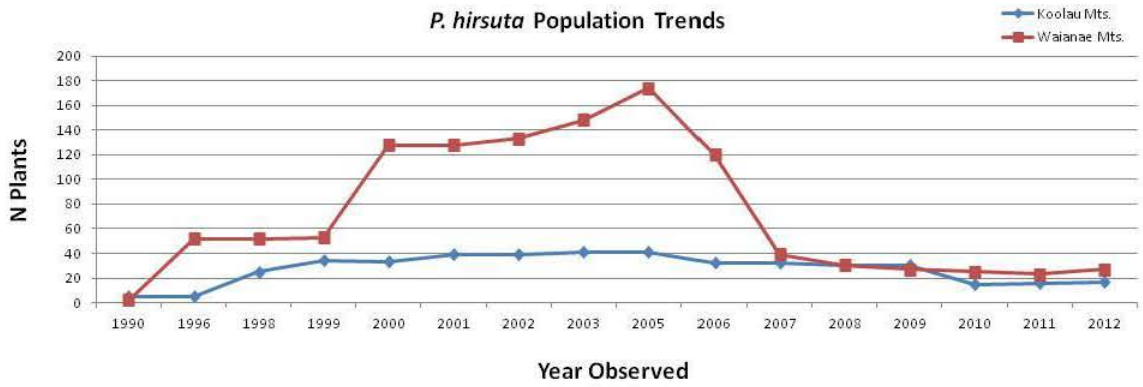

Map removed,
available upon request


Map removed,
available upon request

Population Structure

- Since observations of in situ sites began in the 1980's, there have been no examples of stable population structure that could possibly maintain >100 mature plants. It is unknown how many plants at each stage class are needed to maintain >100 mature plants in each PU. Of all the in situ PUs, only one, Haleauau to Mohiakea, has been observed to be close to the stability goal for mature plants with an estimate of 95 plants in 1996. When this site was surveyed again in 2007, no plants were observed. All of the other PUs have always had less than fifteen mature plants. The PUs in the Waianae Mountains have a few sites with many plants at each site and these sites have declined. In contrast, the PUs in the Koolau Mountains tend to be composed of many sites with only a few plants at each site. Consequently, the sites in the Waianae Mountains have seen a greater decline (see graph below).

- Seedlings have been observed to transition to immature plants and consequently to seed-bearing plants. However, the total number of plants has been declining rapidly since 2005 (see graph below). A few new juvenile and mature plants, however, have been discovered at several sites in the last few years.



Population Estimate History

	2005	2008	2009	2010	2011	2012
Manage For Stability Population Units (matures/immatures/seedlings)						
Haleauau to Mohiakea	95/25/25	6/12/0	8/10/0		12/6/0	6/7/0
Laie &Puu Kainapuaa	1/0/0	0/0/0			2/2/1	2/3/1
Hapapa to Kaluaa	9/12/0	11/9/7	3/11/3	3/10/1	1/6/0	1/2/0
Genetic Storage Population Units (matures/immatures/seedlings)						
Helemano and Opaeula	4/4/0	14/5/6	13/2/6			12/1/6
Helemano to Poamoho	2/0/0	1/0/0				1/0/0
Kaipapau and Kawainui	5/0/0	7/0/0	9/0/0			10/0/0
Kawaiiki	2/0/0	0/0/0				No data
Kaukonahua	4/2/0			0/0/0		0/0/0
Huliwai	11/10/0	0/0/0				0/0/0
Kaluanui & Punaluu	5/0/0				5/2/0	5/3/0
Makaha-Waianae Kai Ridge	2/0/0					0/1/0
Palawai	0/0/0	0/1/0	0/0/0			0/0/0
Waimano	1/0/0					No data

Monitoring Plan

- All *in situ* sites in MFS PUs will be monitored 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 seedlings and all new juvenile plants 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 annually in the winter (January-March) 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. The total number of mature recruits per total number of plants outplanted will be used to guide the number of outplants needed to establish 100 mature recruits. These numbers allow us to begin to determine how to reach replacement stability goals and stable population structure.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Seeds (cuttings in tissue culture until seeds are available)	In situ & Nursery	Seed Banking: -18C & 20% RH & Micropropagation	Unknown	No (awaiting seed production in nursery &/or reintroductions)	Reintroductions &/or Nursery

Genetic Storage Plan Comments:

- The initial goal is to collect vegetative tissue, via cuttings or divisions, from all in situ plants. These will be propagated using standard procedures in the nursery and additional collections will be made from nursery plants to establish founder lines at the Lyon Arboretum Micropropagation Lab. This species, due to the amount of microflora and microfauna that live within the hairs on the plants, has been difficult to establish in vitro. Over the last several years, OANRP and Lyon have been able to represent approximately half of the collected founders in vitro. OANRP will continue with in situ collections and in vitro establishment, as once collections are established in vitro, they are cheaper and easier to maintain than in the nursery.
- Reintroductions and/or nursery stock will be used to collect seeds for storage. For nursery stock, plants will be isolated by PU and flowers will be hand pollinated. Fruit will be collected and seeds stored. Due to the low number of available founders, propagation for reintroductions via seed germination may allow for an increase in the total amount of genetic variation and consequently increase the likelihood for the reintroduced populations to withstand environmental stochasticity.
- Seeds withstand drying and appear to be able to store via conventional methods (orthodox). Seeds of congeners *P. mollis* and *P. kaalaensis* are also orthodox. Storage testing for this species will begin once we are able to collect a large amount of seeds from reintroductions or nursery stock.

Reintroduction Plan

Manage for Stability Population Units -	Reintroduction Site(s)	Number of Plants to be planted	Propagule Type	Propagule PU Source	Number of Founders in Source PU	Plant Size	Pot Size
Haleauau to Mohiakea	ALA-A*	200	clones	All Waianae stock	13-21	15-40cm	6"
Laie and Puu Kainapuaa	KOL-A*	200	clones	All Koolau stock	4-35	15-40cm	6"
Hapapa to Kaluaa	ELI-A*	200	clones	All Waianae stock	13-21	15-40cm	6"

*= not started yet

Comments: OANRP will begin to outplant this species in 2012-2013. It is uncertain how many founders will initially be represented at the reintroductions. This will depend on how many plants are large enough to collect cuttings from before the wild plants decline and die. The minimum number of founders shown above is the number of founders currently represented *ex situ*. The maximum is how many more founders we could potentially have if we were able to collect from every current unrepresented known founder. Once clones are established in the nursery, cuttings and divisions can be used to grow plants for outplanting in two to three months. If seeds can be secured from living collections or outplantings, seed-grown stock may be incorporated into outplantings to increase in the total amount of genetic variation and consequently increase the likelihood for the reintroduced populations to withstand environmental stochasticity.

Stabilization Goals Update for MFS PUs

MFS 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?
Haleauau to Mohiakea	No	No	Partial	No	No	No	No	No	No
Laie and Puu Kainapuaa	No	No	No	No	No	No	No	No	No
Hapapa to Kaluaa	No	No	Partial	Partial (10%)	No	No	No	No	No

5 Year Action Plan

	Proposed Actions for the following years:				
Population Unit	**OIP YEAR 5 1 Oct 2012 – 31 Sept 2013**	**OIP YEAR 6 1 Oct 2013 – 31 Sept 2014**	**OIP YEAR 7 1 Oct 2014 – 31 Sept 2015**	**OIP YEAR 8 1 Oct 2015 – 31 Sept 2016**	**OIP YEAR 9 1 Oct 2016 – 31 Sept 2017**
Manage for Stability Population Units					
Haleauau to Mohiakea	•Monitor/Collect •Begin reintroduction	•Monitor/Collect •Complete reintroduction	•Monitor/Collect	•Monitor/Collect •Supplement reintroduction if needed	•Monitor/Collect
Laie and Puu Kainapuaa	•Monitor/Collect •Survey for more plants	•Monitor/Collect •Begin reintroduction	•Monitor/Collect •Complete reintroduction	•Monitor/Collect	•Monitor/Collect •Supplement reintroduction if needed
Hapapa to Kaluaa	•Monitor/Collect	•Monitor/Collect •Begin reintroduction	•Monitor/Collect •Complete reintroduction	•Monitor/Collect	•Monitor/Collect •Supplement reintroduction if needed
Genetic Storage Population Units					
Helemano and Opaeula	•Monitor/Collect	•Monitor/Collect			•Monitor/Collect
Helemano to Poamoho	•Monitor/Collect	•Monitor/Collect			•Monitor/Collect
Kaipapau and Kawainui	•Monitor/Collect	•Monitor/Collect			•Monitor/Collect
Kaluanui & Punaluu	•Monitor/Collect	•Monitor/Collect			•Monitor/Collect
Makaha-Waianae Kai Ridge	•Monitor/Collect				•Monitor/Collect

Management Discussion for *Phyllostegia hirsuta*

The overall strategy for this taxon will be to collect clones (divisions or cuttings) from wild sites to establish *in vitro* (explants) via micropropagation and for stock to be used for outplantings. All three MFS PUs need reintroductions in order to create new stable populations and meet stability goals. Reintroductions will represent all available founders from within their respective mountain range. Wild founders will be collected from all sites and established in the nursery until micropropagation collections are established. Population goals will be met by augmenting the MFS PUs with plants grown from the cloned wild stock. The genetic storage goals will be met using the micropropagation collections until reintroductions are established and mature seeds can be collected and stored. Seeds may also be collected from nursery stock propagated for outplanting. Collection trips will be prioritized in the next few years to get the remaining unrepresented founders for outplanting. Once the initial collections are made from the Genetic Storage PUs, follow-up visits may not be needed if the stock can be secured in micropropagation.

Threat control will be conducted within the MUs and will include ungulate control, weed control and slug control as needed to achieve and maintain all stability goals (slide 1). The historic sites including: Kawaiiki, Huliwai, Kaukonahua, and Palawai will be resurveyed in the next several years. If new plants are found, they will be incorporated into the plan.

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Chapter 3: *ACHATINELLA* SPECIES MANAGEMENT

3.1 INTRODUCTION

The tabular data and ESU updates are available through a distributed copy of the OANRP database, as they were last year. Please refer to Appendix ES-2 for a tutorial on how to access this data. The annual report from the University of Hawaii Tree Snail Conservation Laboratory (UHTSCL) can be found in Appendix ES-10. That report summarizes captive propagation and Jackson's chameleon (*Chamaeloeo jacksonii* subsp. *xantholophus*) study results. This chapter will update the status of snails in captive propagation at the UHTSCL, OANRPs management of predator proof enclosures, the collaborative reintroduction of snails to Puu Hapapa (Hapapa), monitoring of the reintroduced snails at Hapapa by OANRP and US Fish and Wildlife Service (USFWS), OANRP threat control within the enclosure at Hapapa and OANRP native vegetation restoration efforts at Hapapa. In addition, there is a short section on the status of the *Achatinella* population at Kahanahaiki and discussion of management direction.

3.2 CAPTIVE PROPAGATION UPDATE AND SNAIL REINTRODUCTIONS

For over one decade, OANRP has utilized the UHTSCL to maintain endangered *Achatinella* snails in captive propagation for use in the event of catastrophic loss of a field population. In 2003, based on recommendations made by the Makua Implementation Team (MIT), OANRP collected 10 snails from each of the eight *Achatinella mustelina* field locations designated for management per the Makua Implementation Plan (MIP) *A. mustelina* stabilization plan finalized in 2003. These collections experienced population increases during their first few years in captivity. This growth tapered off after 2-3 years and the populations have been in decline since (Appendix ES-10). It appears that for some *Achatinella* taxa, the current systems in the lab to sustain populations are not suitable for long-term captive rearing. Some taxa grow better at UHTSCL than others for reasons that are not clear. There are successes such as *A. lila* and *A. fuscobasis* whose populations have grown dramatically over the past fifteen years. The tree snail lab continues working to try to improve rearing conditions for tree snail taxa that have been especially challenging. Based on the recommendation of Lab staff, OANRP have ceased making additional collections of *A. mustelina* since 2008 while rearing techniques were being further investigated. On average, OANRP have spent $100 K annually in order to maintain the Army collections at the UHTSCL. OANRP cannot continue to spend this much money without more positive results and are therefore proposing a shift towards use of the lab to serve a short-term holding function.

In April 2012, a snail working group met to discuss shifting the use of the laboratory from long-term rearing to short-term (1-2 years) holding. With the recent discoveries of Jackson's chameleon predation on *Achatinella* and the field observations of them at two of the eight MIP managed sites, back- up representation offsite is more critical than ever before. OANRP collected one female Jackson from Puu Hapapa on 5 September 2012 which had five *Achatinella* shells in her gut and 22 Jackson embryos.

Consequently, OANRP propose using the UHTSCL for short-term holding. This year, OANRP negotiated the captive propagation contract in a new manner. The contract proposal for captive propagation is contained within this report as Appendix 3-1. OANRP proposes to return snails from old collections into sites where threat management has increased since the snails were removed from the wild. For example, OANRP plans to return the five progeny of the snails that came from the "Palikea Lunchspot" to a suitable site near this location which is protected within our rat control grid. After these snails are returned, ten new adult *A. mustelina* will be removed to the UHTSCL for short-term holding from a robust site within the Palikea ESU-F (likely not from the "Palikea lunchspot"). After a period of two years, these ten snails and all their progeny will be returned to the wild and a new batch of ten adult

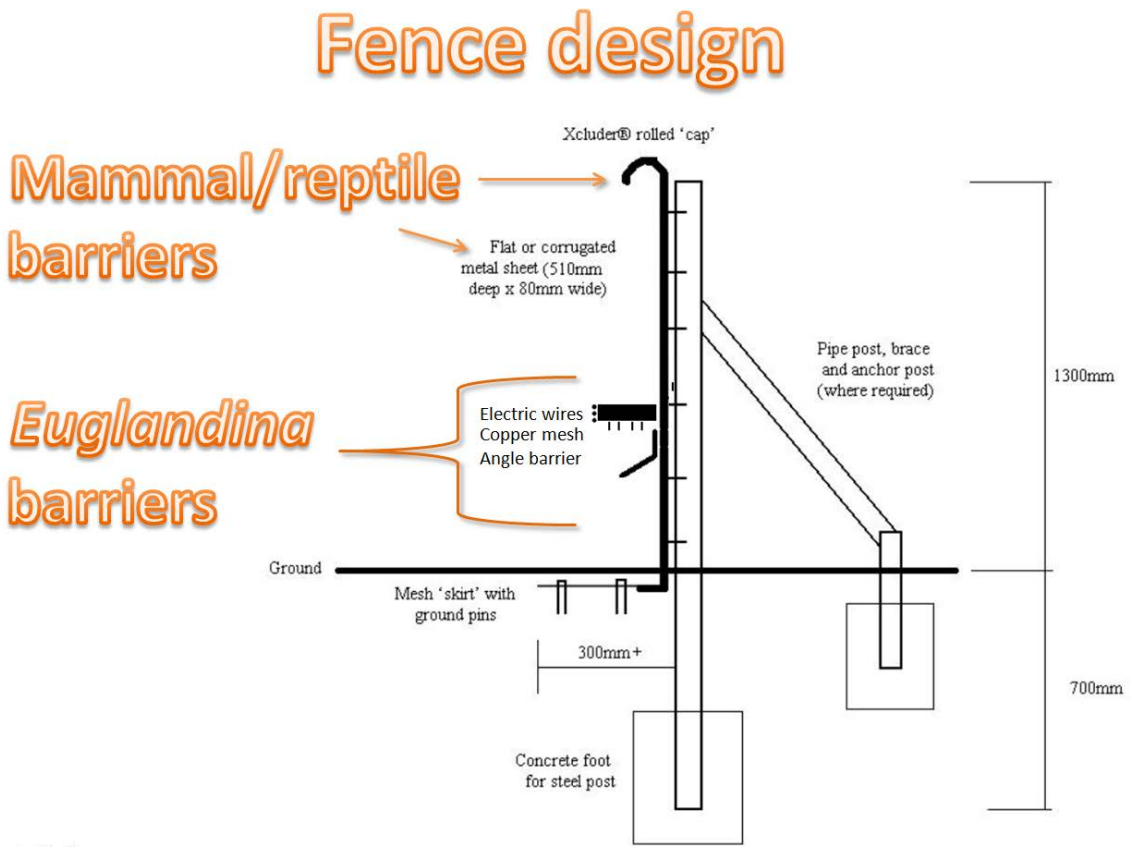
snails will be collected and brought to the UHTSCL. A similar story can be written for many of the very small and relic collections of *Achatinella* within the current collection. This rotation system will ensure that, if there is ever a catastrophic loss of a field population, the UHTSCL would have a robust representative sample of snails from the site to re-populate that area. Snails will be monitored in the field upon their release.

OANRP and USFWS have invested a great deal of effort monitoring the reintroduction effort of *A. mustelina* into the Puu Hapapa predator exclosure with the intent of determining the success level of reintroduction as a management strategy. This reintroduction was by far the largest conducted in Hawaiian Tree Snail history. See Appendix 3-3 by Diane Sether for details and results. OANRP expects this same level of success in upcoming UHTSCL snail rotation efforts and thus will not conduct intensive post release monitoring. Staff do plan to visit the release site, count snails and monitor the ground below the release area. The numbers of snails involved in the every two year release is so few that tracking these individuals will be nearly impossible. Based on the success of the Hapapa reintroduction, OANRP has confidence in the success of rotating snails out of the lab. The status of the snails in the lab will be reported to OANRP on a quarterly basis and rotation schedules can be adjusted to maximize the success of snails in captivity. If an early return to the field is required then OANRP can adjust plans accordingly.

3.3 UPDATE ON PREDATOR RESISTANT EXCLOSURE

With the assistance of Xcluder Fencing Inc NZ and the US Fish & Wildlife Service two snail enclosures were constructed this year, one at Puu Hapapa the other at Palikea. The general structure of the fence is shown below. OANRP has spent considerable time making adjustments to these enclosures improving various elements of the snail barriers.

OANRP has also constructed a test portion of a new design for a jail along the wind-swept summit of the Koolau range at Poamoho that will hopefully hold up to the elements where the Xcluder fence failed. After installation OANRP has confidence the fence will last as it is impressively sturdy. Three major improvements in the OANRP design include the strength of the footing, the fastening being bolted through and the rigid 2”x 6” and ¾’’ ply used. These materials tie all the anchors together in one unit as opposed to the tin in the Xculder design that is very flexible leaving the anchors independent to one another in the high winds. This fence will be left in place for at least 3 months before OANRP makes plans to extend the fence to ensure it can withstand the elements.



Above, a diagram showing the Xcluder fence design.

Reinforced Poamoho footing: 8’ round post driven to 4’ with two 7’ t-posts for stability driven to 6’all tied together with 150 lbs of concrete (dry weight).

Completed test section of OANRP fence design: 2”x6” framing with ¾” ply.

3.4 *ACHATINELLA MUSTELINA* REINTRODUCTION AT PUU HAPAPA

A total of 202 *Achatinella mustelina* were taken to the UHTSCL in 2010 for safe keeping while plans were made for the construction of the enclosure at Puu Hapapa. The snails reproduced considerably in captivity and numbered 340 by the beginning of 2012, when it was time for their reintroduction. However, in addition to the births there was significant adult mortality in the lab and the total number of mature snails that were able to be reintroduced declined from the total number of matures snails collected. Most of the snails reintroduced (84%) were immature but approximately half of the snails collected were immature. In two trips in February 2012, all of these snails were brought from the UHTSCL and flown to the enclosure by helicopter. The snails were removed from their terraria and placed into small mesh baskets attached to the large *Pisonia umbellifera* trees inside the enclosure. Care was taken to reintroduce the snails late in the day so that they encountered cool and moist conditions. At the time of the reintroduction there were at least 24 resident snails living inside the enclosure. During the reintroduction period staff also collected snails from outside of the enclosure and released them inside. In this manner, an additional 93 *A. mustellina* were brought in from the surrounding areas. In all, 457 *Achatinella mustelina* were present inside the enclosure (Table 1). So far only a few common native snails like *Auriculella*, *Philonesia*, *Tornatellinid*, and *Succineid* were also brought into the enclosure.

Table 1. Total *Achatinella mustelina* by Date Within the Puu Hapapa Snail Enclosure

Date	Small	Medium	Large	Total	Comments
12/21/2011	4	6	14	24	Extant snails counted in enclosure before release
1/4/2012	3	7	14	24	Moved in from surrounding areas with USFWS
1/30/2012	2	13	11	26	Moved in from surrounding areas with USFWS
2/8/2012	109	9	53	171	1st reintroduction from the UHTSCL
2/8/2012	2	17	5	24	Moved in from surrounding areas
2/21/2012	106	63	0	169	2nd reintroduction from the UHTSCL
4/11/2012	7	7	5	19	Moved in from surrounding areas with Dr. Hadfield
Totals	233	122	102	457	Total number of snails within the enclosure

Snails crawling from mesh baskets to surrounding vegetation

3.4.1 Fish and Wildlife Service Monitoring at Puu Hapapa

Prior to reintroduction OANRP, USFWS and the UHTSCL debated which methodology should be used to track the fate of the snails following their release into the enclosure. Mark/recapture was considered, but discarded in favor of using ground shell plots to recover dead snails. The UHTSCL marked 53 of the larger snails prior to release, but decided against marking smaller snails as there was concern this may damage the shell (see Figure 1.).

Figure 1. Shell tip damage observed on an empty shell collected from within ground shell monitoring plot.

It is unknown whether the blue marker actually caused the eroding of the shell apex. Tests of shells marked in this manner conducted by the UHTSCL failed to demonstrate similar erosion (Appendix ES-10). The UHTSCL acknowledged that a few of the released adult snails that were paint-dotted in the lab were already showing shell deterioration before release. One OANRP staff reported seeing four out of ten marked snails with apex damage during a night survey.

Following the snail reintroduction in February 2012, USFWS staff surveyed the ground below the two release areas for ground shells (referred to in figure 2, below, as Block 1 (A) and Block 2 (B)) that would indicate snail mortality. They conducted eight, approximately, weekly trips to collect ground shells (See USFWS final report Appendix 3-3 this document). At the end of the eight weeks 22 *Achatinella* shells had been collected which could account for at most six percent of the snails reintroduced from the lab. It is impossible to determine if the immature collected shells were from the reintroduced snails as only mature snails were marked. USFWS assumed shells were from the lab and concluded after 8 weeks that six percent mortality had occurred. During their monitoring, USFWS also collected two *E. rosea* and one Jackson's Chameleon. These finds are included in Appendix 3-4 in the Puu Hapapa enclosure threat control section of this document.

