2013 Status Report for the Makua and Oahu Implementation Plans

December 2013

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*Cover photo *Drosophila obatai*

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EXECUTIVE SUMMARY

The Oahu Army Natural Resources Program (OANRP) has 60 personnel on staff, comprised of support staff, a fence crew, three resource management crews, and a nursery/seed bank management crew. Most of these staff are employed via a Cooperative Agreement funded by the Army through the Pacific International Center for High Technology Research (PICHTR) and administered by the Research Corporation of the University of Hawaii-Pacific Cooperative Studies Unit. Staff levels in Fiscal Year (FY) 2013 were similar to those in FY2012, though there has been staff turnover and replacement hiring is ongoing for several vacant positions. During this reporting period, OANRP hired its first Entomologist to manage the endangered insect program. For FY 2013, OANRP received a total of $6,680,042 to implement both the Makua and Oahu Implementation Plans. This included funding to repair the Ohikilolo fence and the completion of the Makua Military Reservation perimeter fence and the Keaau Management Unit fence for *Hibiscus brackenridgei* ssp. *mokuleianus*. In FY 2013, OANRP did not receive funding for OIP Tier 2 and Tier 3 projects as there was no training conducted that could impact the species at the Tier 2 and 3 levels, as specified in the 2003 Oahu Biological Opinion.

This status report (report) serves as the annual report for participating landowners, the U.S. Fish and Wildlife Service (USFWS), and the Implementation Team (IT) overseeing the Makua Implementation Plan (MIP) and Oahu Implementation Plan (OIP). The period covered in this report is October 1, 2012 to September 30, 2013 and covers Year 9 of the MIP and Year 6 of the OIP. Hawaiian diacriticals are not used in this document except in some appendices in order to simplify formatting. Please refer to Appendix ES-1, *Spelling of Hawaiian Names*.

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

OANRP just completed implementing the ninth year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the sixth year of the OIP (finalized in 2008). The MIP Addendum emphasized management for stability of three Population Units (PUs) per plant taxon in the most intact habitat and 300 individuals of *Achatinella mustelina* in each Evolutionarily Significant Unit (ESU). The original Makua Biological Opinion (BO) in 2007 and amended BO in 2008, both issued by the USFWS, require that the Army provide threat control for all Oahu Elepaio (*Chasiempis sandwichensis*) pairs in the Makua Action Area, stabilization for 28 plant taxa and *Achatinella mustelina*, and take significant precautions to control the threat and spread of fire as a result of the 2007 Waialua fire that destroyed individuals and habitat of *Hibiscus brackenridgei* subsp. *mokuleianus*. The OIP outlines stabilization measures for 23 additional plant taxa, the Oahu Elepaio, and six extant Koolau *Achatinella* species. Since the OIP was finalized, two additional species were added requiring stabilization, *Drosophila montgomeryi* and *D. substenoptera*. Of the OIP plants, management activities are conducted with eleven taxa that are present in the Schofield Barracks West Range Action Area. In 2013, OANRP did not receive funding to support the remaining 12 OIP plant taxa and the six Koolau *Achatinella* species because of the lack of Army training impacts to these taxa.

Infrastructure

The new seed laboratory and OIP office building were completed in November 2012. With the addition of these buildings, OANRP field crews are able to function from one baseyard, improving daily

communications between field crews and program managers. OANRP outreach and purchasing staff 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 November 2013) and a four-year license agreement with the Honolulu Board of Water Supply (expiring November 2014). The U.S. Army Garrison, Hawaii (USAG-HI) is working with Hawaii Reserves, Inc. on a renewal. In addition, the Army signed a new 15-month right of entry permit to monitor rare plant populations on Dole Food Company land (expiring May 2014). The Army also continues to work cooperatively under an MOU with the U.S. Navy for work in Lualualei Naval Magazine. Also, the Army secured another one-year right of entry permit to protect Oahu Elepaio on Gill-Olson Joint Venture property at Palehua (expiring May 2014).

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 six State of Hawaii permits, including a Natural Area Reserves Special Use Permit, a Threatened and Endangered Plant Species Permit, an Invertebrate Permit, a Forest Reserve Access Permit, a Conservation District Use Permit, and a Protected Wildlife Permit. Issues pending negotiation under the real estate agreement include user fees and how to consolidate the content of each of the six 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 appraisal delay was due to a lapse in the Army Corps of Engineers contracted appraiser. A new appraiser is under contract as of this fiscal year and a site visit to the Pahole facility is scheduled for mid-October.

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

Management Unit Protection

The OANRP fencing program completed construction of the 1,800-acre Lihue, 66-acre Makaha Subunit II, and 30-acre Kahanahaiki Subunit II Management Unit (MU) fences this year. The Koloa MU is pig-free, and ungulate removal from the Lihue MU is well underway. Access to Lihue is restricted to one or two days per month. In addition, OANRP has begun clearing the Kamaili MU fenceline and has completed clearing the Army portion of the Poamoho fence in Helemano by funding the Koolau Mountains Watershed Partnership program to carry out this work. OANRP expects to construct the Army portion of the Poamoho fence, the Kamaili MU fence, and the Huliwai fence for *Abutilon sandwicense* using the OANRP fence crew in-house fence crew over the next year. In addition, the perimeter fence will be completed along the northern Kuaokala boundary of Makua Military Reservation via contract. The Army also obtained year end funding to construct the Keaau *Hibiscus brackenridgei* fence and to repair weathered sections of the Ohikilolo ridge fence. OANRP will be transitioning into more intensive MU weed control restoration, and bringing our fence construction schedule to a close. Thus, OANRP will no longer staff an in-house fencing crew as of January 2015. Instead, a few ungulate and fence

specialist positions will be developed with a focus on fence monitoring and maintenance. For more details about OANRP ungulate control see Chapter 1.

In total this year, OANRP spent 6,968 hours controlling weeds across 307 ha. Incipient Control Area (ICA) efforts accounted for 184 ha of this total. Staff spent 1,369 hours on ICA management and conducted 311 visits to 152 ICAs. Weed Control Area (WCA) efforts covered 123 ha. OANRP conducted control in WCAs for a total of 5,598 hours over 529 visits at 148 WCAs. See Chapter 1 for a comparison to last year's control figures. Ecosystem Restoration Management Unit Plans (ERMUPs) were written this year for the following three MUs: Opaeula Lower I, Opaeula and Puaakanoa (Appendix 1-1). OANRP has completed a total of 21 ERMUPs for the highest priority and largest MUs.

OANRP works closely with the Army's Range Division staff in order to reduce the inadvertent introduction of invasive pest species to Army Ranges. OANRP continues to document and control incipient populations of pest plants during road and landing zone surveys. For the first time, this year OANRP surveyed the Schofield Barracks Impact Area roads following the completion of the Battle Area Complex construction. During these surveys, OANRP discovered *Chromolaena odorata*. This discovery is concerning as it documents the further spread of a noxious weed between Oahu training areas. In response, OANRP worked with Range Division staff to insert a natural resources section into the mandatory checklist completed by soldiers when occupying and clearing a training range. In addition, OANRP notified natural resource staff at Pohakuloa Training Area of this major discovery in order to emphasize vigilant gear cleaning prior to interisland movement. OANRP outreach staff continue to brief all incoming "officers in charge" regarding invasive species minimization measures. OANRP were also successful in closing a portion of one Kahuku Training Area (KTA) range for three years in order to halt the spread of *Chromolaena* from infested areas. OANRP also provided funding to the Oahu Invasive Species Committee to implement control of *C. odorata* at KTA. In addition, the KTA washrack is now fully operational following some maintenance issues.

Rodent Control Program

OANRP rat control operations continue to change and improve as new technologies and information become available. Over this reporting period, the diphacinone rodenticide label expired. This change, forced OANRP to convert to a 100% trap-based control approach. Also, during this reporting period OANRP conducted a field trial in cooperation with Kalaupapa National Park to determine the effectiveness and application approach for the Goodnature® automatic traps (A24) which became available for purchase in 2012. The results of this trial are positive regarding the use of the A24 to successfully control rodents in Hawaii. Trial results also indicate that this tool will dramatically cut labor expense for rodent control programs. OANRP staff prepared a technical report regarding A24 trap use and it is included in this report for reference. For more details regarding these topics, refer to Chapter 6 and Appendix 6-1.

Vegetation Monitoring

During this reporting period, OANRP re-read priority MU level plant community health monitoring plots for the upper section of OhikilooMU. In addition, OANRP installed WCA-level monitoring at the Opaeula Lower I MU to investigate the most successful control approach for *Clidemia hirta*. This year, OANRP also investigated the application of gigapan robotic technology (Gigapan) for collecting vegetation monitoring data in the Koolau Mountains. Gigapan was also applied in three different weed control monitoring applications in order to evaluate the efficacy of fountain grass and ginger control projects (See Chapter 1, Section 1.1.3, Weed Control Program). Additionally, OANRP has begun cooperating with Army units that utilize Unmanned Aerial Systems to assess the utility of using this innovative technology to collect canopy vegetation data. Lastly, a Puu Hapapa timed-count monitoring

protocol was developed for *Achatinella mustelina* to follow population response to intensive predator exclusion (See Appendix 3-1).

Fire

OANRP is happy to report that there were no major fires affecting IP management units during this reporting period.

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 Implementation Plans (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 zero and a genetic storage requirement of "n/a (reintroduction)" denote reintroductions that are planned but have yet to be conducted. The number of seeds in genetic storage 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 time of storage. For untested collections, seed viability was averaged from other collections within the same PU or taxon.

As of the end of this reporting period, 43 of 100 MIP PUs (43%) and 9 of 45 (20%) PUs for OIP Tier 1 plant species are at or above the stabilization goal for minimum number of mature plants.

Presented in Chapter 2 of this report are new 5-year plans for *Gardenia mannii*, *Neraudia angulata* and *Nototrichium humile*. The Army secured funding for the Center for Environmental Management of Military lands based at Colorado State University to consult with the USFWS on potential impacts to the twenty newly listed plant taxa during the next reporting period. Required management will be determined through the consultation process and outlined in the Biological Opinion to be issued upon completion of this process.

During this reporting period, OANRP outplanted a grand total of 2,754 individuals of MIP and OIP taxa. Specifically, 1,391 individuals of ten Makua taxa, 575 individuals of five OIP taxa and 788 individuals of six taxa shared between both IPs were outplanted. In the last year, OANRP made 636 observations at in situ sites of IP taxa and 254 observations at outplanting sites.

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 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 2012	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Alectryon macrococcus var. macrococcus	50											
		Central Kaluaa to Central Waieli	16	10	6	0	22	53	0%	20%	No	
		Kahanahaiki to Keawapilau	5	3	2	0	33	8	0%	100%	No	
		Makaha	43	43	0	0	86	75	0%	95%	No	
		Makua	18	18	0	0	20	15	5%	0%	No	
		Alectryon macrococcus var. macrococcus Total:	82	74	8	0	161	151				0 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	210	161	49	19	229	20	62%	100%	Yes	
		Kahanahaiki and Pahole	419	320	99	130	403	276	32%	100%	Yes	
		Makaha and Waianae Kai	12	12	0	0	13	12	67%	58%	No	
		Cenchrus agrimonioides var. agrimonioides Total:	641	493	148	149	645	308				2 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	187	51	136	0	75	0	100%	100%	No	
		North branch of South Ekahanui	204	44	160	4	147	5	100%	100%	No	
		Pahole to West Makaleha	117	66	51	0	106	46	57%	100%	No	
		Palikea (South Palawai)	161	112	49	17	142	63	59%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	669	273	396	21	470	114				1 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	140	53	87	0	60	66	68%	96%	No	
		Makaha and Waianae Kai	59	5	54	0	40	4	40%	100%	No	
		Pahole	114	61	53	3	114	114	100%	100%	No	
		Cyanea longiflora Total:	313	119	194	3	214	184				0 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	372	52	320	180	404	152	100%	100%	Yes	
		Makaha	202	13	189	0	125	0	N/A	100%	No	
		Manuwai	101	0	101	0	0	0	N/A		No	
		Pahole to Kapuna	410	96	314	29	247	170	N/A	100%	Yes	
		Cyanea superba subsp. superba Total:	1085	161	924	209	776	322				2 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 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 2012	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	239	62	177	100	240	97	48%	100%	Yes	
		Opaeula (Koolaus)	125	23	102	0	101	26	0%	35%	No	
		Pahole to West Makaleha	1206	591	615	238	1192	300	98%	95%	Yes	
		Cyrtandra dentata Total:	1570	676	894	338	1533	423				2 of 3
Delissea waianaeensis	100											
		Ekahanui	277	175	102	3	277	58	100%	100%	Yes	
		Kahanahaiki to Keawapilau	309	241	68	0	336	34	93%	100%	Yes	
		Kaluaa	760	628	132	36	828	44	100%	100%	Yes	
		Manuwai	198	0	198	0	0	0	N/A		No	
		Delissea waianaeensis Total:	1544	1044	500	39	1441	136				3 of 4
Dubautia herbstobatae	50											
		Makaha	29	28	1	0	36	0	36%	0%	No	
		Ohikilolo Makai	91	89	2	0	358	700	0%	100%	Yes	
		Ohikilolo Mauka	424	415	9	0	424	1300	0%	100%	Yes	
		Dubautia herbstobatae Total:	544	532	12	0	818	2000				2 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	31	28	3	0	31	26	61%	0%	Yes	
		Kaena	1475	579	896	0	1475	300	100%	0%	Yes	
		Makua	127	125	2	0	127	40	100%	100%	Yes	
		Puaakanoa	148	132	16	0	148	157	46%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1781	864	917	0	1781	523				4 of 4
Euphorbia herbstii	25											
		Kaluaa	0	0	0	0	0	0	N/A		No	
		Kapuna to Pahole	93	46	47	9	171	170	8%	91%	Yes	
		Makaha	67	1	66	0	64	0	N/A	100%	No	
		Manuwai	0	0	0	0	0	0	N/A		No	
		Euphorbia herbstii Total:	160	47	113	9	235	170				1 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 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 2012	# Plant in Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Flueggea neowawraea	50											
		Kahanahaiki to Kapuna	124	7	117	0	104	32	25%	86%	No	
		Makaha	63	10	53	0	64	4	64%	40%	No	
		Manuwai	9	0	9	0	0	0	N/A		No	
		Ohikilolo	1	1	0	0	1	3	50%	100%	No	
		Flueggea neowawraea Total:	197	18	179	0	169	39				0 of 4
Gouania vitifolia	50											
		Keaau	55	55	0	0	61	0	56%	0%	Yes	
		Makaha	0	0	0	0	0	0	N/A		No	
		Manuwai	0	0	0	0	0	0	N/A		No	
		Gouania vitifolia Total:	55	55	0	0	61	0				1 of 3
Hesperomannia oahuensis	75											
		Haleauau	1	1	0	0	1	0	0%	100%	No	
		Makaha	27	3	24	0	29	13	0%	100%	No	
		Pahole NAR	56	2	54	0	58	8	N/A	100%	No	
		Puali	73	1	72	0	73	0	N/A	100%	No	
		Hesperomannia oahuensis Total:	157	7	150	0	161	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	10	7	3	0	9	4	71%	0%	No	
		Keaau	3	1	2	0	7	0	63%	0%	No	
		Makua	45	35	10	0	75	7	73%	100%	No	
		Manuwai	104	61	43	0	0	0	N/A	0%	Yes	
		Hibiscus brackenridgei subsp. mokuleianus Total:	162	104	58	0	91	11				1 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	186	56	130	0	31	60	67%	93%	Yes	
		Central Makaleha and West Branch of East Makaleha	34	26	8	14	78	47	58%	0%	No	
		Kahanahaiki to Pahole	278	147	131	23	286	161	94%	100%	Yes	
		Kadua degeneri subsp. degeneri Total:	498	229	269	37	395	268				2 of 3
Kadua parvula	50											
		Halona	132	97	35	19	132	64	100%	23%	Yes	
		Ohikilolo	257	100	157	5	257	66	100%	100%	Yes	
		To be determined (Ekahanui)	0	0	0	0	0	0	N/A		No	
		Kadua parvula Total:	389	197	192	24	389	130				2 of 3

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 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 2012	# Plant in Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Melanthera tenuifolia	50											
		Kamalieunu and Walanae Kai	1061	815	246	274	1157	880	0%	0%	Yes	
		Mt. Kaala NAR	70	70	0	0	300	250	0%	0%	Yes	
		Ohikilolo	1117	1109	8	0	1117	2009	18%	100%	Yes	
		Melanthera tenuifolia Total:	2248	1994	254	274	2574	3139				3 of 3
Neraudia angulata	100											
		Kaluakaulia	134	65	69	0	164	0	N/A	100%	No	
		Makua	133	117	16	1	39	29	46%	17%	Yes	
		Manuwai	57	52	5	0	0	12	100%	100%	No	
		Walanae Kai Mauka	65	27	38	0	20	46	26%	100%	No	
		Neraudia angulata Total:	389	261	128	1	223	87				1 of 4
Nototrichium humile	25											
		Kaluakaulia	233	198	35	0	233	200	2%	100%	Yes	
		Makua (south side)	53	50	3	0	53	138	0%	100%	Yes	
		Manuwai	0	0	0	0	0	0	N/A		No	
		Walanae Kai	259	205	54	0	259	200	4%	88%	Yes	
		Nototrichium humile Total:	545	453	92	0	545	538				3 of 4
Phyllostegia kaalaensis	50											
		Keawapilau to Kapuna	0	0	0	0	0	0	100%	100%	No	
		Makaha	7	0	7	0	0	0	N/A	100%	No	
		Manuwai	48	2	46	0	0	0	N/A	0%	No	
		Pahole	0	0	0	0	0	10	100%	100%	No	
		Phyllostegia kaalaensis Total:	55	2	53	0	0	10				0 of 4
Plantago princeps var. princeps	50											
		Ekahanui	127	25	102	0	129	33	90%	100%	No	
		Halona	72	29	43	0	72	50	36%	0%	No	
		North Mohiakea	51	39	12	0	37	30	38%	0%	No	
		Ohikilolo	0	0	0	0	11	14	60%	100%	No	
		Plantago princeps var. princeps Total:	250	93	157	0	249	127				0 of 4
Pritchardia kaalae	25											
		Makaleha to Manuwai	117	107	10	2	112	141	2%	2%	Yes	
		Ohikilolo	1676	85	1591	0	1151	473	0%	100%	Yes	
		Ohikilolo East and West Makaleha	334	1	333	0	307	75	N/A	100%	No	
		Pritchardia kaalae Total:	2127	193	1934	2	1570	689				2 of 3

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 of 100

= Ungulate Threat to Taxon within Population Unit

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Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2012	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Sanicula mariversa	100											
		Kamaileunu	128	15	113	6	325	26	100%	100%	No	
		Keaau	27	3	24	0	311	141	2%	100%	No	
		Ohikilolo	39	16	23	0	35	162	2%	100%	No	
		Sanicula mariversa Total:	194	34	160	6	671	329				0 of 3
Schiedea kaalae	50											
		Kaluaa and Waieli	206	198	8	0	207	55	100%	100%	Yes	
		Maakua (Koolaus)	10	10	0	0	10	4	40%	0%	No	
		Pahole	74	63	11	1	84	3	100%	100%	Yes	
		South Ekahanui	100	100	0	0	100	85	89%	100%	Yes	
		Schiedea kaalae Total:	390	371	19	1	401	147				3 of 4
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	179	131	48	334	187	65	90%	100%	Yes	
		Kapuna-Keawapilau Ridge	69	63	6	0	0	4	25%	100%	Yes	
		Makaha	79	79	0	0	30	0	N/A	100%	Yes	
		Schiedea nuttallii Total:	327	273	54	334	217	69				3 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	1961	232	1729	2729	574	90	100%	100%	Yes	
		Keawapilau to West Makaleha	1306	127	1179	2187	548	36	100%	95%	Yes	
		Makaha	0	0	0	0	0	0	N/A	0%	No	
		Schiedea obovata Total:	3267	359	2908	4916	1122	126				2 of 3
Tetramolopium filiforme	50											
		Kalena	117	24	93	0	30	0	6%	0%	No	
		Ohikilolo	3143	2551	592	20	3143	2500	12%	100%	Yes	
		Puhawai	38	3	35	0	11	12	67%	0%	No	
		Waianae Kai	38	30	8	1	38	22	0%	0%	No	
		Tetramolopium filiforme Total:	3336	2608	728	21	3222	2534				1 of 4
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	411	386	25	1	425	0	0%	100%	Yes	
		Puu Kumakalii	44	44	0	0	44	20	27%	0%	No	
		Viola chamissoniana subsp. chamissoniana Total:	570	530	40	1	584	73				2 of 4

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 9 of 45

= 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 2012	# Plant In Original Report	% Completed Genetic Storage Requirement	% 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	59	12	47	0	41	44	27%	58%	No	
		Kaawa to Puulu	100	24	76	6	110	124	0%	38%	No	
		Kahanahaiki	32	3	29	0	0	0	100%	0%	No	
		Makaha Makai	70	35	35	0	97	100	66%	0%	No	
		Abutilon sandwicense Total:	261	74	187	6	248	268				0 of 4
Cyanea acuminata	50											
		Helemano-Punaluu Summit Ridge to North Kaukonahua	72	59	13	7	72	72	8%	0%	Yes	
		Kaluanui and Maakua	221	113	108	50	221	0	0%	0%	Yes	
		Makaleha to Mohiakea	154	111	43	0	147	118	0%	23%	Yes	
		Cyanea acuminata Total:	447	283	164	57	440	190				3 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	114	105	9	0	84	76	0%	3%	Yes	
		Opaeula to Helemano	27	19	8	0	21	13	0%	53%	No	
		Poamoho	27	9	18	0	22	12	0%	0%	No	
		Cyanea koolauensis Total:	168	133	35	0	127	101				1 of 3
Cyanea st.-johnii	50											
		Ahuimanu-Halawa Summit Ridge	44	11	33	0	10	14	21%	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	65	15	50	0	66	19	27%	100%	No	
		Cyanea st.-johnii Total:	131	45	86	1	98	45				0 of 4
Eugenia koolauensis	50											
		Kaleleiki	230	27	203	0	230	55	0%	59%	No	
		Kaunala	131	38	93	54	131	141	0%	100%	No	
		Oio	21	16	5	7	21	74	4%	100%	No	
		Pahipahialua	57	36	21	379	57	291	10%	100%	No	
		Eugenia koolauensis Total:	439	117	322	440	439	561				0 of 4

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 9 of 45

= 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 2012	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Gardenia mannii	50											
		Haleauau	2	2	0	0	3	2	75%	100%	No	
		Helemano and Poamoho	8	8	0	0	10	18	0%	0%	No	
		Lower Peahinaia	11	10	1	0	14	46	0%	0%	No	
		Gardenia mannii Total:	21	20	1	0	27	66				0 of 3
Hesperomannia swezeyi	25											
		Kamananui to Kaluanui	245	133	112	45	246	99	0%	3%	Yes	
		Kaukonahua	128	65	63	52	132	127	0%	0%	Yes	
		Lower Opaeula	27	18	9	0	27	24	0%	0%	No	
		Hesperomannia swezeyi Total:	400	216	184	97	405	250				2 of 3
Huperzia nutans	50											
		Kahana and North Kaukonahua	5	5	0	0	5	6	0%	0%	No	
		Koloa and Kaipapau	4	4	0	0	3	3	0%	25%	No	
		South Kaukonahua	1	1	0	0	1	1	0%	0%	No	
		Huperzia nutans Total:	10	10	0	0	9	10				0 of 3
Labordia cyrtandrae	50											
		East Makaleha to North Mohiakea	344	265	79	0	209	100	18%	86%	Yes	
		Koloa	124	0	124	0	0	0	N/A		No	
		Labordia cyrtandrae Total:	468	265	203	0	209	100				1 of 2
Melicope lydgatei	50											
		Kaiwikoele-Kawainui Ridge	0	0	0	0	0	3	0%	0%	No	
		Kawaiiki and Opaeula	23	23	0	0	24	43	8%	57%	No	
		Poamoho	0	0	0	0	0	0	0%	0%	No	
		Melicope lydgatei Total:	23	23	0	0	24	46				0 of 3
Phyllostegia hirsuta	100											
		Haleauau to Mohiakea	85	63	22	0	13	18	50%	84%	No	
		Koloa	5	3	2	1	5	0	33%	33%	No	
		Puu Palikea	0	0	0	0	0	0	N/A		No	
		Phyllostegia hirsuta Total:	90	66	24	1	18	18				0 of 3
Phyllostegia mollis	100											
		Ekahanui	160	156	4	0	226	35	100%	100%	Yes	
		Kaluaa	72	40	32	0	125	49	0%	100%	No	
		Pualii	95	92	3	0	204	0	100%	100%	No	
		Phyllostegia mollis Total:	327	288	39	0	555	84				1 of 3

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 9 of 45

= 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 2012	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Pteris lidgatei	50											
		Helemano	0	0	0	0	2	2	0%	0%	No	
		Kaluanui	1	1	0	0	1	0	0%	0%	No	
		North Kaukonahua	0	0	0	0	0	0	0%	0%	No	
		Pteris lidgatei Total:	1	1	0	0	3	2				0 of 3
Schiedea trinervis	50											
		Kalena to East Makaleha	620	352	268	333	610	376	100%	91%	Yes	
		Schiedea trinervis Total:	620	352	268	333	610	376				1 of 1
Stenogyne kanehoana	100											
		Haleauau	0	0	0	0	1	1	100%	100%	No	
		Kaluaa	220	12	208	0	124	79	100%	100%	No	
		Makaha	0	0	0	0	0	0	N/A	0%	No	
		Stenogyne kanehoana Total:	220	12	208	0	125	80				0 of 3

Rare Snail Conservation

During this reporting period, OANRP hired a full time Invertebrate Technician to work closely with the Rare Snail Conservation Specialist and oversee the predator exclosures. Within the Puu Hapapa predator exclosure, OANRP and partners continue to monitor population trends, maintain predator control, and conduct exclosure maintenance. The Hapapa exclosure has been predator-free for 13 months. Also, OANRP have translocated *A. mustelina* from outside the exclosure into the exclosure for protection. The Puu Palikea exclosure is complete and has been predator-free for seven months. The Snail Extinction Prevention Program (SEPP) has been actively using the Palikea exclosure as a refuge for rare snail taxa. In addition, OANRP has nearly completed upgrades to the Kahanahaiki predator exclosure. Lastly, the predator exclosure at Poamoho is in the final phases of construction and scheduled to be complete this winter. SEPP will be conducting maintenance on the exlosure and using it for *Achatinella* spp. reintroductions. OANRP are very excited to have a new snail conservation partner in SEPP and have been cooperating extensively. During this reporting period, OANRP returned historic populations of lab snails to the wild per the plan outlined in last year's report and discussed at last year's Snail Implementation Team meeting. Details of this work are summarized in Chapter 3. In addition, as planned, new adult *A. mustelina* snails were removed to the lab for short term offsite representation of snails at sites without predator exclosures. OANRP also assisted the State of Hawaii, Department of Land and Natural Resources, with rare snail surveys along the proposed Poamoho fence.