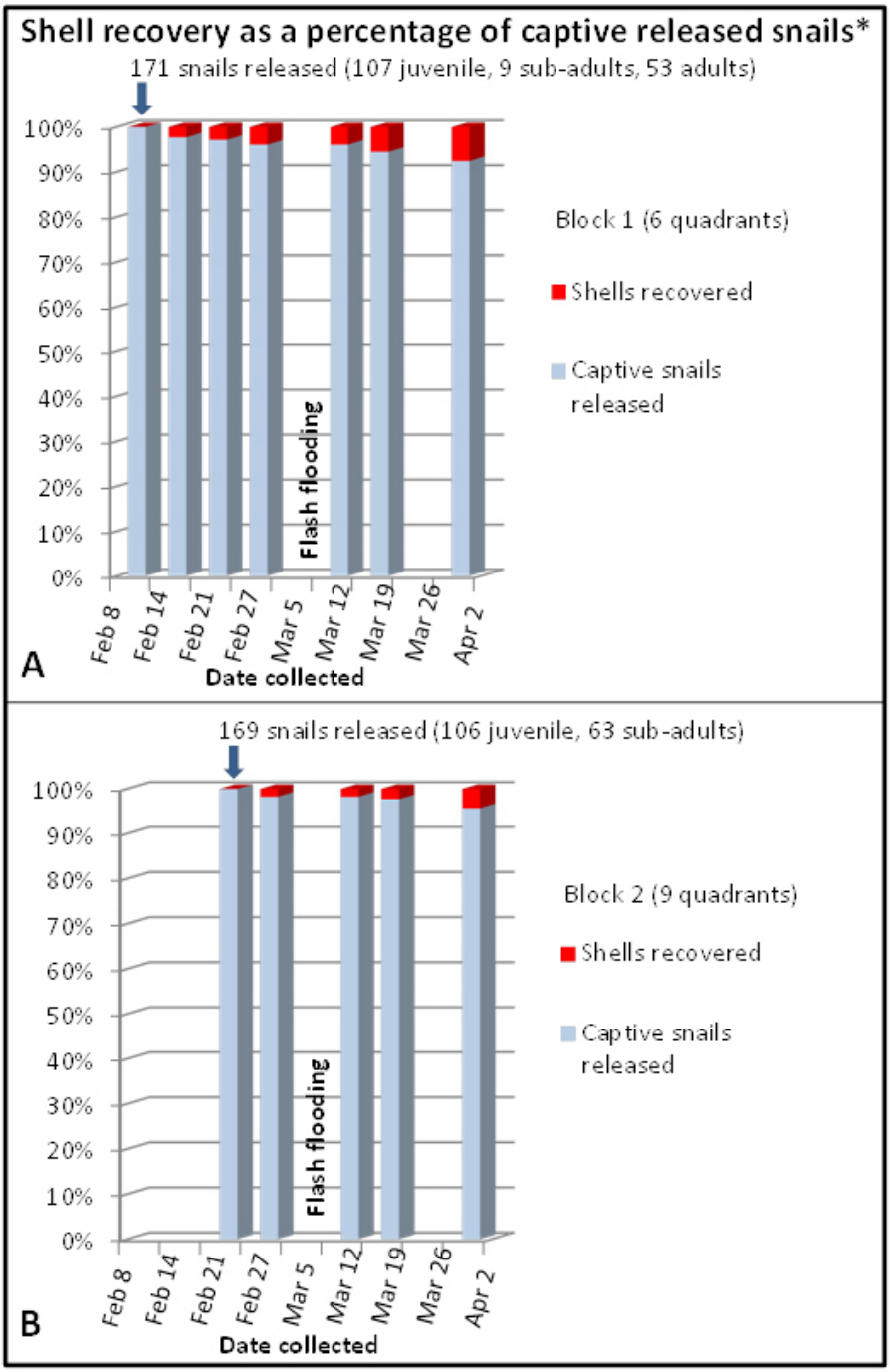


Figure 2. Fish and Wildlife Ground shell plot data. Shell recovery, in red, of *Achatinella mustelina* released in block 1A and block 2 B for each monitoring date. *Recovery percentages may overestimate percentage of captive release.

3.4.2 Threat Control at Puu Hapapa

Major threats to *Achatinella* include rodents, predatory snails (*Euglandina rosea*) and Jackson's chameleons (*Chameleo jacksonii* subsp. *xantholophus*). Rodents have been successfully eradicated using traps and follow up monitoring confirms they remain absent within the enclosure due to the effectiveness of the Xcluder Inc. vermin-proof fence. It is unclear whether the latter two threats (Jackson's chameleons and *Euglandina*) remain within the enclosure as they have proven to be considerably more difficult to locate. We discuss aspects of their reproduction and chart the progress of their removal below.

Jackson's chameleon control efforts at the Puu Hapapa enclosure

***Chamaeleo jacksonii* subsp. *xantholophus,* reproductive biology**: Chameleons in Hawaii are reproductively active at least two times a year, in December and February (Goldberg & Kraus, 2011). As gestation lasts from 6-9 months, a maximum of two clutches is possible per year. One clutch per year is more common (Animal World, accessed 11/7/2012). Litter sizes are, on average, 12 (range 7-21) for Hawaii chameleons, with larger females able to produce more young. For males, the minimum size at first reproduction was smaller in Hawaii than in their native habitat (Kenya). Here, males measuring 70 mm snout to vent length (SVL) had mature gonads while in Kenya they needed to reach 90 mm. For females, this was reversed, with the smallest gravid female found in Hawaii measuring 94 SVL compared to only 80 SVL in Kenya (Lin & Nelson 1980).

Table 2. Chameleon growth rates derived from Goldberg & Kraus (2011) in combination with rearing literature from the internet (Animal World, accessed 11/7/2012).

Age class	Description	Size	Age
Newborn	Sexes indistinguishable	<29 mm	<1 month
Juvenile	Premature horns present on males, tails thickened	30-69 mm	1-4 months
Adult male	sexually mature	>70 SVL	5-9 months
Adult female	sexually mature	>94 SVL	9-12 months

Since 20 December 2011 when the enclosure was completed and sealed from predator incursion, OANRP staff have removed 30 chameleons. Dissection revealed one of the 30 consumed a single *Achatinella* within the previous week. Although no more *Achatinella* were found, others may have been consumed but not detected in the gut. The last chameleon found inside the enclosure was an adult male (84 mm SVL) removed on 20 August 2012. Diligent searching since that time has turned up no further animals (Table 3, Fig. 3).

Table 3. Table showing search effort and number of chameleons found by date.

Date	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	May 2012	June 2012	July 2012	Aug 2012	Sep 2012	Total
Chameleons Found	6	5	1	0	2	2	8	5	1	0	30
Search effort (hrs.)	40	108	2	7	10	20	46	42	35	35	345

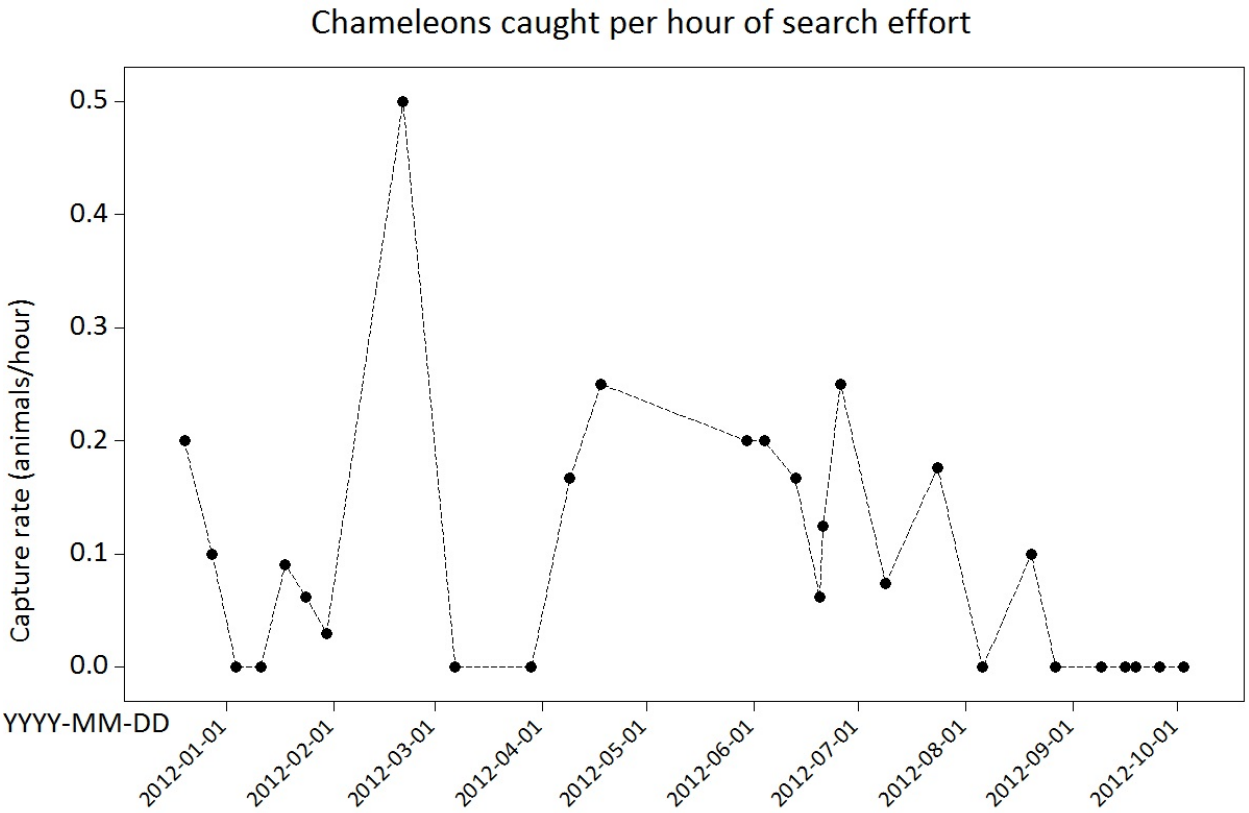


Figure 3. Chameleon capture rate over time.

The last mature female was pulled on 30 Jan. 2012 (101.6 mm SVL). It was one of only two mature females found (the first was removed 28 December 2011). Dissection of these animals revealed no embryos allowing for the possibility that they gave birth in the recent past and that their offspring may remain inside the enclosure. Several juveniles have been found since the discovery of these females, and OANRP staff believe, based on their sizes, they may be from a single litter (Fig. 4).

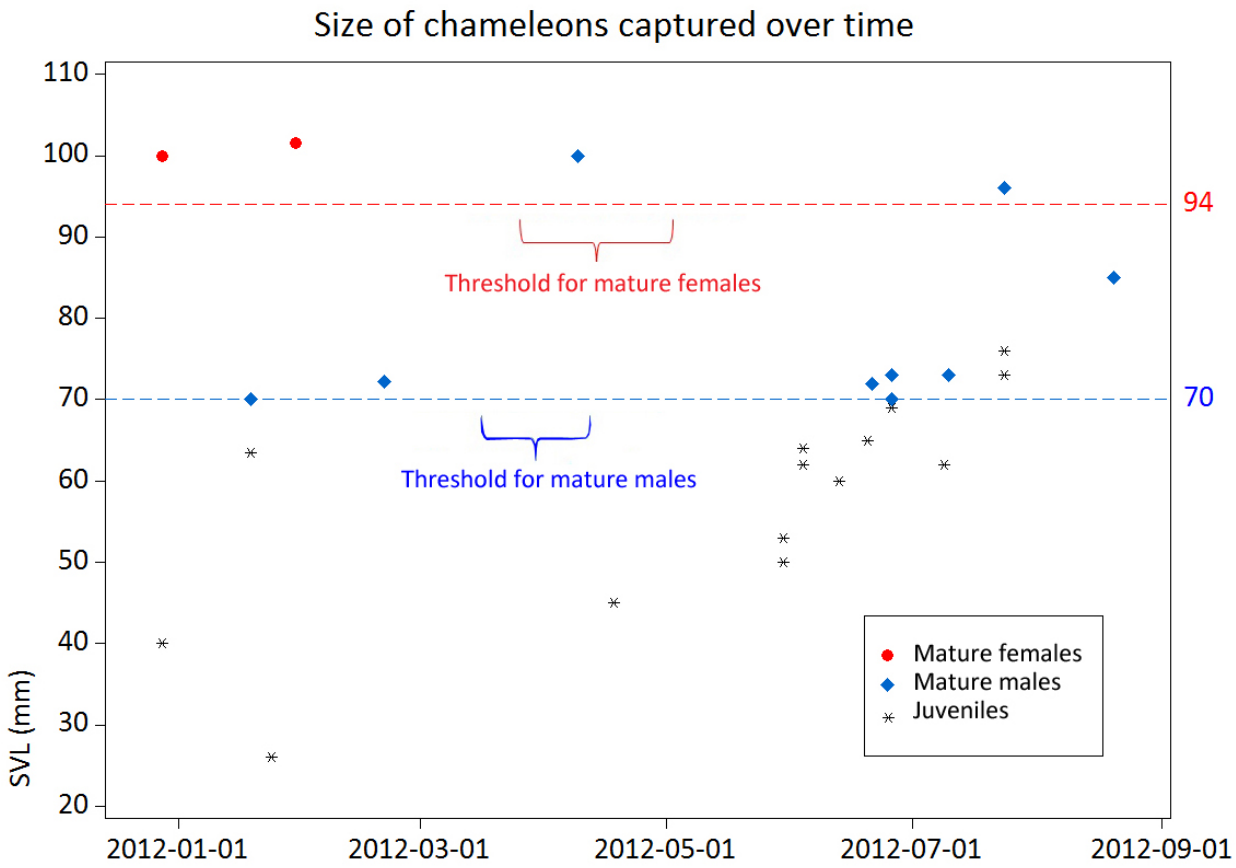


Figure 4. Size and sex of chameleons captured over time.

The rather similar size of the juveniles captured after the last mature female was removed suggests these may be cohorts. Genetic testing is underway at the UHTSCL to determine the relatedness of these individuals.

Challenges: Considering the small size of the enclosure (0.38 acres), the number of chameleons removed so far is astonishing. Some of the trees are 40-50 feet tall and cannot be searched completely by staff. Nonetheless, it is promising that no mature females have been found in over eight months and that the rate of chameleon capture appears to be slowing (see graph above). The UHTSCL staff performed experiments with Jackson's chameleons in the lab to be able to determine how long shells had stayed inside the gut before they were dissolved. Predator exclosures are recommended as a possible field management option but these are only practical to construct where terrain allows and will not be a viable management option for at least four of the eight *A. mustelina* field sites proposed for management.

Photo of a tiny newborn chameleon on an AA battery found inside the enclosure.

Euglandina rosea control efforts at the Puu Hapapa enclosure

Please see Appendix 3-4 for a more thorough discussion of *Euglandina* removal protocol and feeding behavior.

Euglandina rosea reproductive biology

The following data are all taken from Jerlach, 1994. *Euglandina* can reach sexual maturity in 263 days (this was the shortest duration observed to maturity) and at a minimum size of 35.4 mm. On average, they did not lay eggs until they were over 40 mm and were 386 days old. Generally, 9 eggs are produced per clutch and these hatch in 31 days. All eggs are viable at temperatures above 50 degrees F. Based on growth rate data, the snails can be broken down into the following size/age categories shown in Table 4.

Table 4. *Euglandina rosea* size/age categories

Age class	Description	Size	Age
Hatchling	prior to shell thickening	<10 mm	0-41 days
Juvenile	thickened shell, immature	10-30mm	42-311 days
Subadult	sexually mature, not full grown	31-40mm	312-460 days
Adult	full grown	>40mm	460-550 days

Methods of control

Over the past four years 1,170 *Euglandina* have been collected at Puu Hapapa, many of these inside the snail enclosure. The usual hiding place for these predatory snails is the leaf litter. Sometimes they are found on the surface of the ground and sometimes in the vegetation but most often they are hidden under leaves. The leaf litter inside the enclosure was considerable and although staff would have preferred leaving the litter intact, it was obvious that this large amount of leaf litter provided the perfect habitat for *Euglandina* to remain hidden. Keeping the leaf litter intact would have contributed to maintaining more

moisture inside the enclosure which would have been beneficial for the *Achatinella* but not clearing out the leaf litter would have made it impossible to eradicate *Euglandina*.

All of the leaves, sticks and even rocks that were on the ground were raked into piles, loaded into trash cans and dumped over the wall outside of the enclosure. After raking was complete a few *Euglandina* were found but these were probably in the trees and descended to the ground when a few newly fallen leaves started to build up. During the period leading up to the release, staff camped at the site weekly and searched for predators both day and night.

Results to date

Euglandina large enough to be reproductive were only found on two occasions. In December 2011, three adults were found (not measured, simply recorded as "large") followed by another in July measuring 35 mm. Upon dissection, however, the latter snail did not prove to be reproductive (Holland, *pers. comm*.). The last *Euglandina* removed from the enclosure was a juvenile measuring 21 mm on 7 August 2012. Since finding this snail, staff have continued to search intensively (Table 5, Fig. 5) with no new discoveries.

Table 5. Table showing search effort and number of *Euglandina* found by date.

Date	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	May 2012	June 2012	July 2012	Aug 2012	Sep 2012	Total
Euglandina rosea	8	29	3	3	2	0	0	3	1	0	49
Search effort (hours)	7	153	15	28	47	19	5	23	25	31	353

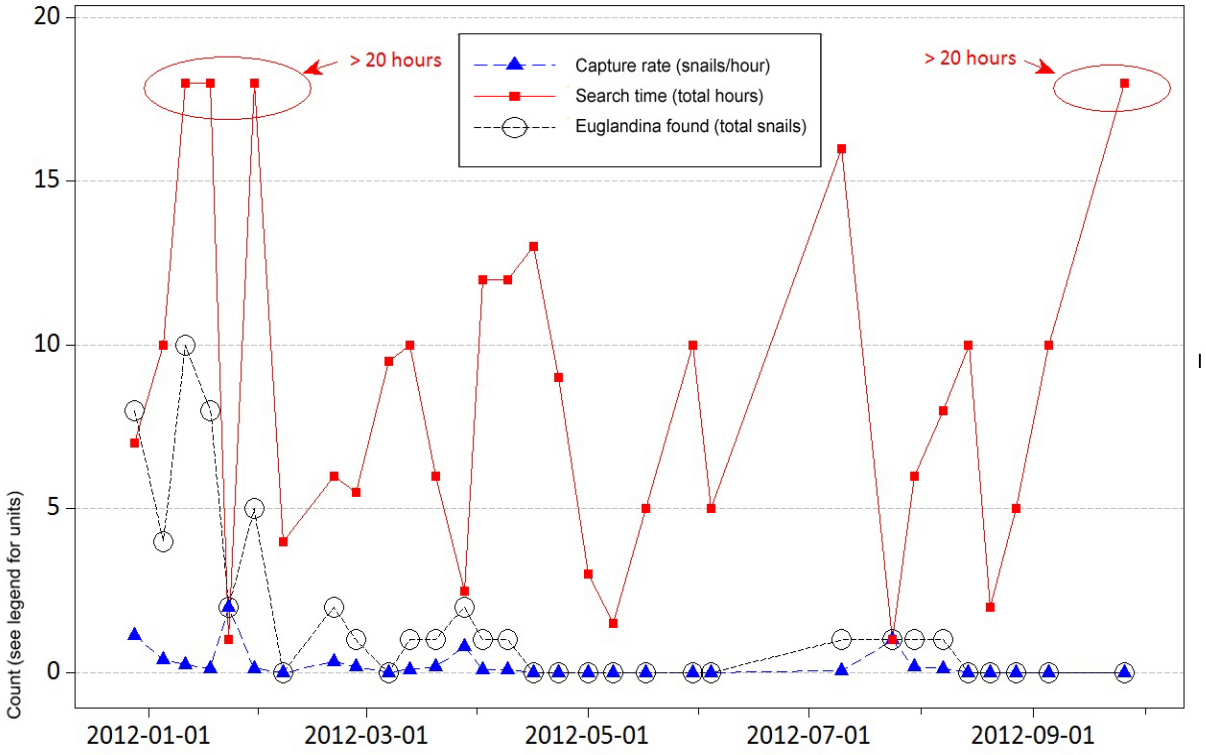


Figure 5. Graph showing total number of snails (*Euglandina*) captured (dotted line with circles), search time in person hours (solid line with squares) and capture rate (dashed line with triangles). The majority of *Euglandina* were captured soon after the enclosure was completed with comparatively few found after May despite sustained search efforts.

3.4.3 OANRP Monitoring efforts at Puu Hapapa

OANRP staff reasoned that mortality of the reintroduced snails was of primary concern and ground shell plots would be sufficient to track mortality. At the time of the release, OANRP staff assumed that most Jackson's chameleons and *E. rosea* had been removed from the enclosure as many hours had been put into the effort with no predators found. One week after the reintroduction, there were 22 shells found in the ground plots (see Appendix 3-3). During a night survey one week after the second snail release, our Rare Snail Conservation Specialist surveyed for snails in the main reintroduction host trees, finding only 60 snails out of 340 released. This caused some alarm. There were two schools of thought. One predicted that finding 60 was not surprising and that there could still be well over 400 snails in the enclosure, they are just hard to spot from the ground in the tall trees. The detectability of snails in the wild varies and it is not clear what proportion of the total number of snails one detects in any one search effort.

Other staff felt that more snails should have been seen and that there might have been mortality that went undetected by the ground shell plots. Staff suspected Jackson's chameleons and birds might have been the primary predators. Since it was unknown how much of a threat birds posed, a literature review was conducted in order to investigate evidence to support this concern. One article was found that noted bird species preyed on snails in Australia, especially during the breeding season when the birds have a greater need for calcium (Allen, 2004). A motion-activated camera was installed with empty shells used as bait. However no video proof of birds eating snails has been observed with tens of hours of footage recorded. The camera was activated by the wind. OANRP staff are currently awaiting a permit which will allow

birds to be collected and have funded the UHTSCL to dissect them to see if they are preying on the native snail population. Given concerns over the fate of the reintroduced snails, OANRP managers reevaluated the need for additional monitoring and decided to develop and implement a protocol that would track population trends over time.

Population Trend Monitoring Plan

Management Objective

- Detect *A. mustelina* population trend over time
- If negative trend is detected, arrest decline via adaptive management strategies

Sampling Objective

- With a 90% confidence level, detect a 20% change in the *A. mustelina* population within the enclosure.

Methods

Monitoring timed count baseline data was collected in June 2012 and then re-monitoring in September. These counts will be conducted quarterly for one year, after which time OANRP managers will reevaluate the monitoring interval. To control for detectability issues, timed counts were repeated three times per quarter, spaced one week apart. The mean number of snails counted each quarter was calculated and used to detect between quarter population trends. The protocol used was based on a timed-count methodology, dividing the enclosure into plots. Since snails were only found in four main areas of the enclosure, the sample size used was 4 plots. The canopy cover within each plot did not overlap with the surrounding vegetation, which created ideal natural boundaries for monitoring purposes. The four areas surveyed were referred to as plots 1-4. During each timed-count survey, the plots were systematically surveyed for a set period of time. To ensure consistency between timed counts, monitoring was always conducted shortly after dark using spot lights and binoculars. Night surveys were chosen because it was known (V. Costello *pers. com*.) to be the best time to observe snails. In addition, the surveys were conducted by experienced observers to control for human error.

Achatinella mustelina population trends

Between June 2012 and September 2012 there was no significant difference detected in the number of snails counted ($T = -0.52$, $p = 0.653$) within all plots combined, indicating the population was stable from June to September 2012. The mean number of snails observed each quarter was 112 snails in June and 114 snails in September (Fig. 6). The first monitoring timed count survey in June did not include plots 3 and 4, so the mean number of snails used for that quarter was calculated using only the second and third monitoring surveys.

If future analysis indicates a negative systematic or perturbation trend, additional investigations should be conducted in order to identify the root cause. Conversely, if trends indicate a growing population, results will be used to document the positive response to predator proof fences.

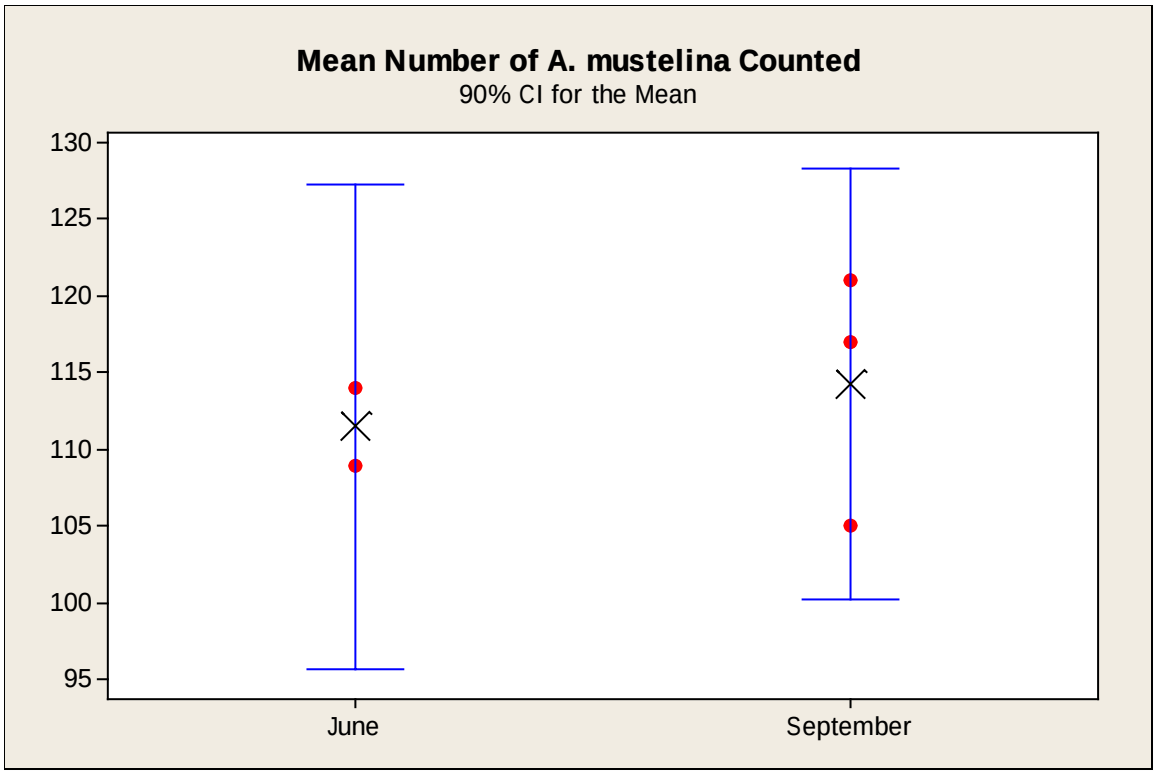


Figure 6. The dots represent the total number of snails counted each survey. The X represents the mean number of snails observed each quarter. The Y axis represents the total number of snails seen; the X axis represents the month the surveys were conducted in. The total graph represents the combined total number of snails seen counted in plots 1-4.

Discussion

One week after the second release, OANRPs Rare Snail Conservation Specialist conducted a preliminary survey to count *A. mustelin*a. The section of the enclosure surveyed was roughly comparable to the area that was subsequently delineated as plots 1 and 2 for the monitoring timed count surveys. During this survey a total of 60 *A. mustelina* were counted. Since the initial survey was not conducted using the timed count protocol it was impossible to test for significant trends. Given this, the programs Rare Snail Conservation Specialist spent considerable effort counting all snails within the general area of plots 1 and 2. Compared to the monitoring timed counts, the initial survey was much lower. The mean number of snails seen during the first set of monitoring timed count surveys for plots 1 and 2 combined was 97 snails and the mean number of snails seen during the second set of monitoring timed count surveys was 87 (Fig. 7). The main monitoring differences for the initial survey (compared to the timed count surveys) were, half the amount of time was spent monitoring and the boundaries were not clearly delineated. Given this, OANRP managers are optimistic that the population did not declined during the three month period following the initial release.

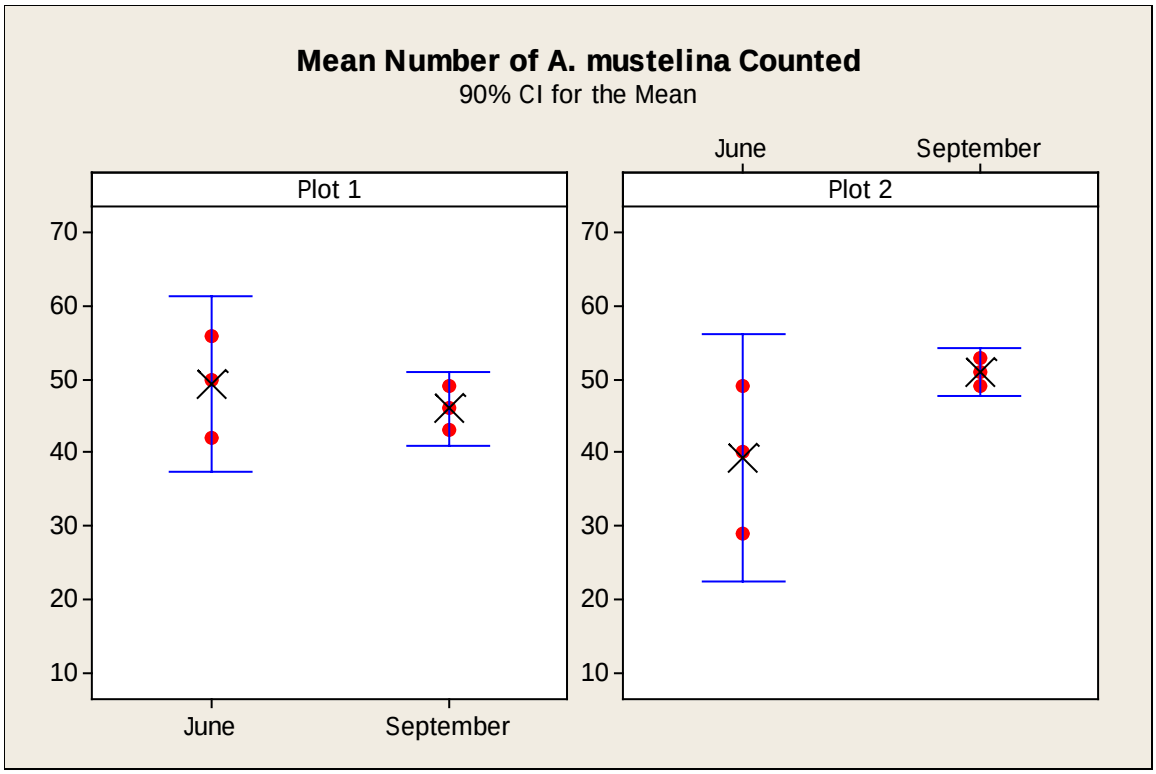


Figure 7. The dots represent the total number of snails counted each survey. The X represents the mean number of snails observed each quarter. The Y axis represents the total number of snails seen; the X axis represents the month the surveys were conducted in. The graphs are separated by plot 1 and 2.

Re-vegetation at Puu Hapapa

Vegetation Restoration Approaches and Site Considerations

A great deal of vegetation was altered during construction of the predator proof fence at Hapapa. Numerous giant *S. terebinthifolius* were felled or heavily trimmed to make a corridor for the fence. Subsequently, there are large gaps in habitat suitable for snails within the enclosure. In order to restore high levels of vegetation cover, and enhance and maintain appropriate snail habitat, restoration has and will involve two methods: maintenance weeding and re-vegetation. See the Restoration Action Plan (appendix 3-2) for Hapapa re-vegetation plan details. The following are highlights:

Weeding: There is currently no non-native canopy within the enclosure; all plants were removed during fence clearing and preparation efforts for the snail reintroductions. Also, almost all non-native understory vegetation was removed at one point after fence completion in order to eliminate habitat for remaining *E. rosea*, and to aid search efforts for this predator. As these weeds return, there will be a low tolerance for the suite of ecosystem altering weeds that occur throughout the greater Hapapa Bench area. In particular, there should be a zero tolerance for the following species: *Blecchnum appendiculatum*, and *Nephrolepis multiflora*. These are significant understory-altering weeds easily managed in a small area such as the snail enclosure. *Passiflora suberosa*, a fast-growing climbing vine, will also be heavily managed in the enclosure.

Re-vegetation: While passive recruitment of native species is expected within the enclosure, re-vegetation is necessary to more promptly restore the integrity of the native forest within the enclosure.

Propagation in the field and at the OANRP nursery is underway and includes: nursery outplants grown from seed and cuttings, seed sowing, and transplanting.

Enhancement of vegetation structure and connections between gaps in appropriate snail habitat is a high priority for re-vegetation. Therefore priority areas include open areas with bare dirt and low levels of canopy cover, and areas adjacent to or within snail reintroduction zones. To date, the following plants have been planted: 4 *Cyanea membranacea*, 11 *Freycenetia arborea*, 14 *Labordia kaalae*, 2 *Urera glabra*, and 39 *Urera kaalae*. There have also been a number of successful transplants made from a variety of species found throughout the bench area and beyond. Seed sow trials are ongoing, and *Bidens torta* is successfully growing. Water is available inside the enclosure at a spigot plumbed to a tank and catchment upslope. Re-vegetation efforts will continue to follow the Hapapa revegetation plan this coming year.

Outplants in snail reintroduction area (plants marked with pinflags and metal tags)

Recruitment of Mamaki in previously bare, open dirt corner of enclosure

3.4.4 Kahanahaiki *Achatinella mustelina* population status

Management Objective

- Detect *A. mustelina* population trend over time
- If negative trend is detected, arrest decline via adaptive management strategies

Site Description

Kahanahaiki encompasses a gulch area to the north and a flat area (Maile Flats) to the south. *Achatinella mustelina* have not been seen in the gulch since 2004 but snails remain in Maile Flats. Kahanahaiki represents the furthest north range and lowest elevation (2,200 ft.) of *A. mustelina* in the Waianae Mountains. This area is the driest location *A. mustelina* occurs (K. Kawelo *pers. com*.).

Methods 2004

In 2004, thorough counts of *A. mustelina* were made across Maile Flats (Fig. 8). OANRP dedicated 135 person hours to this effort. The area was divided into six quadrants: Northwest (NW: 2.6 acres), Northeast (NE: 4.2 acres), Midwest (MW: 3.9 acres), Mideast (ME: 4.7 acres), Southwest (SW: 2.25 acres) and Southeast (SE: 5.7 acres). Trees which hosted snails were flagged.

Figure 8. Location of snail survey quadrants and snail enclosure in the Maile Flats area.

Subsequent surveys in 2009 (and later in 2012) benefitted from the host trees flagged in 2004. The apparent increase in the number of snails counted between 2004 and 2009 (Table 6, Fig. 9) is believed to be the result of a more thorough search effort by staff of host trees, not a true increase in the snail population.

Table 6. Snail counts in the six quadrants. For the years 2009 and 2012 the percent increase or decrease in the number of snails since the previous survey is shown in parenthesis.

		Date		
Location	Quadrant	7/2004	5/2009	5/2012
	SW	38	74 (+95%)	33 (-55%)
	SE	32	22 (-31%)	6 (-72%)
	MW	106	153 (+44%)	55 (-64%)
	ME	2	16 (+700%)	3 (-81%)
	NE	0	0	0
	NW	3	5 (+66%)	2 (-60%)
Total snails		181	270 (+49%)	99 (-63%)

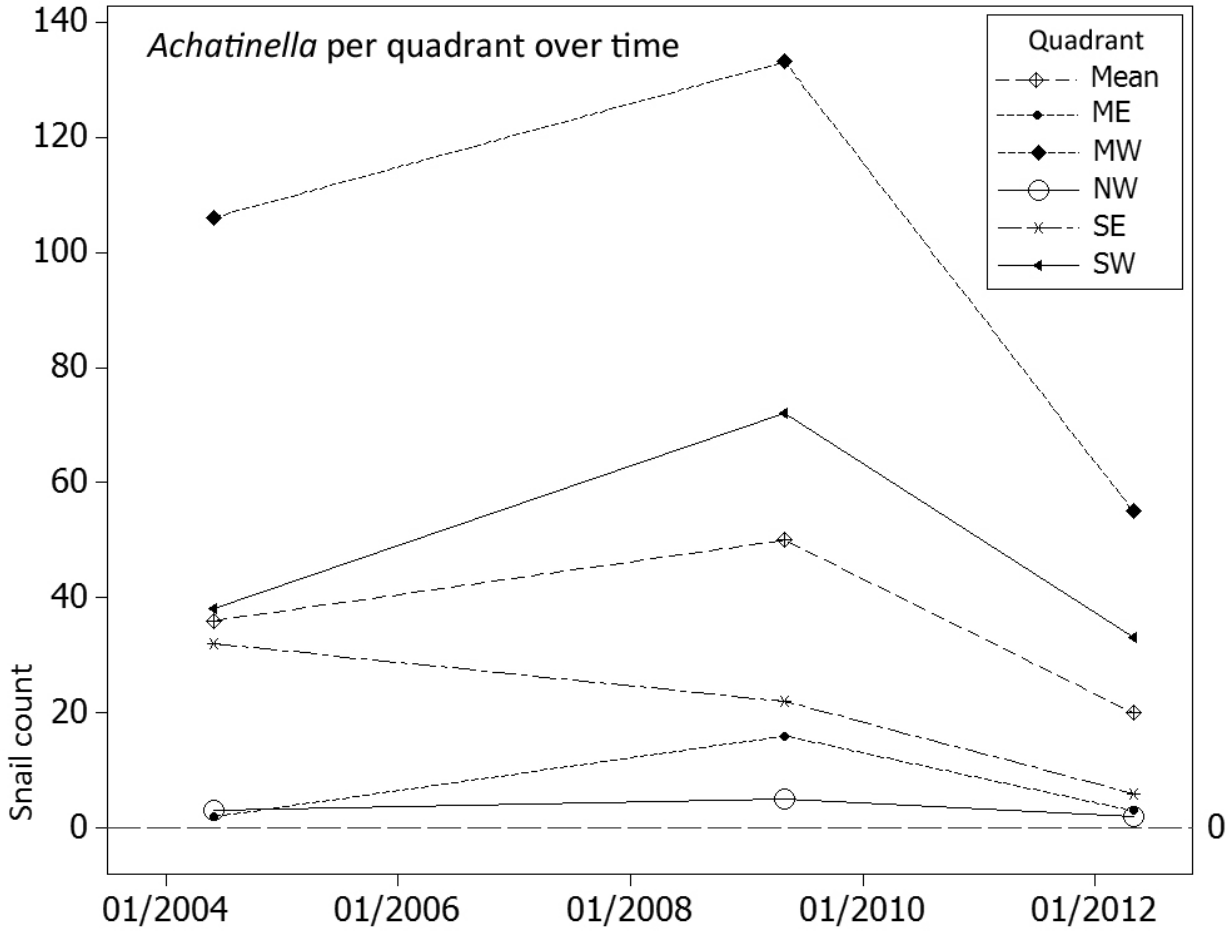


Figure 9. Graphical representation of snail counts in each quadrant (NE not included) from 2004 to 2012.

Methods 2009 & 2012

In 2009, a more systematic monitoring design was developed to ensure consistency between surveys. The six original sections remained the same as in 2004. Each was surveyed by a team of experienced staff. Belt-transects were established, using an arm's length distance between surveyors to ensure each quadrant was thoroughly monitored. The total time required to survey each was recorded. When *A. mustelina* were detected, the host tree was flagged (if not already), snail abundance recorded, and notes taken on its size (using OANRPs standard stage class classification definition). Each new host tree was documented on a sketch map for future reference. The 2009 survey required 100 person hours. The same process was repeated in 2012 with a slight increase in person hours (104). The resulting data (minus the NE quadrant which never had any snails) was used in the analysis outlined below.

Achatinella mustelina population trends

Of the quadrants with snails, all decreased between 2009 and 2012. Overall, the population decreased by 63%; from 270 in 2009 to 99 in 2012. Despite this (apparent) decline, a Wilcoxon Signed-ranks test conducted on the change in snail population over this time period could only be considered marginally significant (W=0, n=5, P=0.059). Looking across a longer time period, the snail population dropped

from 181 to 99 between 2004 and 2012; a 45% decrease. This was clearly not significant (W=1.5, n=5, P=0.138).

Between 2009 and 2012 the number of snails found per tree declined with fewer trees having multiple snails. This is of interest, because, although a related genus (*Partulina*) is known to self-fertilize under laboratory conditions (B. Holland, *pers. comm*.), the same has not been seen for *Achatinella.* It is therefore assumed that reproduction can only occur in the presence of another *Achatinella.* Figure 10 shows the decline in trees with multiple snails.

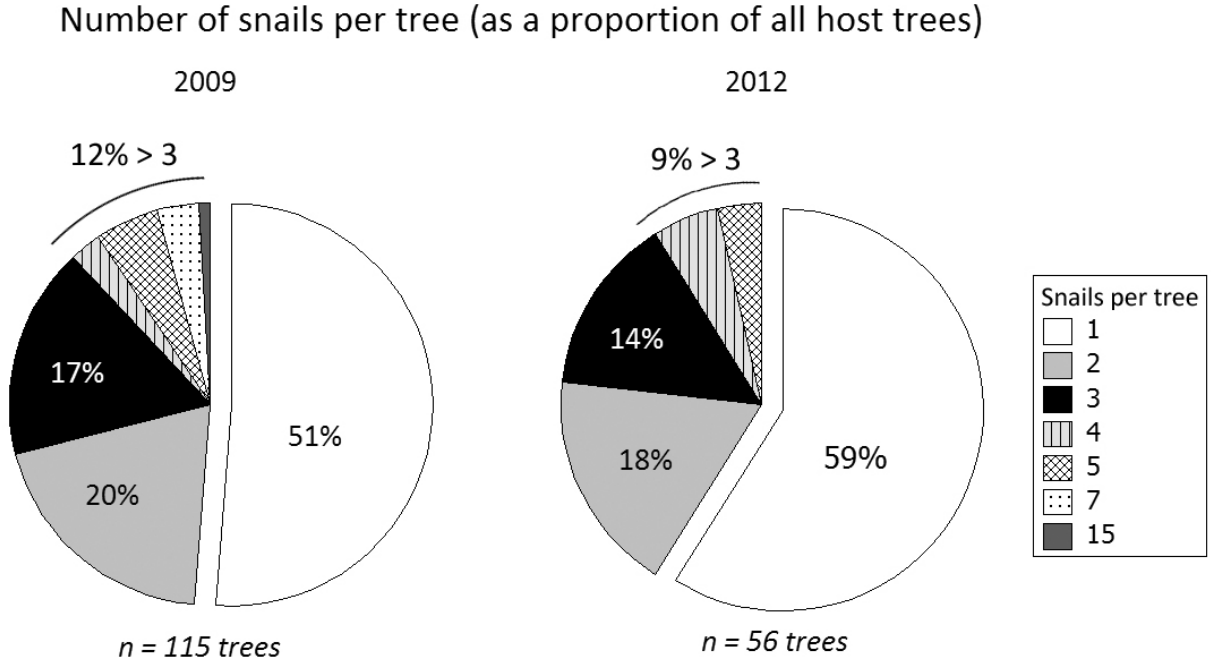


Figure 10. A pie-chart showing the proportion of host trees with single or multiple snails in 2009 compared to 2012. Note that the percentage of trees with more than one snail decreased between 2009 and 2012, while the number with only a single snail increased. This may make mating more difficult.

Discussion

Though only marginally significant, the steady decline of *Achatinella* is plain (Table 6, Fig. 9) and, if no action is taken, they are at risk of disappearing from Maile Flats. Reasons for the decline are unclear but could include predation by rats and *Euglandina rosea*, drought, change in climate and senescence of host trees. Predation pressures on *Achatinella* are compounded by its slow growth, late maturity, low motility, and a low rate of fecundity (approximately one to four offspring per adult per year) (Hadfield & Mountain, 1980). It could be argued that rats are unlikely to be the culprit as a grid consisting of 440 snap traps was installed and maintained in this MU since May 2009. Less effort has been put towards *E. rosea* control. The last sweep for *E. rosea* in the Maile Flats area took place in March 2011. Staff spent 8 hours searching and found 11 large (>20 mm) and four small (<20mm) *E. rosea* as well as 12 clutches equal to approximately 240 eggs. It is extremely difficult to control *E. rosea* across such a large area. Anecdotal observations by staff present at the 2004, 2009 and 2012 surveys suggest the snail decline is due to the death of host trees (in particular *Nestigis sandwicensis* and *Antidesma platyphylum*) combined with unusually hot and dry conditions (V. Costello, *pers. obs*.).

As is evident in Figure 10, not only has the overall number of snails declined, but fewer of these occur in trees where at least one other snail is present. The majority of trees with single snails are not adjacent to

another host tree, making encounter extremely unlikely. This is problematic because lone snails are likely not contributing to reproduction in the population.

Recommended actions

Over the next year, OANRP propose moving *Achatinella* found in the Maile Flats area into a predator resistant enclosure located nearby (Fig. 8) measuring 90 m^2. Sites where snails are removed will be searched again at least three times at night to ensure all individuals are found and relocated. The enclosure will be swept quarterly to ensure no *E. rosea* breach the fence, which has been modified this year to include two of the three barriers (electric, mesh) present at the Hapapa enclosure. If *E. rosea* are found inside, sweeps will be conducted weekly according to the flowchart shown in Appendix 3-4 for Hapapa (this document) until eradicated. In addition, appropriate host plants will be planted within the enclosure. The population that is within the snail enclosure will be monitored quarterly with census counts. This process will result in a population of around 300 snails in the most highly protected zone within Kahanahaiki. Once this threshold is reached, we propose halting augmentation until it is determined whether there is sufficient space for more snails.

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CHAPTER 4: OAHU ELEPAIO

4.1 OIP ELEPAIO MANAGEMENT 2012

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 and monitor a minimum of 75 Oahu Elepaio pairs. The OANRP is required to conduct on-site management at Schofield Barracks West Range (SBW) for as many of the 75 pairs as possible, with the remaining number managed at off-site locations with cooperating landowners. The OANRP has conducted rat control and Elepaio monitoring at Schofield Barracks Military Reservation (SBMR) (1998-present), Ekahanui Gulch in the Honouliuli Forest Reserve (2005-present), Moanalua Valley (2005-present), Palehua (2007-present), Makaha Valley (2005-2009), and Waikane Valley (2007-2008). This chapter will summarize rodent control efforts and Elepaio reproduction results at each of the sites currently being managed, and to provide recommendations for improving the Elepaio program. This section also lists and discusses the terms and conditions for the implementation of reasonable and prudent measures outlined in the 2003 Biological Opinion.

4.1.2 Methods

Monitoring

Throughout the nesting season, from early January to late June, each Elepaio territory was visited at one or two-week intervals depending on breeding activity. The location and age of all birds observed and color band combination, if any, was noted on each visit. Nests were counted as successful if they fledged at least one chick, and nest success (successful active nests) was calculated by the number of successful nests divided by the number of active nests, which 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 protected 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 recordings were used to lure birds into a mist-net. Each bird was weighed, measured, inspected for molt, fat, and health, then released unharmed at the site of capture within one hour.