Table 4 below presents the status summary for the Waianae *A. mustelina* in the MIP. The goal of all populations in both IPs is 300 total snails across all age classes in each ESU. Populations of *A. mustelina* in the MIP have been genetically assigned to one of six ESUs. There has not been a substantial change in the total number of snails in any of the eight managed populations since last year's report.

Table 4. Makua Implementation Plan –Executive Summary – Snails

Achatinella mustelina Evolutionary Significant Unit (ESU)	Population	2013 Snails				# Snails in 2012	# 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	124	51	24	199	208	105	0	100%	No	*5 of 8*
ESU B	B1: Ohikilolo	286	51	47	384	384	300	0	100%	Yes	
	B2: East Makaleha	292	110	74	476	462	40	10	0%	Yes	
ESU C	Lower Kaala NAR/ Schofield Barracks West Range	102	72	17	191	168	50	13	100%	No	
ESU D	D1: North Kaluaa to Schofield Barracks South Range	--	--	--	993	665	86	0	Partial	Yes	
	D2: Makaha	132	35	21	188	188	17	10	100%	No	
ESU E	Ekahanui	257	60	39	356	358	12	10	100%	Yes	
ESU F	Puu Palikea	286	107	79	472	413	40	0	100%	Yes	
Totals					**2,940**	**2,846**	**650**	**61**			***5 of 8***

Elepaio Management

In 2013, OANRP controlled rats to protect 105 pairs of Oahu Elepaio (*Chasiempis ibidis*), which is an increase since last year. The BO requires the protection of 75 pairs. The 30 additional pairs protected above and beyond the BO requirement is a result of successful predator control during previous nesting seasons which facilitated an increase in density of Elepaio pairs. The 30 additional protected pairs were obtained within existing rat control areas at no additional cost to OANRP. The documented fledgings from managed pairs this year numbered 95. This figure is larger than the previous reporting year, when 65 fledglings were observed. This increase may be a result of favorable weather during critical periods of the nesting season and the conversion to 100% kill trap use as compared to previous years, where a combination of snap traps and rodenticide were employed. In addition, the number of successful active nests was the highest documented since OANRP began protecting Elepaio in 2006. For more information, see the Elepaio Chapter 4.

Insect Conservation

The OANRP Entomology Program commenced during this reporting period with FY13 funding to support implementation of the two *Drosophila* stabilization plans and the hiring of an Entomologist. The priority over this reporting period was to locate three extant field sites for *D. montgomeryi* and *D. substenoptera*. Two additional *D. substenoptera* sites were located, but OANRP have not yet been able to locate a third site for *D. montgomeryi*. Surveys will continue. In addition, host plant restoration work has begun in conjunction with *Achatinella* habitat improvement via outplanting of *Urera glabra* and OANRP continues to maintain habitat through ecosystem-scale weed control in existing fences containing *Drosophila* populations. Another high priority was to complete systematic surveys of the action areas for listed insects in preparation for the upcoming reconsultation for Oahu Training Areas. During the course of these surveys, two locations of the listed endangered *D. obatai* were discovered within Schofield Barracks West Range. In addition, other non-listed insects were documented. Preliminary results are presented in Chapter 5 and will be incorporated into the upcoming consultations.

In last year's executive summary, a recommendation was made to survey Army training ranges for three newly listed species of damselfly, *Megalagrion leptodemas*, *M. oceanicum* and *M. nigrohamatum* ssp. *nigrolineatum*. Focused surveys were not yet conducted due to the limited use of the upper elevation Koolau habitat for training. That said, OANRP will conduct surveys for *M. leptodemas* during the next year in order to revise the outdated information on this taxon for use during upcoming Oahu Training Areas Section 7 Consultation.

Hawaiian Hoary Bats

The Army has preliminary results for bat surveys conducted at Waianae Training Areas. The number of detections and locations is not final, however, OANRP has detected bats in the Waianae Mountains. The complete data set will be summarized for use in the upcoming Oahu Training Areas and Makua Section 7 Consultations. There is no further information contained in this report regarding bats. Currently, 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 concluded Sluggo application trials focused on determining preferred buffer size and application frequency of Sluggo for protection of susceptible

"manage for stability" plant populations. In addition, based on Dr. Robert Cowie's greenhouse snail management recommendations from last year, the OANRP Research Specialist installed and monitored perimeter refuge traps designed to detect snails before they enter the greenhouse. So far, this suggested method is effectively detecting slug and snails around the Nike Site Greenhouse.

OANRP continued to fund the captive *Achatinella* propagation program at the University of Hawaii (UH) Tree Snail Laboratory (Lab) and cooperated closely with laboratory staff on the short-term laboratory rotation of *Achatinella* begun during this reporting period. Results of this work are included in Appendix ES-3. The UH Lab also conducted Jackson's chameleon (*Chamaeleo jacksonii*) and introduced bird stomach content analyses. In addition, OANRP funded a molecular systematic assessment of *Achatinella mustelina* diet using snail feces and host plant leaves. Preliminary results of this work are included as Appendix ES-5. In support of the rare plant program, OANRP funded Dr. Janice Uchida to identify the fungal pathogen affecting rare *Phyllostegia* spp. in the greenhouse and in the wild. This project also includes screening fungicides for most effective treatement. This project experienced a six-month delay during the USFWS permitting process.

Research funded by OANRP in support of the Ecosystem Management Program included the work of Dr. Paul Krushelnycky, who is studying the impacts of rodents on native arthropods. His research is conducted at two sites within the Waianae Mountains where OANRP maintains large-scale snap trap rat control grids. For an update on the fourth year of this research refer to Appendix ES-4. In addition, OANRP funded Dr. James Leary of the College of Tropical Agriculture and Human Resources to conduct development and field testing of various novel weed control techniques including Herbicide Ballistic Technology and Incision Point Application. The results of these trials are discussed in Chapter 1.

TABLE OF CONTENTS

CHAPTER 1: ECOSYSTEM MANAGEMENT

Notable projects from the 2012-2013 reporting year are discussed in the Project Highlights section of this chapter. This reporting year covers 12 months, from 1 October, 2012 through 30 September, 2013.

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

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

Report Year	ERMUP 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
2011-2012	Waimano, Ohikilolo (Makua, revised)

Please refer to the relevant Status Reports for the MIP and OIP for copies of these plans, or view them online at http://manoa.hawaii.edu/hpicesu/dpw_ermp.htm. Each ERMUP details all relevant threat control in each MU for the five years immediately following its finalization. The ERMUPs are working documents; OANRP modifies them as needed and can provide the most current versions on request. They will not be included in Status Reports until they need to be rewritten to cover another five years. This year, three new ERMUPs were written for Opaeula Lower I, Opaeula, and Puaakanoa and are included as Appendix 1-1. Vegetation monitoring projects referenced in the Opaeula Lower I and Opaeula plans are attached as Appendix 1-2 (Pilot study to identify the most effective weed control re-treatment interval for *Clidemia hirta* for Opaeula Lower MU) and Appendix 1-3 (Vegetation Response to the Release of Ungulate Pressure for Opaeula and Koloa Management Units).

1.1 UNGULATE CONTROL PROGRAM

Summary

- OANRP completed Makaha Subunit II (2,600 m) Kahanahaiki Subunit II (1,500 m) and the final portion of Lihue (12,240 m), MU fences.

- At this time, about 500 meters of the Kamaili fence has been cleared. OANRP's portion of the Poamoho fence has been completely cleared by KMWP staff, and is awaiting the delivery of newer fence materials.

- All totaled, about 5,000 meters of fencing was built during the reporting year, enclosing approximately 2,100 acres.

- OANRP was able to acquire about $500,000 in year-end funding to construct the Keaau *Hibiscus brackenridgii* MU fence and replace approximately a three kilometer section of the Ohikilolo fence on the south rim of MMR.

- Existing funds will be used to complete the Makua Rim fence; this fence will be built by an outside contractor.

- OANRP is proposing to finish Kamaili, Huliwai, the Northern rim of Makua Valley, Keaau, the Ohikilolo replacement section and Poamoho by the end of the next reporting period.

  Pigs breached the fences at Pahole and Kapuna but have nearly all been removed. In order to stop the flow of piglets squeezing through the fence, OANRP and NAR staff retrofitted the older hog-wire fences with "Fickle-fence", a black polypropylene plastic mesh barrier.

- Hunting operations were conducted in the lower unit of the Manuwai MU for about eleven months before snaring commenced in 2012. A total of 35 pigs were removed, 14 males, 12 females and nine of unknown sex (the carcasses were never located). After about four months a total of eight pigs were removed once management was switched to snaring including: two males, three females, three of unknown sex, and two goats. No ungulate sign has been observed since November 2012.

- Pig eradication efforts continued in Lihue MU. Since the Army has gone back to full time training at Schofield Barracks West Range, OANRP has had limited access to complete the eradication. To date, a total of 512 pigs have been removed. Sign in all portions of the unit has been dramatically reduced. Efforts are focused on increasing coverage in areas minimally covered and making sure all snares are well set. OANRP is exploring the use of Forward Looking Infra-Red (FLIR) attached to military Shadow unmanned aircraft as a means to detect and measure the population of feral pigs left within the unit. The hope is that this technology will help identify areas to focus efforts in order to achieve eradication.

- Pig eradication efforts continue in Koloa. A volunteer hunter caught four pigs on an initial hunt in the unit. Since then, OANRP has spent 758 hours setting and checking 300 snares in the unit. To date, no animals have been caught in snares and no sign has been observed since March 2013. Shortly after fence completion, one small pig was found inside that likely died from a fall.

OIP/MIP Management Unit Status

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

MIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
ARMY LEASED AND MANAGED LANDS													
Kahanahaiki	Kahanahaiki I	Yes	Yes	64/64	1998					7	0	Complete. Portions of the fence were retrofitted with fickle fence to stop ingress of small pigs.	None
	Kahanahaiki II	Yes	Yes	30/30	2013		X			6	0	Fence is complete and ungulate free	Pig
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002					3	0	Complete. Fence is in need of some repair 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. A three kilometer section of the perimeter fence from 3-points to the saddle makai is slated for replacement in 2014.	Pig/Goat
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		X			1 0	0	Ohikilolo ridge fence is complete, excluding goat ingress from south. A three kilometer section of the perimeter fence from 3-points to the saddle makai is slated for replacement in 2014. Six smaller ungulate free PU fences are also complete. The Northern Makua rim section is slated for construction in 2014.	Pig/Goat
Puu Kumakalii	Puu Kumakalii	No	-	-	-	-	-	-	-	2	0	None needed but is partially included within the 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	High priority fenceline for Waianae Mountains Watershed Partnership. OANRP may construct PU sized fences for PUs that could not be managed within existing MU fences.	Pig/Goat Cattle
	West of East Makaleha	No	No	0/3	TBD	X				1	0	A PU fence has been proposed but is being deferred for now. A partnership fencing effort with the Snail Extinction Prevention Program may be a possibility. Permission from Oahu Branch required.	Pigs and Goats
Ekahanui	Ekahanui I	Yes	Yes	44/44	2001	X				6	3	Complete and ungulate free.	None
	Ekahanui II	Yes	Yes	165/159	2009	X				5	1	Complete and ungulate free. The completed fence is several acres larger than the original proposed MU fence	None
Haili to Kealia	Haili to Kealia	No	-	-	-	X	-	-	-	1	0	As per DOFAW staff 'no fence needed'	None
Kaena	Kaena	Partial	-	-	-	X	-	-	-	1	0	There is a predator proof fence installed by State but it does not protect all of the plants	None
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999	X				4	3	Completed by TNCH. The completed fence is several acres larger than the original proposed MU fence.	None

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
	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
	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.	None
Keaau	Keaau	No	No	0/33	2014	X	X	X		2	0	Permission has been granted to construct this fence. Funding was provided year end for construction in 2014.	Pig/Goat/ Cattle
Keaau/Makaha	Keaau/Makaha	Yes	Yes	1/3	2009	X	X			1	0	Complete and ungulate free. The completed fence is smaller than the original proposed fence because the original was not feasible due to the terrain.	None
Manuwai	Manuwai I	Yes	Yes	166/166	2011	X	X			7	1	Complete and ungulate free	Pig/Goat
Napepeiauolelo	Napepeiauolelo	Yes	Yes	1/1	2009	X	X			1	1	Complete and ungulate free	None
Pahole	Pahole	Yes	Yes	215/215	1998	X				16	0	Complete and ungulate free	None
Palikea	Palikea I	Yes	Yes	23/21	2008	X				2	0	Complete and ungulate free 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. The completed fence is smaller than the original proposed fence because it was just reconfigured.	None
	Kapuna III	Yes	Yes	56/182	2007	X				5	0	Complete. The completed fence is smaller than the original proposed fence because it was just reconfigured.	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	The *Schiedea obovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free. OANRP will not construct larger unit because of the degraded nature of the forest and PU effort relocation.	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

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
	Kamaileunu and Waianae Kai	No	No	0/1	TBD	X			X	1	0	Need to scope. This fence was not included in the Makua Addendum because a majority of the plants are located on the cliffs and it is not feasible to fence the area.	Goat
Makaha	Makaha I	Yes	Yes	85/96	2007					10	1	Complete and ungulate free.	None
	Makaha II	Yes	Yes	66/66	2013	X	X		X	4		Complete and ungulate free	Pig/Goat
DOLE FOOD COMPANY, INC.													
Alaiheihe and Kaimuhole	Alaiheihe and Kaimuhole	No	No	0/100	TBD	X				4	0	OANRP has pursued construction of this fence largely for Hibbra with the landowner Dole Food Co. but they are currently trying to sell the land and do not want any encumbrances. This land is a potential ACUB.	Pig/Goat/ Cattle/ Donkeys

OIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
ARMY LEASED AND MANAGED LANDS															
Kaala-Army	Kaala	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. OANRP to follow the State's lead on this fence.	None
Kaunala	Kaunala	Yes	Yes	5/5	2006		X				1			Complete and ungulate free.	None
Kawaiiki I/II	Kawaiiki I/II	No	No	0/11	TBD	X			X			2		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			OANRP is looking at alternatives to building smaller units by becoming involved in partnerships that are proposing larger units in the area. No IP PU extant	Pig
Lihue	Lihue	Yes	No	1800/ 1800	2012		X			4	6			Completed large MU. Also, six PU fences were constructed before larger unit was planned/constructed. A total of 512 pigs removed.	Pig/Goat
Poamoho	Poamoho Lower	No	No	0/156	TBD	X	X		X		1			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		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			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 and ungulate free.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	273/273	2001/ 2007						1			Complete. Portions of this fence need replacement/maintenance. Significant rust along summit crestline sections. OANRP will request funding to accomplish this.	None
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006	X					1			Complete and ungulate free.	None
South Kaukonahua	South Kaukonahua I	No	No	0/95	TBD		X				3	3	1	Postponed pending completion of Section 7 consultation in 2015. The Tier 1 taxa Hesperomannia arborescens occurs within this MU.	Pig

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
	South Kaukonahua II	No	No	0/.5	TBD		X					2		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	2014	X		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					4	1		OANRP has shifted PU efforts from Kaipapau to other existing MUs.	Pig
Kaleleiki	Kaleleiki	Yes	Yes	2/2	1998	X					1			Completed by DLNR. May need to expand existing fence.	None
Manana	Manana	No	No	0/19	--	X	X				1			OANRP is managing Labordia cyrtandrae within the Koloa MU as the wild plant found at Manana died.	Pig
Manuwai	Manuwai II	Yes	Yes	138/138	2011	X	X			1	1			Complete and ungulate free. The Lihue and Manuwai II unit share a strategic boundary and the ungulate free status is subject to pig traffic that although not highly probable, is possible could breach the unit	Pig/Goat
North Kaukonahua	North Kaukonahua	No	No	0/31	TBD	X	X	X			3	1		OANRP is partnering with the State to build a larger unit encompassing large amounts of suitable habitat.	Pig
Poamoho	Poamoho Lower II	No	No	0/5	2014	X	X	X			1	4		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	2014	X	X	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	2014	X	X	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	--	X						1		This fence contains only OIP tier 2 and 3 taxa and thus is postponed indefinitely until the Army has a nexus to these taxa.	Pig
Waimano	Waimano	Yes	Yes	4/4	2011	X	X				1			Complete and ungulate free.	None
North Pualii	North Pualii	Yes	Yes	20/20	2004	X				1	1			Complete.	None
	BOARD OF WATER SUPPLY														
Kamaili	Kamaili	Partial	No	0/7	2014	X	X		X		1			Construction is ongoing. Line clearing has begun.	Pig/Goat
	HAWAII RESERVES INC.														

Management Unit	Management Unit Fence	Fenced	Ungulate Free	Acreage Current/ Proposed	Year Completed or Proposed	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
Koloa	Koloa	Yes	Yes	177/160	2012	X	X		X		4	2		Complete and ungulate free.	Pig
KAMEHAMEHA SCHOOLS															
Waiawa	Waiawa I	No	No	0/136	TBD	X			X		2	1	1	KMWP is looking to build fences to protect this habitat.	Pig
	Waiawa II	No	No	0/136	TBD	X			X		2	1		KMWP is looking to build fences to protect this habitat.	Pig
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION															
North Halawa	North Halawa	Yes	No	.5/4	TBD	X					1			Complete. Management Actions for *Cyanea stjohnii* have fallen off of OANRP's list.	Pig
KUALOA RANCH INC.															
Kahana	Kahana	Yes	No	1/23	TBD	X						1		Complete	Pig
U. S. FISH AND WILDLIFE SERVICE															
Kipapa	Kipapa	No	No	0/4	TBD	X							1	U.S. Fish and Wildlife Service secured funding to construct a fence in the Oahu Refuge and OANRP have supported the effort via expertise.	Pig

1.2 ENVIRONMENTAL OUTREACH

The OANRP outreach program is tasked with:

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

Highlights from the 2013 reporting year are discussed below. See Appendix 1-4 for photos and examples of outreach materials.

Volunteers

During the reporting period for 2013 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. At Kaala MU, efforts are entering the second phase of treatment to control the incipient moss, *Sphagnum palustre*. Control will be conducted across the entire infestation area to treat re-sprouts and untreated plants. A large portion of volunteer time has also been spent within the Kahanahaiki "Chipper Site" controlling emerging weedy seedlings and saplings as follow up to the initial clear cut control effort from previous years.

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

Report Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Work Site**	Total Volunteer Trips	Total Baseyard Volunteer Hours***
2013	3,767.5	957	69	569.5
2012	4,302.5	1261.5	78	602.5
2011	4194	1231	76	618
2010	3415	1299	58	885

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

Reducing the number of volunteer trips in FY2013 allowed outreach staff to take advantage of speaking opportunities with active duty soldiers at bimonthly (twice per month) Range Briefs, sharing information on protection of natural resources through the prevention of invasive weed spread. Refer to the section below on "Troop Education" for more information.

Additionally, maintaining a sustainable schedule for volunteer trips allowed outreach staff to meet volunteer weeding goals while balancing other outreach program goals.

The table below summarizes volunteer service trips by location.

Volunteer service for FY 2013

Management Unit	Projects	Total Number of Field Days
Kahanahaiki	Invasive weed control	14
	Invasive weed control/common native outplanting	1
	Trail Maintenance	2
Kaala	*Sphagnum* moss control	10
	Sphagnum moss and other incipient weed control	5
	Other incipient weed control only	7
Palikea	Incipient weed control	3
	Invasive weed control	4
	Invasive and incipient weed control	1
Makaha	Invasive weed control	5
	Waianae High School Field Day	2
West Makaleha	Invasive weed control	3
Pahipahialua	Invasive weed control	4
Kahuku cultural site	Invasive weed control	1
Kaluaa	Invasive weed control	3
Kaunala	Invasive weed control	2
Ohikilolo	Invasive weed control	1

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

- Maintained a volunteer database of 1,618 total volunteers and communicated regularly with active volunteers.
- Maintained and updated online sign-up system for volunteers to register for upcoming service trips using iVolunteer Online: www.oanrp.ivolunteer.com.
- Solicited feedback from volunteers using online evaluation form to provide post-service trip comments and suggestions. Feedback is used to help outreach staff refine and improve service trip opportunities. Samples of feedback can be found in Appendix 1-4.

Internships and Temporary Staff

Outreach staff developed internships at OANRP and with cooperating agencies. Staff coordinated orientation, training and gear assignments for all interns and for temporary field technicians. This year OANRP hosted the highest number of interns and temporary hires to date, providing valuable natural resource management training for a total of 11 interns and temporary staff, in addition to 18 Hawaii Youth Conservation Corp (HYCC) members that worked with the program for a week in the summer. Bulleted points below highlight outreach staff efforts with interns and temporary hires.

- Hosted three teams of interns from HYCC, providing hands-on natural resource training for 18 youth. Together, HYCC interns contributed a total of 448.5 volunteer hours in July.
- Evaluated and scored 23 applicants, interviewed 10 applicants, and awarded five individuals with 3-5 month, paid OANRP summer internships. Interns were placed with field and horticulture crews to gain valuable career skills and experience in the field of natural resource management.

- Evaluated and scored seven applicants, interviewed three applicants, and awarded one individual with a 12-month AmeriCorps Internship with OANRP. Intern has been placed with a natural resource field crew.
- Brought on two new part-time student hires as field technicians (one former AmeriCorps member and one former summer intern).
- Coordinated orientation and training for two temporary hires brought on as field technicians and two DoD employees rotating through the Army's Civilian Career Internship Program and Career Program 18 Intern Training Program.

Educational Materials

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

- Outreach Exhibits and Activities:
    - Created new button making activity designs to use at outreach events for the following endangered species: *Hesperomannia oahuensis*, Oahu elepaio (*Chasiempis ibidis*), kahuli (*Achatinella lila*), and akoko (*Euphorbia rockii*);
    - Nahululeihiwakuipapa workshop at the Hawaii Conservation Conference – contributed to interviewing and resume-building activity for emerging conservation professionals.
- Signage:
    - "This fence protects a fragile native Hawaiian ecosystem…" – A sign created for OANRP-managed fences. Provides information on the purpose of fencing, caring for fences, and who to contact with questions or reports of damage.
- Brochures & Flyers:
    - "Growing Native Hawaiian Plants with the Oahu Army Natural Resources Program" – A pamphlet describing cultural significance, cultivation techniques, and fun facts about common native Hawaiian plant species (part of workshop materials for the 2013 Joint Spouses Conference);
    - "Report Devil Weed Sightings!" – A resource for Kahuku Motocross Track users, containing a map of motocross trails at Kahuku Training Area and information on identifying devil weed (*Chromolaena odorata*) and how to report any sightings;
    - "OANRP Outreach and Volunteer Opportunities" – Updated brochure to provide accurate overview of the current process of becoming a volunteer at OANRP or requesting a presentation at a local school or community event.
- New PowerPoint Presentations:
    - "Fighting Extinction with the Oahu Army Natural Resources Program." – Presented at the 2013 Sacred Hearts Academy Science Symposium for Girls;
    - "Environmental Requirements" – A natural resources brief presented twice per month at the USAG-HI Range Brief. Addresses particular endangered species concerns at each Army training range, highlighting what soldiers can do to protect natural resources.
- Other:
    - Developed a blog for volunteers and the public to provide an online resorce for volunteering with the program and information on OANRP management areas;
    - Planning Committee members and facilitators for the Nahululeihiwakuipapa Workshop: Building Conservation Legacies through Ka Imi Ike (Knowledge Seeking) and Kahu Hoilina (Stewardship) at the 2013 Hawaii Conservation Conference, a session targeting youth interested in conservation careers;

- Developed talking points for the 2013 Wildfire News Conference held at the Honolulu Fire Department's East Kapolei Fire Station.

Troop Education

Outreach staff 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, staff provided field and OANRP baseyard opportunities for troops to participate in natural resource conservation service projects.

Event	**Description**	**Number of presentations**	**Estimated Number of People Served**
Range Brief Presentation: "Environmental Requirements"	A 20-minute brief on natural resource considerations on training lands. Presented twice monthly at mandatory Range Information Briefs at Schofield Barracks. Presentation emphasizes the importance of gear and vehicle cleaning, fire prevention, and information on the recently completed Kahuku Training Area Wash Rack. Target audience members include Officers in Command and Range Safety Officers.	23	2620
Environmental Compliance Officer (ECO) training presentation: "Protecting Natural Resources"	A one-hour presentation for the ECO training courses held at Schofield Barracks. Outreach staff constantly revise the presentation to relay current information on ways to prevent potential threats to natural resources on Army lands. Targest audience includes soldiers, civilians, and contractors.	8	270
Training Area Presentation: "Protecting Natural Resources in Makua"	A 15-minute presentation on natural resource considerations at Makua Military Reservation (MMR). Presentation emphasizes the importance of gear and vehicle cleaning, in addition to fire prevention. Target audience includes soldiers, civilians, and contractors who are scheduled to use MMR.	5	337
Earth Day Volunteer Trip for Soldiers at Kahuku Training Area (KTA)	Targeted invasive weeds at Pahipahialua MU. Soldiers gained appreciation for KTA's natural and cultural resources.	N/A	8
Wounded Warrior volunteer efforts at OANRP baseyards and nurseries	Provided volunteer opportunities for recovering soldier at OANRP East and West Baseyards and in rare plant nurseries	N/A	1
Total number of people served:	**3236**		

Outreach Events

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

- Total number of outreach activities = 22
- Total number of people served (approximated) = 2,779

Outreach activities for FY2013

Event	Estimated Number of People Served	Audience
UH NREM Intern Class Presentation	21	undergraduate students
UH Conservation Biology Class-Graduate Level	13	graduate students
Kaiser High School Presentation	15	high school students
Windward Community College Botany 130 Presentation	28	undergraduate students
Waialua Elementary Aina in the Schools Family Night	100	elementary students and families
Leilehua High School Career Fair	30	high school students
Live and Learn Event (Schofield Barracks)	75	military families
Boy Scout Troop 664 (Mililani) Education Night	40	Boy Scouts and families
Molokai High School Career Fair	138	high school students
Sacred Hearts Academy Science Symposium for Girls	40	middle school students
Agriculture and Environmental Awareness Day	125	5th grade students from four elementary Schools
Hawaii Pacific University Presentation at Environmental Studies Class	16	undergraduate students
Kamehameha Schools Career Day	60	middle school students
Direcotorate of Family, Moral, Welfare and Recreation	200	Schofield families
Windward Community College Botany 130 Presentation	30	undergraduate students
Schofield Earth Day Festival	75	Schofield families
Fort Shafter Earth Day Festival	90	military families
Hawaii Conservation Alliance, Talk Story Presentation	15	general public
Hawaii Conservation Conference Emerging Professionals Workshop	93	college students and young conservation professionals
Hawaii Conservation Conference Open House Exhibit	75	general public
Luncheon Talk Story: All in the Ohana	500	conservation community
HCC Display in Exhibit Area	1000	conference attendees
Total number of people served:	**2779**	

Contributions to Conferences

OANRP staff contribute to outreach by presenting research findings at various conferences throughout the Pacific. This reporting year, a total of 6 staff presented at the 2013 Hawaii Conservation Conference, held at the Hawaii Convention Center. These presentations are listed in the table below.