Rodent Control

Rodents were controlled with a combination of Victor® rat traps baited with peanut butter and molasses/peanut-butter flavored Ramik® mini-bars (0.005% diphacinone) placed on rods in tamper-resistant plastic Protecta® rodent bait stations to shield it from rain and reduce the risk of poisoning to non-target species. Bait stations were secured in trees at least one meter off the ground and wired shut to

restrict access by dogs (*Canis familiaris*) and feral pigs (*Sus scrofa*). Snap traps baited with peanut butter were used to augment the control. Traps were tied to trees or rocks to prevent scavengers from removing them. Traps were counted as having caught a rodent if hair or tissue was stuck to the trap, and traps were cleaned with a wire brush after each capture so previous captures were not counted again. Rodent control was conducted for the duration of the Elepaio nesting season. The number of bait stations and snap traps deployed varied among sites. At Ekahanui, bait stations were not used. Instead, a rat trapping grid was deployed for management of all Elepaio territories at this site. Two bait stations and four snap traps were deployed in each Elepaio territory at Palehua. Three bait stations and six snap traps were deployed at SBW and Moanalua where access is more restricted and where territories are scattered over greater distances. Traps and bait stations were checked and rebaited once a week for the first month when rodent capture rate and take of bait were high, then once every two weeks for the rest of the breeding season. The frequency of rebaiting is also higher during the first month so that we are able to kill the maximum amount of rodents possible before Elepaio nesting begins, thus giving the birds the best possible chance at having successful nests. Traps and bait stations were deliberately concentrated in sections of each territory known to have been used habitually for nesting, thereby increasing the efficiency of the control program. Application of diphacinone bait was conducted in compliance with U.S. Environmental Protection Agency registration numbers 61282-26 and special local need registrations HI-980005.

4.1.3 Results

With 97 Elepaio pairs managed during the 2012 breeding season, the OANRP exceeded the 75 pairs required for species management. In general, rodents were controlled only in territories that contained a breeding pair. Rodents were also controlled in a few territories that contained a single male or were vacant in order to create a larger continuous control area, or because there was some turnover of territory occupancy and it was not clear at the beginning of a season which territories contained a pair.

In 2012, Pono Pacific was contracted to conduct rodent control and monitoring of Elepaio at Moanalua. At SBW, Ekahanui and Palehua, they were contracted to only conduct rat control. OANRP conducted monitoring of birds at SBW, Ekahanui and Palehua. OANRP also assisted in monitoring of Elepaio at Moanalua. The results of management conducted for each area during the 2012 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 management unit. SBW is a combination of the separate gulches. 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 pairs territories in which rodent control was conducted, the number of active nests observed, total successful and failed nests, how many fledglings were observed, and the ratio of fledglings per pair.

Banded Oahu Elepaio at Palehua.

Schofield Barracks West Range

Schofield Barracks West Range Territory Occupancy Status and Rat Control 2012

Schofield Barracks West Range Site Demographic Data

SBW	2012	2011	2010	2009	2008	2007	2006	2005
Singles	16	15	5	9	6	11	5	12
Pairs	58	56	25	19	12	13	14	16
Pairs with Rat Control	28	31	22	14	11	6	14	16
Active Nests[1]	23	34	22	10	7	2	3	6
Successful Active Nests[2]	16/23=70%	22/34=65%	11/22=50%	6/10=60%	2/7=29%	0	0	3/6=50%
Unknown Nest Outcome[3]	0	0	5	2	4	2	3	3
Failed Active Nests	7	12	6	2	1	0	0	0
Family Groups Found[4]	11	11	9	9	3	3	3	2
Fledglings Observed[5]	28	46	25	16	7	3	3	6
Fledglings/Managed Pair[6]	1	1.48	1.14	1.14	0.64	0.50	0.21	0.38

[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, 70% (16/23) were successful in producing 21 fledglings, while 30% (7/23) of the active nests failed. Seven fledglings were found in six managed pairs where no nesting had been observed (family groups). A total of 28 fledglings were observed in territories benefiting from rodent control management. Another five fledglings were observed in territories not protected from rats.

Rodent Control

Rodent control was initiated from 30 November 2011 and continued through 31 May 2012 in four gulches at SBW: Banana (BAN), Baby Water (BAW), Mohiakea (MOH), North Haleauau (NWA). A total of 28 pairs were managed in these gulches during the 2012 breeding season. Three gulches that include Guava (GUA), Coffee (COF) and South Haleauau (SWA) were not managed this season.

Schofield Barracks West Range Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits[1]
2001	45	2520	1490	59%	22	60	3,2,2
2002	50	5263	3156	60%	71	88	4,4,3
2003	60	6096	2768	45%	115	120	4,4,4
2004	64	3887	2715	70%	97	120	3,3,2
2005	90	6763	1900	28%	210	172	5,5,7,6
2006	72	5635	2782	49%	212	144	5,7,6,5
2007	58	3130	1704	54%	72	100	7,0,1,1
2008	70	5702	2028	36%	204	128	10,0,4,2
2009	57	5667	671	12%	80	114	10,9,9,9
2010	84	9875	1571	16%	228	170	14,11,13,12
2011	94	14251	3374	24%	510	195	15,11,13,11
2012	93	12396	1408	11%	501	192	16,15,15,14

[1]Number of site visits by gulch: NWA, BAN, MOH, BAW.

Summary

The 2012 breeding season proved to be a good season with an average of one fledgling produced per managed pair. Access to SBW was very good this year allowing for optimum monitoring of the population. Fewer successful nests and fledglings were found in 2012, than in 2011, and is likely due to a late start in nesting and severe weather in March with rainfall 136% above normal for that month (Kodama 2012).

It is likely that access to SBW will be reduced for the 2013 breeding season. Full-time training by the Army during weekdays may limit our ability to manage this Elepaio population to the extent that we were able to in previous breeding seasons. An effort will be made to conduct rodent control and monitor the birds on weekends and holidays if restricted access goes into effect.

Honouliuli Forest Reserve - Ekahanui

Ekahanui Territory Occupancy Status and Rat Control 2012

Ekahanui Site Demographic Data

EKA	2012	2011	2010	2009	2008	2007	2006	2005
Singles	11	14	5	6	5	4	2	8
Pairs	31	30	32	39	20	19	22	20
Pairs with Rat Control	29	30	30	23	19	18	20	20
Active Nests[1]	21	15	12	15	11	7	10	8
Successful Active Nests[2]	9/21=43%	8/15=53%	1/12=8%	7/15=47%	6/11=55%	3/7=43%	3/10=30%	4/8=50%
Unknown Nest Outcome[3]	0	1	6	7	2	3	6	1
Failed Active Nests	12	6	5	1	3	1	1	3
Family Groups Found[4]	6	15	2	4	5	8	5	11
Fledglings Observed[5]	18	26	3	11	12	11	9	16
Fledglings/Managed Pair[6]	0.62	0.87	0.10	0.48	0.63	0.61	0.45	0.80

[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, 43% (9/21) were successful, producing 10 fledglings, 57% (12/21) of active nests failed. Eight fledglings were found in six managed pairs where no nesting had been observed (family groups). A total of 18 fledglings were observed in territories benefiting from rodent control management.

Rodent Control

The second breeding season of rodent control using the large scale trapping grid was initiated from 01 Dec 2011 and continued through 20 June 2012 at Ekahanui. During that period there were 15 site visits resulting in 520 rats killed using 619 snap traps. A total of 29 pairs were managed during the 2012 breeding season.

Summary

Although not as successful as 2011, this year proved to be a good breeding season at Ekahanui. There were more successful nests than in any of the previous seasons and the number of fledglings found was the highest of any previous year, besides 2011. The number of nests that failed was also very high, unfortunately. The reason for this is unknown, but some nest failures may be due to bad weather and heavy rainfall in March.

In late January surveys were conducted in two drainages north of the Ekahanui management unit to see if the ongoing rodent control in this area might be impacting Elepaio populations in gulches elsewhere. In 2009, four years after management began at our Ekahanui management unit, a survey by The Nature Conservancy was conducted in North Ekahanui gulch and Huliwai gulch. One pair and eight single male territories were found. Three years later, at the beginning of this year, another survey was conducted in the same two drainages and six pairs and 10 single males were found. That's an increase of 12 birds in only three seasons. This was a very encouraging find, but it is unknown whether or not the management in Ekahanui is directly affecting the population size in the surrounding gulches.

Nesting Oahu Elepaio at Ekahanui.

Palehua

Palehua Territory Occupancy Status and Rat Control 2012

Palehua Site Demographic Data

HUA	2012	2011	2010	2009	2008	2007
Singles	0	0	1	2	5	7
Pairs	16	17	18	15	11	11
Pairs with Rat Control	16	17	18	15	11	11
Active Nests[1]	8	13	10	9	6	6
Successful Active Nests[2]	3/8=38%	10/13=76%	2/10=20%	6/9=67%	4/6=67%	3/5=50%
Unknown Nest Outcome[3]	0	2	0	0	0	0
Failed Active Nests	5	1	8	3	2	3
Family Groups Found[4]	3	5	2	4	4	4
Fledglings Observed[5]	6	16	4	14	10	7
Fledglings/Managed Pair[6]	0.38	0.94	0.22	0.93	0.91	0.64

[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, 38% (3/8) were successful in producing three fledglings, while 62% (5/8) nests failed. Three fledglings were found in three managed pairs where no nesting had been observed (family groups). A total of six fledglings were observed in territories benefiting from rodent control management.

Rodent Control

Rodent control was initiated from 29 November 2011 and continued through 05 June 2012 at Palehua. A total of 16 pairs were managed during the 2012 breeding season.

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2007	32	5518	1729	31%	118	33	17
2008	33	3372	713	21%	36	35	9
2009[1]	37	5203	1137	22%	22	37	14
2010	42	7722	519	7%	99	45	21
2011	43	7916	716	9%	84	84	18
2012	36	5652	423	7%	126	72	17

[1]Feral pigs accessed bait stations on two occasions near the end of the season and consumed rodenticide.

Summary

Overall, it was a disappointing breeding season at Palehua. Like many of the other management sites, nesting began later in the season in 2012. There was very little breeding activity and the first fledgling was not observed until mid-April. The lack of nesting might be the result of unfavorable weather conditions and heavy rainfall in March, which averaged more than two inches above normal at Palehua (Kodama 2012).

Fledgling Oahu Elepaio at Palehua.

Moanalua Valley

Moanalua Territory Occupancy Status and Rat Control 2012

Moanalua Site Demographic Data

MOA	2012	2011	2010	2009	2008	2007	2006
Singles	19	10	8	7	3	5	4
Pairs	32	21	19	28	28	29	26
Pairs with Rat Control	24	16	17	24	25	26	22
Active Nests[1]	15	13	22	19	18	18	11
Successful Active Nests[2]	10/15=67%	5/13=38%	4/22=18%	7/19=37%	10/18=56%	7/18=39%	4/11=36%
Unknown Nest Outcome[3]	2	5	7	6	2	5	3
Failed Active Nests	5	3	11	6	6	6	4
Family Groups Found[4]	2	3	2	7	8	8	8
Fledglings Observed[5]	13	9	7	16	24	17	14
Fledglings/Managed Pair[6]	0.54	0.56	0.41	0.67	0.96	0.65	0.64

[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, 67% (10/15) were successful in producing 11 fledglings, 33% (5/15) failed. Two 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). Two fledglings were found in two managed pairs where no nesting had been observed (family groups). A total of 13 fledglings were observed in territories benefiting from rodent control management.

Rodent Control

Rodent control was initiated from 28 November 2011 and continued through 11 June 2012 at Moanalua. A total of 24 pairs were managed during the 2012 breeding season.

Moanalua Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	# of Site Visits
2006	66	16945	2340	14%	323	134	19
2007	81	14185	1707	12%	348	162	16
2008	87	13638	1622	12%	325	174	16
2009	78	12238	955	8%	239	150	15
2010	80	12720	1053	8%	343	160	20
2011	81	13138	2129	16%	376	162	16
2012	72	10603	1757	17%	483	150	16

Summary

Overall, it was a much improved breeding season at Moanalua over the previous year. Eight more Elepaio pairs were protected with rat control this season. This, combined with increased monitoring, resulted in the number of successful nests being doubled and the fledgling count increased by four.

In 2011, the State of Hawaii funded Pacific Rim Conservation to conduct surveys for Oahu Elepaio in Moanalua Valley and their findings were shared with OANRP. This August, our program revisited locations where birds had been detected by the State surveys. A total of six new Elepaio pairs were found and added to the population in Moanalua Valley.

Adult Oahu Elepaio feeding fledglings.

4.1.4 OIP Summary

Management Actions 2012

- Conducted rodent control in a total of 97 territories with pairs at four management sites.
- Following the breeding season, during the months of September and October, OANRP removed all Protecta® rodent bait stations from Elepaio territories in SBW, Moanalua and Palehua. In each territory that contains a pair, a new grid system was established consisting of 12 Victor® snap traps placed throughout the territory boundary. This will result in increased rodent control coverage within each territory and, hopefully, more effective rodent control throughout the breeding season.
- The table below summarizes the number of managed pairs and reproductive output since 2005.

Summary of Elepaio Management Table

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings
2012[1]	97	38	22	65
2011[1]	94	47	34	96
2010[1]	87	18	15	39
2009[2]	81	29	24	60
2008[3]	74	25	20	56
2007[3]	78	18	26	46
2006[4]	69	11	17	33
2005[5]	44	7	16	25

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

Management Actions 2013

- Conduct rodent control and Elepaio monitoring at SBW, Ekahanui, Palehua and Moanalua to meet required 75 managed pairs.
- Mist-net and band all adult and juvenile Elepaio within the management units to improve yearly demographic monitoring.
- Conduct surveys within and beyond management units to monitor 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.

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.*

[No high explosive rounds landed above the firebreak road from 2011-2012]

2. *The Army will notify the Service within 24 hours of any fires that burn any portion of a known Elepaio territory and the number of Elepaio territories affected*.

[No fires affected any known Elepaio territories]

3. *The Army will limit training actions in the forest above the fire break road at SBMR in the Elepaio nesting season (January to May) to small numbers of troops (platoon or less) that remain in one location for short periods of time (one hour or less), to limit possible nest disturbance*.

[No training actions have occurred above the firebreak road]

4. *The depository designated to receive specimens of any Oahu Elepaio that are killed is the B.P. Bishop Museum, 1525 Bernice Street, Honolulu, Hawaii, 96817 (telephone: 808/547-3511). If the B.P Bishop Museum does not wish to accession the specimens, the permittee should contact the Service's Division of Law Enforcement in Honolulu, Hawaii (telephone: 808/541-2681; fax: 808/541- 3062) for instructions on disposition*.

[One abandoned Oahu Elepaio egg was collected from a nest at Schofield Barracks West Range. The egg was turned over to the B.P. Bishop Museum.]

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.*

[No fires occurred above the firebreak road]

2. *The Army will notify the Service within 24 hours of any instance in which training was not conducted in accordance with the Wildland Fire Management Plan (WFMP).*

[All training was conducted in accordance with the WFMP]

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 2012

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.

Adult Oahu Elepaio and nest.

Makua Territory Occupancy Status and Rat Control 2012

Makua Site Demographic Data

Makua	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001
Single Males	2	2	2	1	1	2	4	0	3	4	4	2
Single Females	0	0	0	0	1	1	1	1	0	0	0	0
Pairs	0	0	0	2	2	2	1	0	3	3	3	2
Pairs with Rat Control	0	0	0	2	2	2	1	0	3	3	3	2
Active Nests[1]	0	0	0	1	1	0	0	0	2	4	1	1
Successful Active Nests[2]	0	0	0	0	0	0	0	0	1/2=50%	1/4=25%	1/1=100%	1/1=100%
Unknown Active Nests[3]	0	0	0	1	0	0	0	0	1	2	0	0
Failed Active Nests	0	0	0	0	1	0	0	0	0	1	0	0
Family Groups Found[4]	0	0	0	0	0	0	0	0	0	0	0	0
Fledglings Found[5]	0	0	0	0	0	0	0	0	1	1	2	1
Fledglings/Pair[6]	0	0	0	0	0	0	0	0	0.33	0.33	0.67	0.50

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of 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 08 December 2011, no pairs were observed (only two single males). No nests or fledglings were observed.

Rodent Control

No rodent control was initiated for any of the territories (pair territories in 2009) in Lower Makua.

Makua Rat Control Data

Year	# of Bait Stations	Amount of Bait Available	Amount of Bait Taken	% Bait Taken	# of Rats Trapped	# of Snap Traps	Sites[1]	# of Site Visits[2]
2000	12	736	310	42%	13	12	1	12
2001	18	1752	768	44%	33	31	1,2	12,3
2002	24	4234	1917	45%	59	37	1,2	15,3
2003	24	2979	916	31%	26	36	1,2	12,2
2004	24	3016	1838	61%	37	36	1,2	16,4
2005	10	932	406	44%	10	14	1	8
2006	12	192	172	90%	14	24	2	1
2007	12	384	365	95%	8	24	2	2
2008	16	628	178	28%	24	32	2	3
2009	12	810	115	14%	23	24	2	5
2010	12	576	179	31%	25	24	2	3
2011	0	-	-	-	-	0	-	-
2012	0	-	-	-	-	0	-	-

[1]Site: Kahanahaiki (1) and Lower Makua (2)
[2]Number of visits per site respectively.

4.2.3 MIP Summary

Management Actions 2012

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

Management Actions 2013

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

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CHAPTER 5: OPEAPEA (HAWAIIAN HOARY BAT)

5.1 BACKGROUND

Description/Life History

The Opeapea (*Lasiurus cinereus semotus*) is a medium-sized bat that is insectivorous and nocturnal. It has a diverse diet, feeding on a variety of native and non-native night-flying insects, including moths, beetles, crickets, mosquitoes, and termites (Whitaker and Tomich 1983). Forest and pasture boundaries, forest road corridors, streams, bays, and inlets all appear to be important foraging areas for this species (Kepler and Scott 1990, Jacobs 1993, Reynolds *et al*. 1997/1998). They have been observed foraging either just before or after sunset depending on the time of year, and activity patterns may also be affected by altitude (Jacobs 1993 and Menard 2001). They are solitary roosters, although mothers and pups roost together, and will utilize the foliage of both native and nonnative vegetation. They have rarely been observed roosting in lava tubes, cracks in rocks, or man-made structures. Mating appears to occur between September and December with birth of young (twins typically) during May or June. Mother bats likely stay with their pups until they are six to seven weeks old. Little is known regarding dispersal or movements, but inter-island dispersal is possible. Genetic evidence suggests that this endemic species is closely related to the North American hoary bat (Morales and Bickham 1995).

Purpose

In 1970, the U.S. Fish and Wildlife Service (USFWS) granted the Opeapea endangered species status under the federal Endangered Species Act (U.S. Fish and Wildlife Service 1970). As of yet, no critical habitat has been designated for this species. Opeapea have been documented on Hawaii, Kauai, Maui, Molokai and Oahu, along with one unconfirmed sighting from Kahoolawe (Hawaii Natural Heritage Program 1996).

In 2010, the Kahuku Wind Power Habitat Conservation Plan (SWCA 2010) documented the presence of low numbers of Opeapea within their survey areas adjacent to the Kahuku Training Area (KTA). As a result of these surveys and since the Army wanted to do some major road construction projects, it was recommended that the Army conduct preliminary surveys in preparation for formal consultation with the U.S. Fish and Wildlife Service (USFWS) for the possible impact that training may have on this species. Possible training impacts on this species may include but are not limited to fire as a result of live-fire training, disturbance from night time helicopter training, habitat alteration for road construction, etc. These surveys were conducted using similar methods as outlined in Gorreson et al. (2008) but modified to fit our needs with assistance from staff at the U. S. Geological Service Biological Resource Division (BRD) (Pinzari Pers. Comm.).

5.2 METHODS

Surveys

In order to get baseline data on the presence/absence of Opeapea, OANRP deployed the Song Meter SM2BAT Ultrasonic Recorder (Wildlife Acoustics, Inc. Concord, MA) to record echolocation calls. This Full Spectrum Direct Recorder is designed for long term passive monitoring that can record continuously to memory cards for up to several weeks. These units were programmed to switch on and off automatically just prior to sunset and after sunrise. All bat call files were recorded with the associated date and time data.

OANRP deployed four acoustic recorders and situated them attached to trees about two meters above the understory at open sites along roads, helicopter landing zones, or construction sites. They were placed

about 1000 meters apart, to avoid double counting bats, in KTA, Schofield Barracks Military Reservation East Range (SBE) and Kawailoa Training Area (KLOA). The map below shows the locations of the bat detectors at each of the Army Koolau Mountains training areas. The detectors were deployed every other month and data collected for approximately seven days, depending on battery life. All of the collected call files were put through an analog high-pass filter to filter out frequencies below 1kHz, and another digital filter to filter out frequencies below 12kHz. Call files were then processed with Song Scope Bioacoustics Software (Version 4) to filter any ambient noise and then audibly and visually inspected for quality assurance (Pinzari Pers. Comm.).

It has been found that activity levels may be an indicator of areas of high use by bats due to insect abundance and that bat activity may be assessed by utilizing bat detectors to record echolocation calls (Gorresen et al. 2008). OANRP recorded the number of detector nights (# of detectors X # of nights deployed) per survey, the number of nights that bat activity was recorded, the number of pulses (bat echolocation calls) per one minute period that were recorded each survey and the time at which the pulses were recorded. With this data, OANRP was then able to assess the bat activity levels at each of the survey sites. OANRP used the number of events per survey to represent bat activity levels. Events are defined as any one minute period with bat vocalizations recorded. The number of pulses or duration of these vocalizations will vary per event.

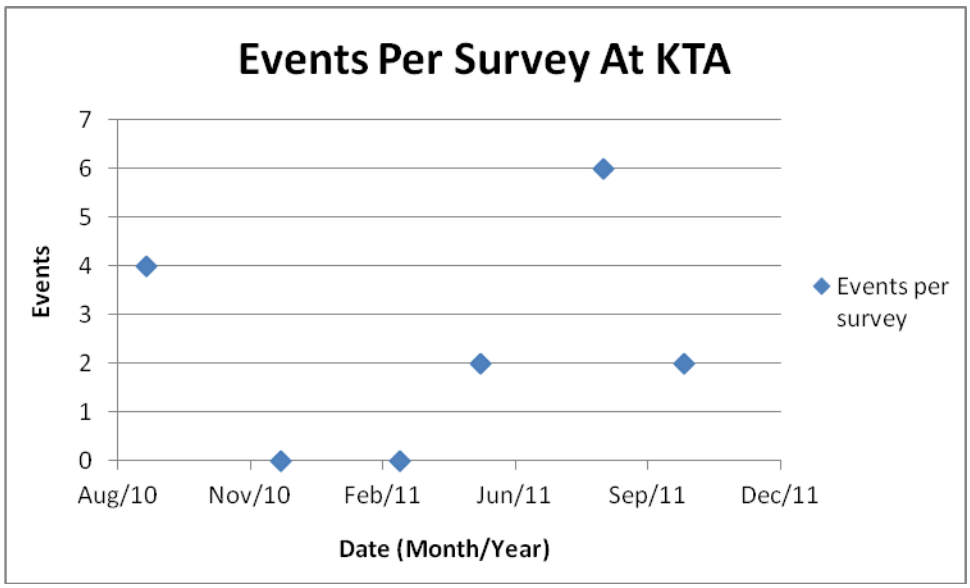
Map denoting Army training areas and bat detector deployment sites. OANRP and military LZ's are highlighted.

5.3 RESULTS

Kahuku Training Area

Month	Total # of Active Nights	Total # of Pulses	Detector Nights	Events per survey
Sep-10	4	77	23	4
Dec-10	0	0	30	0
Mar-11	0	0	41	0
May-11	2	38	36	2
Aug-11	4	124	32	6
Oct-11	2	24	27	2
Totals	**12**	**263**	**189**	**14**

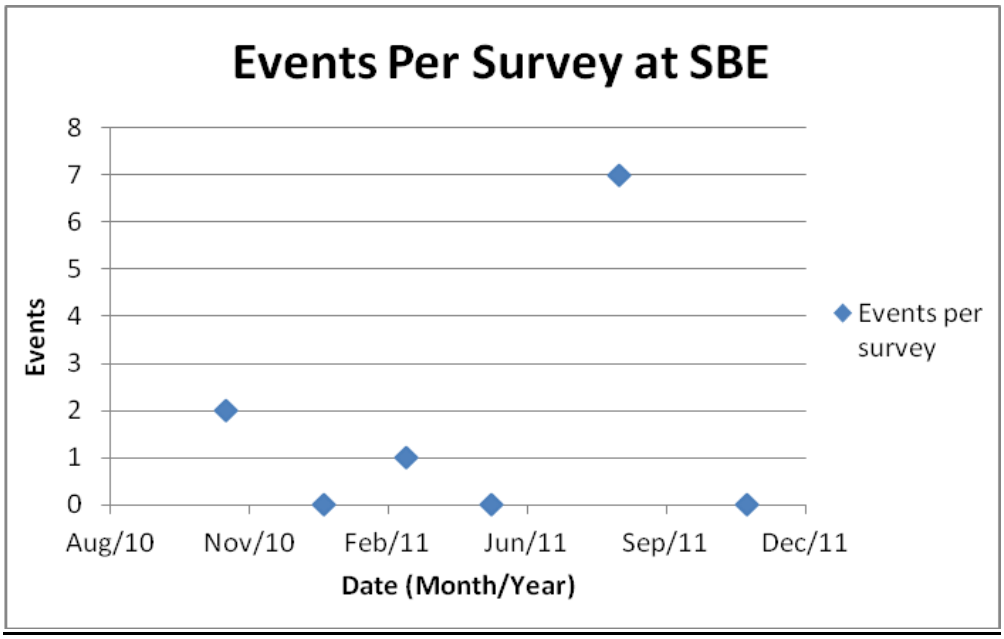
The table above shows the overall data results collected from the surveys at KTA from September 2010-October 2011. There were a total of 189 detector nights at KTA. Of those, 12 had recorded bat activities for a total of 14 events. This equals to 6% or 1:16 detector nights an Opeapea was recorded. The graph below illustrates the recorded number of Opeapea detection events for each survey at KTA



Schofield Barracks East Range

Month	Total # of Active Nights	Total # of Pulses	Detector Nights	Events per survey
Nov-10	2	30	32	2
Jan-11	0	0	23	0
Mar-11	1	3	28	1
May-11	0	0	35	0
Aug-11	3	96	27	7
Nov-11	0	0	31	0
Totals	**6**	**129**	**176**	**10**

The table above shows the overall data results collected from the surveys at SBE from November 2010-November 2011. There were a total of 176 detector nights at SBE. Of those, six had recorded bat activities for a total of 10 events. This equals approximately 5% or 1:22 detector nights an Opeapea was recorded. The graph below illustrates the recorded number of Opeapea detection events for each survey at SBE.



Kawailoa Training Area

OANRP is still awaiting the analysis of the collected data from KLOA. Preliminary results from surveys in the KLOA do show that Opeapea are located there

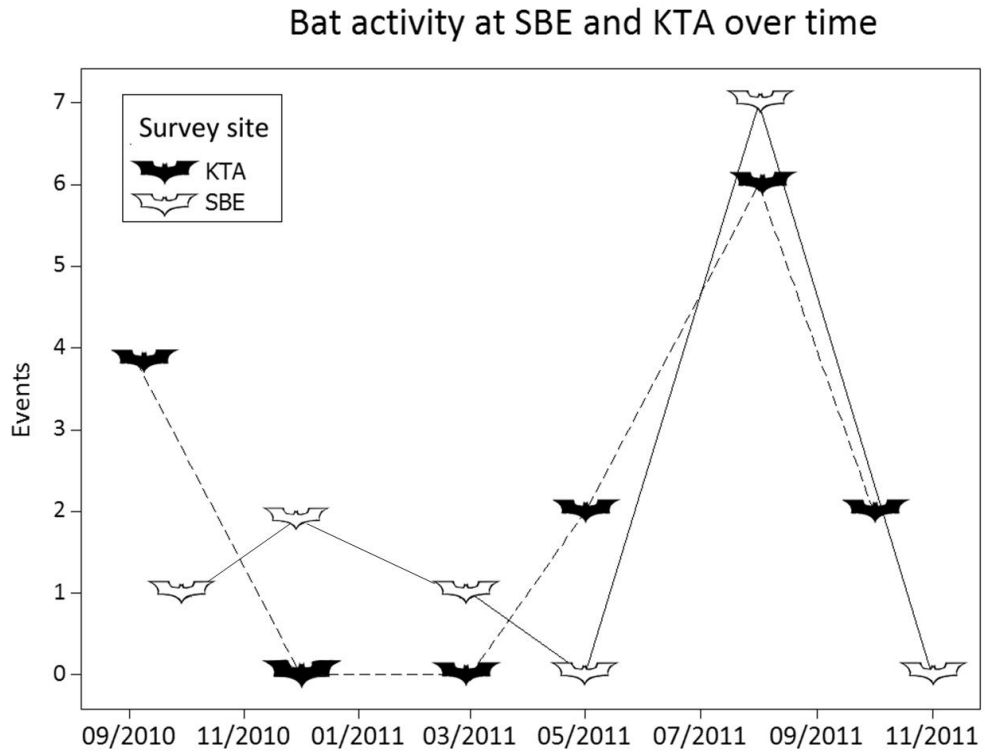
5.4 DISCUSSION

Overall, detections for Opeapea were very low and inconsistent when compared to similar surveys done on Kauai or even nonexistent at both sites. At Puu Ka Pele Forest Reserve and the Pacific Missile Range Facility (PMRF), Kauai, similar bat surveys, on average, recorded hundreds of pulse counts on active nights (Pinzari et al. 2010). One active night even had over a thousand. On average, OANRP recorded 54 pulse counts per active night.

The SBE 2 site and the KTA 1 site (Kanes DZ) had no Opeapea detections during any of the surveys. The SBE 2 site is along the road corridor and is much more covered by canopy than the other survey sites which could explain why no Opeapea were detected. The KTA 1 site is completely the opposite. It is a very open LZ that is surrounded by forest so optimal habitat for Opeapea to at least fly through. This site appeared to be the type of site that would be utilized by Opeapea.

Detections did vary throughout the year at both sites but did seem to peak around August with a jump in the number of events recorded, which both graphs illustrate. The graph below combines both survey sites to better illustrate activity levels recorded throughout the year. This may be associated with insect abundance but it is unclear right now as to why. All of the detections appeared to be just individuals passing through the area on their way to other sites. There was only one feeding buzz recorded at either

site for any of the surveys. It is very possible that the Opeapea roost in the forest at KTA and SBE and move to another more favorable site for feeding (James Campbell National Wildlife Refuge, Lake Wilson, golf courses, etc.)



OANRP combined all of the time of recorded detections data between both sites since number of detections were so low to try and look at a correlation. A Pearson's correlation analysis (P-value = 0.696) showed that there was no correlation for time of night and recorded activity. More data would be needed to look at if time of year played any role in time of night and recorded activity.

5.5 CONCLUSION/RECOMMENDATIONS

These surveys document that the Army has Opeapea on at least two of their training areas in the Koolau Mountains. Based on these survey results OANRP can make some recommendations for the future management of Opeapea on Army lands.

- Complete the last of the KLOA surveys to look at activity levels here
- Initiate and complete surveys for Army training areas in the Waianae Mountains: Makua Military Reservation, Schofield Barracks South and West Ranges, and Dillingham Military Reservation. These surveys will be a shorter duration of six months. Surveys will begin in November 2012 and continue through May 2013.
- Until formal consultation is completed, the Army should not fell trees over 15 feet tall during the pupping season, July1 through Oct 15 each calendar year. This precaution is based on informal conversations with U.S. Fish and Wildlife Service biologists.
- In addition, the Army will begin preparing a Biological Assessment to cover Opeapea in the 2013 calendar year.

- In order to estimate bat detection probability and occupancy, OANRP would need to intensify the survey effort by increasing the number of sites within each area and the number of visits. This may be an important analysis to look at to get a clearer picture of Opeapea usage of Army training areas.

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CHAPTER 6: RODENT MANAGEMENT

6.1 SUMMARY OF OANRP RODENT CONTROL PROGRAM

Since 1997, OANRP has managed MIP and OIP species that are subject to rodent predation with various strategies. Some species are managed seasonally, such as during the Elepaio nesting season, while others are protected year-round, such as *Achatinella* spp. Methods have included using Ramik® mini-bars (rodenticide with 0.005% diphacinone) in small-scale bait station grids in combination with traps, bait station grids without traps, traps only in small grids, large-scale trapping grids, predator exclusion fences, and a recently deployed grid of automatic self-resetting rat traps (see section 6.4). OANRP is continually researching and assessing rat control methods to determine the most effective strategies for the protection of natural resources. Table 1 summarizes OANRP's current rat control methods.

Table 1. Current rat control strategies utilized by OANRP as of October 2012. The number of traps in SBW, Moanalua, and Palehua are estimates for the 2013 Elepaio season. OANRP contracts Pono Pacific to conduct rat control and Elepaio monitoring at several sites.

MU/Area	Primary Threatened Spp.	Rat Control Method	# Bait Stations	# Traps	Type of Trap	Deployment Period	Baiting Interval
Ekahanui	*A. mustelina*	Bait Stations and Traps	27	47	Victor	Year-round	6 weeks
Waieli- Hapapa	*A. mustelina*	Bait Stations and Traps	19	38	Victor	Year-round	6 weeks
Ohikilolo	*A. mustelina, P. Kaalae*	Bait Stations and Traps	43	47	Victor w/ boxes	Year-round	6 weeks
Opaeula Cabin	None	Bait Stations and Traps	4	6	Victor	Year-round	6 weeks
Kahanahaiki	*A. mustelina*	Predator Exclosure	N/A	N/A	N/A	Year-round	N/A
Palikea	*A. mustelina*	Predator Exclosure	N/A	N/A	N/A	Year-round	N/A
Waieli- Hapapa	*A. mustelina*	Predator Exclosure	N/A	N/A	N/A	Year-round	N/A
Koloa	*A. livida*	Trapping Grid	0	76	Victor w/ boxes	Year-round	6 weeks
Makaha	*A. mustelina*	Trapping Grid	0	30	Victor	Year-round	6 weeks
Kamaohanui- Skeet Pass	*A. mustelina*	Trapping Grid	0	60	Ka Mate	Year-round	6 weeks
Kahanahaiki†	*A. mustelina, C. superba*	Trapping Grid	0	465	Victor w/ boxes	Year-round	2 weeks
Palikea†	*A. mustelina*	Trapping Grid	0	189	Ka Mate	Year-round	2 weeks
Palikea- Mauna Kapu	*A. mustelina*	Trapping Grid	0	15	Victor w/ boxes	Year-round	6 weeks
Opaeula	*A. sowerbyana*	Trapping Grid	0	91	Victor w/ boxes	Year-round	6 weeks
Poamoho	*A. sowerbyana*	Trapping Grid	0	16	Victor w/ boxes	Year-round	6 weeks
W. Makaleha	*C. grimsiana*	Trapping Grid	0	28	Victor	Year-round	6 weeks
Pahole**	*C. superba*	Trapping Grid	0	45	Automatic traps	TBA- trial period	TBA- trial period
SBW- N. Haleauau‡	*A. mustelina*	Trapping Grid	0	28	Victor	Year-round	6 weeks
SBW†	Elepaio	Trapping Grid	0	372*	Victor	Annual: Dec-June	2 weeks
Ekahanui†	Elepaio	Trapping Grid	0	619	Victor w/ boxes	Annual: Dec-June	2 weeks
Moanalua†	Elepaio	Trapping Grid	0	312*	Victor	Annual: Dec-June	2 weeks
Palehua†	Elepaio	Trapping Grid	0	180*	Victor	Annual: Dec-June	2 weeks
		Total:	**93**	**2664**			

* *Estimated # of traps. Each managed Elepaio territory will have 12 traps installed ~12 m apart in trees. All bait stations have been removed.*

** *Grid consists of new automatic self-resetting traps and are being tested at Pahole*

† *Contracted Pono Pacific to maintain rat grids during Elepaio nesting season*

‡ *N. Haleauau snail sites are included during Elepaio nesting season*

6.2 RODENTICIDE CONCERNS AND CHANGING RODENT CONTROL STRATEGIES

In 2012, OANRP reviewed the effectiveness of rodenticide bait station grids program-wide and implemented many changes in the overall rat control strategy. In consultation with the U.S. Fish and Wildlife Service, OANRP decided to significantly reduce the use of Ramik® as a management tool. This has led to a shift towards the use of rat trap only grids, both small and large. In this section, concerns with bait station grids are discussed first and then the changes in rat control program that OANRP instituted in 2012 are presented.

Note that OANRP still uses small bait station grids for rodent control at several sites (see Table 1, above). At some sites, bait station grids with snap traps have shown to be very effective at protecting resources

from rodent damage. In drier habitats, the Ramik® bait may persist for several weeks and still be palatable to rats. Bait station grids with snap traps at remote and relatively dry MUs, such as Ohikilolo MU, have shown to be a very useful management tool for protecting resources. Additionally, the dual method approach of using bait stations and snap traps together may kill more rats. For example, some rats may be more likely to consume Ramik® bait than trigger a snap trap.

However, there are many issues with rodenticide use that gave rise to questions about its use as a primary method for rat control in some areas. These issues include: Ramik® bait efficacy and dynamics, palatability/longevity, and expense. These concerns are discussed below.

Ramik® Bait Efficacy and Dynamics Concerns

The only rodenticide that is registered in Hawaii for conservation use is Ramik®, a restricted use pesticide in Hawaii that requires a Certified Pesticide Applicator permit to use. The active ingredient of Ramik® is diphacinone, an anticoagulant. Research has shown that a black rat, the most common species in some of Oahu's mesic forests (Shiels 2010), must feed on the bait for approximately seven consecutive days to reach a lethal dose. However, the poisoned rat may persist for up to seven more days before succumbing to the poison (Swift, pers. comm.). Because of this information, there is concern that rat baiting with Ramik® around rare resources may cause rats to actually frequent the area more due to the bait being a perceived food source. This may actually increase the risk of predation on the rare resources because rats are known to diversify their diets and may consume both the bait and the resources that are being managed.

The lethal dose for a rat varies widely for individual rats depending on factors such as age, size, sex, and species. It has been documented that some black rats can consume as little as 15.5 grams (half a bait block) and die in three days while others can survive for ten or more days while consuming 90 grams (over 3 bait blocks) a day. Furthermore, some rats may consume much more than the lethal dose of the bait before they stop feeding while others may sample the bait a few times and then either get scared away by a more dominant rat or simply find an alternate food elsewhere and not return (Swift, pers. comm.). Clearly, it is difficult to determine how many rats can be killed from 16 bait blocks in a bait station; therefore, it is more difficult to determine how effective baiting grids are at controlling rat populations than with rat traps where the number of rats killed is known.

Additionally, many areas where rat bait stations have been deployed by OANRP in the past are relatively small and are concentrated right around the rare resources. There is concern that such small baiting grids are insufficient to control rat populations to the level necessary to adequately protect the resource. With up to nine black rats per hectare in Oahu's mesic forests (Shiels 2010), there will always be rats eager to move into an area that was previously occupied by another rat.

Ramik® Bait Palatability/Longevity Concerns

The Ramik® pesticide label states that there must be a fresh supply of bait available at all times when using the bait for rat control. OANRP's baiting grids have typically been maintained at 2-6 week intervals. However, in wet habitats the bait has been observed to be moldy after only one week (see Figure 1). It is likely that rats would not be strongly attracted to the bait toward the end of the baiting interval or even sooner depending on the amount of mold. Not only is this not effective rat control, there is concern about compliance with the Ramik® label specification.

Figure 1. Ramik® bait with mold growth seven days after bait stations were restocked. Photos taken on 5 April 2012, at Northern LZ, Koloa MU, Ko'olau Mountains.

Expense Concerns

The data from the 2012 Elepaio season indicate that the majority of Ramik® applied is not eaten by rats and is disposed of according to label specifications. See Figure 2, below, for data from 2012 at Schofield Barrack West Range (SBW) as an example of the amount of bait that is essentially wasted.

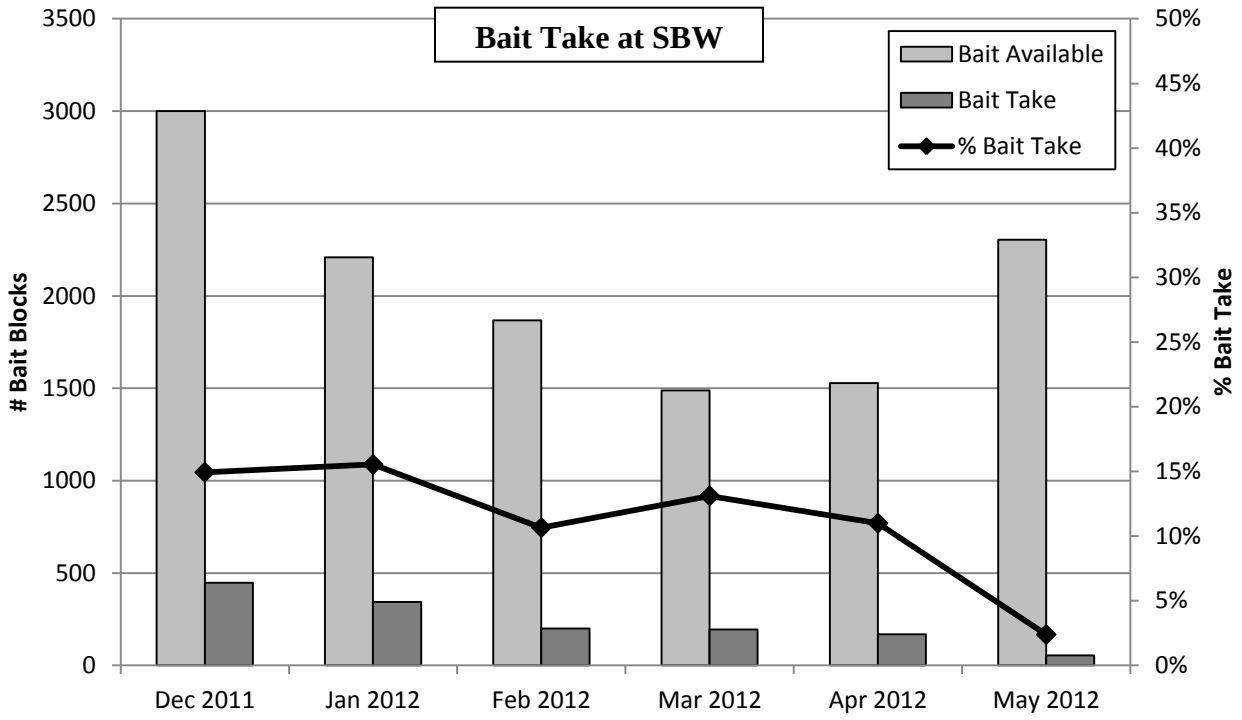

Figure 2. The amount of bait available and the amount of bait take each month in 93 bait stations at Schofield Barracks West Range during the 2012 Elepaio nesting season. The line represents the percentage of bait take out of all bait available that month.

The bait take is fairly low in the beginning of the season and remains low. Note the difference between bait available and bait take. Over the season there were approximately 11,000 bait blocks wasted at SBW, equivilant to over $1,900 worth of bait. At the end of the season there is a noticeable decline in bait take; this may be related to seasonal fluctuations in rat populations as often rat catches in traps are low in the spring/summer.

It is noteworthy to mention that a portion of the bait that is reported as "bait take" may actually be lost to slugs, insects, and mold. There is no way to determine what percentage of bait is lost to these non-rodent factors but it is suspected to be significant. Field crews working in various MUs have continually reported this concern along with an overall concern with the efficacy of baits.

In contrast to bait take, data from rat trap kills over the same time period at SBW show a more dramatic decline (Figure 3).

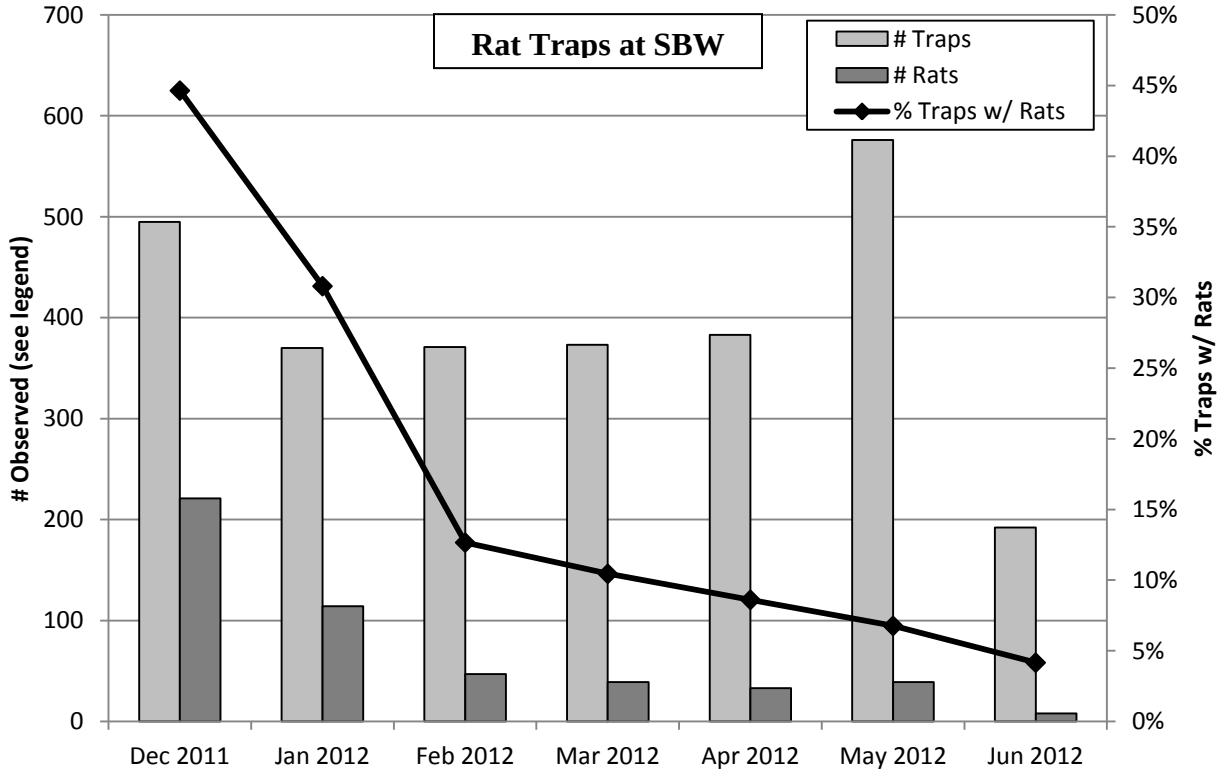

Figure 3. The total number of rat traps checked and total number of rats killed in traps each month at Schofield Barracks West Range during the 2012 Elepaio nesting season. There were 192 traps total at SBW. The amount of traps observed each month varies according to how many times the sites were visited. The line represents the percentage of traps checked each month with rat kills.