Presentation Title	Presenter	Venue	Date
Changes in distribution and abundance of *Hylaeus* bees on Oahu and Hawaii: Implications for conservation and management	Karl Magnacca	Hawaii Conservation Conference	16-July-13
Genetic Considerations for the Reintroduction Design of a Critically Endangered Plant, *Schiedea kaalae* (Caryophyllaceae)	Lauren Weisenberger	Hawaii Conservation Conference	16-July-13
Attack of the Clone: Humans Rally to Protect Kaala from an Invasive Moss	Stephanie Joe (OANRP) and Amanda Hardman (DOFAW)	Hawaii Conservation Conference	17-July-13
A bolt in time to save the Army's bottom line – Investigating the utility of automatic rat traps in Hawaii	Katie Franklin	Hawaii Conservation Conference	18-July-13
Gigapan Robots: A cost effective way to monitor natural resource conservation goals	Lalasia Bialic-Murphy	Hawaii Conservation Conference	18-July-13
Malama kekahi i kekahi: Restoring pono thru opening gates to aloha aina based cultural groups	Kaleomanuiwa Wong	Hawaii Conservation Conference	18-July-13

Public Relations

Outreach staff wrote articles, press releases, and bulletins and provided coordination and accurate information to the local, state, regional, and national media and agencies. The table below summarizes all media featuring OANRP in 2013.

Media coverage of OANRP activities in FY2013

Title	Publication	Date	Format
State's native ecosystems are under attack by some very unsuspecting subjects	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2013/03/01/invasion-of-the-aina-snatchers/	01-March-2013	Article
Protecting Hawaii's precious water supply	Hawaii News Now http://www.hawaiinewsnow.com/story/21560677/protecting-hawaiis-precious-water-supply	08-March-2013	News story
Natural Resources gives Hawaiian plants a new home in Manuwai	Public Works Digest http://www.imcom.army.mil/Portals/0/hq/about/publications/pwd_digest/PWDApr-May-Jun13.pdf	April-June 2013	Article

Outreach staff also produced, edited, and 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 56: Autumn 2012

- Volume 57: Winter 2013
- Volume 58: Spring 2013
- Volume 59: Summer 2013 (distribution delay due to federal government shutdown)

Outreach Program Recognition

The OANRP Outreach Program received national recognition from the National Environmental Education Foundation for coordinating a volunteer event for National Public Lands Day in 2013. Likewise, seven individual OANRP volunteers received national recognition from the President's Volunteer Service Award program for dedicating 100 or more hours of their time with OANRP in the 2013 reporting year.

- Registered and planned volunteer work day in Kahanahaiki, Makua Military Reservation for November 8, 2013 in celebration of National Public Lands Day (official holiday is September 28, 2013). Received cash award totaling $6368.38 to purchase supplies including: volunteer rain jackets, rain pants, spiked tabis, gloves, pruners, and educational guidebooks on Kahanahaiki.
- Nominated seven OANRP volunteers for the President's Volunteer Service Award. Four volunteers were eligible for the Bronze Level Award (serving 100-249 hours each within the reporting year); two were eligible for the Silver Level Award (serving 250-499 hours each within the reporting year); and one was eligible for the Gold Level Award (serving over 500 hours within the reporting year). Each awardee will receive presidential pins and certificates of appreciation.

2013 President's Volunteer Service Award Nominees

Award Level	Hours per volunteer in FY2013
Gold	601.25
Silver	412
Silver	285.75
Bronze	200.5
Bronze	152
Bronze	120
Bronze	100

See Appendix 1-4 for photos and samples of outreach materials.

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 6,967.6 hours controlling weeds across 306.64 ha – a program record. This figure includes both incipient and ecosystem control efforts by staff and volunteers but does not include survey efforts or travel time. The table below compares this year's effort with that of previous years.

Report Year	Effort (hrs)	Area (ha)
2012-2013	6,967.6	306.64
2011-2012	5,860	275.67
2010-2011	5,778	259

This year's increase is due to a program prioritization of weed control projects. 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, MMR, and SBW.

Preparing to spray *Sphagnum palustre* with volunteers at Kaala.

Incipient Control Areas

Incipient control efforts are tracked in Incipient Control Areas (ICAs). Each ICA is drawn to include one incipient taxon; the goal of control is eradication of the taxon from the ICA. ICAs are primarily drawn in or near MUs. Those not located within or adjacent to an MU were selected for control either because they occur in an Army training range (for example, *Rhodomyrtus tomentosa* in SBE) or are particularly invasive (*Morella faya* in Kaluaa). Many ICAs are very small and can be checked in an hour or less, and in some MUs multiple small ICAs can be checked in one day. In contrast, a few ICAs, like those for *Angiopteris evecta* in Kapuna or *Chromolaena odorata* in Kahuku, are quite large and require days to sweep completely. Typically, ICAs are swept repeatedly, until eradication has been achieved and staff are reasonably confident there is no remaining seed bank. In the absence of data regarding seed longevity, staff do not consider a site eradicated until ten years after the last sighting. The goal of ICA efforts is to achieve local eradication of the target species. OANRP currently manages about 60 taxa in 190 ICAs.

Of the total 306.64 ha swept, ICA efforts covered 184.34 ha. Staff spent 1,369.2 hours on ICA management and conducted 311 visits to 152 ICAs. While these effort and area are lower than last year, they are dramatically higher than 2010 figures, as shown in the table below.

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

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

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

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

ICA Effort in MUs

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
KTA No MU	7	*Acacia mangium* *Cenchrus setaceus* *Chromolaena odorata* *Melochia umbellata* *Miscanthus floridulus* *Rhodomyrtus tomentosa* *Sideroxylon persimile*	61	478.2	Efforts on *C. odorata* account for most of the time spent. Hours recorded here do not include hours spent by OISC. *C. setaceus* and *M. umbellata* also required significant time investments.
Kaala Army	7	*Angiopteris evecta* *Anthoxanthum odoratum*	36	384.45	The majority of time and effort was spent on *S. palustre*. Changing moss

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Crocosmia x *crocosmiifolia*			control needs account for the decline in effort from last year (781 hrs). Most control trips were run by the outreach program. Volunteers also provide the majority of labor for *C. crocosmiifolia* and *J. effusus.*
		Festuca arundinacea			
		Juncus effusus			
		Setaria palmifolia			
		Sphagnum palustre			
Kaala NAR	5	*Crocosmia* x *crocosmiifolia*	19	113	Volunteers provided the majority of effort for *C. crocosmiifolia* (60hrs), *J. effusus* (26hrs), and *S. palustre* (25hrs). *P. glomerata* was found for the first time at the shelter.
		Diplazium esculentum			
		Juncus effusus			
		Pterolepis glomerata			
		Sphagnum palustre			
Ohikilolo Lower	1	*Cenchrus setaceus*	7	79.45	Control on *C. setaceus* is discussed below. It is a priority for control.
Palikea	4	*Angiopteris evecta*	23	59.4	All *C. crocosmiifolia* control is done with volunteers and accounts for most of the time spent on ICAs in Palikea. *A. evecta* was found for the first time.
		Crocosmia x *crocosmiifolia*			
		Dicliptera chinensis			
		Setaria palmifolia			
Lihue	1	*Erythrina poeppigiana*	3	34	This taxon has not dispersed widely.
Kapuna Upper	3	*Angiopteris evecta*	13	33.50	The majority of effort was spent on *A. evecta* control. This infestation covers a large area, but recruitment and maturation of plants is slow.
		Rubus argutus			
		Sphaeropteris cooperi			
Opaeula	3	*Angiopteris evecta*	20	32.10	The majority of this time was spent on *S. palmifolia*. *A. evecta* was found for the first time. *R. caduca* may be beyond eradication.
		Rhyncospora caduca			
		Setaria palmifolia			
SBE No MU	5	*Cenchrus setaceus*	10	20	SBE is heavily used for training, and is close to residential Wahiawa. It has a particularly high diversity of alien plants. This year, most effort was spent on *S. condensatum*, and a new *C. setaceus* ICA was discovered. Last year, 131.35 hours were spent on control; next year, effort needs to rise to at least this level to begin making progress on ICA eradication.
		Rhodomyrtus tomentosa			
		Schizachyrium condensatum			
		Senecio madagascariensis			
		Vitex trifolia			
Ohikilolo (Upper)	5	*Araucaria columnaris*	18	18.5	The majority of time spent was on *E. stipoides* control. This taxon continues to be difficult to eradicate, and a new site was found this year. Other taxa require minimal effort.
		Cirsium vulgare			
		Ehrharta stipoides			
		Fraxinus uhdei			
		Rubus argutus			

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

ICA Target Taxa

Taxa	Effort	Comments
Chromolaena odorata	396.35	Effort includes only OANRP time. Time spent conducting survey sweeps in buffer areas is not included. See discussion in section 1.1.3.4 below.

Taxa	Effort	Comments
Sphagnum palustre	292.65	This year, sphagnum control was a priority Outreach project, with volunteers providing the majority of hours. Most time was spent in Kaala Army MU, but some time was also spent in Kaala NAR. Buffer surveys were completed around the infestation in Kaala Army and all outliers were treated. Initial knockdown is complete and efforts now are focused on re-treatment.
Crocosmia x *crocosmiifolia*	143.35	Volunteers conduct the majority of *Crocosmia* control at both Kaala and Palikea.
Cenchrus setaceus	130.2	This high-priority taxon is discussed in section 1.1.3.4 below.
Juncus effusus	38	Volunteers conduct the majority of control on this species (Kaala).
Angiopteris evecta	50.93	This taxon is relatively widespread, but has been targeted for eradication in select MUs. Most effort was spent in Kapuna Upper.
Melochia umbellata	15.75	Restricted to KTA, this taxon has long-lived seeds. Regular control will be needed for many years.
Erythrina poeppigiana	35	Found only on Schofield Barracks. Since the infestation is behind the live-fire range, access is limited primarily to weekends. Some large mature trees survived initial treatment, and this year were re-treated with Inicision Point Application (IPA) Milestone, which is effective on Fabaceae (see section 1.1.3.6 for a description of IPA).
Setaria palmifolia	21.8	This grass is widespread across Oahu and has been targeted for control at select MUs. The seeds are long-lived and sustained efforts are needed to achieve eradication.
Ehrharta stipoides	17.45	Widespread in Palikea, this cryptic grass has been found at an increasing number of sites. Its ability to thrive in the shade, form dense mats, and disperse easily make it challenging. Staff are possible dispersal vectors.
Pterolepis glomerata	16.85	This taxon is only a target in the Waianae Mountains. It is a control priority. This year a new site was found at the summit of Kaala.
Miscanthus floridulus	14	This grass infestation is centered around Pahipahialua gulch in KTA. Aerial control will be needed in the future.

Unfortunately, new invasive weeds are found with some regularity on training ranges and in MUs. This year, *Dovyalis hebecarpa* was found in the Kaluaa and Waieli MU and *Sideroxylon persimile* turned up in the Makua valley portion of Ohikilolo MU. ICAs have been drawn at both locations.

In the coming year, OANRP expects *C. odorata* effort to remain constant or increase, as additional effort is needed to complete surveys, and treat known infestation areas at both KTA and SB. This weed will continue to be of highest priority. Staff also hope to maintain effort on *C. setaceus*, particularly at MMR, as this taxon has a good prognosis for eradication if actions are front-loaded (see section 1.1.3.4). Efforts must increase for *S. condensatum* and *M. floridulus* to ensure that these grasses do not become ecosystem threats and training hazards. Both grasses increase the fire threat to training ranges, and the knife-sharp blades of *M. floridulus* pose a hazard to soliders conducting maneuvers. Aerial control options will be used for *C. setaceus*, *C. odorata*, and *M. floridulus* to treat large, hard-to-access infestations and improve efficiency. All incipient weeds at SBE must receive more attention, as this training range receives heavy use, increasing the potential for weeds to spread from it to other ranges.

As eradication efforts continue on *S. palustre*, staff expect effort may decrease slightly, since work is in the re-treatment phase. Similarly, now that initial knockdown of *A. evecta* is complete, staff plan to re-visit sites at one to two year intervals to allow seedlings to thin themselves; this interval should still allow staff to treat plants before they mature. Efforts on *R. tomentosa*, *E. poeppigiana*, *A. mangium*, and *A. mearnsii* should remain constant in the coming year, as all have long-lived seeds. OANRP hopes 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 and goals are set based on a variety of factors including: presence of MIP/OIP rare taxa, potential for future rare taxa reintroductions, integrity of native forest, invasive species presence, and fire threat. Different WCAs have different goals; some simply track trail and fenceline vegetation maintenance. The goals and priorities for weeding in a particular WCA are detailed in the appropriate ERMUP. For some low-priority WCAs, no control may be planned for many years. WCAs drawn outside of MUs typically provide a way of tracking weed control effort at genetic storage rare plant sites or along access trails and roads. OANRP does not necessarily plan to control 100% of the acreage in a WCA every year. Some WCAs are not intended to be controlled every year, particularly those in sensitive habitats. Others, like the ones in Ohikilolo Lower which facilitate fuel break maintenance, are monitored quarterly and are swept in their entirety. Visitation rates and goals are further elucidated in the ERMUPs. Via the ERMUPs, staff hopes to more accurately show how priorities are set for different WCAs over a multi-year time period. This year, more WCA area was designated as additional fence exclosures were completed. See the 2009 Status Update for the MIP and OIP, Appendix 1-2, for information on control techniques.

In the OANRP database, specific reports can be generated which detail the amount of time spent in each WCA, the weeds controlled, the techniques used, and the rare taxa managed. These database reports, as well as the ERMUPs, provide a more detailed look into each MU and each WCA, and are recommended to the IT/FWS for review. It can be difficult to compare effort spent between WCAs/MUs and to judge whether the effort spent was sufficient. Since goals for each site vary, and estimating the effort needed for each WCA is very challenging. Staff continue to 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 2012 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).

Volunteer clearing *Psidium cattleianum* in Kahanahaiki

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

Management Unit	2013 Report Year					2012 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Aimuu No MU		0.43	**99 m^2**	**1**	**1.5**	0	0	0	Weed control was conducted at this site in conjunction with rare plant monitoring.
Ekahanui	87.50	78.46	**3.40**	**17**	**157.50**	3.44	24	175.75	Control efforts focused around rare species locations. One IPA sweep was conducted around the wild *Abutilon sandwicensis* population.
Ekahanui No MU	N/A	10.07	**118 m^2**	**1**	**1**	573 m^2	2	4.25	Limited weed control is conducted outside the MU. Weed control was conducted around a Genetic Storage *Delissea* site.
Haili to Kealia I and II	12.8	2.14	**223 m^2**	**1**	**1**	453 m^2	1	1	This area is alien-dominated. Long term goals need to be evaluated.
Haili to Kealia No MU	N/A	0.82	**528 m^2**	**1**	**3**	0	0	0	This region encompasses the Kuaokala access road. Staff controlled *Sphaeropteris cooperii* along the road, and will continue to do so opportunistically.
Helemano	60.63	61.01	**1.76**	**12**	**52**	78 m^2	2	2.3	Helemano is a low priority MU due to the small number of Tier 1 taxa. This combined with difficult access due to weather, resulted in low effort at this MU. Staff conducted one large scale sweep targeting *Psidium cattleianum*. Other efforts focus on treatment of *Setaria palmifolia* outliers.
Huliwai No MU	N/A	1.75	**0**	**0**	**0**	0.18	1	1.5	Last year staff assisted a State-sanctioned volunteer group with control of *Chrysophyllum oliviforme*. No control work was done here this year, although the volunteer group continues to work in the area.
Kaala Army	50.03	50.72	**22.3**	**49**	**542.25**	5.89	31	513.7	*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. In addition, staff prepared and maintained reintroduction sites.
Kaena	10.06	3.06	**4.75**	**5**	**65**	1.7	3	50	Weed control continues to focus around rare taxa.

Management Unit	2013 Report Year					2012 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 East of Alau	14.51	0.89	**0.48**	**2**	**35**	0.14	2	23.5	This year, the size of the WCA was increased to accommodate work on a fuel break between the rare plant population and access road. This accounts for the increase in area covered and time spent as well. Control efforts continue around the rare taxa.
Kahanahaiki	37.70	42.88	**3.86**	**52**	**577**	6.66	110	1,150.9	The decrease in hours from 2012 to 2013 is primarily due to the completion of the chipper project in October 2012. This year, most effort focused around rare taxa, on select patches of native forest, and follow-up weeding in the chipper site. Weed control work began in the Kahanahaiki II subunit and was focused around rare taxa reintroduction sites.
Kaleleiki	0.12	0.80	**259 m²**	**1**	**20**	660 m²	2	15.5	Control was conducted around rare taxa. The MU needs to be re-drawn to include all known *Eugenia koolauensis*, and a larger management plan is needed.
Kaluaa and Waieli	80.97	82.9	**14.8**	**68**	**776.75**	3.18	42	287.35	Control efforts continue to focus around rare plant locations and the Hapapa snail enclosure. Efforts were bolstered by large-scale IPA sweeps.
Kaluaa No MU	N/A	3.88	**0.48**	**3**	**31.5**	0.44	3	45	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/trail to the trailhead.
Kaluakauila	42.73	9.64	**3.08**	**14**	**113.5**	3.89	14	118.75	Control efforts focused on grass control and *Leucaena leucocephala* control around rare taxa. The ridgeline fuelbreak was maintained.
Kamaileunu I	0.41	0.49	**0**	**0**	**0**	0.18	2	18	No weed control was conducted at this exposed *Sanicula mariversa* site this year.
Kapuna Upper	172.35	177.35	**2.1**	**24**	**113.5**	0.95	18	105	Control efforts continue to focus around rare taxa and reintroductions. Staff expanded some WCAs to accommodate new rare plant reintroductions.
Kaunala	1.98	1.99	**0.35**	**5**	**110.4**	0.42	3	31.5	Staff efforts focused around rare taxa, and volunteer efforts continued in areas with no *E. koolauensis*.

Management Unit	2013 Report Year					2012 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Koloa	71.54	70.80	**0.36**	**4**	**2.8**	0	0	0	The invasive fern *Angiopteris evecta* was controlled wherever found. Staff plan to begin sweeps targeting *Psidium cattleianum* in the next year.
KTA No MU	N/A	1.31	**106 m²**	**2**	**11**	224 m²	2	4	Little weed control is conducted outside of MUs. Weed control was conducted around a small *E. koolauensis* site in East Oio. Staff conducted a joint volunteer trip with Cultural Resources, and cleared around a heiau site.
Lihue	710.93	706.95	**0.82**	**7**	**79.5**	4.33	13	129.75	Efforts centered around rare taxa exclosures, snail sites, and along the fenceline.
Makaha I	34.20	35.26	**4.10**	**39**	**431**	1.66	30	244.75	Weed control efforts focus around rare plant sites in the southern part of the exclosure, *Toona ciliata* control, and *Coffea arabica* control. Volunteer trips supplement staff efforts here.
Makaha II	26.69	2.65	**0.53**	**3**	**26.69**	0.57	4	19	Clearing was conducted for the Makaha II fenceline. Some control was performed around *Cyanea longiflora* and *C. grimesiana*.
Manuwai	122.49	124.91	**6.45**	**21**	**189.75**	0.74	13	222.5	Efforts focused around wild and reintroduced rare taxa sites. Some grass control was performed on the northern fenceline. Most of one WCA was swept targeting canopy weeds with IPA.
MMR No MU	N/A	10.23	**293 m²**	**1**	**8**	0	0	0	Minimal effort was spent outside of MMR MUs. One trip was conducted to clear weeds from an LZ.
Nanakuli No MU	N/A	3.99	**0.71**	**1**	**12**	0	0	0	This is the Halona ridgeline, an area between the Palikea and Palikea IV MUs. *Sphaeropteris cooperi* control was conducted here to reduce this source population and protect neighboring MUs.
Napepeiauolelo	0.75	0.93	**0**	**0**	**0**	0.11	1	3	There are no extant rare plants at this site.
Oahu North Central No MU	N/A	0.20	**0.20**	**1**	**0.5**	0	0	0	This area includes the Lower Kaala NAR contour road. A patch of *Ehrharta stiopoides* was found and treated on the eastern end of the road.

Management Unit	2013 Report Year					2012 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Ohikilolo	273.59	147	**6.21**	**23**	**262.5**	3.64	16	258	In the Ohikilolo Ridge (upper) half of this MU, control efforts continued across native dominated forest and around rare taxa. In the Lower Makua half of this MU, weed control was conducted in native dominated forest; IPA was used on some sweeps.
Ohikilolo Lower	28.75	4.44	**12.82**	**25**	**269**	4.07	13	159	Maintaining fire breaks around the rare taxa here continues to be labor-intensive. While most effort went to grass control, many trips targeted *Leucaena leucocephala* removal.
Oio	1.33	1.63	**0.12**	**1**	**3**	0	0	0	Minimal control was conducted. Due to the poor health of the *E. koolauensis* population at this site, OANRP is 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	Opaeula is a low priority MU due to the small number of Tier 1 taxa. Almost all of the Opaeula exclosure has been swept once. Staff continue to focus on neighboring Helemano, which has not yet been fully weeded, and thus is slightly higher priority
Opaeula Lower I	10.15	6.80	**0.72**	**16**	**230.6**	88 m²	1	4.25	Weed control work began in earnest this year. Efforts focused on *Psidium guajava* and *Clidemia hirta* control across the MU, as well as on reintroduction site prep. See the MU plan in Appendix 1-1.
Pahipahialua	0.60	0.60	**0.21**	**6**	**107**	423 m²	3	30	Staff efforts focused around rare taxa, and volunteer efforts continued in areas with no *E. koolauensis*.
Pahole	88.02	31.60	**2.81**	**23**	**146**	3.03	23	194	Control efforts continue to focus around rare taxa sites and grass sprays.
Pahole No MU	N/A	9.40	**19.48**	**7**	**148**	5.33	4	8	Staff continue to control weeds along the Pahole road and around the Nike greenhouse. This year the grass along the road grew out of control; road maintenance accounts for the increase in effort.
Palawai No MU	N/A	1.45	**0**	**0**	**0**	0.25	1	1.5	This area immediately abuts the Palikea MU. No control was conducted this year.

Management Unit	2013 Report Year					2012 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Palikea	9.95	10.59	**4.55**	**51**	**692.95**	2.29	28	197	This year, efforts focused on controlling weeds at rare taxa sites and the snail enclosure, controlling grass, and removing stands of *Psidium cattleianum* from the eastern end of the MU.
Poamoho No MU	N/A	94.67	**465 m²**	**2**	**30**	0	0	0	Staff trained in rappelling assisted KMWP in controlling cliff-growing *Leptospermum scoparium.*
Poamoho Upper	24.34	24.34	**222 m²**	**1**	**5**	0	0	0	Staff controlled weeds within the Poamoho snail enclosure. Weed control efforts throughout the MU will be coordinated with KMWP and NARS staff.
Puaakanoa	10.70	1.07	**0.69**	**2**	**24**	0.29	1	10	Fire is a major threat to the MU. Weed control efforts focus on fuel reduction and *Leucaena leucocephala* control around the *Euphorbia celastroides* var. *kaenana*.
Pualii North	7.99	4.78	**0.57**	**4**	**13**	673 m²	3	14	OANRP focused control efforts around rare taxa sites and reintroductions. *Trema orientalis* was removed from the eastern end of the exclosure.
SBW No MU	N/A	1.97	**2.06**	**5**	**15**	0.64	4	8.25	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	**207 m²**	**1**	**4**	0.13	1	2.5	Control efforts focused around rare taxa at the mouth of the gulch around which this MU is centered.
Waianae Kai Neraudia Mauka	0.53	2.59	**0.38**	**6**	**60.5**	0.30	4	20	The forest in this area is degraded. Control efforts centered around *Neraudia angulata* and reintroduction sites.
Waianae Kai NoMU	N/A	3.31	**207 m²**	**1**	**1**	438 m²	2	2.25	Weed control focused on the *Gounia vitifolia* exclosure.
Waimanalo to Kaaikukai No MU	N/A	0.64	**234 m²**	**1**	**28.75**	0.27	1	1	This area encompasses the Palikea access trail. One volunteer trip was conducted at a native forest patch midway along the trail. This is not a priority project.
Waimano	3.95	4.06	**0.45**	**4**	**22**	313 m²	2	7.75	Most of the MU is native forest. Control efforts targeted the weedy gulch bottom and rare taxa sites. Due to changes in taxa priority, OANRP will not be conducting work at this MU in future.