As expected when rat control is first implemented, in the beginning of the nesting season a high percentage of traps caught rats but as rats were removed from the area, fewer and fewer of the traps caught rats. This indicates an initial "knockdown" in rat numbers at the beginning of the trapping. Declining rat numbers in traps could also be related to seasonal fluctuations in rat populations; rat catches in other trapping grids are often low in the spring/summer months.

These trends in bait take out of bait available and in trapping data were observed at all Elepaio areas in 2012 (see Elepaio Chapter 4 for more details).

Changes to Rodent Control Strategies in 2012

After consultation with partner agencies and discussing the aforementioned concerns, OANRP has removed 76% of existing bait stations across many MUs over the last year. These changes are in compliance with the Army's initiative to reduce pesticide use by 55% since 1993. See Table 2 below for details.

Table 2. Rat control sites that have switched from small bait station grids and rat traps to rat trap only grids. Rat control for next year's Elepaio nesting season has not yet commenced so exact numbers of traps installed are not yet available. Also note that in Pahole the trapping grid consists of automatic traps (see section 6.4).

MU/Area	Primary Threatened Spp.	Current # Traps	# of Bait Stations in 2011	# Traps in 2011
Moanalua	Elepaio	312*	72	144
Palehua	Elepaio	180*	36	72
SBW	Elepaio	372*	93	186
Pahole**	*C. superba*	45	13	0
W. Makaleha	*C. grimsiana*	28	12	24
Opaeula	*A. sowerbyana*	91	23	46
Makaha	*A. mustelina*	30	8	16
SBW- N. Haleauau‡	*A. mustelina*	28	11	22
Koloa	*A. livida*	76	19	38
	Total:	**1162***	**287**	**548**

* *Estimated # of traps. Each managed Elepaio territory will have 12 traps installed ~12 m apart in trees.*

** *Grid consists of new automatic self-resetting traps and are being tested at Pahole*

‡ *N. Haleauau snail sites are included during Elepaio nesting season*

Bait station grids that were small (fewer than 10 stations) and in very wet habitats have all been switched to snap trap only grids. For every bait station that was removed from an area, 1-2 snap traps were installed. These traps are in addition to the traps that previously existed. Additionally, all Elepaio territories that were previously managed with small baiting grids will be transitioned to snap trap only grids for the upcoming 2013 Elepaio nesting season. Each territory will have a small grid of 12 traps spaced around the core area used for nesting. Most territories are adjacent to one another therefore the small grids may create continuous grids in some areas. Note that the re-visitation interval for all grids has not changed; labor costs will be the same or less for all areas that have recently transitioned to traps only.

OANRP is confident that snap trap only grids can be effective at protecting resources. MUs with large scale trapping grids to control rats have shown positive ecosystem responses. These include: increased native invertebrate abundances, reduced fruit predation on *Cyanea superba* subsp. *superba*, and increased native seed rain (*Diospyros hillebrandii*) and common native seedlings (see OANRP 2010, 2011 for details). These results indicate that using rat traps without deploying rodenticide can be effective at managing rat populations. Furthermore, after installation of the trapping grid at Ekahanui in 2010, the Elepaio nesting season was the most successful nesting season ever recorded which indicates that changing rat control strategies did not harm the Elepaio population; in contrast the population increased (OANRP 2011). Additionally, snap trap grids require no permit, are cheaper to deploy and maintain than

bait stations when maintained at the same interval, allow for detection of rat kills, and kill the rat immediately so that it cannot continue to damage resources.

In summary, at $56 per 5 gallon bucket (or 320 bait blocks), program wide use of Ramik® can be very costly and may not be the most effective tool for rat control, especially in wet habitats or when only a few bait stations are deployed. With the development of a more persistent bait than peanut butter alone (see section 6.3), snap trap grids are a promising management tool. OANRP is optimistic about the changes made to the rat control program in 2012 and expects that rat control in 2013 will prove to be more effective and cheaper.

6.3 BAIT PERSISTENCE TRIALS FOR RAT TRAPS

One of the main obstacles with snap traps is bait persistence in the field; slugs/ants remove bait often within 24 hours. Finding bait that persists in the field and is attractive to rats for a longer duration is crucial, especially with the increased reliance of OANRP on trapping grids alone for rat control.

Many types of potential baits have been trialed including: peanut butter, Nutella®, liquid scents on sponges, dog treats, tootsie rolls, nuts, homemade scented wax concoctions, peanut butter inside plastic tubing, peanut butter wrapped in metal mesh, coconut, chocolate chips, various scented commercial waxes, commercial baits for squirrels, and more. OANRP has had very little success in deterring slugs with zinc tape, salt or by elevating traps. Ants are also very problematic. Bait trials for some substances were discontinued for reasons such as lack of persistence in the field, attractiveness to rats, and difficulty of use. Several trials are ongoing; finding better bait is a never-ending endeavor.

Other types of lures for rats currently being investigated in New Zealand include audio tones, visual cues, and various scents including rat odors and pheromones. The development of such tools is in the preliminary stages; nevertheless it is promising that such alternative and high-tech attractants are being investigated.

Recently, NRS purchased a wax product from a New Zealand company (Pest Control Research www.pestcontrolresearch.co.nz) that is scented with real peanut butter and has been molded to fit Victor® snap traps perfectly (Figure 4). Thus far, this peanut butter wax bait seems to be very promising and may greatly improve trapping efficacy.

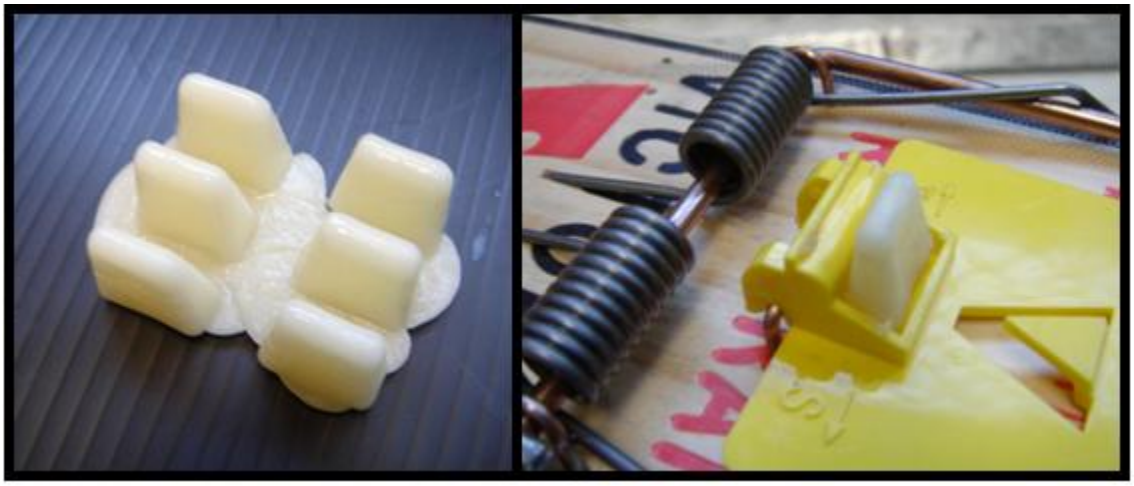

Figure 4. Peanut butter scented wax bait for Victor® rat traps.

Preliminary experimentation with the peanut butter wax in the Kahanahaiki trapping grid indicate that approximately 50-60% of traps had wax present after two weeks. After four weeks, 25-30% of traps still

had wax present. In contrast, when peanut butter is used on traps in large-scale trapping grids, NRS often find that 80-100% of traps have no peanut butter after two weeks. These results suggest that the peanut butter wax may last significantly longer on traps than peanut butter. In a trial at Kahanahaiki where NRS alternated using peanut butter and peanut butter wax on every other trap, 39% of rat catches were from traps baited with peanut butter wax (16 out of 41) and the rest were from traps baited with peanut butter. It could be that rats are not as attracted to the peanut butter wax as they are to regular peanut butter. Nevertheless, since 39% of the total kills in that period were from traps baited with the wax alone, it indicates that the wax is indeed somewhat attractive to rats. In addition, the fact the wax persists in the field much longer than peanut butter, it is the most promising alternative trap bait discovered so far. Future trials will strengthen this assertion.

Over the next year, OANRP will begin using this wax more extensively at various sites, specifically in the trapping grids and in areas with Elepaio. To maximize bait attractiveness to rats and longevity, OANRP will use the wax as supplemental bait; all traps will be baited with the wax and also a fresh dab of peanut butter or another bait, such as Nutella®. This way, the traps will be highly attractive to rats while the first bait (i.e. peanut butter) is present and will remain baited with the wax after the peanut butter has been removed. Potentially, this baiting system could greatly reduce labor costs since the majority of traps will remain baited for longer periods and re-baiting intervals could be stretched at some sites. It is not clear what the long-term cost of using peanut butter wax in trapping grids will be as the amount used over time is yet to be determined; however, the first shipment of wax from New Zealand cost about $30 per pound including shipping. Even with the relative expense of the wax, this baiting system could also greatly increase the efficacy of rat control efforts and increase benefits to natural resources.

6.4 AUTOMATIC SELF-RESETTING RAT TRAP TRIAL

OANRP recently acquired over 50 automatically resetting rat traps that can reset up to 24 times. These traps are a new tool created by Goodnature® (www.goodnature.co.nz) in New Zealand to humanely kill rats of any species or age class. Each trap can kill up to 24 rats using a single CO_2 cartridge and are designed to be baited with a long-lasting attractant (see Figure 5). A trap costs $149.50 NZD or about $123 USD.

Figure 5. Goodnature® A24 Automatic Rat Trap with CO_2 cartridge. Photo courtesy of www.goodnature.co.nz.

There are possible advantages of using this new tool. Primarily, long-term rat control costs could be significantly reduced with the use of automatic traps because they don't need to be serviced as often as traditional traps thereby reducing staff time spent re-baiting, fewer traps may be necessary for the same level of rat control, and helicopter time would be reduced due to less frequent servicing of traps in remote areas. Even with the high cost per trap, the automatic traps could save a significant amount of money in long-term labor costs.

For example, in Kahanahaiki, typically four staff reset 464 snap traps twice a month and typically fewer than 60 rats are killed each month. Since 2009, the average labor cost for installing and maintaining the grid each year has been over $40,000. If automatic traps were used in a grid layout of 100 meters by 50 meters (as suggested by D. Peters, pers. comm.), there would be 54 traps. At the highest catch rate generally seen of 60 rats per month, it would be 21 months before all traps would need new CO_2 cartridges. In reality, the traps could probably be checked 2-4 times a year by fewer staff to refresh the bait and replace CO_2. This roughly equates to less than 20% of the labor currently required for grid maintenance. Finding bait that lasts as long as possible is crucial to maximize the utility of the traps.

In collaboration with Kalaupapa National Park and the State of Hawaii, OANRP has commenced a trial in Pahole Natural Area Reserve to investigate the use and efficacy of the automatic traps in Hawaii. Forty five traps have been deployed in a 200 meter circular buffer around the outplanted population of *Cyanea superba* in Pahole (Figure 6).

Figure 6. Map of the automatic trap grid layout at Pahole NAR that is centered around the *C. superba* population (indicated by stars). The trap lines are labeled A, B, C, D, E with eight additional traps around the perimeter. Each black symbol represents one trap. The circle represents a 200 meter buffer around the C. superba plants; the squares are an example of the home-range size of a black rat (~4 ha, Shiels 2010).

The grid was laid out in accordance with the New Zealand Department of Conservation's recommendation for trap placement. Trap lines are spaced 100 meters apart with traps installed 50 meters apart on the trap lines. Eight additional traps are deployed on the perimeter between trap lines for a total of 45 traps.

This project is the first attempt at systematically collecting data on the application, effectiveness, and cost of using these traps for natural resource management in remote Hawaiian forest settings. The overall goal of this study is to begin the process of collecting data on the utility of these traps to become more knowledgeable regarding how they function and whether or not they reduce rat activity enough to protect natural resources. OANRP hopes to learn about the functionality of these traps so that future decisions regarding the use of these traps will be more informed.

This project will be conducted in two phases: Phase 1 will include preliminary data collection on a subset of traps. Cameras will record animal (rat, cat, mongoose) activity at the traps and the number of kills will be recorded. Phase 2 includes installing a grid of 45 automatic traps centered around *C. superba* at Pahole gulch to monitor rat predation on fruit and deploying tracking tunnels to assess changes to rat

activity. *C. superba* have been shown to be heavily predated upon by rats (Pender et al. 2012) and these plants will provide a reference for how the automatic traps affect rat predation on natural resources.

Preliminary data from this project indicate that the traps are very effective at attracting and killing rats. Three days after installation on 26 October 2012, 12 traps had killed 19 rats. By 31 October 2012, 14 more rat carcasses were found beneath 12 traps; several traps had three carcasses below them. The traps already appear to be a very promising management tool.

For more details, please see Appendix 6-1 for a full project overview.

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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 program's Research Specialist (RS) which, this year, focused on the control of invasive slugs (Pulmonata, Stylommatophora) and ants (Hymenoptera, Formicidae). Work on predators of the endangered tree snail *Achatinella mustellina* appears in Chapter 3: *Achatinella* Species Management.

7.1 SLUG RESPONSE TO HIGH AND LOW DOSE APPLICATION OF SLUGGO® IN THREE MANAGEMENT UNITS (MUS)

7. 1.1 Introduction

Slugs can seriously reduce the survival of rare native Hawaiian plants (Joe & Daehler 2008). In addition, control of slugs using the organic molluscicide Sluggo® (trademark omitted from the rest of this document) (Neudorff, Germany) was shown to enhance germination of certain rare plant species (Kawelo *et al*. 2012). In late 2010, OANRP successfully petitioned the Hawaii Department of Agriculture (HDOA) to expand use of Sluggo under a Special Local Needs (SLN) Label which allows it to be used in forests to protect native plants (see section 5.2 of the OANRP Year End Report (YER) http://manoa.hawaii.edu/hpicesu/DPW/2011_YER/008.pdf). The label will expire at the end of 2015, at which time, OANRP hopes to provide HDOA with information pertinent to the SLN renewal.

The purpose of this experiment was to determine whether Sluggo (a.i. iron phosphate 1% by weight) applied at a rate of 1 lb. per $93m^2$ once a month provides equal slug suppression as when applied bi-monthly. 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. The cost of the bait itself is also an expense. A 25 lb. bag retails at 70$ (Grow Organic Website accessed 11/8/2012).

The two rates tested are referred to in this document as the bimonthly treatment and the monthly treatment respectively. Frequency of bait application, therefore, and not the *amount* of Sluggo applied at a single time was manipulated in this study.

The experiment was carried out in three MUs (Fig. 1) to determine the lowest effective application rate for those specific areas.

Figure 1: Location of the three MU's where Sluggo frequency was tested.

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These sites were chosen for the following reasons:

1. each contained plants known to be vulnerable to slugs (Table 1)

2. regular, slug long-term control is planned in these areas for at least the duration of the Sluggo SLN

3. slug damage to plants has been observed and slugs are common (*i.e.* they were detected within 15 minutes when searches are carried out by experienced staff)

4. no native snails are present in proximity to the treatment areas (see section 5.3.4 page 241 of the 2011 YER)

Table1: Rare plant species treated in each MU, size of treatment area amount of Sluggo used at each treatment.

Location	Plant species treated	Treatment area (m^2)	Sluggo required per treatment (lbs.)
Ekahanui	*Cyanea grimesiana* subsp. *obatae, Delissea waianaensis, Phyllostegia mollis, Schiedea kaalae*	930 (large)	10
Palikea	*C. grimesiana* subsp. *obatae, C. superba* subsp. *superba*	625 (medium)	7
3 Points	*C. longiflora, C. grimesiana* subsp. *obatae, S. obovata*	144 (small)	1.5

Though the primary purpose of this work was to save labor costs associated with controlling slugs in the three MUs in particular, this work also addressed the following questions regarding size and slug density.

1. If differences between slug numbers existed between sites, did those with higher densities of slugs require more frequent Sluggo applications?

2. Did smaller areas require more frequent Sluggo application than larger ones or vice versa? We expected smaller areas (*i.e.* 3 Points) would have greater problems with slug incursion than large ones (*i.e.* Ekahanui).

7.1.2 Methods

At each MU, treatment and control sites were established no closer than 30m and no farther than 100m from one another. Treatment areas within each MU remain those shown in section 5.3.4 pages 238-241of the 2011 YER. 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 6 oz. of beer. Traps were scattered throughout the site at least 2m from its nearest neighbor and, in the treatment areas, at least 2m from the edge of the Sluggo application area and kept there for the duration of the study. Traps were filled every two weeks, after which any captures were recorded and the species recorded. Slugs were counted at both treatment and control sites every two weeks for the duration of the study (Oct. 15, 2011-June 1, 2012 for Ekahanui and Palikea; Nov. 15, 2011 – June 1, 2012 for 3 Points) and their species recorded. Refer to Table 2 for a timeline of sampling events. The mean number of slugs found in the 10 treatment and the 10 control traps comprise a single sampling event (referred to later in the results section).

Pitfall trap with beer used in this study.

Table 2. List of slug sampling events and Sluggo application dates.

Date (± 2 days)	Activity
10/01/2011	Pitfalls baited in Ekahanui & Palikea for pre-treatment slug counts
10/15/2011	Slugs counted in pre-treatment sample, pitfalls re-baited for post-treatment counts. Bimonthly Sluggo treatments begin in the treatment sites within Ekahanui & Palikea
11/1/2011	Slugs counted at Ekahanui & Palikea, pitfalls rebaited, bimonthly treatments continue. Pre-treatment pitfalls baited at 3 Points
11/15/2011	Slugs counted at Ekahanui & Palikea, pitfalls rebaited, bimonthly treatments continue. Slugs counted in the 3 Points pre-treatment sample, pitfalls re-baited for post-treatment counts. Bimonthly Sluggo treatments *begin* in the treatment site at 3 Points
12/01/2011	Slugs counted at all three MU's, pitfalls rebaited, bimonthly treatments continue
12/15/2011	Slugs counted at all three MU's, pitfalls rebaited, bimonthly treatments continue
1/01/2012	Slugs counted at all three MU's, pitfalls rebaited, bimonthly treatments continue
1/15/2012	Slugs counted at all three MU's, pitfalls rebaited, bimonthly treatments continue
2/01/2012	Slugs counted at all three MU's, pitfalls rebaited, *bimonthly treatment ends.* Monthly Sluggo application (all MU's) *begins*
2/15/2012	Slugs counted at all three MU's, pitfalls rebaited. No Sluggo applied
3/01/2012	Slugs counted at all three MU's, pitfalls rebaited. Monthly Sluggo application takes place
3/15/2012	Slugs counted at all three MU's, pitfalls rebaited. No Sluggo applied
4/01/2012	Slugs counted at all three MU's, pitfalls rebaited. Monthly Sluggo application takes place
4/15/2012	Slugs counted at all three MU's, pitfalls rebaited. No Sluggo applied
5/01/2012	Slugs counted at all three MU's, pitfalls rebaited. Monthly Sluggo application takes place
5/15/2012	Slugs counted at all three MU's, pitfalls rebaited. No Sluggo applied
6/01/2012	Slugs counted at all three MU's. *Monthly application trial ends*

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. The abbreviation 'ns' is used in lieu of non-significant. Nonparametric statistical methods were used to analyze datasets with non-normally distributed residuals and dissimilar variation between groups, otherwise parametric methods were used.

Pre-treatment differences due to MU and non-random assignment of treatment and control areas were analyzed using a Two-way ANOVA followed by a Tukey's HSD. Slug counts were normally distributed. In October, prior to the beginning of the biweekly application trial, there were no significant differences in slug numbers between treatment and control sites ($F_{1, 23} = 1.16$; P = ns) as expected. Significant

differences between MUs were evident, however, with Ekahanui having more slugs than either 3 Points or Palikea ($F_{2, 23}$ = 66.65, P = 0.000) (Fig. 3). Please note that 3 Points was sampled Nov. 1, 2011, 1 month after the other two sites but *before* any Sluggo was applied in that area (Table 2).

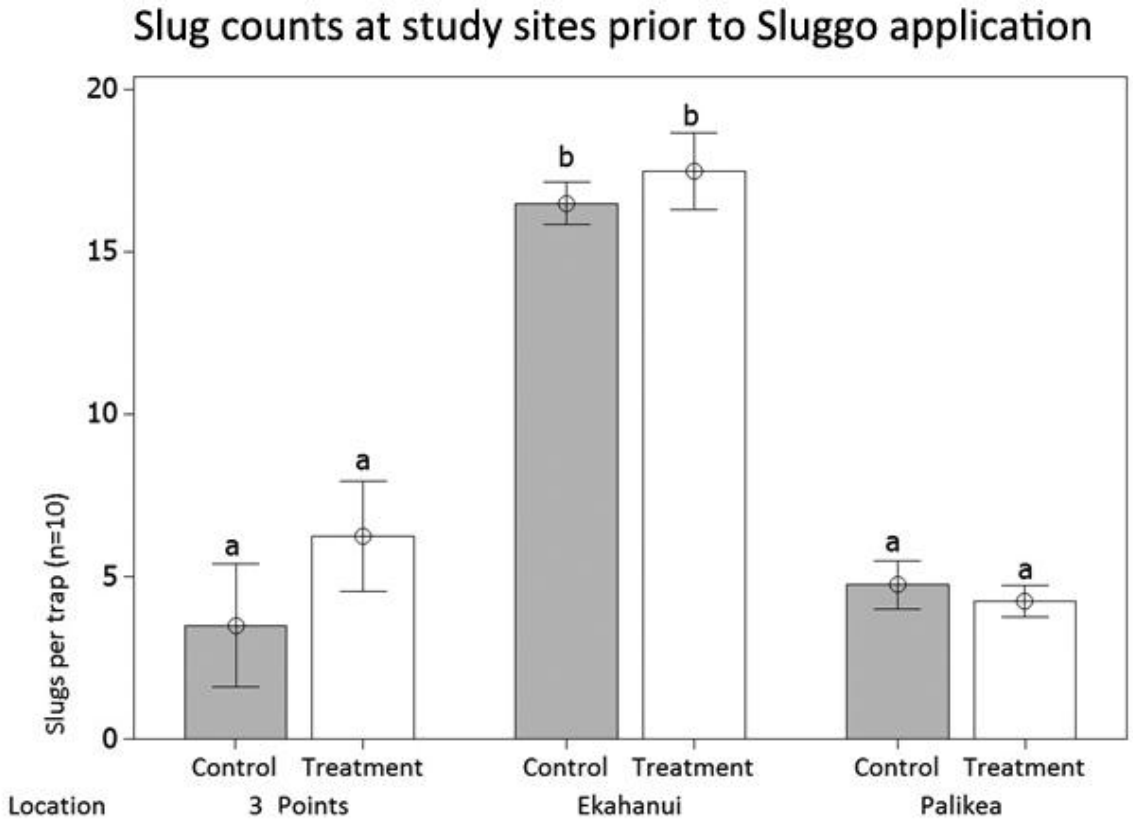

Figure 3. Mean number of slugs (bars are ± 1 SEM) in treatment and control areas before the beginning of the trial (Oct. 1, for Ekahanui and Palikea and Nov. 1, 2011 for 3 Points). Ekahanui has more than twice the number of slugs as the other two MUs. Letters denote groups that differ significantly from one another according to post hoc comparisons using Tukey's HSD, therefore group 'a' differs from 'b' but not from other 'a's.

Ekahanui and Palikea received the bimonthly treatment of Sluggo starting 15 Oct. 2011 through 1 Feb. 2012 at which time the bimonthly trial ended and the monthly treatment began. This means that the two treatments did not occur simultaneously, which would have been the preferred design. Instead the monthly treatments followed the bimonthly treatments in the same treatment sites used previously. Monthly treatments began 1 Feb. 2012 continued through 1 June 2012 (Table 2). Due to staggered field schedules, 3 Points did not receive its first Sluggo treatment until 15 Nov. 2011. This was one month after both Palikea and Ekahanui began receiving their bimonthly treatment; therefore, there is less data available for the 3 Points bimonthly treatment (n = 5 sampling events vs. n = 7 for other MUs). By contrast, all three MU's received the monthly treatment for the same amount of time (Table 2) (n = 9 sampling events).

Unlike the data shown in the Fig. 3, analysis post-treatment relied upon the *mean* number of slugs from all traps during a single sampling event; not those from individual traps as the unit of replication. Thus, the sample unit was equal to the average number of slugs found across 10 traps at a given site (treatment or control) in a given MU at a particular time. Sample sizes, therefore, were generally small; the result

(with the exception of the first dataset analyzed with a General Linear Model (GLM)) was data with a positive skew and long right tail. Non-parametric analysis was used for these datasets.

7.1.3 Results

Application of Sluggo at *either* the bimonthly or monthly application rate in the treatment areas reduced slugs significantly over the control group at all MUs (GLM, $F_{2, 89} = 30.84$, $P = 0.000$) (Fig. 4).

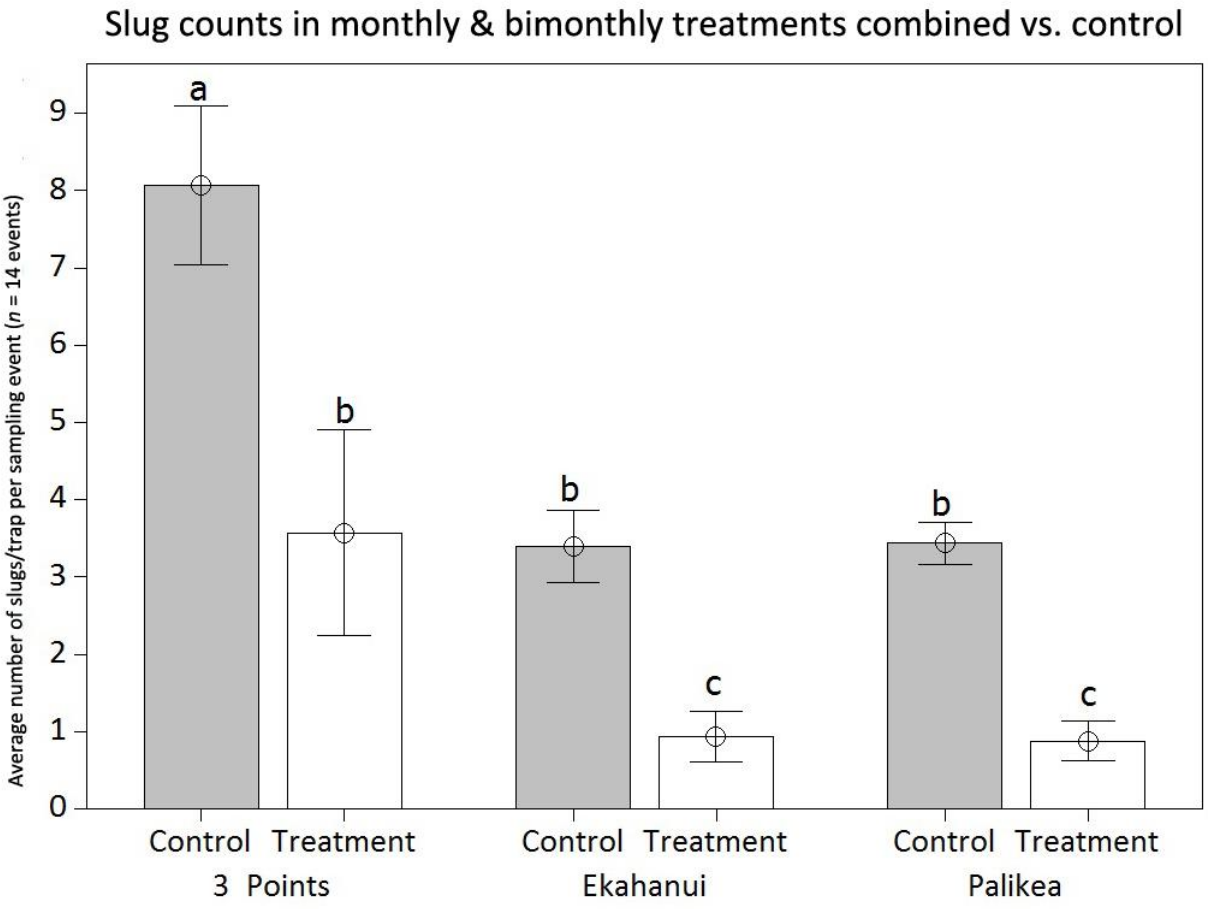

Figure 4. Relative slug abundance (bars are ± 1 SEM) in treatment and control areas across sampling events (15 Nov. 2011-1 June 2012) by MU. Although Ekahanui initially had the highest density of slugs, 3 Points had higher numbers than the other MUs over the duration of the study. Letters denote groups that differ significantly from one another according to post hoc comparisons using Tukey's HSD.

Seasonal trends in the number of slugs at untreated (control) sites illustrate the consistently high numbers of slugs at 3 Points compared to either Palikea or Ekahanui (Fig. 4). Reasons for this are unclear as all three areas receive approximately 1,250mm of rainfall per year (Giambelluca *et al.* 2011) and it has been established slug populations respond positively to increased moisture. Rainfall itself, however, is not as important to forest floor moisture (Nystrand &Granström 1997), so perhaps microhabitat plays a role in determining local slug abundance.

Slug counts in the treatment areas only are shown in Figure 5. Slugs remain low in both the bimonthly and monthly treatments for Ekahanui and Palikea only, with a spike in numbers evident at 3 Points when the monthly treatment commences.

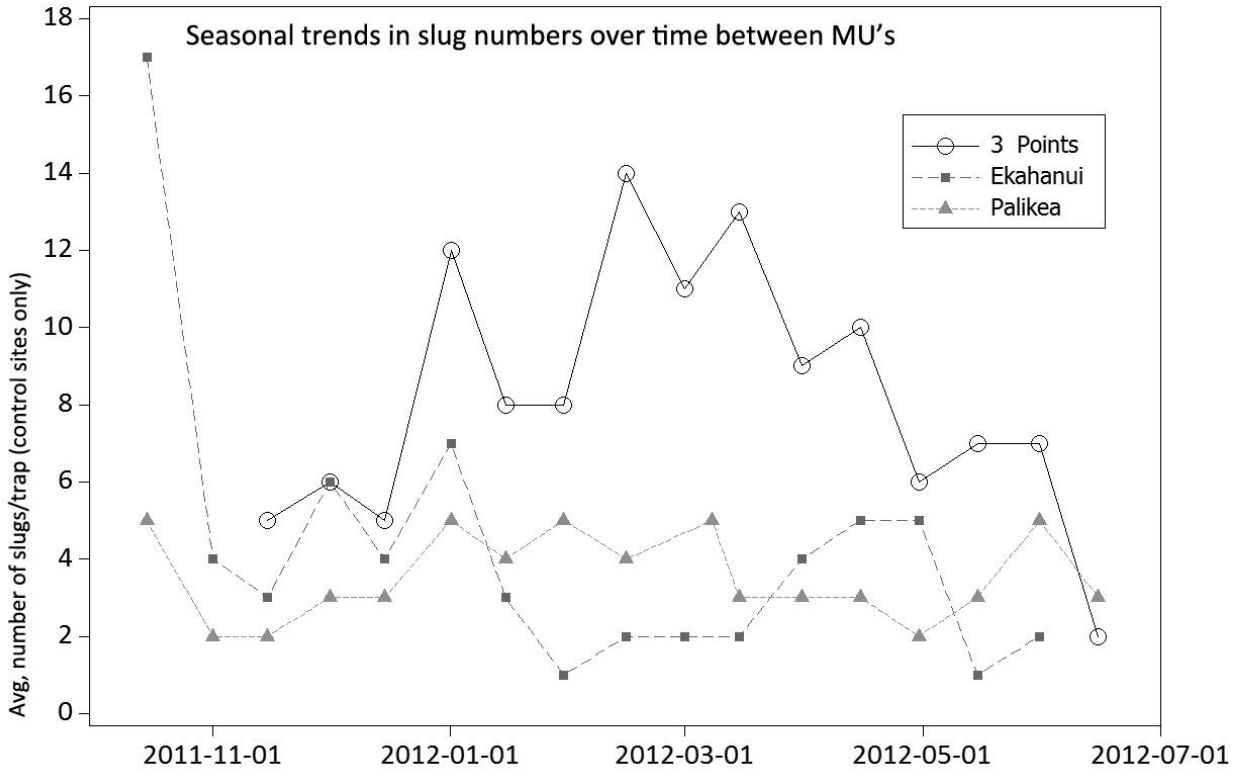

Figure 4. Overall, 3 Points had higher numbers of slugs for a longer amount of time than the other two MU's.

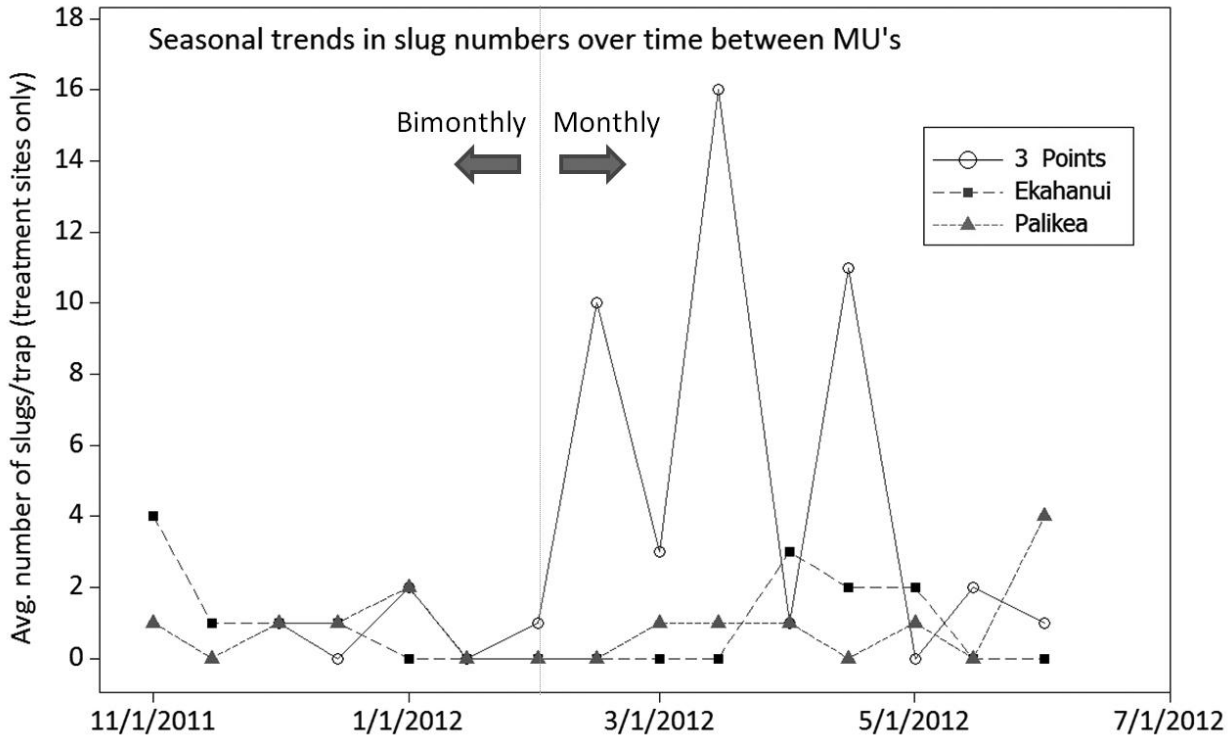

Figure 5. Slug counts in the treatment areas over time. Note the almost immediate increase in slug numbers at 3 Points when Sluggo was applied only once per month. By comparison, slug suppression at Palikea and Ekahanui appears unaffected by a scaled back treatment regimen.

Overall (across all MUs), application of Sluggo bimonthly did not achieve better suppression of slugs than at a monthly dose (Kruskal–Wallis test, H= 1.60, $d.f.$= 1, P = ns). Note that control groups were omitted in the analysis but are shown alongside the treatment groups in the graph below for comparison (Fig. 6).

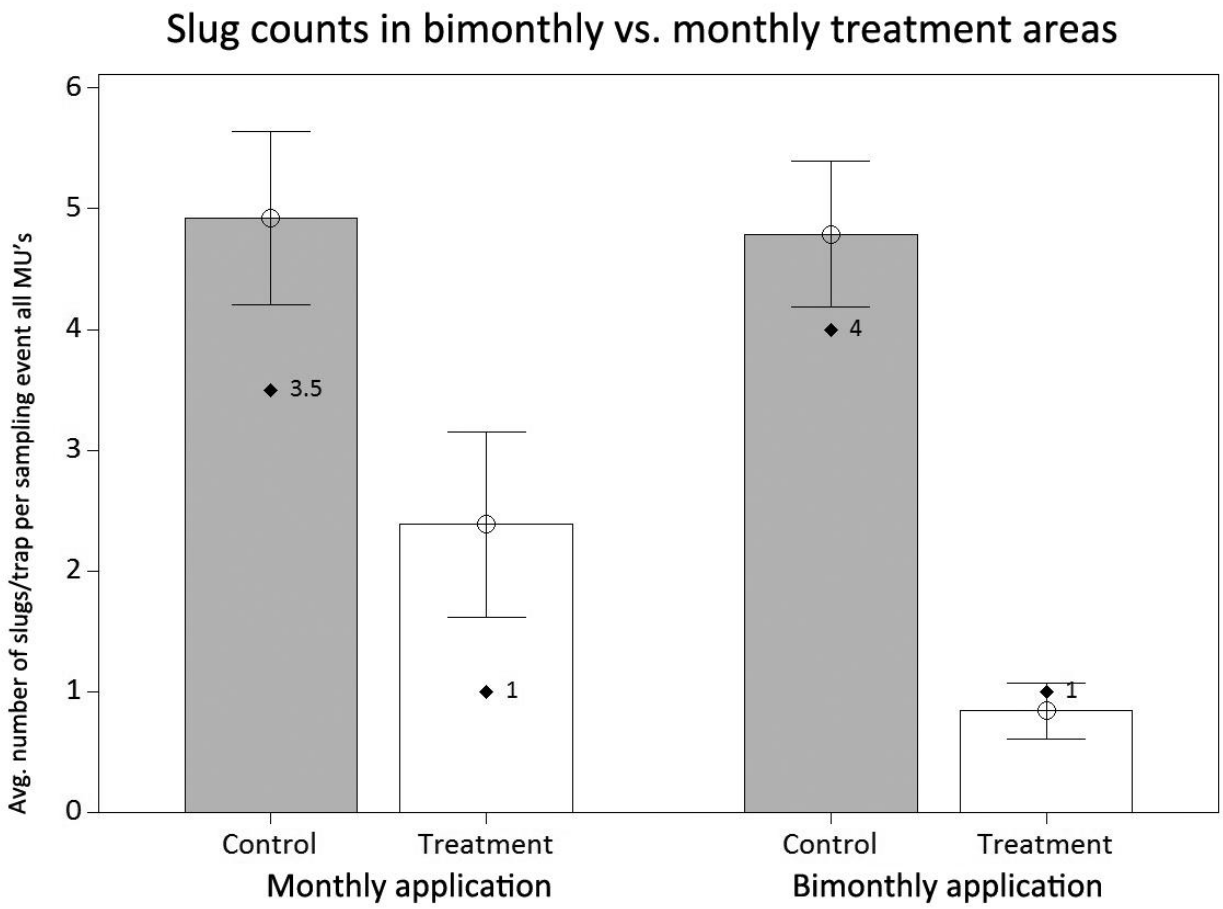

Figure 6. Relative slug abundance (bars are ± 1 SEM) in low vs. high dose treatment areas across all MUs. Although the means of the bimonthly and monthly application differ, the medians (shown as black diamonds) are identical.

Trends within individual MUs

Outcomes of the two treatments (bimonthly vs. monthly rate) and comparisons of each treatment type against its control group, were compared using the Wilcoxon–Mann–Whitney U test (MWU) followed by a Bonferroni adjustment for multiple comparisons (3 total for each MU: bimonthly rate vs. control; monthly rate vs. control and monthly vs. bimonthly rate).

3 Points

At 3 Points, only the bimonthly application significantly reduced slugs over the control group (MWU, W= 40, $n_1 = n_2 = 9$, $P = 0.036$). The monthly treatment was relatively ineffective (W= 103, $n_1 = n_2 = 5$, $P = 0.399$). Though the bimonthly application suppressed slugs over the control group, this difference was not significant when compared against the monthly rate (W= 103, $n_1 = 5$, $n_2 = 9$, P = ns) (Fig. 7).

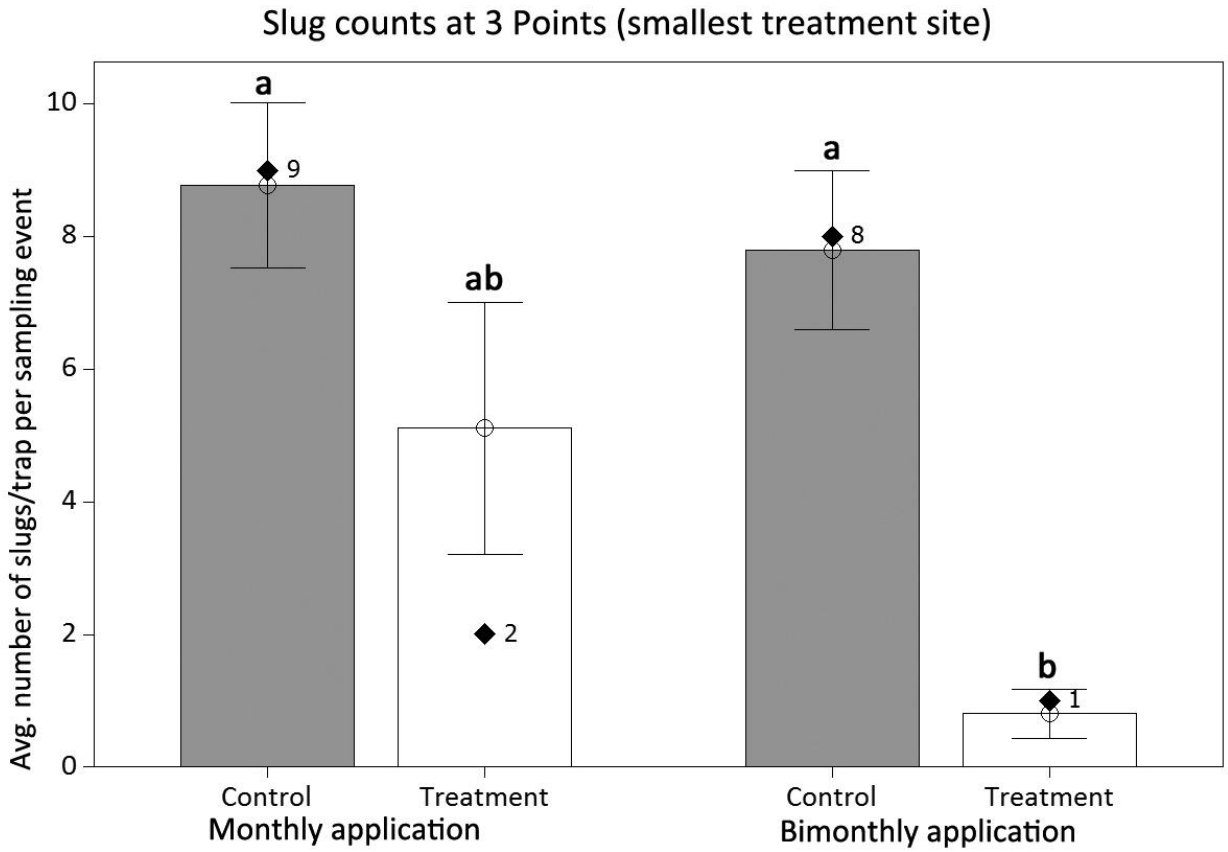

Figure 7. Relative slug abundance (bars are ± 1 SEM) in monthly and bimonthly treatment sites compared to controls at 3 Points MU. Medians are labeled and represented by black diamonds. Letters indicate groups that are significantly different from one another. Notice that the monthly treatment group does not differ significantly from any other group.

Palikea

Unlike 3 Points, in Palikea both the monthly and bimonthly treatments significantly reduced slugs over the control. Findings for the bimonthly group using MWU were W= 76, $n_1 = n_2 = 7$, P = 0.009 and W= 119.5, $n_1 = n_2 = 9$, P = 0.009 for the monthly group respectively. When both treatment groups were compared against one another, there was no significant difference in slug suppression (W= 79, $n_1 = 7$, $n_2 = 9$, P = ns) (Fig. 8).