Management Unit	2013 Report Year					2012 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	**Area weeded (ha)**	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
West Makaleha	38.04	1.51	**0.35**	**13**	**171**	1.29	13	114.5	Efforts focused around rare taxa sites inside the exclosure.
West Makaleha No MU	N/A	0.32	**659 m²**	**2**	**3**	0	0	0	Control is conducted as needed to maintain the access trail.
TOTAL	N/A	1888.50	**122.30**	**529**	**5598.44**	56.98	443	4199	See discussion below.

Weeding *Clidemia hirta* at Opaeula Lower I

This year, WCA efforts covered 123 ha, an increase over last year (57 ha). Also, staff spent 5,598 hours over 529 visits at 148 WCAs. This is the greatest amount of effort spent in the last five years:

Report Year	Effort	Visits
2012-2013	5,598.4 hours	529
2011-2012	4,199 hours	443
2010-2011	5,123 hours	409
2009-2010	3,255.9 hours	353
2008-2009	2,652.4 hours	267

The development of new tools, an increased focus on restoration actions, and use of volunteers, interns, and temporary hires accounts for this year's record numbers. In particular, the use of Incision Point Application (described in section 1.1.3.5) to conduct large sweeps accounts for much of the dramatic increase in area controlled this year. 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.

Although weed control efforts on average increased, some MUs experienced greater increases than others, and some MUs experienced declines. The following table highlights the changes in effort and area for the twenty 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 2013 effort. Decreases are noted in italics.

Changes in Effort and Area in Select MUs, 2012/10/01 through 2013/09/30

Management Unit	2013 Effort (hrs)	2012 Effort (hrs)	Change in Effort	% Change from 2012	2013 Area (ha)	2012 Area (ha)	Change in Area	% Change from 2012
Kaluaa and Waieli*	776.75	287.35	489.4	170.3%	14.8	3.18	11.62	365.4%
Palikea*	692.95	197	495.95	251.7%	4.55	2.29	2.26	98.7%
Kahanahaiki*	577	1150.9	*-573.9*	*-49.9%*	3.86	6.66	*-2.8*	*-42.0%*
Kaala Army*	542.25	513.7	28.55	5.6%	22.3	5.89	16.41	278.6%
Makaha I and II*	457.69	263.75	193.94	73.5%	4.63	2.23	2.4	107.6%
Ohikilolo Lower	269	159	110	69.2%	12.82	4.07	8.75	215.0%
Ohikilolo	262.5	258	4.5	1.7%	6.21	3.64	2.57	70.6%
Opaeula Lower I	230.6	4.25	226.35	5,325.9%	0.72	0.01	0.71	7,100.0%
Manuwai	189.75	222.5	*-32.75*	*-14.7%*	6.45	0.74	5.71	771.6%
West Makaleha*	171	114.5	56.5	49.3%	0.35	1.29	*-0.94*	*-72.9%*
Ekahanui*	157.5	175.75	*-18.25*	*-10.4%*	3.4	3.44	*-0.04*	*-1.2%*
Pahole No MU	148	8	140	1,750.0%	19.48	5.53	13.95	252.3%
Pahole	146	194	*-48*	*-24.7%*	2.81	3.03	*-0.22*	*-7.3%*
Kaluakauila	113.5	118.75	*-5.25*	*-4.4%*	3.08	3.89	*-0.81*	*-20.8%*
Kapuna Upper	113.5	105	8.5	8.1%	2.1	0.95	1.15	121.0%
Kaunala*	110.4	31.5	78.9	250.5%	0.35	0.42	*-0.07*	*-16.7%*
Pahipahialua*	107	30	77	256.7%	0.21	0.04	0.17	425.0%
Lihue	79.5	129.75	*-50.25*	*-38.7%*	0.82	4.33	*-3.51*	*-81.1%*

Management Unit	2013 Effort (hrs)	2012 Effort (hrs)	Change in Effort	% Change from 2012	2013 Area (ha)	2012 Area (ha)	Change in Area	% Change from 2012
Kaena	65	50	15	30.0%	4.75	1.7	3.05	179.4%
Waianae Kai Neraudia Mauka	60.5	20	40.5	202.5%	0.38	0.3	0.08	26.6%
Helemano	52	2.3	49.7	2,160.9%	1.76	0.01	1.75	17,500.0%
Kaena East of Alau	35	23.5	11.5	48.9%	0.48	0.14	0.34	242.9%
Puaakanoa	24	10	14	140.0%	0.69	0.29	0.4	137.9%
Pualii North	13	14	*-1*	*-7.1%*	0.57	0.07	0.5	714.3%
Totals	5,394.39	4,083.5	1,310.89	32.10%	117.57	54.14	63.43	117.2%

* = areas where volunteers contribute to control efforts

Most MUs experienced increases in both effort and area controlled. The MUs which experienced the most dramatic increases include Opaeula Lower I, Helemano, Pahole No MU, Kaala Army, Pahipahialua, Kaunala, Waianae Kai Neraudia Mauka, and Kaluaa and Waieli. This was the first year management efforts were implemented at Opaeula Lower; an ERMUP was written for it to guide actions and is included in Appendix 1-1-2. Last year, staff performed almost no weed control at Helemano due to weather and helicopter difficulties, but were able to access the site this year. Work in the Pahole 'No MU' consists of grass control along the Pahole access road and weed abatement around the Nike Greenhouse facility. Unfortunately, tall *Urochloa maxima* grew out of control along the Pahole road, requiring both labor-intensive weedwhacking and spraying. Control at the Kaala Army MU historically has focused on *Hedychium gardnerianum* control. This year, more area than ever was swept for *H. gardnerianum*, but additional effort was also spent on preparing rare plant reintroduction sites. At Pahipahialua, volunteer labor accounts for the increase in effort. Area swept at Kaunala decreased, as efforts were concentrated directly around rare taxa, although staff time increased, reflecting the labor-intensive nature of weed control at this degraded MU. Rare plant reintroductions at the Waianae Kai Neraudia Mauka MU necessitated increased effort in site preparation. Both time and area increased dramatically at the Kaluaa and Waieli MU. This is due to large canopy weed sweeps using IPA, volunteer trips, and focused weeding around the snail enclosure and surrounding bench.

Some MUs experienced declines in effort and/or area controlled. These include Kahanahaiki, Lihue, Pahole, Ekahanui, Pualii North, Kaluakauila, Manuwai, and West Makaleha. The most dramatic decline in effort was seen at Kahanahaiki. This was expected as the chipper project concluded at the very beginning of the reporting period. However, Kahanahaiki still had the third-most effort spent of any MU, much of which is due to follow-up weeding by volunteers in the chipper site. While volunteer effort continues to be important at Kahanahaiki, less effort was spent here than in previous years due to a decision to prioritize *S. palustre* control trips at Kaala this year. Area covered decreased in Kahanahaiki, primarily due to decreases in number of WCA sweeps and narrowed focus directly around rare taxa sites. One WCA was swept in its entirety this year: native taxa dominated Kahanahaiki-11. Interestingly, only 35 hours were needed to sweep this 2.7 acre WCA for all weeds, as opposed to 140 hours in 2011 and 103 hours in 2007. This trend suggests native vegetation at this site is recovering.

At Lihue, declines in area and effort can be attributed to less weed control done outside of rare taxa sites, as well as less effort spent inside rare taxa sites. Ungulate removal was the focus of efforts in Lihue this year. Reduced effort spent on grass control accounts for some of the decline in area and effort seen at Pahole. Less effort was spent at Ekahanui clearing rat-trap trails and maintaining fencelines this year, though some of this decline was offset by IPA control conducted around the *Abutilon sandwicensis* population. A negligible change in effort was seen at Pualii North, which was more than offset by a large

rise in area treated. At Kaluakuila, only a small decrease in effort was seen. The decrease in area can be attributed to reduced need for grass control and increased focus around rare taxa reintroduction sites. Last year, fence-clearing at Manuwai accounted for the majority of effort spent. This year, although total effort declined, area weeded increased greatly as staff began to actively manage vegetation in the MU. All efforts either focused around rare taxa reintroduction sites, or on large IPA canopy weed sweeps. At West Makaleha, effort actually increased as area controlled decreased. Efforts focused directly around rare taxa, with less time spent conducting grass control across the MU.

In the coming year, OANRP hopes to maintain and even increase weeding efforts across MUs. In particular, new tools such as IPA may allow staff to efficiently treat tree weeds on an MU scale, allowing OANRP to make an impact on a landscape scale for the first time. However, IPA projects will need to be chosen carefully and evaluated within the context of the actions and goals detailed in the ERMUPs for each MU. In addition, OANRP is in the process of hiring an additional staff detailed to work specifically on weed-control projects. The new position will manage groups of temporary hires, and will supplement field team weed control efforts by targeting discrete weed control projects. Other tools OANRP plan to explore include aerial boom and ball spraying, and herbicide ballistic technology.

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

New tools and weeding strategies

Interns, ready for a day of weeding.

Staff using IPA to control a large *Grevillea robusta*.

Aerial spraying options: boom spraying (left) and spray ball (right)

Inter-Agency Collaboration

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

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

Vegetation Monitoring

Vegetation monitoring was conducted at the Ohikilolo (Upper) MU this year, three years after the study was installed. The project is described and analyzed in Appendix 1-5, "Plant Community Health Monitoring for Ohikilolo MU (Upper Section)." The results of this study will be used to modify weed control plans at this MU.

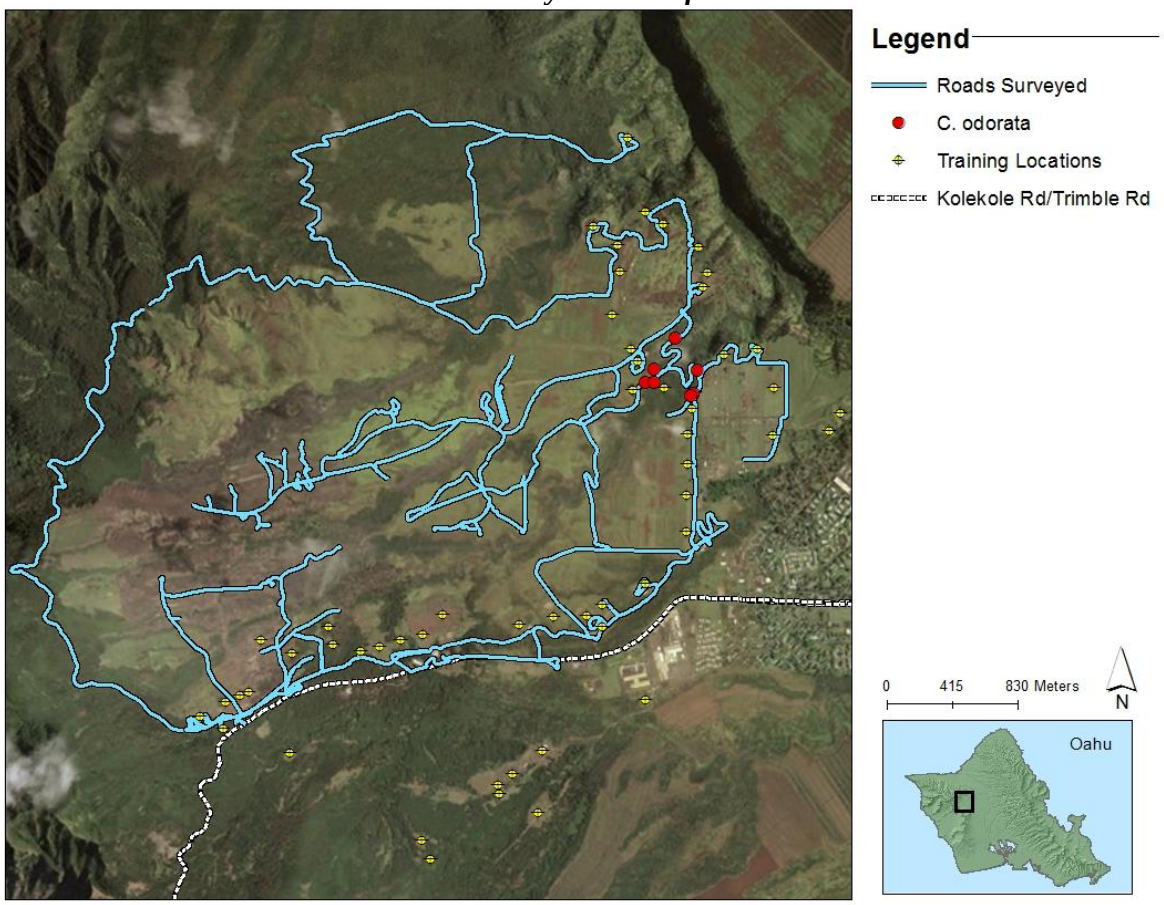
Reading vegetation monitoring plots at Ohikilolo, September 2013

1.4 WEED SURVEY UPDATES: NEW FINDS

In order to increase detection of potential weed threats on Army training ranges, many road surveys on Army training ranges were expanded this past year to include as many drivable side roads as possible. This is the second year expanded surveys were conducted at SBE, and the first year they were conducted at MMR, SBS, and SBW. Since DMR is so small, road surveys already typically involved driving all open roads.

This new approach revealed the alarming find of *Chromolaena odorata* on Schofield Barracks West Range. Although the expanded surveys require more time and effort, early weed detection is critical to saving costs in the long term. Staff took advantage of weekend range maintenance days to conduct the surveys. Over 33 miles of road were monitored (see map), including areas around training structures, the firebreak road, and the Radiological Controlled Area, which required coordinating special access.

Roads surveyed at Schofield Barracks



In the coming year, expanded surveys will begin at KTA and KLOA, and will be continued on all other training ranges. Surveys of partner-land roads used by OANRP (no training activity) will be conducted every other year, with the exception of the heavily utilized Pahole and Kaala access roads.

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 submitted 21 samples of non-native species for identification.

The table below summarizes the results of surveys and incidental observations where significant alien taxa were seen over the past year, or where species were submitted to Bishop Museum for identification. When evaluating a new discovery, staff consider distribution and invasive potential to determine whether control is warranted. The Hawaii Pacific Weed Risk Assessment (HPWRA) provides a valuable indicator of invasive potential.

Summary of Alien Taxa Survey Results

Survey Type	Survey Code or MU	Significant Alien Taxa Seen	Discussion
Camp/ Other	None	None	No significant weeds found at campsites
Weed Transect	WT-Kaala-01	*Cyclosorus parasiticus*	Common weedy fern at lower elevations, but not previously known from Kaala. This sighting is at the extreme upper edge of its known elevation range. Will monitor and control.
Weed Transect	WT-Kaluaa-01	*Ardisia elliptica*	This species was known from nearby, but this observation represents a range expansion. No control to take place along the trail
Landing Zone	LZ-HON-137, Palikea Camp	*Urochloa maxima*	Few locations with this species present in the MU. Should control or eradicate from this campsite and landing zone.
Landing Zone	LZ-KLOA-018, Black	*Tabebuia heterophylla*	This species is known to naturalize, but the HPWRA indicates it has low invasive potential. One immature was observed and controlled. Note/remove any new individuals on LZ, but no other specific control required.
Landing Zone	LZ-SBE-170, Ku Tree	*Stenotaphrum secundatum**	This species is commonly planted as erosion control on ranges. It will not be controlled.
Landing Zone	LZ-SBE-172, Lower 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.
Landing Zone	LZ-MOKFR-189, Nike	*Sisyrinchium exile* *Sidastrum micranthrum*	This plant was found last year on SBE and was a new island record. This new find on this LZ is surprising. There is no apparent threat, but more findings will be important to document. *S. micranthrum* is a common roadside weed, but does not occur in the MUs accessed from this LZ. Upgrades to this LZ including control of problematic weeds will occur this year.
Road	RS-DMR-01, Dillingham Roads	*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-KAALA-01, Kaala Road	*Cyperus sanguinolentus**, *Epilobium billardierianum* subsp. *cinereum*, *Veronica arvensis**	*C. sanguinolentus* occurs at the top of the road and population size appears to be increasing. Should note if becomes found along boardwalk. *E. billardierianum* and *V. arvensis* are both small herbaceous plants and are unlikely to pose a risk to the ecosystem. *V. arvensis* is a new state record and it is curious that the first place it showed up at was Kaala.
Road	RS-KAENA-01, Kaena Point Rd	*Cyperus sanguinolentus*, *Sidastrum micranthrum*	*C. sanguinolentus* has a wide range; new finds of this species on this survey and on Kaala Road. Possible that previously mis-identified. *S. micranthrum* common along other disturbed roadsides. Will be controlled during regular weed control efforts if found in Kaena MU.

Survey Type	Survey Code or MU	Significant Alien Taxa Seen	Discussion
Road	RS-KLOA-01, Poamoho Road	*Acanthospermum australe*	This species more commonly found on surveys in the Waianaes and is known from surveys in KTA. More recently showing up on other surveys in the Koolaus. Staff should continue to note spread up the Poamoho Road.
Road	RS-KLOA-08	*Polysicas nodosa*	While this has been observed naturalizing around SBE and on Schofield Barracks itself, it is not known from Drum Road. No action is planned, but staff will share this find with KMWP.
Road	RS-KTA-02	*Chromolaena odorata, Santalum album*	Chromolaena known from area but not seen on road before. Shows getting moved around via vehicles. *S. album* might be concerning if heavily infesting area. All locations in Kahuku should be noted.
Road	RS-KUAOKA-01, Kuaokala Road	*Castilloa elastica*	Known from only KTA Rd surveys. May have potential to naturalize. Staff should note spread along road.
Road	RS-LKN-01, Lower Kaala NAR road	*Juniperus* spp.,* *Paspalum paniculatum,* *Digitaria violascens**	The *Juniperus spp.* is naturalizing along road. Bishop recognizes this from only one other submission with an unconfirmed ID from Waimanalo. Will recollect with fertile material to try to confirm ID, and will note spread along road, but no control is anticipated. *P. paniculatum* represents a range extension for this species based on Bishop Museum records. Manuwai is the closest managed fence unit to the road. Both these species will be controlled if found in the MU. *D. violascens* is known as naturalized in Hawaii and is unlikely to pose a threat to Manuwai MU.
Road	RS-PAHOLE-01, Pahole Road	*Urochloa plantaginea,* *Stylosanthes* spp.	A patch of *U. plantaginea* was found at bottom gate. Plants were controlled and will continue to be sprayed during regular biannual road sprays. Staff should note any spread further up the road. *Stylosanthes scabra* is common along Kaala road. Not surprising that found on road survey. No ecosystem threat anticipated.
Road	RS-PALIKEA-01, Palehua Road	*Barleria repens, Cinnamomum burmannii, Elaeodendron orientale**	There are several private residences along this road, many with ornamental plants in their front yard. *B. repens* and *E. orientale* likely always present but not identified until this year. *C. burmannii* has been noted to be invasive elsewhere, and should be monitored for further spread.
Road	RS-SBE-01	*Rhodomyrtus tomentosa*	A large ICA for this species covers some of SBE. Control of this species is difficult because it covers so much area. It should be kept clear of the road as apriority.
Road	RS-SBS-01, South Range Roads (Southern portion)	*Oenothera kunthiana,* *Verbena bonariensis, Megaskepasma erythrochlamys*	Little management is done in SBS, which is heavily used for training and dominated by alien forest. The *V. bonariensis* was found in road fill and construction areas. *O. kunthiana* is likely spreading around the same way. *M. erythrochlamys* is known as having naturalized at Wahiawa Botanical Garden and in lowland gulches on SB West Range. It will not be controlled where found along the road, but there will be zero tolerance for this weed if found in MUs.
Road	RS-SBS-02 South Range Roads (Southern portion)	*Cinnamomum burmannii, Macaranga mappa, Schflerra actinophylla, Toona ciliata*	Both *C. burmannii* and *M. mappa* are invasive elsewhere on island and would merit control if found close to an MU, but are just noted for now. *S. actinophylla,*and *T. ciliata* are priority targets in the Kaluaa and Waieli MU, and source populations makai of these MUs means continued control of these weeds.

Survey Type	Survey Code or MU	Significant Alien Taxa Seen	Discussion
Road	RS-SBW-01, West Range Firebreak Road	*Sideroxylon persimile*	Known to naturalize in forested areas elsewhere on island. Should be re-located, and removed.
Road	RS-SBW-04, SBW Interior Roads	*Albizia adiantifolia, Barleria cristata, Eriobotrya japonica, Chromolaena odorata,* unknown *Asteraceae,* Lolium multiflorum,* Petrorhagia velutina, Sideroxylon persimile, Urochloa distachya**	SBW is highly degraded habitat, heavily managed by mowing, spraying, or sometimes burning. In 2012, construction on a new training facility, the Battle Area Complex, was completed. This year was the first time interior roads on SBW range were surveyed, resulting in a suite of new weeds observed. *A. adiantifolia* has been observed to naturalize at another locale. *B. cristata* is not known from elsewhere on the island. *E. japonica* is known to naturalize, however slowly. *L. multiflorum* is an ornamental grass and has invasive characteristics. *P. velutina* is only known from Schofield on Oahu, but is widely spread throughout the range on open fields. The *U. distachya* submission to Bishop Museum confirms the species is naturalizing on Oahu. No control for any species other than *C. odorata* will take place. *C. odorata* was a very disappointing find. As it occurs in high density on KTA, it is not entirely surprising it was found along roadsides at SBW. This species is treated as an incipient on range, and active control is taking place where it is found.
Incidental	Kaluaa	*Ehrharta stipoides*	One clump was found at the Hapapa Cabin. This species is not known from this area, but is prolific at Palikea MU and was likely spread by people to Hapapa. It will be controlled as an incipient.
Incidental	Kaluaa	*Begonia* spp.	Bishop Museum is still confirming species of *Begonia*. Appears to be naturalizing. Need to assess distribution, and may consider control if feasible.
Incidental	Lower Makua	*Sideroxylon persimile*	This has naturalized in Makaha Valley and is likely the source of this find. Only one plant noted. Will be treated as an incipient target for now. Scheduled for scoping and control this year.
Incidental	Lower Makua	*Coffea arabica*	Found along access trail to the back of Makua Valley. Previously thought to be restricted to Koiahi Gulch (site of a former coffee plantation). Likely spreading out from this gulch. Scheduled for some initial control and scoping this coming year to prevent further spread to the back of the valley.
Incidental	SBE	*Habenaria rodeinsis**	This orchid is uncommon on Oahu. It was removed as a result of collection. No further action necessary.

***=** Submitted to Bishop Museum for identification or documentation

1.5 INVASIVE SPECIES UPDATES

***Cenchrus setaceus,* Fountain Grass**

In this reporting year, partner agency staff identified one possible new *C. setaceus* site at KTA. Control work continued at all known *C. setaceus* locations, which include locations at KTA, SBE and MMR. Efforts at MMR are discussed under a separate heading below.

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

The table below summarizes all control work conducted by OANRP on *C. setaceus* from January 1, 2000 to Sept. 30, 2013. All efforts are included here to demonstrate the staff cost of eradication efforts for a taxon which has a potential major impact to Army training ranges. Staff cost includes both time spent conducting control and transport time. All of the sites listed below are thought to have been spread via military training, except for perhaps the sites at MMR and Keaau. Preventing further introductions, particularly from military training, is critically important.

Summary of* Cenchrus setaceus *Control

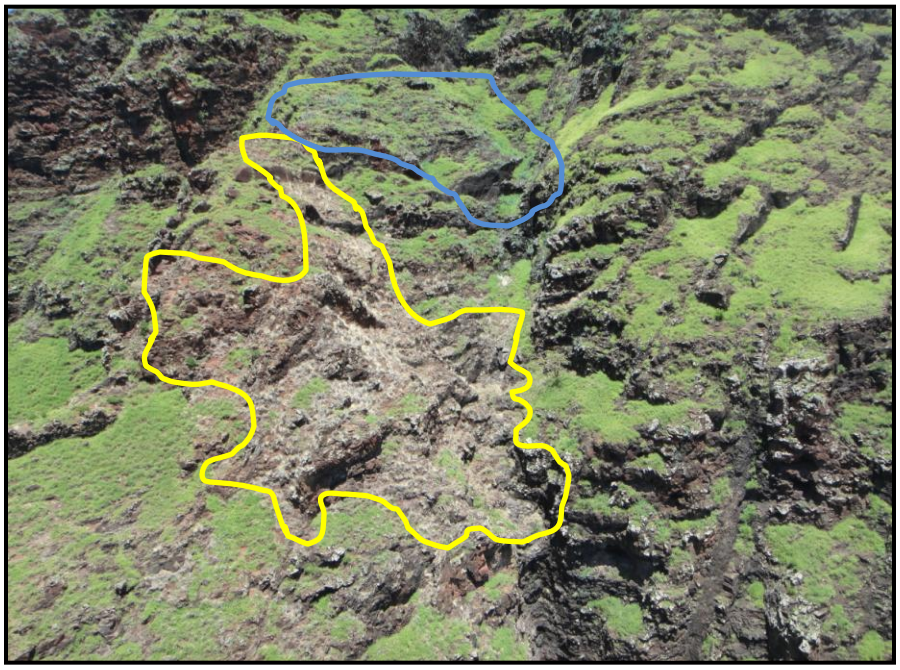
Site Code	Date Found	# Visits	Effort (hrs)	Date Last Mature Obs.	Date Last Immature Obs.	Staff Cost	Notes
DMR-CenSet-01	2001, Jan.	11	9.2	2001-08-30	2001-08-30	$203	Control efforts here have been successful, and the site is considered extirpated.
KTA-CenSet-01	2000, July	30	55	2005-03-29	2004-09-29	$688	A power sprayer was used to control all vegetation at this site, which greatly aided detection. If no additional plants are seen through 2015, it will be deemed eradicated.
KTA-CenSet-02	2012, Apr.	5	12.75	2012-02-11	2012-11-14	$661	This site is a priority for control due to the area's heavy usage by both military and motocross. Few plants have been found following initial control.
KTA-CenSet-03	2012, Apr.	5	13	2013-06-20	2013-08-06	$710	Close to site #2, this site also receives heavy use. The area was treated with a pre-emergent herbicide in April 2012, and no significant recruitment was seen until June 2013 when 17 plants were controlled.