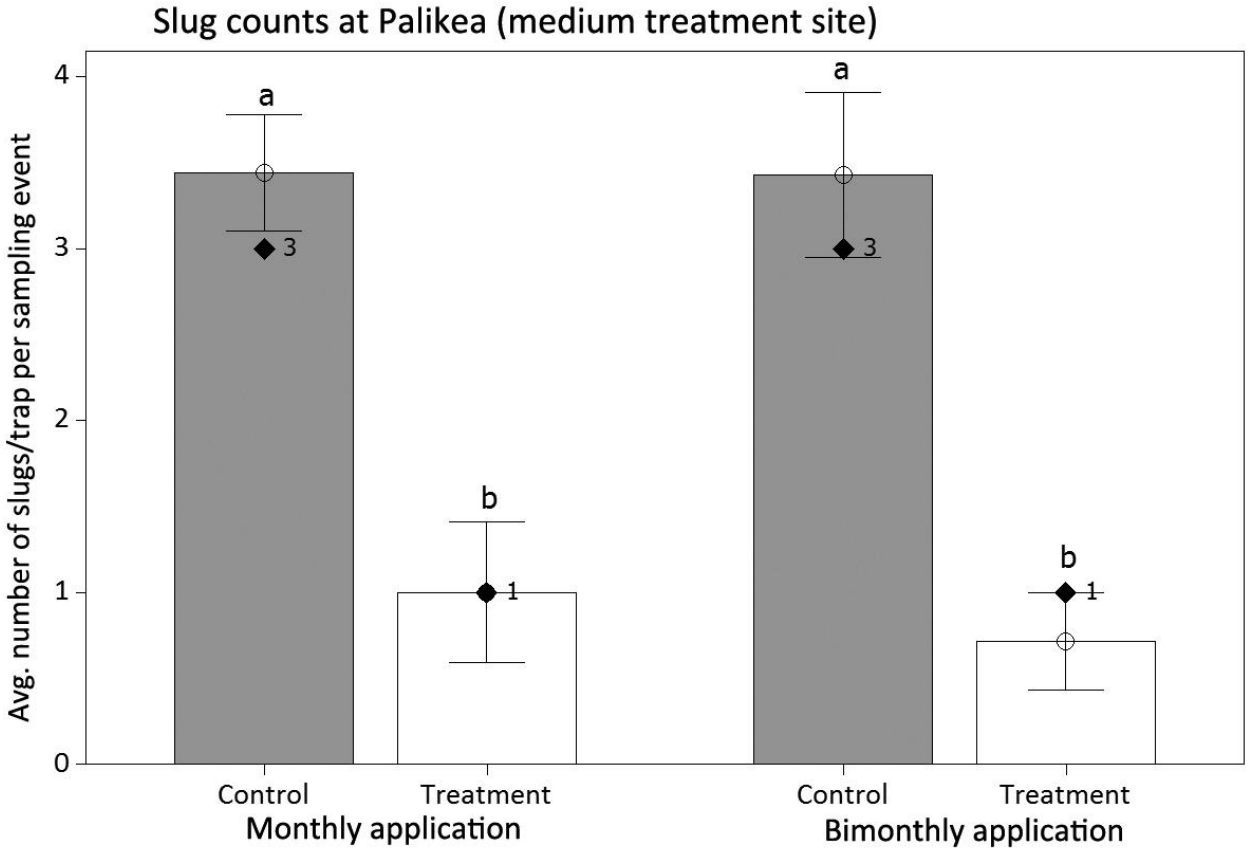

Figure 8. Relative slug abundance (bars are + 1 SEM) in the monthly and bimonthly treatment sites compared to controls at Palikea MU. Medians are labeled and represented by black diamonds. Letters indicate groups that are significantly different from one another. Notice that the monthly treatment group does not differ significantly from the bimonthly treatment, while both treatments differ from the controls.

Ekahanui

As in Palikea, both the monthly and bimonthly treatments significantly reduced slug numbers over the control group. Results were W= 75, $n_1 = n_2 = 7$, $P = 0.014$ for the bimonthly group and $W = 93.5$, $n_1 = n_2 = 8$, $P = 0.026$ (MWU) for the monthly group. As with Palikea, significantly greater suppression of slugs was *not* achieved when Sluggo was applied bimonthly compared to the monthly ($W = 62.5$, $n_1 = 7$, $n_2 = 8$, P = ns) (Fig. 9).

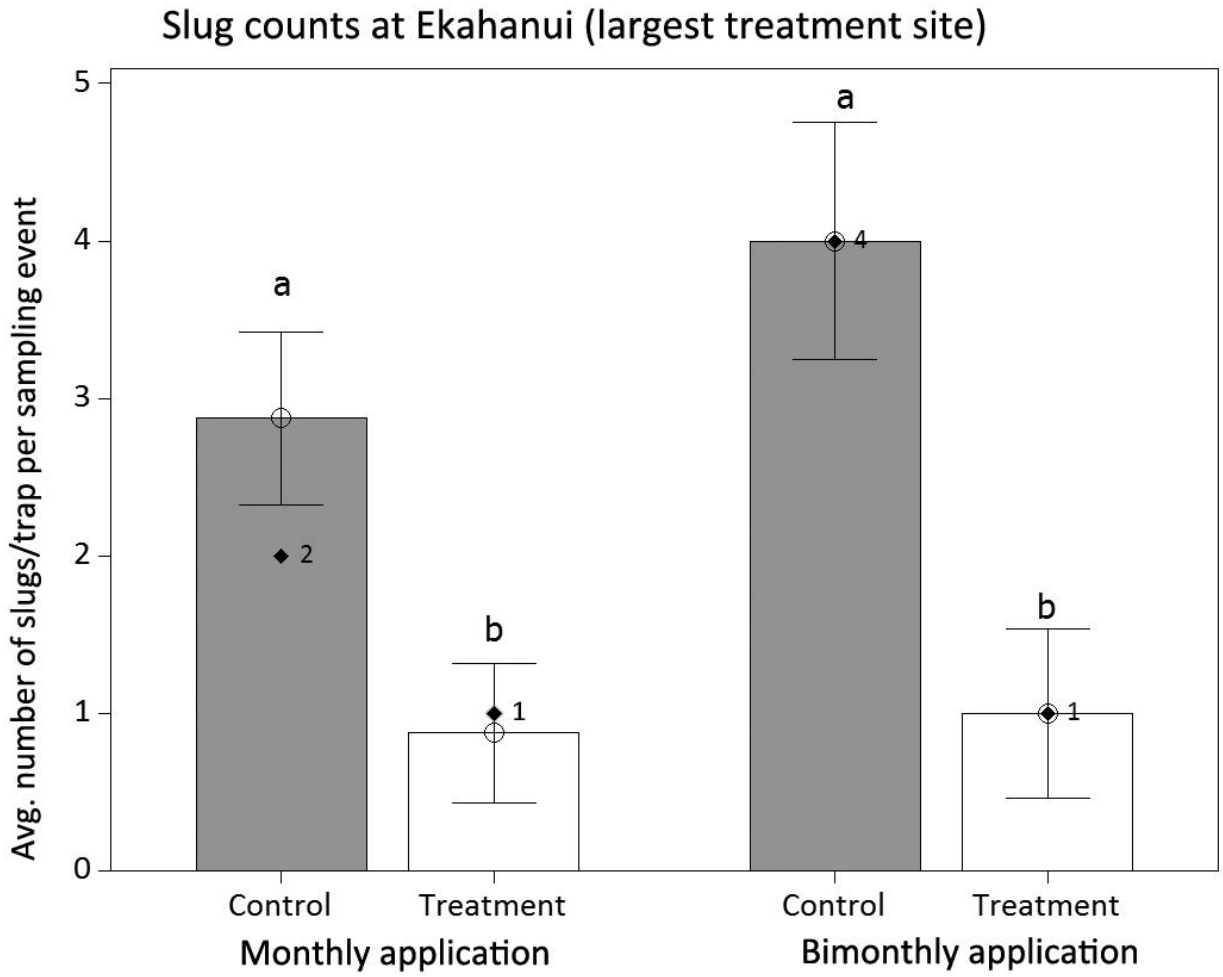

Figure 9. Relative slug abundance (bars are + 1 SEM) in monthly and bimonthly treatment sites compared to controls at Ekahanui MU. Medians are labeled and represented by black diamonds. Letters indicate groups that are significantly different from one another. Notice that the monthly treatment group does not differ significantly from the bimonthly treatment, while both treatments differ from the controls.

7.1.4 Discussion

At the outset, Ekahanui had significantly more slugs than the other two units (about twice as many per trap, see Fig. 3). Both Palikea and 3 Points, prior to the beginning of treatment, had similar numbers of slugs (~5/trap). This finding may have been an anomaly, however, as numbers were consistently higher at 3 Points over the next several months and numbers at Ekahanui, even in untreated areas, never reached

those initially observed in October 2011 (Fig. 4). It seems more likely that 3 Points had and continues to have, higher numbers of slugs than either Palikea or Ekahanui but that this was not detected initially. These high numbers may explain why only the bimonthly application of Sluggo effectively suppressed slugs at 3 Points, while the monthly rate provided equally good suppression of slugs at Palikea and Ekahanui. This explanation is unsatisfactory however, because in addition to having the highest slug density, 3 Points also had the smallest treatment area (only 144m^2 vs. Palikea's 625 m^2 or Ekahanui's 930m^2). A small treatment area meant greater incursion of slugs from untreated areas. Thus, the effect of density and treatment area are confounded in the case of 3 Points. The effect of consecutive treatments (bimonthly followed by monthly) may also have inflated the efficacy of the monthly application. It is possible that lingering suppression of slugs from the bimonthly treatment was responsible for the perceived efficacy of the monthly treatment. Figure 5 suggests this is not the case however. If the bimonthly application was responsible for the success of the monthly application, we would expect slug numbers to gradually rise in Palikea and Ekahanui as the monthly application progressed. This did not happen. Alternatively the dramatic dips in slug numbers directly following each monthly treatment at 3 Points shows that slugs are responding but recovering before the next Sluggo application.

7.2 FUTURE RESEARCH

Starting in October 2012, we have resumed treatment of all rare plants in these three MUs with one difference. We increased the treatment area at 3 Points so that it now measures 250m^2. We may expand this area to be more comparable to the Palikea site where monthly application was successful (~500m^2). Also of interest would be to reduce the size of the treatment areas at Palikea and Ekahanui to see whether slug incursion becomes a problem, as we suspect happened at 3 Points. Alternately, we could increase the treatment area at Palikea or Ekahanui to examine whether Sluggo could be just as affective when applied less frequently than once per month (say once every six weeks for example).

Presently, however, slugs are only being counted in the treatment and control sites at 3 Points while applying Sluggo once per month. If slug numbers are significantly depressed in the treatment site relative to the control after 4 months, we will have evidence that Sluggo applied over a greater area reduces the need for repeat visits despite high pest density. As this work demonstrated, Sluggo applied once a month in Ekahanui and Palikea is as effective as bimonthly application thereby reducing the cost of labor and materials associated with slug control.

Further research is needed to determine the resource response to different slug densities. Missing from this particular study was any regeneration or survival data for the rare plant species treated . We do not know the level of slug suppression needed to create the greatest benefit for rare plant taxa. This is expected to differ for different species of plants in different areas at different times of year. We will focus on tackling these complex questions in future studies.

7.3 SURVEY OF INVASIVE ANT SPECIES

In Hawaii, ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads (See Appendix 7-2 of the 2010 YER).

As stated in previous reports (see section 5.4 of the 2011 YER) OANRP conducts annual surveys of invasive ants in high-risk areas using a standard protocol developed by University of Hawaii entomologists (see appendix 7-1 of the 2010 YER). 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 (plants, snails or endangered *Drosophila*) may prove vulnerable to ant attack. Careful monitoring will increase our chances of early detection and eradication.

Table 3. List of ant species found in each MU. New records for 2012 are indicated with an asterisk. Risk (low, medium and high) is taken from species factsheets (Sarnat 2008).

Management Unit	Ants recorded prior to 2012	Ants recorded 2012	Action needed?
Pahole	*Solenopsis genimata, S. papuana, Paratrechina bourbonica, Leptogenys falcigera*	*S. papuana*	*S. geminata* remains absent following treatment in 2011
Kaluakauila	*Anoplolepis gracilipes, Cardiocondyla emeryi, Ochetellus glaber, Paratrechina bourbonica, Plagiolepis alludi, S. papuana*	*Paratrechina bourbonica, Plagiolepis alludi*	*Anoplolepis gracilipes* is an aggressive species; however, it was not detected in 2012
Kaala	*Solenopsis papuana, Ochetellus glaber, Tetramorium simillimum, Cardiocondyla venustula, C. wroughtoni, C. minutior*		No ants detected in 2012
Kahanahaiki	*Cardiocondyla emeryi, C. wroughtoni, C. venustula, Leptogenys falcigera, Ochetellus glaber, Plagiolepis alludi,S. geminata, S. papuana, Technomyrmex albipes, Tetramorium simillimum*	*Ochetellus glaber*	*Solenopsis geminata* remains absent following treatment in 2011. *Ochetellus glaber* is a low risk species
Pahole mid-elevation nursery (Nike site)	*Solenopsis papuana, S. geminata, Ochetellus glaber, Anoplolepis gracilipes*	*Anoplolepis gracilipes, Solenopsis papuana, Ochetellus glaber, Cardiocondyla obscurior* Tetramorium bicarinatum**	*S. geminata* not detected this year following treatment in 2011. Research into *A. gracilipes* control is on-going. New species detected this year not considered high risk species
Kaena East of Alau	*Tetramorium simillimum, Solenopsis papuana, Ochetellus glaber*	*T. caldarium*, Ochetellus glaber, Monomorium floricola**	Ants found are low risk species
Lower Ohikilolo	*Ochetellus glaber, Pheidole megacephala*	*Ochetellus glaber, Pheidole megacephala, Monomorium destructor**	Ants found are too widespread at low elevations for control
Honouliuli	*Solenopsis papuana, Pheidole megacephala*	*Solenopsis papuana, Pheidole megacephala*	*Solenopsis papuana* detected at high elevation sites, but is not considered a threat. *Pheidole megacephala* was only found on the road at the trailhead

Makaha	*Anoplolepis gracilipes, S. papuana*	*Anoplolepis gracilipes, S. papuana*	These two species were only found in the parking lot, they were not detected at the outplanting sites at higher elevation. Only *A. gracilipes* is a species of concern
Ekahanui	*Solenopsis papuana, Plagiolepis alludi*	*Solenopsis papuana, Technomyrmex albipes**	Species present are not considered a high threat
Palikea	*Cardiocondyla venustula, Pheidole megacephala, Solenopsis papuana*	*Solenopsis papuana*	*Pheidole megacephala* doesn't appear established, not detected in 2012.

7.3.1 Ant Control Actions

Three infestations of the *Solenopsis geminata* (tropical fire ant or TPA) were identified and treated in 2011 by State and OANRP staff (infestations were at Pahole Mid Elevation Nursery, Puu 2210 and Peacock Flats). Follow up monitoring in 2012 failed to detect continued persistence of TPA. Further monitoring in 2013 is recommended to assure successful eradication.

7.3.2 Yellow Crazy Ant Control

Anoplolepis gracilipes or yellow crazy ant (YCA) continues to be a problem at the Pahole Mid Elevation Nursery where is occupies an area of approximately 1 acre. Since its initial discovery at that site in 2008, OANRP has attempted control using various insecticides with no success (see section 5.4.1.1 in 2011 YER).

USFWS recently developed a bait mixture containing 25% cat food, 25% Karo syrup and 50% water with the active ingredient dinotefuran (the pesticide Safari™ 20 SG, Valent U.S.A. Co.) which successfully controlled YCA on a small atoll. Following their protocol, we tested this mixture at our Wahiawa baseyard where YCA is well established and present in high numbers. Treatment took place on 30 August 2012 at the recommended rate (6 g a.i./0.5 ha). Numbers of foragers at cards with non-toxic bait (SPAM, peanut butter and honey mixture) were counted before and after treatment to determine treatment efficacy (n = 20 cards). Initial results showed a dramatic knockdown within 1 week but full recovery occured after about 1 month (Fig. 10). A one-way ANOVA was used to test for differences in YCA visitors to bait cards pre and post-treatment across the four time periods sampled (Fig. 11). A significant decline due to treatment was found ($F_{3, 79} = 10.87$, $p = 0.000$).

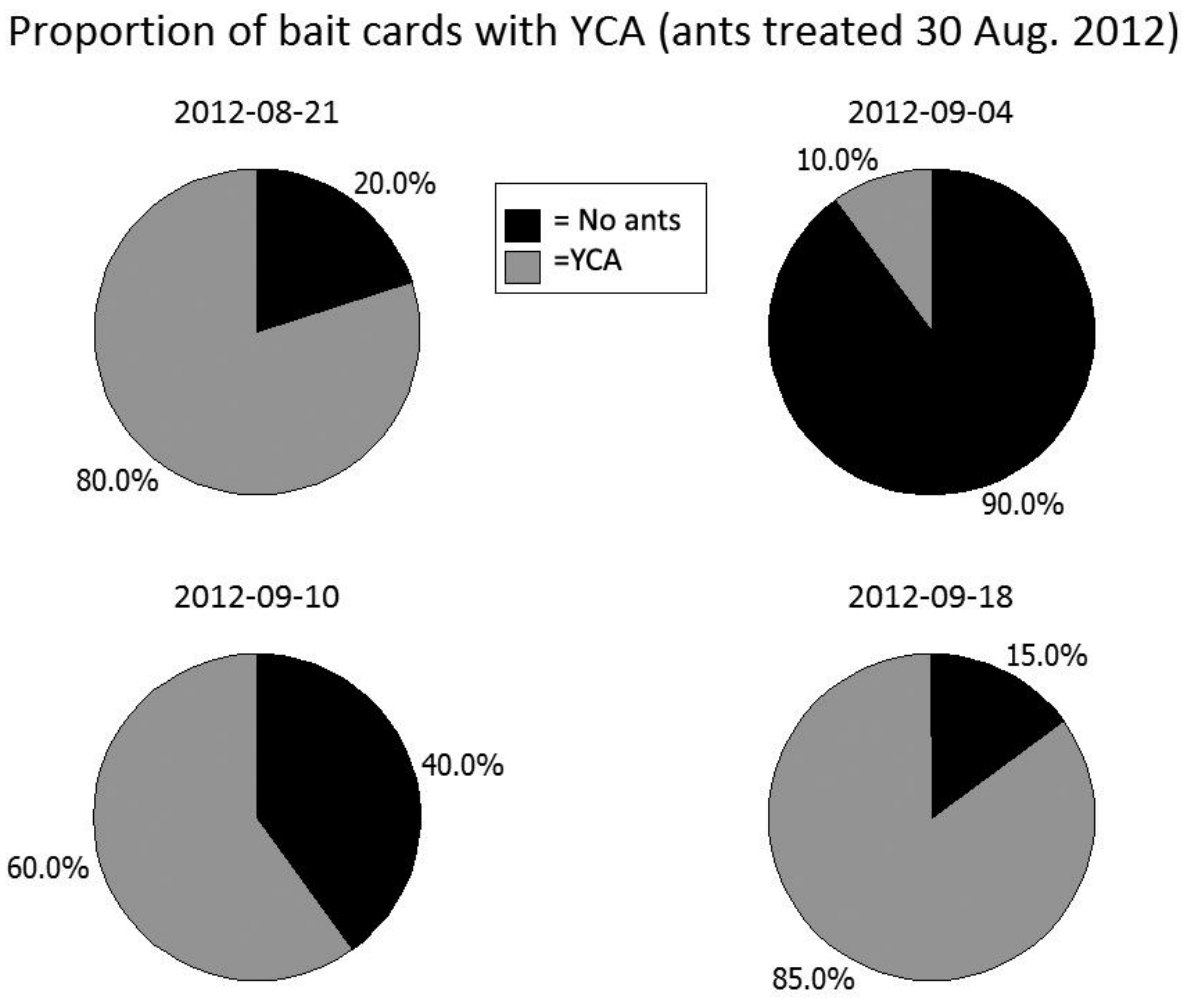

Figure 10. Proportion of bait cards with at least 1 YCA forager before and after treatment. Following treatment the number of baits with ants drops, but recovers in about 18 days.

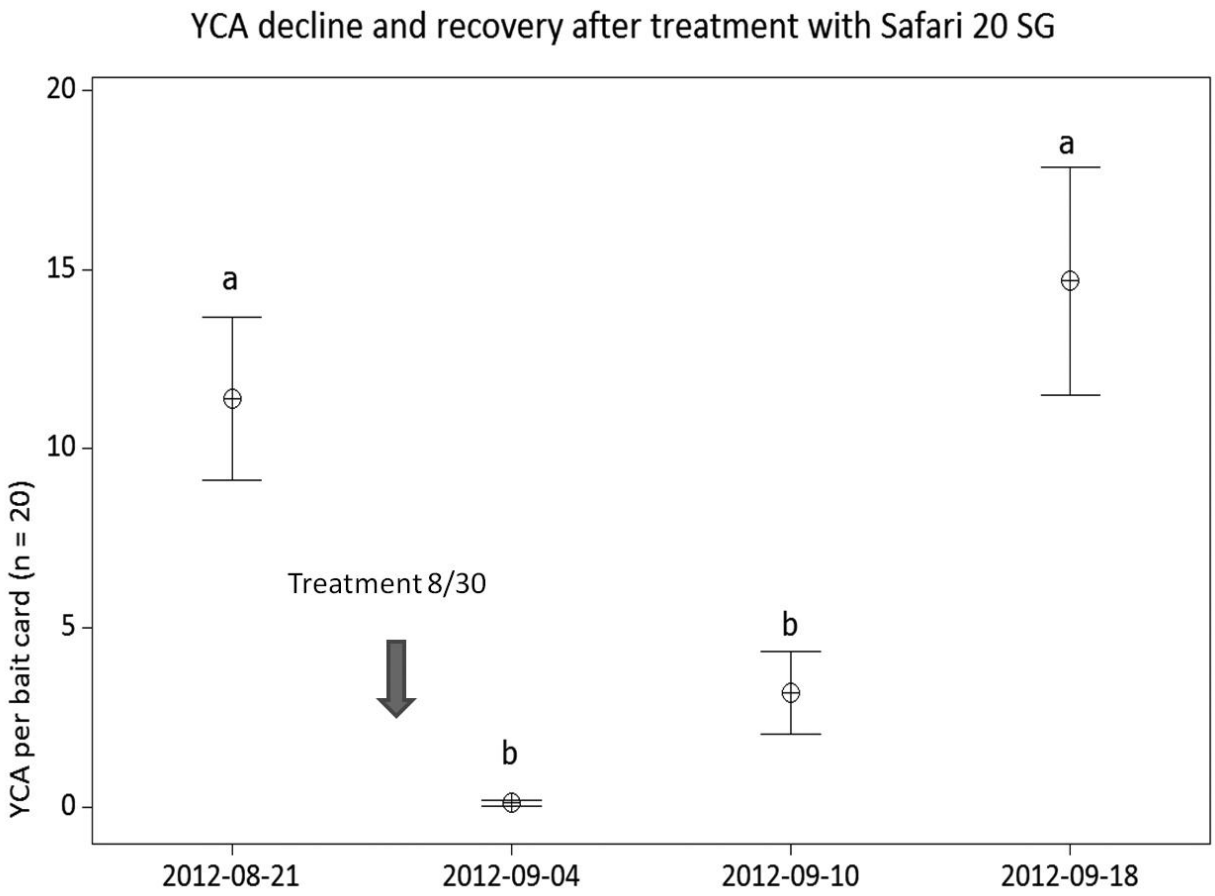

Figure 11. Ant counts over time at bait cards (bars are ± 1 SEM) following treatment with Safari 20 SG. Letters denote groups that differ significantly from one another according to post hoc comparisons using Tukey's HSD. Though ants 10 days after treatment remained significantly lower than pre-treatment, recovery is noticeable.

Though ants were able to recover fully in one month's time, incursion from surrounding areas is high and eradication at the Wahiawa baseyard was not expected. This is the first time we have found YCA to respond to any insecticide. We remain hopeful that with further testing, including multiple treatments, Safarai 20 SG might be used to eradicate the isolated population of YCA from Pahole Mid Elevation Nursery.

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