Site Code	Date Found	# Visits	Effort (hrs)	Date Last Mature Obs.	Date Last Immature Obs.	Staff Cost	Notes
KTA-CenSet-04	2013, July	1	16	-	2013-07-25	$287	Located by partner agency OISC, 3 immature plants were found at this site. Species is being confirmed.
MMR-CenSet-01	2006, March	6	0.51	-	2006-03-13	$13	One plant was found during the course of other management work. No other plants seen.
MMR-CenSet-02	2011, Nov.	16	146	2013-09-18	2013-09-18	$9,671	Control efforts are discussed below.
KeaauNoMU-CenSet-03		1	12	2013-05-06	2013-05-06	$1,454	Control efforts are discussed below.
SBE-CenSet-01	2004, Apr.	4	1.6	2004-09-21	-	$97	Only one mature plant was found, and no recruitment has ever been seen. If no plants are found by 2014, it will be considered exterminated.
SBE-CenSet-02	2012, Feb.	5	3.3	2012-02-06	2012-08-14	$281	Regular maintenance will be needed at this site, but it appears likely that the infestation was caught before it could develop a large soil seed bank.
Total Effort for *C. setaceus* Control = 84 visits, 269.4 person hours, and $14,063 in staff time alone							

Control Efforts at MMR

The *C. setaceus* infestation continues to be a high priority for eradication. As landscape-scale delimitation surveys were completed last year, this year's efforts focused on a combination of aerial sprays and ground-based control; 79.45 person hours were spent at Makua. OANRP is lead on all operations on MMR, and OISC is lead on all operations off-range at Keaau.

- **Aerial Spraying Operations**: This year, 33 hours were spent conducting aerial ball spraying over the course of three days in March and May. The entire Aerial Spray Zone was treated once, with some portions treated twice. The success of aerial sprays depended in large part on the weather. Sprays were only conducted when grasses were green and growing to ensure that herbicide application was effective. Due to the steep nature of the terrain and highly technical flying required, extremely low winds were critical; waiting for perfect conditions was logistically difficult but crucial for a safe operation. For most of the sprays, the pilot did not need a spotter, as there were so many plants to treat. In the coming year, follow-up sprays will likely depend more on spotters to locate plants. Some plants located on cliffs could not be reached either by the ball sprayer or from the ground; Herbicide Ballistic Technology options will be investigated for these remaining plants.
- **Ground Control Operations**. This year, 46.45 hours were spent conducting ground-based control. Staff swept the walkable portions of the infestation, particularly the makai-facing cliffs and ledges of Ohikilolo ridge.



Taken in May 2013, this photo shows the core of the *C. setaceus* infestation. The bright green grass, most of which is not *C. setaceus*, indicates perfect timing for aerial spraying. The dry, brown area is the dead grass treated during March 2013 aerial operations (yellow outline). Just above it, area treated in May is tinged faintly with blue dye (blue outline).

C. setaceus *Control Efforts at MMR and Keaau*

Map removed to protect rare resources

- **Range Expansion**. While most plants were found on the makai-facing cliffs and ledges of Ohikilolo ridge, staff regularly found small numbers of plants in the nearby *Euphorbia celastroides* var. *kaenana* fuel breaks, 160m away. *Cenchrus setaceus* readily colonizes the open areas in the fuel breaks. This year, for the first time a *C. setaceus* plant was found in the *Hibiscus brackenridgii* spp. *mokuleianus* fuel break, 260m away from the core. This range expansion demonstrates how easily *C. setaceus* disperses via wind and takes advantage of breaks in the *Urochloa maxima* dominated landscape. Regular buffer surveys will be conducted to locate any new outlier plants, particularly in the areas between the various fuel breaks.
- **Keaau, Private Land**. OANRP staff assisted OISC in conducting initial surveys and control at the Keaau outlier site on private land. Over 150 plants were controlled at the outlier site, along a small gulch. In addition, staff swept the southern edge of the primary infestation, which also lies on private land, and controlled a handful of plants. Efforts in Keaau are curtailed by the landowner's restriction against herbicide use and the discovery of some plants on cliffs, which will be very difficult to control manually.
- **Monitoring**. Gigapan photopoints were taken after both the March and May aerial control efforts. Staff plan to re-take them in winter of 2013, before beginning aerial control again in early 2014. The photopoints will be analyzed to determine the efficacy of past aerial sprays and censused to locate priority spray zones and guide future actions.

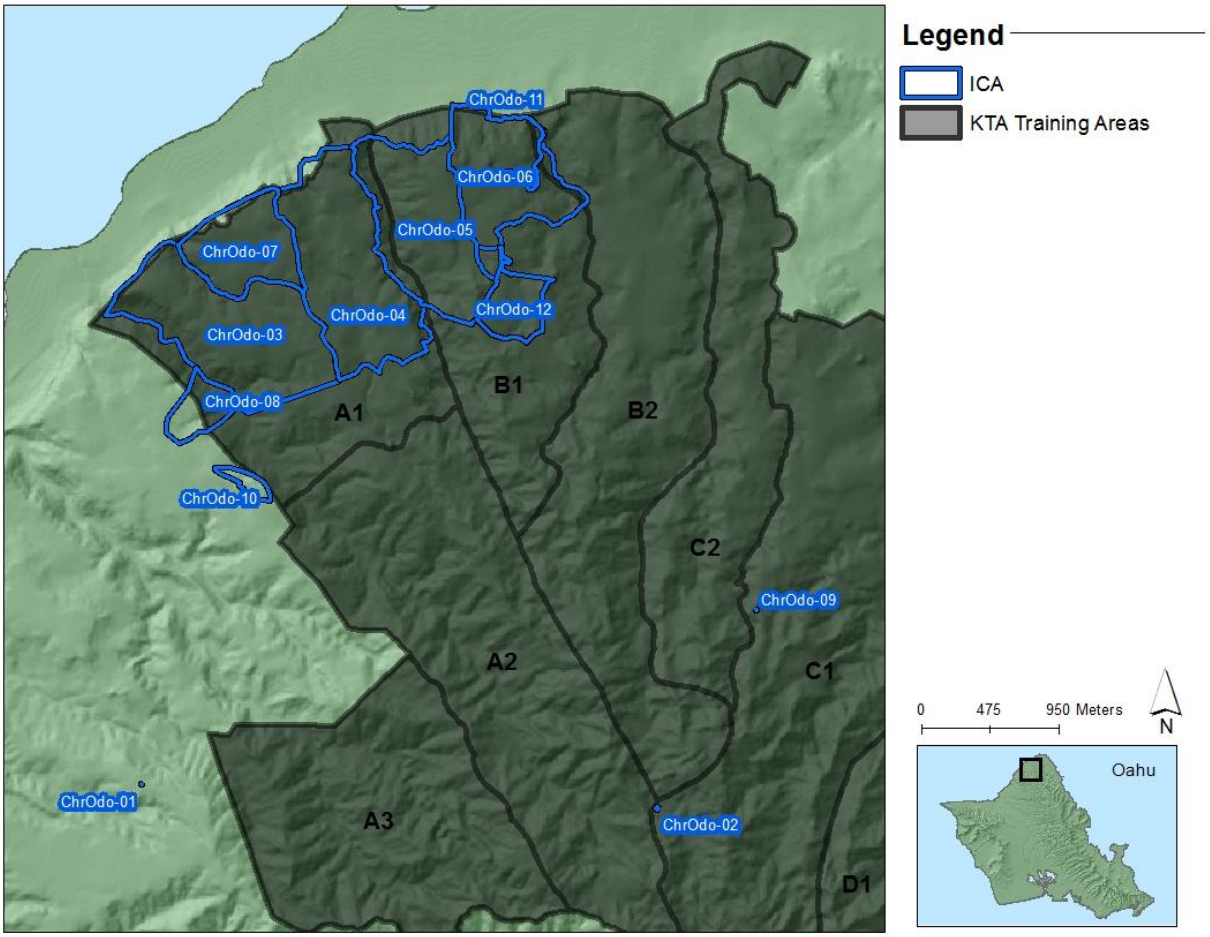
Left: Germinating seeds from the three month collection. Right: Buried seed trial site on Ohikilolo ridge

- **Buried Seed Trial**. A buried seed trial was installed in January 2012 to look at the long-term persistence of *C. setaceus* seeds in the soil. Tediously cleaned seeds were placed into cloth bags, buried on the edge of the known infestation in Makua, and marked with pin flags. Two different batches of seed were used, as the first batch was of poor quality. Every three months for a year, two bags of each seed batch were dug up and brought to the Propagule Management team for assessment. The seeds collected at both nine and twelve months germinated or rotted prior to being dug up, and no viable seeds remained, indicating that the seeds do not persist in the soil beyond one year. The final bags of seed will be collected at the two year mark, to confirm this finding. This is very promising, as it suggests that intensive control efforts are only needed for a few years to achieve eradication.

***Chromolaena odorata*, Devil Weed**

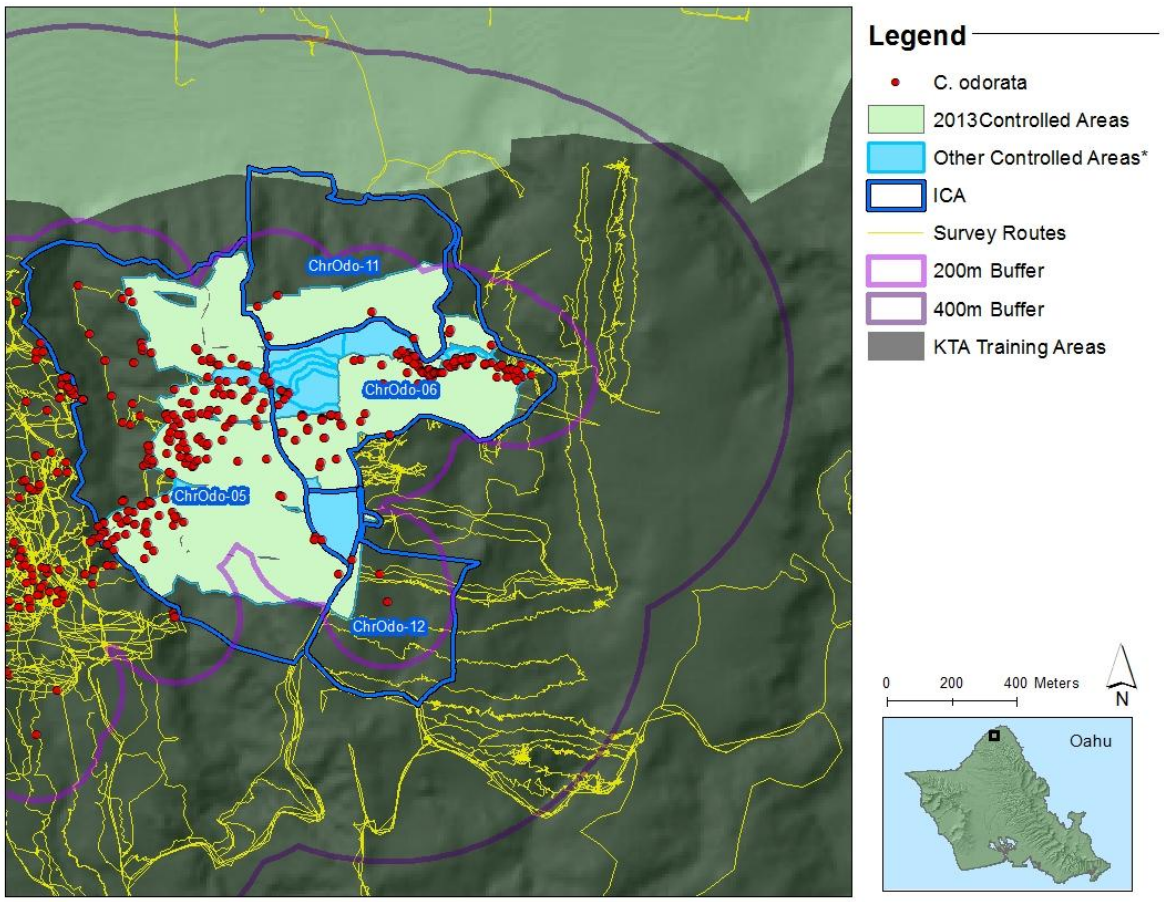
Control of *C. odorata* is a high priority for OANRP. Please see the 2011 Year End Report, Appendix 1-2 to view the draft management plant for *C. odorata* control.

C. odorata *Incipient Control Areas at KTA*



- This year, OANRP contracted OISC to conduct all *C. odorata* control across the western portion of KTA. This encompasses almost all of the Alpha 1 training range, as well as a portion of Alpha 2, and includes the following ICAs: KTA-ChrOdo-03, -04, -06, -07, and AimuuNoMU-08. OISC conducted surveys across these ICAs and the 200m and 800m buffers, and performed control work at *C. odorata* hot spots. In the course of the year, OISC located new outlier plants which necessitated the creation of new ICAs. See Appendix 1-6 for a full description of OISC efforts. OANRP has already renewed this contract for 2014. Next year, OISC will again sweep the ICAs and treat hotspots, but will not survey the entire 800m buffer again. In the buffer areas, survey efforts will focus only on trails and gulch bottoms, where *C.odorata* appears to spread. OANRP plans to adopt the same strategy once staff complete buffer surveys on the eastern side of the infestation.
- OANRP staff conduct control across the following ICAs: KTA-ChrOdo-02, 05, -06, -09, -11, -12 and WaimeaNoMU-ChrOdo-01. This year, staff spent 384 hours controlling 489 mature, 996 immature, and 704 seedlings of *C. odorata* plants at KTA. The table below summarizes these efforts, and the map below depicts them geographically.

OANRP* C. odorata *Control Efforts at KTA

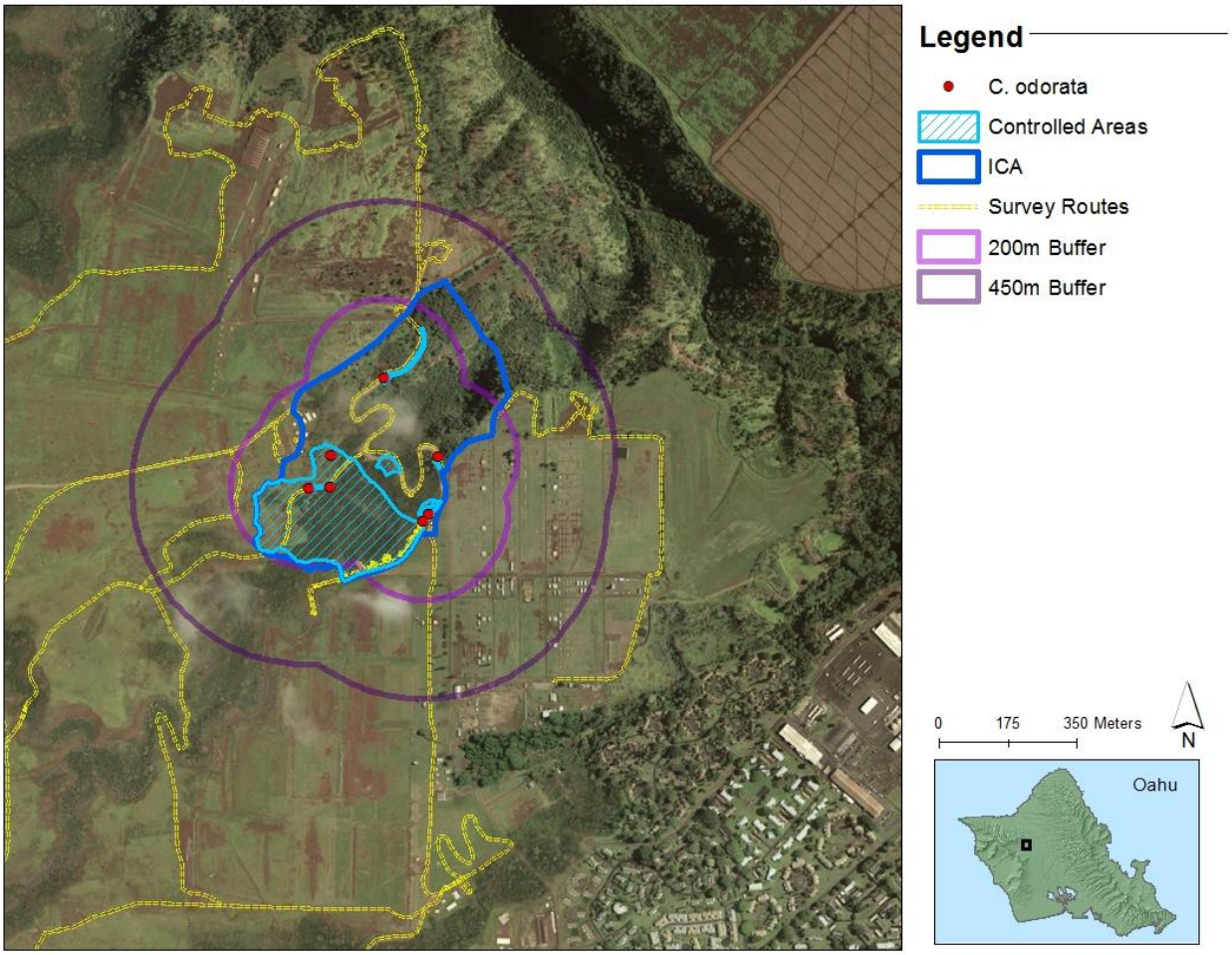


*The "Other Controlled Areas" layer shows controlled areas in OANRP-assigned ICAs swept prior to this report year, and not swept again in 2013.

KTA Control Efforts

ICA	Status
WaimeaNoMU-ChrOdo-01	Outlier. Only 1 immature plant found here. No additional plants seen. Some buffer surveys have been conducted, but much of the buffer is on private land.
KTA-ChrOdo-02	Outlier. Only 1 immature plant found. No additional plants seen. Surveys on trails in the buffer area have been started.
KTA-ChrOdo-05	Large ICA. Staff swept large portions of this ICA this year, although much of the buffer remains. 230 hours were spent here, controlling 443 mature and 648 immature plants over 106 acres. This ICA is home to the densest part of the entire infestation. Staff hope to spray this core aerially in the next year.
KTA-ChrOdo-06	Large ICA. Most of this area has been swept in the last two years. Hotspots in the ICA have been effectively suppressed with pre-emergent herbicides. 80.5 hours were spent here controlling 28 mature and 283 immature across 47 acres.
KTA-ChrOdo-09	New outlier ICA. One mature plant was found during a road survey. Only one recruit has been seen here since. Buffer sweeps have begun around this site.
KTA-ChrOdo-11	New ICA. In the course of sweeping the buffer, 2 mature and 17 immature plants were found north of the Opana Radar Tracking facility. Much of this ICA still requires initial surveys. There is a motocross trail running on the north edge of the ICA.
KTA-ChrOdo-12	New ICA. Established when plants were found along a road in an area where exhaustive ground surveys done over a year ago found no plants. Theorized that new plants were tracked in along the road. Plan to survey all roads and trails in this ICA.

C. odorata *Control Efforts at SB*



- During road surveys May 2013, staff discovered *C. odorata* at Schofield Barracks (SB). This find was disheartening, as it clearly indicated that military activity served as a vector for this noxious pest. Interestingly, Cultural Resources staff had conducted a survey at one of the SB infestation sites in January and February of 2012. Photos from those trips were reviewed, and no *C. odorata* were seen. Rather, it appears that an open, disturbed area in February 2012 was colonized by *C. odorata* by May 2013, see photos below. This highlights the aggressive colonizing properties of *C. odorata*, and indicates that this one site at the Schofield infestation is very new. Plants from a larger cluster of *C. odorata* further to the east likely were the source for this new site. Given the size of the larger cluster, it likely established at SB three or more years ago, prior to discovery of *C. odorata* by staff at KTA. Control efforts have been implemented, barriers set-up to prevent troops from venturing into the infestation accidentally, and "no mowing" signs hung up along a roadside patch of plants. Since the infestation lies to the east of actively used training areas, scheduling access to the infestation does not require a range reservation and staff can access the area even when SB ranges are in use. Some sites can be treated from existing roads and trails, but other portions are off-road, dominated by *Urochloa maxima* and require an EOD escort to access. Aerial sprays of this infestation will be critical to working towards eradication in the coming year.

Top photo: 22 February 2012.

Bottom photo: 23 May 2013.

Note the *Falcataria molucana* tree in the far left and the *Syzigium cumini* tree in the far right; both trees are in each photo. The yellow arrow indicates the disturbed area seen in 2012, and the location of *C. odorata* in 2013.

- See section 1.1.3.5 below for a further discussion of *C. odorata* spread prevention measures.
- The *Chromolaena Odorata* Working Group (COWG) was formed this year to address island and state-wide *C. odorata* concerns including: identifying priority areas for surveys, motocross spread, agricultural spread, funding, and potential biocontrol development.

1.6 Invasive Species Spread Prevention on Training Ranges

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

- After the discovery of *C. odorata* at Schofield, OANRP staff shared a pressed, laminated *C. odorata* sample and informational fliers with PTA and MCBH. While outreach had been done to these groups in previous years, the new find highlighted the need for increased vigilance.
- In the course of conducting surveys of military landing zones (LZ) in the Kawailoa Training Area, staff observed a marine helicopter landing at an unscheduled LZ. Also, staff noted heat damage to vegetation at two other LZs, and soil transfer at a third; these instances highlight the potential for training to cause weed spread and fire. All observations were documented and passed to the Range Division (Appendix 1-7, part 1).
- Language specific to the spread of invasive weeds, fire prevention, and natural resources concerns was incorporated into the Manuever Training Area Opening sheet (Appendix 1-7, part 2). The previous form only mentioned reporting range fires. This document is used by Range Control to check-in all units as they enter a training range.
- Staff began presenting at the Officer In Command/Range Safety Office (OIC/RSO) briefs. This class is required for all officers; they must present their OIC/RSO card when checking in with Range Control prior to beginning training, and cannot schedule any training activities without it. Staff participated in over 20 briefings this report year, see Appendix 1-7, part 3 for a small sample of the presentation.

Blockade and "Restricted Area, No Entry" sign across one of the two entrances into Bravo 1 at KTA.

- The Bravo-1 range at KTA was closed to military training on 1 April 2013 (Appendix 1-7, part 4). Bravo-1 encompasses the core of the *C. odorata* infestation, and OANRP had previously received permission to close a small, 3.84 ha portion of it to training. Signs were installed along

the road bordering one side of this 'No-Go' area. A map showing the area was posted in the KTA Range Office (Appendix 1-7, part 5). In talks with Range Control and Range Maintenance, it was determined that closing off the entire Bravo-1 area north of the Bravo 2 gate would allow Range staff to enforce the closure more easily. Two roads to the area were blocked, with access only allowed to OANRP, Army Wildland Fire, and Range staff. In addition, Units may no longer request Bravo-1 for training via the online RFMSS scheduling system. Bravo-1 will remain closed for three years.

The West Base wash rack consists of a paved surface for washing, which drains into a bioretention area. The bioretention area currently is mulched and awaiting planting.

- In early October 2013, construction was completed on a small vehicle washing station at OANRP's West Baseyard. Although the bio-retention plantings are not yet complete, the area is usable. This wash area will facilitate better sanitation of staff vehicles and gear.
- There are currently two wash racks available for troop use. The East Range Wash Rack, located conveniently just outside both entrances to SBE, is available for all units to use, no matter where they have been training. It experiences very heavy use, although it was closed twice in the past year, once for three-four months, then again for two-three months. The KTA Wash Rack, located several hundred yards from the KTA range office and primary entry gate, was opened for use in April 2013. It was only used for 16 days of 137 available; Range Scheduling staff indicated that all uses were by OANRP. This is frustrating, as the memo closing the Bravo 1 range also requires the use of the wash rack for all units departing KTA and OANRP have been publicizing this requirement at OIC/RSO briefings. Part of the issue may be that the KTA facility has been plagued by minor technical and logistical problems. Wash rack use is clearly required in the BO, and supported by various Army regulations. The federal Natural Resources Manger, Biologist, and OANRP staff started working with Range Division and DPW to improve wash rack use (and improve BO compliance) by creating a Range SOP requiring wash rack use at all ranges, clearly determining which office is responsible for staffing the wash racks, and adding wash rack use to troop range clearing paperwork.
- The federal Biologist, with assistance from OANRP staff, has written a landscape policy requiring that any landscaping done on the cantonment must use native plants or listed non-invasive ornamental plants. In addition, the policy prohibits the use of invasive or noxious plants.

1.7 Novel Weed Control Technique Development

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, 2011, and 2012 MIP and OIP Status Reports.

Herbicide Ballistic Technology

This year, HBT efforts centered around *Psidium cattleianum*. Staff monitored all four previously installed HBT trials, installed aerial control trials at KTA and LZ Black (KLOA), and prepared for a third aerial trial at Radio LZ (KLOA). Unfortunately, work on *Hedychium gardnerianum* at Kaala was not able to continue, as the Special Local Needs registration for the herbicide used to target this weed was not renewed by the herbicide company, and is unlikely to be available in the next few years.

The results of the four previously installed HBT trials, located in KTA, were discouraging. In all these trials, projectiles were applied from the ground to discrete, short-stature, multi-trunked, *P. cattleianum* clumps. The table below summarizes results.

Trial Name	Herbicide*	Notes
Directionality -*Installed May 2010* -*Monitored April 2013*	Triclopyr, 16%	This trial compared four different application patterns, to look at whether the number and angle of firing points affected efficacy. No difference was detected. Two of 16 plants were dead in 2013, all others maintained some canopy or had re-sprouting.
Basal -*Installed May 2010* -*Monitored April 2013*	Triclopyr, 16% Imazapyr, 3%	Projectiles were applied only to the basal bark of mature trees, roughly 5-10cm in basal diameter. Imazapyr was ineffective, with poor defoliation seen. Triclopyr was more promising, with most trees defoliated in 2013, although basal suckering was seen.
Cocktail -*Installed Nov. 2010* -*Monitored April 2013*	Triclopyr, 4% Imazapyr, 3%	This trial compared efficacy between projectiles with only triclopyr, only imazapyr, and a cocktail of both. Imazapyr was not a match, with little damage seen. The cocktail projectiles similarly had poor results. The 4% triclopyr projectiles were slightly more effective, but did not perform as well as the 16% projectiles used in the Directionality trial.
Rate & Concentration -*Installed Feb. 2011* -*Monitored April 2013*	Triclopyr, 4% and 16%	Two different concentrations of triclopyr projectiles were compared, as well as three different rates of application. No noteworthy differences were seen between treatments. One plant of 16 was dead in 2013; most had basal suckering.

*This refers to the composition of the projectile. Active ingredient is listed first, followed by the percent of active ingredient in each projectile.

From these trials, the primary lessons learned were: 1. Triclopyr projectiles at 16% active ingredient were the most successful formulation tested; 2. While the direction of treatment wasn't important, applications to basal bark resulted in the most sustained defoliation; 3. Multiple applications may be required to control *P. cattleianum*. Given Dr. Leary's successful trials and control on *Miconia calvescens* on Maui, it was decided to continue work on *P. cattleianum*, despite the mixed results seen.

In March 2013, two additional trials were installed using helicopter-based HBT and triclopyr 16% projectiles to treat *P. cattleianum* (see Appendix 1-8). In the KTA Aerial Tagged Trial, 20 plants were measured and tagged prior to treatment. The plants were chosen based on their clumping, multi-trunk growth pattern, which is similar *P. cattleianum* on the Koolau summit. Aerial control took half an hour, and used approximately 1,820 projectiles, on average a high rate of 14 projectiles/trunk. The trial was monitored briefly one month after installation (qualitative observations only), and monitored thoroughly four months after treatment in July 2013. Results so far are promising, with eleven of twenty trees

showing full defoliation. Eight trees were mostly defoliated, with some branches appearing to have been untreated, likely because they were shielded by other branches or located close to the direction of fire and protected from spatter. Three exhibited basal suckering. One tree was not treated. Non-target impacts were described in one and two meter buffers around each treated tree. Most collateral damage was found within a meter of the treated tree, with some damage seen two meters away, and no damage seen beyond two meters. Most impact was centered directly underneath or behind (away from the direction of application) the treated tree. The trial will be monitored for another year. A second HBT application may be made to test whether multiple treatments result in death of all tagged *P. cattleianum*.

KTA Aerial Tagged Trial

Left: view from the helicopter during treatment. Right: major defoliation to the treated plants as well as to the areas immediately surrounding plants was visible one month after treatment (2013-04-25)

This pair of photos shows plant #5 prior to treatment (2013-03-22) on the left, and four months after treatment on the right (2013-07-31). Note the non-target impact is centered on one side, away from the direction of fire.

The LZ Black Aerial Landscape trial was designed to look at the efficacy of HBT on *P. cattleianum* and its non-target impacts in a landscape setting. Gigapan photopoints were installed at two locations on LZ Black, looking east towards a long ridge. *Psidium cattleianum* on the ridge were treated with HBT from the air, but were not tagged. The trees treated were larger than desired (up to four meters tall), so Dr. Leary only treated distinct individuals or clumps and skipped over many of the large stands. The gigapan photopoints were re-taken on 1 July 2013, a little more than three months after treatment. The images were analyzed, with individual treated trees or clumps assigned an identifying code and compared in the

pre- and post- imagery. Although few plants were completely defoliated, many exhibited major defoliation, a promising result for such large targets. The pattern of non-target impact was similar to KTA, with damage directly around treated trees. As expected, non-target trees growing intertwined with treated *P. cattleianum* had major defoliation. See Appendix 1-8 for additional photos and discussion.

LZ Black Aerial Landscape Trial

P. cattleianum 'H', on the day of treatment (2013-03-25), left, and three months after treatment (2013-07-01), right.

OANRP staff traveled to Maui in September to work with Dr. Leary on a *Miconia calvescens* HBT operation. The trip allowed staff to gain experience with aerial use of HBT, observe logistics on a large-scale, multi-day HBT operation, and test tablet data collection devices.

In the coming year, staff plan to work with Dr. Leary on the following: 1. Monitor existing aerial trials on *P. cattleianum*, including conducting a re-treatment; 2. Install an aerial control trial on *Leptospermum scoparium*; 3. Use an experimental batch of glyphosate projectiles to treat *C. setaceus* outliers at the MMR infestation; 4. Use an experimental batch of imazapyr projectiles to conduct a trial on *Hedychium* sp. at either/both SBE and the Kaala cliffs (Experimental Use Permit held by Dr. Leary).

Incision Point Application

Work on IPA development focused on efficacy trials, field operation trials, and tools. In order to conduct more efficacy trials, which test the efficacy of four herbicide active ingredients on invasive trees, Dr. Leary hired a part-time assistant in August. OANRP staff developed a list of 27 taxa on which to conduct trials. Assistance from partner agencies in locating convenient trial sites has been helpful. Six trials have been installed thus far: *Spathodea campanulata, Psidium guajava* (OANRP managed lands); *Cordia alliodora, Chrysophyllum oliviforme, Melaleuca quinquenervia* (Waimea Valley), and *Citharexylum caudatum* (Ohulehule Conservancy). The remaining 21 taxa trials are scheduled for installation by the end of the year.

In order to promote and facilitate other agencies and groups in conducting their own efficacy trials, Dr. Learly drafted "A Technical Guide for Field Testing the Incision Point Application (IPA) Herbicide Delivery Technique to Invasive Woody Species," (Appendix 1-9). OANRP staff contributed to the

article, which was published as a CTAHR technical report and will be used in an upcoming weed control workshop coordinated by KMWP in December 2013.

Field operation trials look at the time and cost required to treat target weeds and provide efficiency data for large scale weeding efforts. On the ground, they simply are another day of weeding for OANRP staff. Staff sweep across a designated area, treating all targets found with IPA, and taking a GPS point at each plant treated. This point data, along with GPS tracks and herbicide use for each applicator, is sent to Dr. Leary for analysis. Before incorporating operational trials into team weeding actions, staff conducted two operational trials in February 2013 on *Toona ciliata* and two more on *Grevillea robusta* in March. All four trials occurred in the Kaluaa and Waieli MU. These trials were monitored in June 2013, to ensure that IPA was successful in controlling the target weeds and that no non-target damage was seen.

Results of Kaluaa Operational Trials

Taxon	Herbicide	Qty. Used	Area (acres)	Hours	# of Targets	Notes
Toona cilitata	Polaris (imazapyr)	1.81L	4.61	30	1,686	4 months post treatment. All trees fully defoliated except for extremely large individuals. Small size classes already showing insect frass. No signs of collateral damage seen.
Grevillea robusta	Milestone (aminopyralid)	2.285L	17.23	41.5	823	3 months post treatment. Most trees defoliated, although many of the larger trees were not. All showed symptoms of Milestone activity. Only 1 instance of non-target effect seen, on a small *Alyxia stellata* vine rooting directly out of a treated tree.

Treated *T. ciliata* are 100% defoliated four months post treatment.

Left: dead *G. robusta* across one of the treatment areas. Right: Some *G. robusta* had dropped all their foliage.

Building on the positive results seen at Kaluaa, IPA operational trials have slowly been incorporated into staff weeding activities. Since June, six field operation trials have been conducted. Operational trials contributed greatly to the record area weeded by OANRP this year. Since IPA facilitates a different style of weeding, involving sweeping large areas for select target weeds, it is expected expanded use of IPA by staff will continue to result in increases in acreage swept. Dr. Leary's preliminary findings indicate that the average cost of removal per target weed using IPA is $0.95, with the majority of the cost coming from labor.

This year, new IPA applicators were purchased and tested. Originally designed for veterinary use as sheep drenchers, these applicators are small, adjustable, come with refillable, lidded 250mL bottles, and are relatively inexpensive at $30-35 apiece. While the existing hydropack-based IPA equipment is effective, staff noted that it was difficult to quickly empty the packs of excess herbicide at the end of an operation, the packs took some time to clean, and the long tubes connecting the pack to the nozzle sometimes caught on vegetation in the field. However, these are relatively minor problems, and the large 1.5L capacity of the hydropacks makes them ideal for multi-day operations. The sheep drenchers are easy to clean, do not have any hoses, and the herbicide can easily be changed out in the middle of an operation, allowing the applicator to hit multiple species. As staff conduct more IPA field operation work, equipment is anticipated to evolve yet again.

Two types of IPA gear: left, IPA hyropack, retrofitted with long tubing and adjustable applicator; middle, Foretrex 301 GPS unit (used for both sets of gear); right, sheep drencher

Works Referenced

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

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.
- **Species Occurrence Maps:** These maps display historic and current locations, MUs, landmarks and any other useful geographic data for each taxon. Other features may be used on public documents to obscure locations of rare elements.
- **Population Units:** A summary of the PUs for each taxon is provided with current management designations, action areas and management units.
- **Habitat Characteristics and Associated Species:** These tables summarize habitat data taken using the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form. The data is meant to provide an assessment of the current habitat for the in situ and outplanting sites. Temperature and rainfall estimates are also included for each site when available.
- **Population Structure:** Data from monitoring the population structure for each species is presented with a plan to establish or maintain population structure at levels that will sustain stability goals.
- **Population Estimate History:** A review of population estimates for each Population Unit(PU) is displayed in a table. Estimates come from the MIP, OIP, USFWS 5-year Status Updates and OANRP field observations. In most cases, these estimates cannot be used to represent a population trend.
- **Monitoring Plan:** Current monitoring techniques and plans are discussed in this section. Monitoring of the in situ and reintroduced populations will be conducted to determine progress toward attaining taxon stability. Data to be collected may include number, vigor, and phenological phase of all plants or samples of the individuals by size class. This information may be evaluated using an appropriate statistical analysis to assess current and projected status of the monitored PUs. Adaptive modifications to the in situ management, augmentation, or reintroduction strategies for the PUs for each taxon and

each MU will be made based on the results of the monitoring program. As research results bring in new information on reintroduction and threat control methods, techniques will be modified. While the stabilization of the PU is the end goal, changes in management of the PU, threats to the PU, and the quality of the surrounding habitat must be monitored to determine which factors are affecting the taxon's ability to reach stability goals.

- **Reproductive Biology Table:** This information was summarized by OANRP based on best available data from the MIP, OIP, USFWS 5-year Status Updates, OANRP field observations and other published research. Phenology is primarily based on observations in the OANRP rare plant database. The suspected pollinator is based on casual observations, pollinator syndromes as reported in the MIP and OIP, or other published literature. The information on seeds is from data collected at the Army seed lab and from collaborative research with the Harold L. Lyon Arboretum.
- **Genetic Storage Section:** This section provides an overview of propagation and genetic storage issues. A standardized table is used to display information recorded for each taxon or PUs where applicable. The plan for genetic storage is displayed and discussed. In most cases, seed storage is the preferred genetic storage technique; it is the most cost-effective method, requires the least amount of maintenance once established, and captures the largest amount of genetic variability. For taxa that do not produce enough mature seed for collection and testing storage conditions, micropropagation is considered the next best genetic storage technique. The maintenance of this storage method is continual, but requires much less resources and personnel than establishing a living collection in the nursery or a garden. For those taxa that do not produce storable seed and cannot be established in micropropagation, a living collection of plants in the nursery or an inter situ site is the last preferred genetic storage option. In most cases, current research is ongoing to determine the most applicable method. For species with substantial seed storage data, a schedule may be proposed for how frequently seed bank collections will need to be refreshed to maintain genetic storage goals. This schedule is based only on storage potential for the species; other factors such as threats and plant health must be factored into this schedule to create a revised collection plan. Therefore, the frequency of refresher collections will constantly be adjusted to reflect the most current storage data. The re-collection interval is set prior to the time period in storage where a decrease in viability is detected. For example, *Delissea waianaeensis* shows no decrease in viability after ten years. OANRP would not have to re-collect prior to ten years as the number of viable seeds in storage would not have yet begun to decrease. The re-collection interval will be 10 years or greater (10+ yrs). If its viability declines when stored collections are tested at year 15, the interval will be set between 10 and 15 years. Further research may then be conducted to determine what specific yearly interval is most appropriate The status of seed storage research is also displayed and discussed. Collaborative research with the USDA National Center for Genetic Resources Preservation (NCGRP) and Lyon Arboretum Seedlab is ongoing.
- **Reintroduction Plan:** A standardized table is used to display the reintroduction plans for each PU. Every outplanting site in each PU is displayed showing the number of plants to be established, the PU stock and number of founders to be used and type and size of propagule (immature plants, seeds, etc.). Comments focus on details of propagation and

planting strategies.

- **Stabilization Goals Update:** For each PU, the status of compliance with all stability goals is displayed in this table. All required MFS PUs are listed for each taxon. 'YES, NO or PARTIAL' are used to represent compliance with each stability goal. For population targets, whether or not each PU has enough mature plants is displayed, followed by an estimate on whether a stable population structure is present. The major threats are listed separately for each PU. The boxes are shaded to display whether each threat is present at each PU. A dark shade identifies PUs where the threat is present and the lighter boxes where the threat is not applicable. The corresponding status of threat control is listed as 'YES, NO or PARTIAL' for each PU. A summary of the status of genetic storage collections is displayed in the last column.
- **5-Year Action Plan:** This slide displays the schedule of actions for each PU. All management is planned by 'MIP or OIP Year' and the corresponding calendar dates are listed. This table can be used to schedule the actions proposed for each species into the OANRP scheduling database. Comments in this section focus on details of certain actions or explain the phasing or timeline in some PUs.
- **Management Discussion:** A summary of the management approach, overall strategy and important actions for each taxon.

Gardenia mannii

- **Scientific name:** *Gardenia mannii* (St. John & Kuykendall)
- **Hawaiian name:** Nau, nanu
- **Family:** Rubiaceae (Coffee family)
- **Federal status:** Listed Endangered in 1996
- **Requirements for OIP Stability**
  - 3 Population Units (PU)
  - 50 reproducing individuals in each PU (long-lived perennial; Dioecious*, Large percentage of non-flowering/ fruiting plants)
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
  - Tier 1 stabilization priority

- **Description and biology:**
  - **Habit**- *Gardenia mannii* is a tree 5-15 m (16-49 ft) tall
  - **Leaves**- The leaves are thin or occasionally thick, chartaceous (papery), oblanceolate to elliptic-oblanceolate, 6-27 cm (2.4-11 in) long and 3.5-10 cm (1.4-3.9 in) wide, clustered at the tips of the branches. Prominent lateral veins, upper surface with remains of a viscid exudate, fine short hairs along midrib and on lower side especially along veins.

Modified from: Oahu Implementation Plan, 2008. Oahu Army Natural Resource Program. *Not in original OIP

Gardenia mannii

- **Description and biology continued:**
  - **Flowers-** The fragrant flowers are solitary and terminal. The calyces bear 4-6 terminal spurs. The corollas are cream colored externally, white within, and are 7-9 lobed. *Gardenia mannii* can be found to be flowering or fruiting at any time of the year. However, it is often difficult to find reproductive individuals of *G. mannii*. It appears that many trees do not produce viable fruit. The flowers are very fragrant with a scent similar to that of cultivated Gardenias, and they are presumed to be insect pollinated. Flowers open in the late afternoon and last for two days. (See breeding system description below)

  - **Fruit-** The fruits are broadly ellipsoid, 1.8-4.5 cm in diameter, yellow to orange when ripe, and contain numerous seeds. The seeds are compressed, 1.8-2.2 mm long, and embedded in a bright reddish orange pulp.

  - **Seeds**- The seeds of *G. mannii* are embedded in a bright reddish orange pulp, suggesting seed dispersal by fruit eating birds. Seed dispersal by birds would help to explain the normal pattern of distribution of the species, which generally occurs as widely scattered individuals. Seldom can several plants be found growing next to one another.

  - **Distribution:** *Gardenia mannii* is endemic to Oahu, and it occurs in both the Koolau and Waianae Mountain Ranges. The species occurs along the entire length of the Koolau Mountains, on both its windward and leeward sides. In the Waianae Mountains it has been recorded from only three areas on the windward side of the mountain range. Two of these areas are in the southern part of the Waianae Mountains in the Honouliuli Preserve - Ekahanui Gulch and the area of Kaluaa and Maunauna Gulches. The third area in the Waianae Mountains is Haleauau Gulch in back of SBMR West Range. The species has been found at elevations ranging from 270-730 m (900-2,400 ft) in elevation.

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

Gardenia mannii

- **Population trends:** There are particular trees along major trails that have been known to botanists for decades, however, the number of individual plants of *G. mannii* appears to be declining. The plant has disappeared from many locations where it was formerly recorded. Immature plants are rarely observed and no seedlings have been observed by OANRP.

- **Habitat:** *Gardenia mannii* in the Koolau Mountains occurs in wet forests, or in forests that are transitional between mesic and wet, and often far to the lee of the main summit divide of the Koolau Range. These forests are usually dominated by ohia lehua *(Metrosideros spp.)* and uluhe *(Dicranopteris linearis).* In the drier reaches of these forests, koa *(Acacia koa)* is often a co-dominant tree species. The few records of *G. mannii* in the Waianae Mountains have all been from mesic forests. The species can be found on ridge tops, on gulch slopes, and in gulch bottoms.

- **Taxonomic background:** The genus *Gardenia* is represented in Hawaii by three endemic species, two of which are found on Oahu, *G. brighamii and G. mannii.* The third species is *G. remyi,* which is closely related to *G. mannii*, and occurs on Kauai, Molokai, Maui, and Hawaii. It appears that there are very few mature individuals of *G. mannii* in cultivation in spite of the species' attractive flowers that are pleasantly scented, unlike the other native *Gardenia* of Oahu, *G. brighamii,* which is now commonly planted as an ornamental plant in Hawaii. As such, for *G. mannii,* there is very little biological information available that might be obtained from cultivated plants.

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

Gardenia mannii

- **Threats:** Major threats to *Gardenia mannii* include feral pigs, invasive alien plants, and impacts from military activities such as foot traffic and fire. The species is also susceptible to predation by rats and the black twig borer. The most serious of the invasive alien plant species currently threatening *G. mannii* include Koster's curse *(Clidemia hirta),* strawberry guava *(Psidium cattleianum),* manuka *(Leptospermum scoparium),* and octopus tree *(Schefflera actinophylla).*

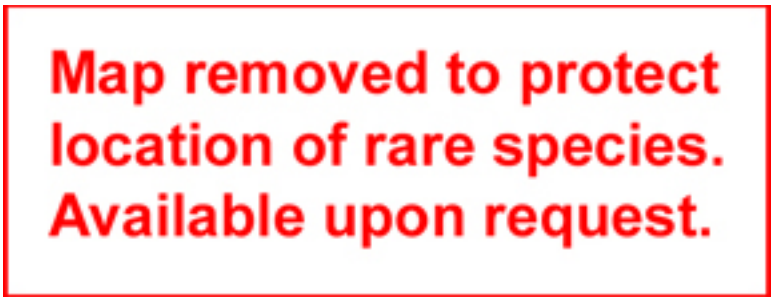
  Although the potential for fire affecting *G. mannii* PUs is probably greater in the Waianae Mountain than in the Koolau Mountains, the Koolau plants could also be affected by fire, since the wet forests of the Koolau Mountains may burn in times of drought. Historically there have been large fires in native forests on the leeward side of the central Koolau Mountains that have burned out of control for many days and have destroyed many acres of native vegetation. Among the endangered plants of the wet forests of the Koolau Mountains, *G. mannii* would be particularly threatened since many individuals occur at relatively low elevations far to the lee of the summit ridge of the Koolau Range and close to potential ignition sources. For instance, in the Helemano and Poamoho population unit, some individuals are located not very far off the road that leads to the Poamoho Trail trailhead.

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

Selected Historic Collections of *Gardenia mannii*

Area	Year	Collector	Pop. Reference Code/Notes
Moanalua Valley	1909	Forbes, C.N.	*Type Location*
Pupukea (Pipe Line Trail)	1915	Forbes, C.N.	
Palolo Crater	1922	Skottsberg, C.J.F.	
Palehua	1922	Skottsberg, C.J.F.	
North Halawa Valley	1925	Judd, A.F.	
Kahana Valley	1928	Bergman, H.F.	
Waipio-Waiawa Ridge	1928	Degener, O.	
Poamoho	1929	Lyon, H.L.	
Nuuanu Ridge	1930	Caum, E.L.	
Haleauau Valley	1930	Swezey, O.H.	SBW-A/C?
Waikane-Scofield Trail	1932	Suehiro, A.	
Waiahole Ditch Trail	1932	Meebold, A.	
Kaaawa Valley	1932	Meinecke, W.	
Waikane Valley	1932	Hume, E.P.	
Poamoho-Helemano Ridge (Marsh Trail)	1933	Meinecke, W.	
Waikane-Schofield Trail	1933	Fosberg, F.R.	
Kipapa Gulch	1934	Grant, M.L.	
Waiamano Gulch	1935	Degener, O.	
Ekahanui	1936	Degener, O.	
Palolo Valley	1945	Kruckeberg, A.R.	
Waiamao (Palolo)	1945	Hirae, A.	
South Kaukonahua	1945	Kuykendall, J.R.	
Wiliwili Ridge	1947	St.John, H.	
Kawaiiki Ditch Trail	1947	St.John, H.	
Castle Trail (Koolaupoku)	1968	Herbst, D.R.	
Kaluaa Gulch	1969	Herbst, D.R.	
Kaluaa Gulch	1973	Nagata, K.M.	
Peahinaia Ridge	1976	Stemmermann, R.L.	
Kaluaa (Puu Hapapa)	1985	Takeuchi, W.N.	
Kaiwikoele	1985	Takeuchi, W.N.	
Kawailoa	1985	Takeuchi, W.N.	~25 individuals
Pukele	1986	Takeuchi, W.N.	
Manana Trail	1987	Perlman, S.	
Poamoho	1987	Perlman, S.	

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


Map removed to protect
location of rare species.
Available upon request.


Map removed to protect
location of rare species.
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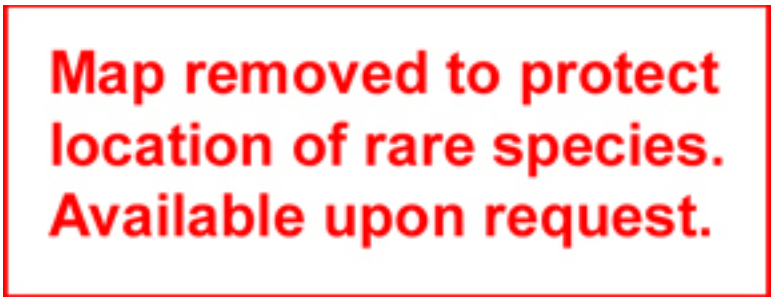


Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Haleauau	in situ with future augmentation	SBW	Lihue
Helemano and Poamoho	in situ with future augmentation	KLO	Poamoho
Lower Peahinaia	in situ with future augmentation	KLO	Opaeula Lower I
Genetic Storage Population Units			
Ihiihi-Kawainui ridge	in situ	None	None
Kahana and Makaua	in situ	None	None
Kaipapau to Punaluu	in situ	None	None
Kaiwikoele, Kamananui, and Kawainui	in situ	KLO	None
Kalauao	in situ	None	None
Kaluaa and Maunauna	in situ	None	None
Kamananui-Malaekahana Summit Ridge	in situ	None	None
Kapakahi	in situ	None	None
Kaukonahua	in situ	SBE	None
Manana-Waimano Ridge	in situ	None	None
Upper Opaeula/Helemano	in situ	KLO	None
Pukele	in situ	None	None
Waialae Nui	in situ	None	None

Associated Species at Manage for Stability Population Units

PU	PRC	Canopy	Understory
Haleauau	SBW-A, C	AcaKoa, AntPla, BobEla, ElaBif, ElaGra, IleAno, MetPol, NesSan, PlaSan, PsiCat, PsiGua, PsyHat, PsyMar, SchTer, TooCil	AcaKoa, AlySte, AspNor, BleApp, BudAsi, CibCha, CliHir, CopFol, DipSan, DooKun, DryFus, FreArb, KadAff, LanCam, MelSpp, NepExaHaw, PsiCat, RubArg
Helemano and Poamoho	HEL-(A,F,H,Q,Y) KNH-G PMD-(D,M,R)	AcaKoa, AntPla, BobEla, CheTri, ElaBif, MelClu, MelOah, MetPol, PolOah, PriMar, PsyMar, SyzSan	AlySte, BroArg, CliHir, DicLin, DipPin, JunPla, LinRep, NepCor, PteGlo, SadPal
Lower Peahinaia	OPA-(B,O,P,S,T,U) PAA-K	AcaKoa, AntPla, BobEla, CheTri, ElaBif, MelClu, MelOah, MetPol, PitGla, PolOah, PsyKad, PsyMar, SyzCum, SyzSan	AlySte, BroArg, CibCha, CibGla, CibMen, CliHir, DicLin, DrySan, DubLax, ElaBif, FreArb, LinRep, MelClu, PsiGua, PsyMar, PteGlo, SmiMel, VacRet, WikOahOah

Species are listed in alphabetical order as observed by OANRP; introduced taxa are underlined (i.e. AbuGra, CycPar)

Habitat Characteristics at Manage for Stability Population Units

PU	*in situ* PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Haleauau	SBW-A, C	2200′ – 2500′	Moderate	Intermediate	Mid Slope	North	1530.1 – 1616.4
Helemano and Poamoho	HEL-(A,F,H,Q,Y) KNH-G PMD-(D,M,R)	1480′ – 2200′	Flat – Moderate	Open – Intermediate	Upper Slope – Ridge Crest	Varies	3667.7 – 5496.6
Lower Peahinaia	OPA-(B,O,P,S,T,U) PAA-K	1800′ – 2250′	Flat – Moderate	Intermediate	Mid Slope – Ridge Crest	Varies	4301.6 - 5021.8

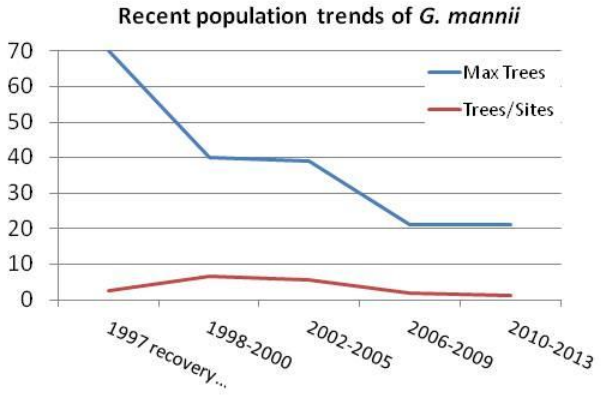
Information was compiled from OANRP observation forms & GIS data; Rainfall data complied from Rainfall Atlas of HI (Giambelluca et. al. 2013). PRC = Population Reference Code.

Population Structure

- Only two large immature (based on size) plants have ever been observed. Every other observation (from 39 different wild sites since 1999) has been of only large mature trees. No seedlings have ever been observed indicating that no reproduction is occurring.

- The 1997 USFWS recovery plan estimates of a total of 70-100 trees as determined by botanists at the Hawaii Natural Heritage Program. OANRP estimates in 2008 included most of the same data and added results of more recent surveys for a total of 124 trees. Since 2008, surveys of these older sites found fewer trees and data shows a decline to the current estimates of 59 mature trees. While some sites have not been recently visited, they are likely declining at a similar rate and reproduction is likely non-existent.

This graph shows the population trend of the 27 sites (out of a total of 39 known sites) that have been monitored in the past and again within the last 4 years. It is not an estimate of the total number of trees. To be the most conservative, the lowest estimate of 70 trees was used as the historic number of known trees. Within the last 15 years, the total number of known trees and the mean population size (number of trees per site) at these sites has decreased from 70 to 21 trees and from 2.6 to 1.1 trees per site.



G. mannii: Poamoho (HEL-F): population collapse

1999: 10 mature trees
2012: 2 mature trees

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 plants and all new 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. It is crucial that the gender of each tree be determined to facilitate restoration outplanting planning. If flowers or fruit are observed on any individual tree with unknown gender, these should be collected and observed and gender will be documented.

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

Breeding system study of *Gardenia*

- Due to the inability to observe many flowers of *G. mannii*, a study was initiated on the living collection of *G. brighamii* at Koko Crater Botanical Garden in 2011, to serve as a surrogate to better understand the reproductive biology within *Gardenia* native to Oahu. Anecdotal observations of *G. mannii* flowers suggested dioecy within the species, but infrequent visitation to populations and low reproductive activity has made the breeding system difficult to confirm. The study was conducted in collaboration with Honolulu Botanical Gardens, Waimea Botanical Gardens, Lyon Arboretum, Oahu Plant Extinction Prevention Program, and OANRP.

- Starting in 2011, 121 flowers were collected from 20 plants representing 6 different wild founders from both Oahu and Lanai. Flowers were collected on the evening they bloomed and were assessed for the presence of pollen and ovules under a stereo microscope. All flowers had either pollen (male) or ovules (female). All trees with flowers with ovules produced fruit. Of the 8 trees where fruit were collected, all trees produced viable seeds that germinated. For all of the trees, all flowers collected were either male or female. Based on these observations, we believe *G. brighamii* to be dioecious.

- For *G. mannii*, the SBW-A site in the Haleauau PU has been observed at least 32 times since 1997. Over this period, flowers were only observed twice, a flower collected only once and all four plants have only produced fruit with no seeds. The single flower collected from one of these trees in 2008 had ovules and no pollen (female). In the Koolau Mountain PUs, flowers collected from two trees in Poamoho had pollen and no ovules (male). The results of the *G. brighamii* study, in combination with the anecdotal observations of *G. mannii*, suggest dioecy for this species as well.

- Five of the (formerly) eight known trees in the Waianae Mts. are female, and the remaining are/were unknown (always observed vegetative). The two plants in the Kaluaa and Manauna PU (Waianae Mts.) have never been observed reproductive. In the Koolau Mountains, two of the (formerly) six known trees from the HEL-F Poamoho site were male, and the remaining were unknown. No other plants have been observed while reproductive to determine gender. Additional trips are necessary to determine the gender of trees in other PUs in the Koolau Mts. None of the plants held as a nursery living collection have flowered while in cultivation.

Reproductive Biology Table

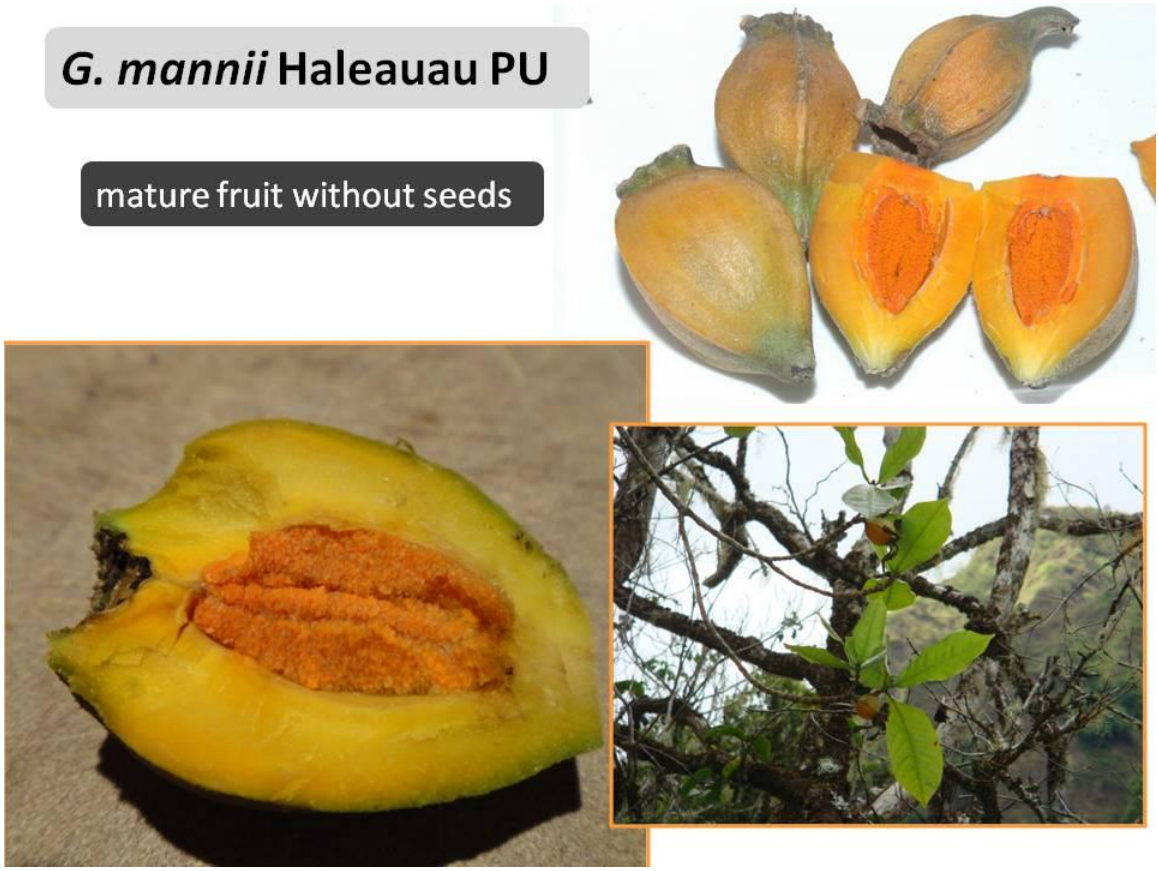
	Observed Phenology		Reproductive Biology		Seeds	
MFS (Manage for Stability) Population Unit	Flower	Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
Haleauau	Jun-Jul	year round[1]	dioecious[2]	insects (flies?)[3]		No?[4]
Helemano and Poamoho	Jan-Jun	year round[1]	dioecious[2]	insects (flies?)[3]		No?[4]
Lower Peahinaia	observations only ever made Jun-Aug[1]		dioecious[2]	insects (flies?)[3]		No?[4]

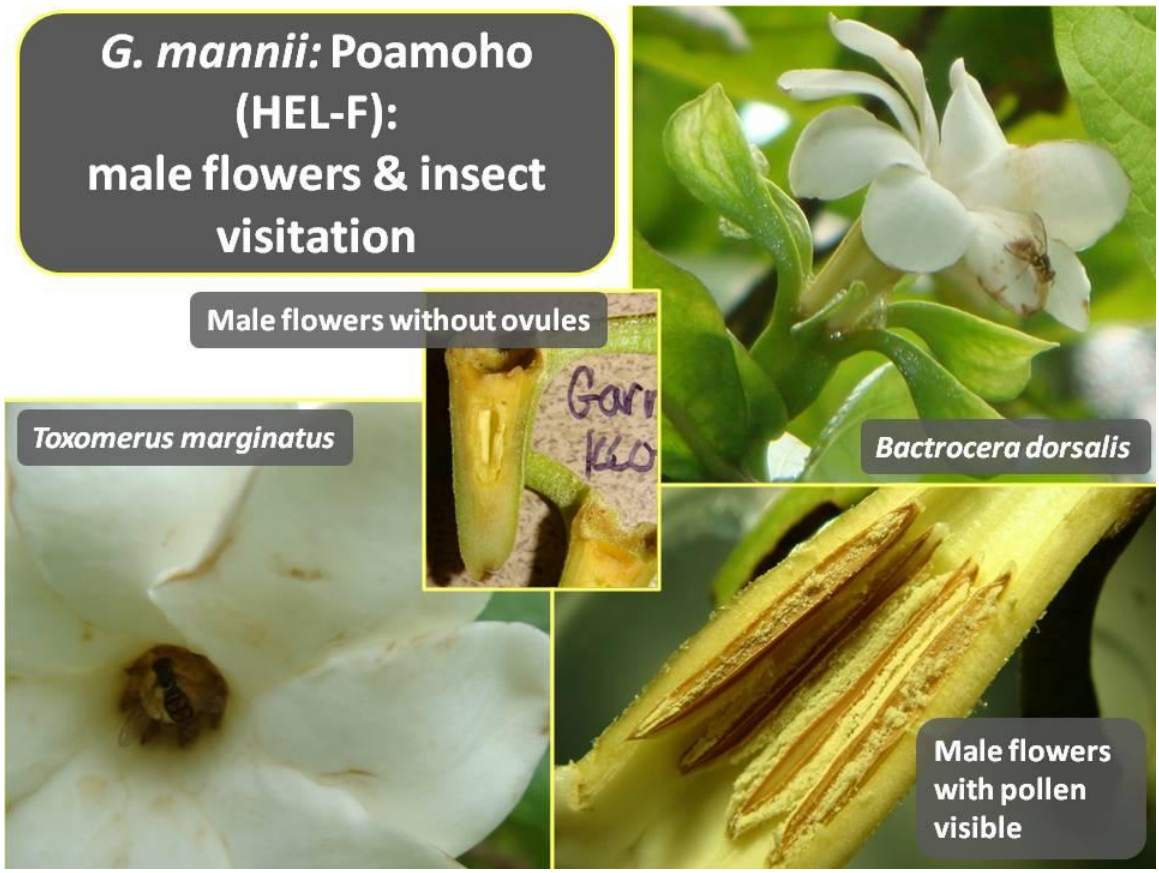
[1]Fruit can typically appear on the trees year round. OANRP suspects this is due to the long period of time a fruit takes to mature, as this has been recorded anecdotally for *G. brighamii* at Koko Crater Botanical Garden. The observations in Lower Peahinaia were of buds and fruit or vegetative trees.

[2]Via anecdotal observations of this taxon and a comprehensive study of *G. brighamii*, OANRP believes both taxa to be dioecious.

[3] One hover fly (*Toxomerus* marginatus) and one oriental fruit fly (*Bactrocera dorsalis*) have been observed on open flowers on a male tree in Poamoho. Both species are adventive. Insects identified by entomologists Paul Krushelnycky & Karl Magnacca.

[4]It is unknown whether *G. mannii* seeds are dormant at maturity, but seeds of *G. brighamii* are not (germinate prior to 45 days) so it is less likely that this taxon has dormancy.





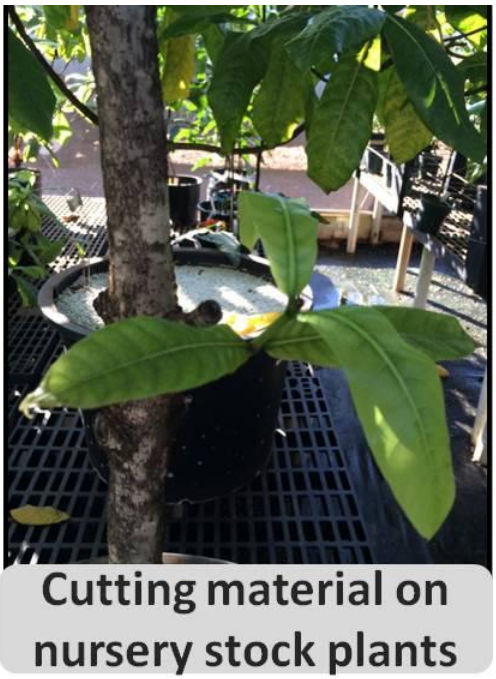
Genetic Storage Plan

What propagule type is used for meeting genetic storage goals?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
clones (cuttings & air layers)	in situ wild	living collections in nursery	N/A	not initiated	produce seeds from living collection

Genetic Storage Plan Comments:

- Vegetative propagation via air layers and cuttings has been successfully initiated on wild trees. There are currently 9 founders represented in the OANRP nursery. Priority was given to the Waianae founders. Once those were secured, collections began in the Koolau Mountains. Pollen from flowers of wild plants can also be collected and stored.
- In 2012, a collection of seeds was received from a 1990 collection that had been stored at the National Tropical Botanical Garden (NTBG). The fruit was from a single tree in Kapakahi. The seeds were no longer viable. Conditions at NTBG were not suitable for long-term seed storage. Two other fruit collections were made from two trees in Opaeula in 1996 (OPA-B). One fruit contained no seeds (similar to the observations in Haleauau), and the other tree had seeds that were germinated and propagated at the Lyon Arboretum Micropropagation Lab (OPA-B-2). Plants grown from this collection were distributed to Wahiawa Botanical Garden and the Pahole Mid-Elevation Facility nursery, where they still exist in their collections. This tree was observed among several other trees of *G. mannii*. No viable seeds of this species have been collected since then, over 17 years ago.
- The plan is to grow the living collection to produce flowers. Pollen will be stored and hand pollinations will be conducted in order to produce seeds for research and hopefully eventual genetic storage. To date, OANRP has been unsuccessful in producing reproductive plants in the nursery collections, and may look to *inter situ* sites and botanical gardens to plant the living collection if need be. There is stock from four females, one male, and six unknown trees currently in the nursery.


G. mannii Air Layers:
Haleauau PU
G. mannii Air Layers:
Poamoho
rat damage
Prominent root development
indicating appropriate to harvest



***G. mannii* Propagation**

Reintroduction Plan

Manage for Stability PU	Reintroduction Site(s)	Number of Plants	Propagule Type	Source Populations (N of trees at each site)	N (total) of Founders Represented	Plant Size	Pot Size
Haleauau	Lihue MU (GarMan PU fence)	100	Cuttings of mature trees; seedlings	SBW-A (3), SBW-C (1), KAL-A (1), KAL-B (1)	6	40-100 cm	1-gallon Tall Pot
Helemano and Poamoho	Poamoho MU (DLNR/OANRP fence)	100	Cuttings of mature trees; seedlings	HEL-F,H,L,Y (6), KAI-V (1), KAN-E,I,N,X (8), KAW-J (4) KNH-G (1), KNL-A (2) OPA-B,O,P,S,T,U (10), PAA-K (1) PMH-D,R (2), PMH-R (1) SBE-B (1)	5-37	40-100 cm	1-gallon Tall Pot
Lower Peahinaia	Lower Opaeula	100	Cuttings of mature trees; seedlings	Same as above	5-37	40-100 cm	1-gallon Tall Pot

Comments: OANRP will begin to outplant this species into the Haleauau PU in 2014, and plans to outplant Koolau Mt. stock in the Helemano and Poamoho PU in 2016 and Lower Peahinaia PU in 2015. There are six available founders from the Waianae Mts. (four females and two unknown sex). If neither of the two unknowns are male, the outplanting in the Haleauau PU will need to be augmented with male trees from the Koolau Mountains. Depending on how many additional founders are collected within the next couple years, it is unknown how many founders will initially be represented at the Helemano and Poamoho PU and Lower Peahinaia PU outplantings. The minimum number of founders shown above is the number of founders currently represented *ex situ*. The maximum is the total number of possible founders. Once clones are established in the nursery, cuttings and divisions can be used to propagate plants for outplanting in three to four months. If seeds can be collected from any *in situ* or *ex situ* trees, seedling stock will be incorporated into outplantings. This will allow for a balanced sex ratio and an increase in the total amount of genetic variation, which may consequently increase the likelihood for the reintroduced populations to withstand environmental stochasticity. Outplantings will occur over three seasons so the sites can be tested with smaller amounts of plants before the full planting is completed. As the gender of each founder tree is determined, outplantings may need to be supplemented. The Haleauau reintroduction will be within a secondary fence due to the uncertainty of pig-free status within the larger Lihue fence.

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?
Haleauau	No	No	Partial	Partial	No	No	No	No	Yes
Helemano and Poamoho	No	No	No	Partial	No	No	No	No	Partial
Lower Peahinaia	No	No	Partial	Partial	No	No	No	No	No

5 Year Action Plan for MFS PUs

	Proposed Actions for the following years:				
Manage for Stability Population Units	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 2016- September 2017	OIP YEAR 11 October 2017- September 2018
Haleauau	•Monitor annually	•Monitor annually •Begin outplanting	•Monitor annually •Continue outplanting	•Monitor annually •Complete outplanting	•Monitor annually
Helemano and Poamoho	•Monitor annually •Collect propagules •Construct fence	•Monitor annually •Collect propagules •Construct fence	•Monitor annually •Collect propagules	•Monitor annually •Begin outplanting	•Monitor annually •Continue outplanting
Lower Peahinaia	•Monitor annually •Collect propagules	•Monitor annually •Collect propagules	•Monitor annually •Collect propagules •Begin outplanting	•Monitor annually •Continue outplanting	•Monitor annually •Complete outplanting

5 Year Action Plan for Genetic Storage PUs

Proposed Actions for the following years:					
Genetic Storage Population Units	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 2016- September 2017	OIP YEAR 11 October 2017- September 2018
Ihiihi-Kawainui Ridge		•Monitor/Collect			
Kahana and Makaua		•Monitor/Collect			
Kaipapau to Punaluu	•Monitor/Collect				
Kaiwikoele, Kamananui, and Kawainui	•Monitor/Collect		•Monitor/Collect		•Monitor/Collect
Kalauao		•Monitor/Collect			
Kaluaa and Maunauna		•Monitor		•Monitor	
Kamananui-Malaekahana Summit Ridge	•Monitor/Collect		•Monitor/Collect		
Kapakahi				•Monitor/Collect	
Kaukonahua	•Monitor/Collect		•Monitor/Collect		
Manana-Waimano Ridge		•Monitor/Collect			
Upper Opaeula/Helemano	•Monitor/Collect		•Monitor/Collect		•Monitor/Collect
Pukele				•Monitor/Collect	
Waialae Nui					•Monitor/Collect

Management Discussion for *Gardenia mannii*

The overall strategy for this taxon will be to collect clones (air layers or cuttings) from wild sites to establish a nursery living collection that can be used as genetic storage and as stock plants to produce outplants. All three MFS PU need reintroductions in order to create new stable populations and meet stability goals. Wild founders will be collected and established in the nursery. A focus on monitoring and collecting from plants in the next few years will bolster the number of founders available for outplanting. Recent observations have found rapid declines in the number of mature trees due to unknown reasons. If this is found to be the case at the other PUs, a concerted effort to collect from all remaining trees must be made to secure the remaining founders ex situ. Collections from living collection stock will be made to determine if explants can be kept *in vitro* at Lyon Arboretum as a genetic storage method. Population goals will be met by augmenting the MFS PU with plants grown from the cloned wild stock. The genetic storage goals will be met using the nursery living collection until mature seeds can be collected and stored or *in vitro* collections are established. Collections will be prioritized in the next few years to secure collections of the remaining unrepresented founders for outplanting. Collections may take 2-3 trips over a year to secure propagules. A primary focus will be determining the breeding system and gender of available founders. This information will be used to guide outplanting strategy based on equalizing the male and female trees in each site. In particular, male trees from the Koolau Mountains may be needed to augment the Haleauau PU outplanting if all of the Waianae Mountain stock from Haleauau and Kaluaa to Maunauna PUs are female.

Threat control will be conducted within the MU and will include ungulate control, weed control, rat and slug control as needed to achieve and maintain all stability goals (slide 1). Sites that have not been monitored in several years include: Kawaiiki, Huliwai, Kaukonahua, and Palawai. These sites will be resurveyed in the next several years. If new plants are found, they will be incorporated into the plan.

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Neraudia angulata

- **Scientific name:** *Neraudia angulata* var. *angulata* and *N. angulata* var. *dentata*
- **Hawaiian name:** ma'aloa
- **Family:** Urticaceae
- **Federal status:** Listed endangered on October 29, 1991
- **Requirements for MIP Stability**
  - 4 Population Units (PU) (4 due to presence of both varieties in the Makua AA)
  - 50 reproducing individuals in each PU (short-lived perennial)
  - stable population structure
  - threats controlled
  - complete genetic representation of all PUs in storage

- **Description and biology:**
  - **Habit**- Erect shrubs 1.5-3 m tall; branches pubescent with erect and ± appressed hairs.
  - **Leaves**- The leaves are alternately arranged. Leaves grayish to greenish on lower surface, thin, elliptic, elliptic-ovate, or ovate, 7-15 cm long, 3-5.5 cm wide, upper surface sparsely silky pubescent, the hairs somewhat spreading or appressed, 0.2-0.4 mm long, lower surface moderately silky pubescent, the hairs appressed or somewhat spreading, 0.3-0.6 mm long, their tips primarily directed toward apex and margins, margins coarsely dentate above the middle or entire, apex long-acuminate or acute, base cuneate to rounded, petioles 0.8-3 cm long, pubescent with appressed and spreading hairs.

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

Neraudia angulata

- **Description and biology continued:**
  - **Leaves continued-** The leaf margins are sometimes toothed. In some cases the teeth are large and numerous, giving the leaf margin a ragged appearance. The degree to which the leaf margins of a given plant are toothed can vary according to the time of year. *N. angulata* var. *angulata*= Lower leaf surface with primarily appressed hairs and entire margins. *N. angulata* var. *dentata*= Lower leaf surface with hairs somewhat spreading and margins of at least some of the leaves coarsely dentate above the middle.
  - **Flowers-** Staminate flowers on pedicels 0-1 mm long, calyx silky pubescent, the hairs ascending, the lobes 2-3.5 mm long; pistillate flowers sessile, calyx conspicuously angled, silky pubescent, the hairs ascending to erect, also with some short, erect, uncinate hairs, apex 4-toothed, the teeth acuminate to long-acuminate, stigma 2-8 mm long, lacking receptive hairs on 1 surface. According to the literature on *N. angulata*, the species is dioecious (with male and female flowers on separate plants). *However, cultivated plants have shown that this is not always so, as some plants can have both male and female flowers, though they are separated temporally and are consecutively monoecious (i.e., a plant will present only male or only female flowers during a particular flowering season (OANRP per. obs. 2013). This has only been observed in the variety *angulata* while all observations of plants in the variety *dentata* appear strictly dioecious.

    Neraudia is wind-pollinated (Wagner *et al.* 1990). Flowering and fruiting occurs throughout the year. The red fleshy calyx surrounding the mature fruit suggests that fruit-eating birds disperse the species' seeds. The plants appear to live for fewer than 10 years (Lau pers. comm. 2000).
  - **Fruit-** Achenes 1.5-2 mm long, angled, surrounded by the conspicuously angled and ridged, fleshy calyx, apical portion conical, not separated from basal portion by a constriction.

Modified from: MIT 2003, Wagner et. al. 1990. * = not in original MIP

Neraudia angulata

- **Description and biology continued:**
  - **Seeds**- Seed ovoid
  - **Distribution:** *Neraudia angulata* has been recorded throughout the Waianae Mountains from 370-701 m (1,200-2,300 ft) in elevation. It was historically known from both the windward and leeward sides. Its range has constricted and it is no longer known from the windward side of the southern Waianae Mountains. It is still known from Lualualei to Makua on the leeward side and on the northern send of the windward side.

- **Population trends:** It is difficult to gauge long term population trends with *N. angulata* because of the tendency of its populations to fluctuate (Lau pers. comm. 2000). It is clear, however, that the number of sites where this species grows is diminishing.

  OANRP insert: It is uncertain how long *N. angulata* lives, and for the MIP was originally believed to live less than 10 years. OANRP investigated life span using observation data of the wild Makua population over the last 13 years. Plants that were initially observed as immature lived for approximately 4 years (3.73 ± 1.88, range 0.53-7.99 years, n = 22 plants) after first observation. Plants that were initially observed as mature lived for 3 years (3.1 ± 1.44, range 0.75-7.02 years, n = 50 plants). This confirms the original estimate that plants live less than 10 years.

- **Habitat:** *Neraudia angulata* typically grows in dry forests and shrublands, and it occasionally extends into mesic forests and shrublands. Some of the plants occur on gulch slopes. Others are found growing on steep to nearly vertical cliffs, and on cliff ledges. The species can be found in the forest understory, as well as among shrubs and grasses in exposed, sunny locations.

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

Neraudia angulata

- **Taxonomic background:** *Neraudia* is an endemic Hawaiian genus with five species. A single species is endemic to Kauai (*N. kauaiensis*) and another to Hawaii Island (*N. ovata*). *N. sericia* is known from Maui and Molokai. Two species occur on Oahu. *N. angulata* is endemic to Oahu and *N. melastomifolia* which also occurs on Kauai, Oahu, Molokai and Maui. There are two recognized varieties of *N. angulata*: var. *angulata* and var. *dentata*. Variety *dentata* is characterized by leaf undersides with hairs projecting out from the leaf surface. Variety *angulata*, on the other hand, has leaf undersides with hairs lying close to the leaf surface, resulting in a silvery sheen. Another character distinguishing the two varieties is the leaf margin. Variety *angulata* does not have toothed margins. With var. *dentata*, however, examination of a colony large enough to provide an adequate sample will show that some percentage of the plants in the colony have at least some of their leaves exhibiting toothed leaf margins. The taxonomy of *N. angulata* is in need of further study. The two varieties reportedly can be found growing near one another, yet remain distinct entities (Cowan 1949). However, populations have been found that seem not to represent either strict var. *dentata* or strict var. *angulata* (Lau pers. comm. 2000) having both dentate leaf margins and appressed hair.

- **Threats:** Fire poses a threat to many of the *N. angulata* population units. Fires have already destroyed or damaged portions of *N. angulata*'s habitat within the Makua action area, particularly in the Kaluakauila and Punapohaku PUs. Wildfire has also reached habitat and populations in the Waianae Kai Makai PU and have come close to the Manuwai PU. Other threats to *N. angulata* include feral goats and pigs, and alien plants. Also, *N. angulata*'s range extends into lands in the lower elevations of the Waianae Mountains, which were heavily grazed in the 1800's and early 1900's before being reforested. The areas impacted by grazing are now dominated by non-native vegetation.

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

Selected Historic Collections of *N. angulata*

Area	Year	Collector	Pop. Reference Code/Notes
Mt. Kaala	1912	Forbes, C.N.	
Kaena uplands	1915	MacCaughey, V.	
Lualualei (below Kanehoa)	1932	Christophersen, E.	
Waieli Gulch	1933	Storey, W.B.	
Kalena (West)	1933	Fosberg, F.R.	
Kaimuhole	1933	Russ, G.W.	IMU-A?
Above Mokuleia (Firebreak Trail)	1947	Cowan, R.S.	
Ekahanui	1948	Cowan, R.S.	
Makaleha	1950	Hatheway, W.H.	
Nanakuli	1950	Hatheway, W.H.	
Kapuna Gulch	1950	Degener, O.	KAP-A?
East Makaleha Gulch	1951	Fosberg, F.R.	
Puu Pane Trail	1956	Rock, J.F.C.	
Mohiakea Gulch	1977	Warshauer, F.R.	
Kahanahaiki	1986	Lau, Joel	
Waianae Kai	1991	Obata, J.K.	WAI-A?

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

Map removed to protect location of rare species. Available upon request.

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Management Units for Threat Control
Kaluakauila	Reintroduction	MMR	Kaluakauila
Makua	in situ & augmentation	MMR	Ohikilolo (Lower)
Manuwai	Reintroduction	None	Manuwai
Waianae Kai Mauka	in situ & augmentation	None	Waianae Kai Mauka

Genetic Storage Population Units			
Halona	in situ	None	None
Kapuna	in situ	MMR	None
Leeward Puu Kaua	in situ	None	None
Makaha	in situ	None	None
Punapohaku	in situ	MMR	None
Waianae Kai Makai	in situ	None	Waianae Kai Makai

*= outplanting not started yet

Habitat Characteristics for *in situ* Sites in MFS PU

PU	*in situ* PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Kaluakauila	MMR-F	1400′	Flat - Moderate	Intermediate	Mid Slope	Northwest	1046.5
Makua	MMR-A MMR-B MMR-D MMR-E	1220′ – 1640′	Steep – Vertical	Open	Lower – Mid Slope	North	1230.0 – 1338.8
Manuwai	ANU-A ANU-B	1470′	Steep	Intermediate	Moderate – Steep	Northeast	1363.7
Waianae Kai Mauka	WAI-A WAI-F	2100′ - 2380′	Moderate-Vertical	Open – Closed	Mid – Upper Slope	West – Southwest	1786.5

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

Associated species at selected MFS PU

PU	PRC	Canopy	Understory
Kaluakauila	MMR-F	AleMol, CorFru, DioSan, NesSan, NotHum, PasEdu, PasSub, PolSan, PsyOdo, SapOah, SchTer	AgeRip, CarMey, CorFru, DioSan, PasEdu, PolSan, PsyOdo, NepMul,
Makua	MMR-A MMR-B MMR-D MMR-E	AleMol, AntPul, DodVis, HibArnArn, LeuLeu, NotHum, PipAlb, PleFor, PsyOdo, SchTer, SyzCum, TooCil	Ageade, Agecon, Agerip, AlySte, ArtAus, BidTor, BleApp, CarMey, Dodvis, GreRob, KalPin, LanCam, Leuleu, Melmin, MicStr, PlePar, PluCar, PsyOdo, SalCoc, SidFal, UroMax
Manuwai	ANU-A ANU-B	AbuSan, AleMacMac, AleMol, DioHil, DioSan, LeuLeu, MelAze, NesSan, PisBru, PolSan, PsiCat, PsyOdo, SapOah, SchTer, SyzCum, TooCil	AdiHis, AdiRad, AgeRip, ArtAus, BleApp, CarWah, CliHir, DodVis, HypPec, LeuLeu, PsiSpp, RivHum, SetPar, UroMax
Waianae Kai Mauka	WAI-A	AleMol, ChaTom, ChrOli, DioHil, DioSan, DodVis, GreRob, HibArnArn, PimDio, PipAlb, PsiGua, PsyOdo, RauSan, SchTer, StrPen	AgeRip, AlySte, BidTor, BudAsi, CanGal, CarMey, ChaTom, EraGra, IpoCai, KadAcu, KadCor, KalPin, LanCam, OplHir, PasSub, RivHum, RumAlb

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

Makua MFS PU

Population Structure

- Observation data is scant and infrequent monitoring prevents analyses of a trend or population structure at most sites. Seedlings and juvenile plants are observed in the larger (>30 matures) wild populations and newly mature plants are found regularly at the sites in the Makua and Waianae Kai Mauka PUs.

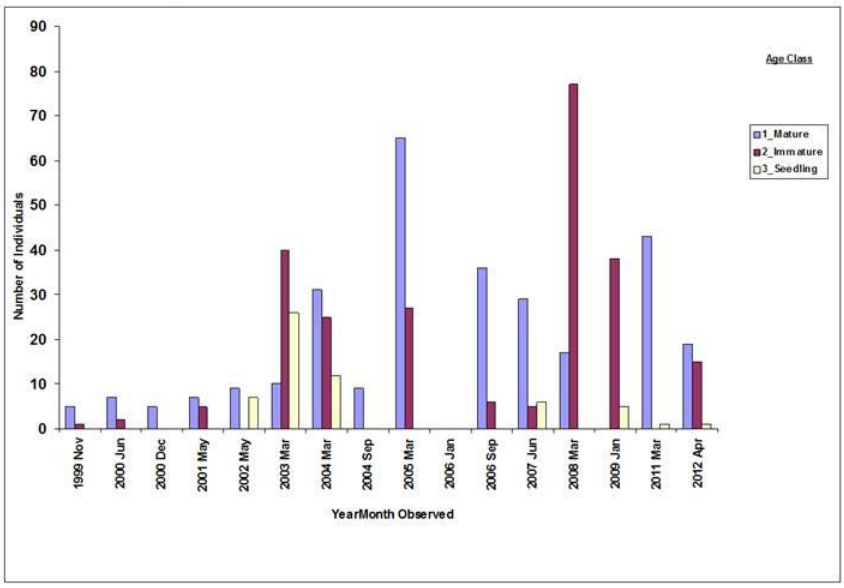
- Observation data from the MMR-A wild site (next page), show that the population persists despite fluctuating widely (between less than 10 and more than 60 mature plants) over the last decade. No outplanting has occurred at this site. New plants were tagged during collection trips and observed to live for another 1-7 years. Newly found immature plants live for an average of 3.73 years and plants found when mature have been observed to live for 3.1 years. Based on this data, we estimate the life span of *N. angulata* to be 4-5 years. Ungulate and weed threats have been controlled at this site, potentially contributing to increases in population size. However, since this wild site is not expected to have the habitat capacity alone to support the stabilization target of 100 mature plants, other outplanting sites have been established at MMR-E and MMR-I.

- Observation data from the outplantings of this taxon at the Makua PU (MMR-E) show that new seedlings germinate from the fruit produced by the outplants. These seedlings survive to become immature plants. The number of new plants that survive to maturity in the MMR-E outplanting site, however, was not enough to replace the outplants as they died and hence the population declined. The habitat at the MMR-E site may not have been optimal, therefore a new outplanting site (MMR-I) was selected (as discussed in the reintroduction plan below). Given the short life span, large numbers of plants may be necessary to initiate a new populations that will remain stable.

Population Estimate History

Population Monitoring History										
	1999	2000	2003	2005	2006	2007	2008	2009	2011	2012
	(number of matures/immatures/seedlings)									
Makua (MMR-A)	5/1/6	7/2/0	10/40/26	65/27/0	35/6/0	29/5/6	17/77/0	10/38/5	43/0/1	19/15/1

Population Trend for: NerAng.MMR-A



Observation data from the MMR-A site in the Makua PU show the status since 1999. While seedlings are seldom observed at the site, new plants are observed regularly and survive to maturity. Access at this site is difficult and early observations from 1999-2000 may be low because rappelling protocols were not yet developed. Also, an ungulate fence was installed at this site in 2005 allowing juvenile plants to establish and mature in the areas beneath the cliff. This site is the most frequently monitored and provides the best example of how populations can fluctuate but persist.

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 plants and all new 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. Sites in Genetic Storage PUs will be monitored less frequently. The same data will be collected when those are visited as well.

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

Reproductive Biology Table

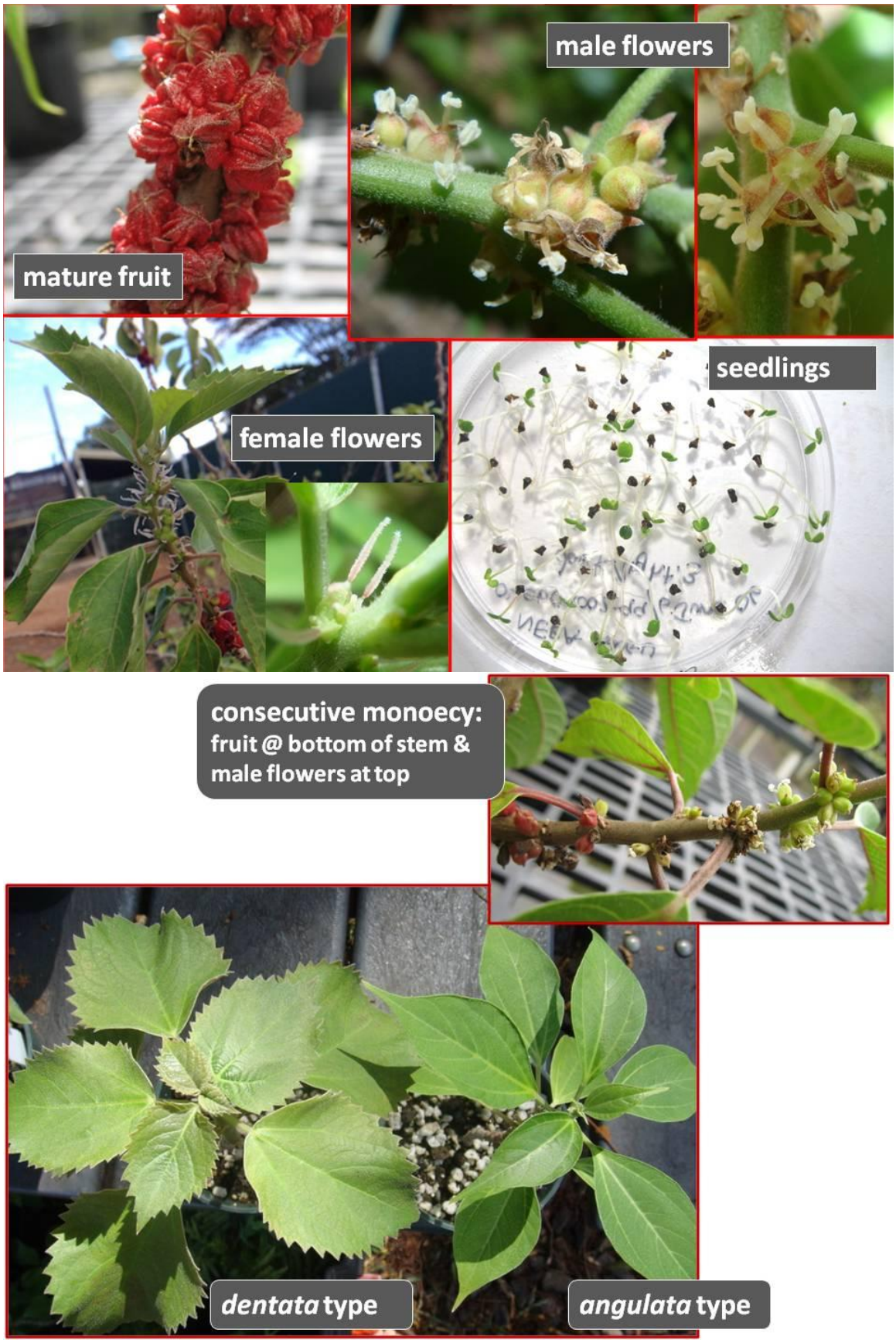
	Observed Phenology[1]			Reproductive Biology		Seeds	
Population Unit	**Flower**	**Immature Fruit**	**Mature Fruit**	**Breeding System**	**Suspected Pollinator**	**Average # Per Fruit**	**Dormancy**
Kaluakauila	Jan-May	Jan-July	Feb-July	Dioecious[2]	wind[3]	1	PD (MPD?)[4]
Makua	Jan-Sept	Jan-Nov	Apr-Sept	Dioecious[2]	wind[3]	1	PD (MPD?)[4]

1 It is likely that plants flower and fruit year round, and the time of year we make our observations is likely influencing our interpretation of phenology. There are not enough observations of plants at other PUs to present periods of time for flowering and fruiting.

2 Plants in all PUs display unisexual (imperfect) flowers. The majority of PUs appear to have plants that are mostly dioecious. Some plants in PUs that display the variety *angulata* have presented unisexual flowers as consecutively monoecious. In other words, we have observed plants that display female flowers during one flowering period, followed by male flowers in the next flowering period. We have never observed simultaneous monoecy (a display of male and female flowers at the same time on the same plant).

3 Anthers can be observed dehiscing in nursery stock. Dehiscence, triggered by desiccation, will cause clouds of pollen to drift in air from anther, confirming wind pollination.

4 Seeds display some type of physiological dormancy. It is unclear whether or not this dormancy is compounded morphologically, i.e. the embryo continues to develop after the fruit are mature. Fresh seeds take 290 (± 150) days to complete germination. Maximum germination is achieved by holding imbibed (saturated) seeds at ambient temperatures in the absence of light for 6-12 months, then exposing them to light.

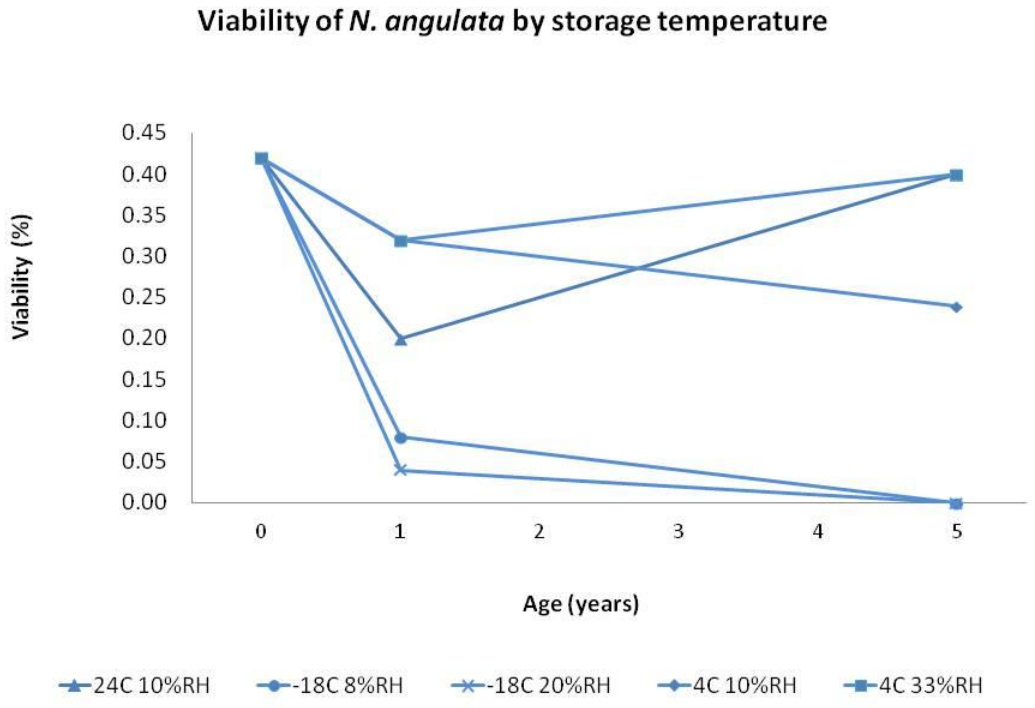

mature fruit
male flowers
female flowers
seedlings
consecutive monoecy:
fruit @ bottom of stem &
male flowers at top
dentata type
angulata type

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.
clones (plants)	in situ populations	nursery living collections	5-10	Yes	Clones in living collection, seeds from reintroductions

- Due to the uncertainty of seed storage (and initially poor germination), the confusion at first over different varieties, and the fast decline of the species, clones via cuttings were collected and plants have been maintained clonally as a living collection for genetic storage and to provide propagules for outplanting. As new founders become established at the wild sites, clones are collected and maintained in the nursery living collection. This process has a benefit of accumulating founders in the nursery living collection that can then be used to establish genetically diverse outplantings.
- Once outplants are established, they will be the source for making seed collections. Once seed collections are known to be secured in storage, the living collections will be outplanted or used to establish inter-situ sites, such as in botanical gardens. If successful, these inter-situ sites can continue to provide stock for outplanting, seeds for storage, and may have the benefit of being more efficient to manage over a longer period than the nursery living collections.
- Collections from PUs with no outplanting planned (GSC PUs) will be maintained in nursery living collections for a maximum of three years until they can be established in inter-situ sites such as botanical gardens, other nurseries or with partner agencies. The stock from these PUs may be needed to supplement outplantings in order to address the limited number of founders at some PUs (Waianae Kai Mauka) or experiment with mixing stock to improve fitness of the outplants. Once established in the living collection or inter-situ sites, seeds will be collected and stored.
- Complicated by dormancy, it has been difficult to assess the storage potential of seeds of this species. Initial viability assays with low germination were originally thought to be an effect of dormancy, but continued low viability of frozen seeds after five years of storage indicate a break in dormancy has not yet occurred, and rather a negative trend in viability suggests that these seeds may be short-lived or sensitive to freezing.
- There is no decline in viability of refrigerated seeds after 5 years (Graph 1). Ten year tests will be conducted in Dec 2013 and 2014. At that time OANRP should be able to determine whether seeds stored at -18C are dormant or dead (sensitive to freezing) and whether refrigerated seeds remain viable (not short-lived) and the re-collection interval for this taxon could be set for at least every ten years. Research collaborators at the USDA-ARS seed bank will be able to project stored seed longevity with this ten-year data set as well.

Graph 1



Reintroduction Plan

Manage for Stability Population Units	Reintroduction Site(s)	Number of Plants	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population	Plant Size	Pot Size
Kaluakauila	MMR-F +	250	Cuttings of mature plants	MMR-G KAP-A	3	30-100 cm	1 gallon tall
	MMR-J *	150	Cuttings of mature plants	MMR-G KAP-A	6	30-100 cm	1 gallon tall
Makua	MMR-E + MMR-I ^	103 100	Cuttings of mature plants	MMR-A MMR-B	~25	30-100 cm	1 gallon tall
Manuwai	ANU-B ^	100	Cuttings of mature plants	ANU-A	4	30-100 cm	1 gallon tall
Waianae Kai Mauka	WAI-F ^	150	Cuttings of mature plants	WAI-A	~10	30-100 cm	1 gallon tall

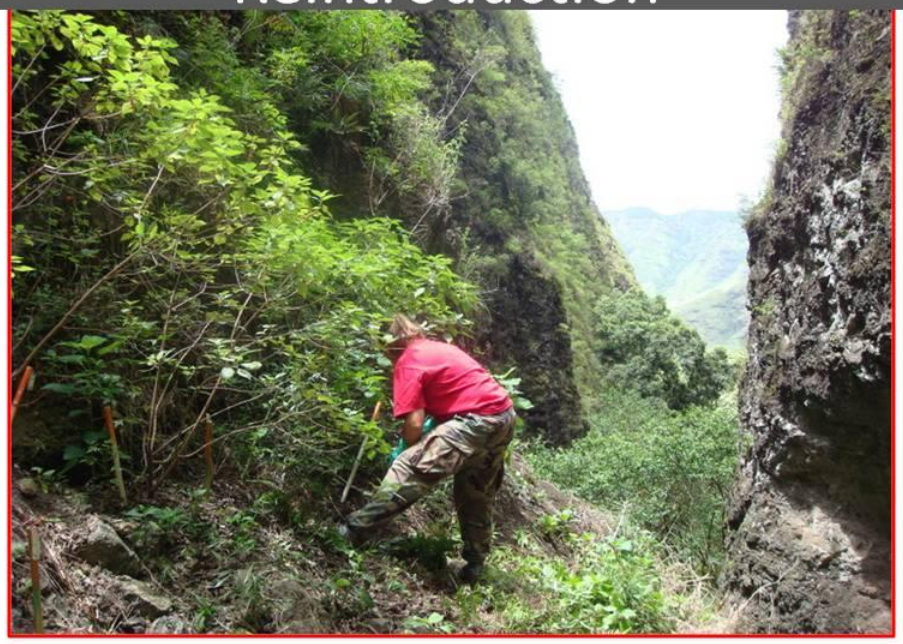
*reintroduction not started yet +reintroduction complete ^reintroduction ongoing

The first attempt at outplanting into the Kaluakauila PU (MMR-F) was started in 2003 and last supplemented in February 2012. A total of 247 plants were planted here over this period and 65 are remaining alive as of May 2013. Plants were grown first from cuttings of the KAP-A-1 (female) plant and outplanted in 2003. Another founder (KAP-A-3) was added in 2008, but that plant is also female. The MMR-G plant, which is male, was also added to the site in 2008 after being discovered nearby in 2005. From 2003 to 2008, no male plants were outplanted at the site. Seedlings were first observed at MMR-F in 2013, five years after the MMR-G plant was added. More outplanting is currently needed at this PU to meet stability goal of 100 mature plants. *Due to the decline of outplants at MMR-F, a new site (MMR-J) may be established in Kaluakauila using the KAP-A and MMR-G stock. This will be the second attempt at outplanting for this PU and would replace the MMR-F site if it declines. The Kaluakauila PU will be supplemented with an additional 150 plants at either MMR-F or MMR-J and then monitored to determine success for at least three years.

The Makua MMR-E site was started in 2003 and was last supplemented in February 2010. A total of 103 plants (no dioecy observed in this stock) were outplanted into the site over this period. Only one outplant and one juvenile F1 plant remain at MMR-E as of July 2013. The outplants were grown from cuttings of mature plants from MMR-A and MMR-B. Due to poor survivorship of outplants at MMR-E, no more planting was conducted. Instead, the MMR-I site was started in 2013 with 90 outplants grown from cuttings of the same stock as MMR-E. The MMR-I site will be supplemented again in the coming year and then monitored to determine success for at least three years. If seedlings and juvenile plants survive at this site, it will be supplemented with additional plants only as needed to ensure that stability goals are maintained.

The outplantings at the Manuwai and Waianae Kai PUs were started in March 2013. These sites will also be supplemented in the coming year and then monitored to determine success for at least three years. If seedlings and juvenile plants survive at this site, it will be supplemented with additional plants only as needed to ensure that stability goals are maintained.

Outplants at the Makua Reintroduction



Recruitment at Kaluakauila Reintroduction

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?
Kaluakauila	No	No	Yes	Yes	No	Yes	No	No	No
Makua	Yes	No	Yes	Yes	No	Yes	No	No	No
Manuwai	No	No	Yes	Yes	No	Partial	No	No	No
Waianae Kai Mauka	No	No	Yes	Yes	No	No	No	No	No

5 Year Action Plan

	Proposed Actions for the following years:				
Manage for Stability Population Units	**MIP YEAR 10 October 2013 – September 2014**	**MIP YEAR 11 October 2014 – September 2015**	**MIP YEAR 12 October 2015 – September 2016**	**MIP YEAR 13 October 1 2016- September 2017**	**MIP YEAR 14 October 1 2017- September 2018**
Kaluakauila	•Monitor annually	•Monitor annually •Begin reintroduction	•Monitor annually •Complete reintroduction	•Monitor annually •Collect mature fruit	•Monitor annually •Collect mature fruit
Makua	•Monitor annually •Complete reintroduction	•Monitor annually •Collect mature fruit	•Monitor annually •Collect mature fruit	•Monitor annually •Determine if more outplanting is needed	•Monitor annually •Begin outplanting if needed
Manuwai	•Monitor annually •Complete reintroduction	•Monitor •Collect mature fruit	•Monitor •Collect mature fruit	•Monitor •Determine if more outplanting is needed	•Monitor annually •Begin outplanting if needed
Waianae Kai Mauka	•Monitor •Complete reintroduction	•Monitor •Collect mature fruit	•Monitor/Collect •Collect mature fruit	•Monitor/Collect •Determine if more outplanting is needed	•Monitor annually •Begin outplanting if needed

5 Year Action Plan

	Proposed Actions for the following years:				
Genetic Storage Population Units	**MIP YEAR 10 October 2013 – September 2014**	**MIP YEAR 11 October 2014 – September 2015**	**MIP YEAR 12 October 2015 – September 2016**	**MIP YEAR 13 October 1 2016- September 2017**	**MIP YEAR 14 October 1 2017- September 2018**
Halona	•To be Determined				
Kapuna	•Survey (no plants currently known)				
Leeward Puu Kaua	•To be Determined				
Makaha	•Survey (no plants currently known)				
Punapohaku	•Monitor/Collect		•Monitor/Collect		•Monitor/Collect
Waianae Kai Makai	•Survey (no plants currently known)				

Genetic Storage Population Units that are not located within the Makua Military Reservation or Schofield Barracks Action Area and not used for outplanting at MFS PUs will not be monitored or managed, and no genetic storage collections will be made. These are Halona, Leeward Puu Kaua, Makaha and Waianae Kai Makai PUs) Genetic Storage PUs within Action Areas will be monitored more frequently and surveys will be conducted only as time allows at sites where no plants are currently known.

Management Discussion for *N. angulata*

The overall strategy for this taxon will be to focus on maintaining the MFS PUs at Kaluakauila, Makua, Waianae Kai Mauka and Manuwai. These PUs will be monitored for threats and to document population structure biennially. Clones (cuttings) will be collected from wild sites to establish a nursery living collection for genetic storage and as stock plants to produce outplants. The genetic storage goals will be met using the nursery living collection until collections are established at botanic gardens (or other *inter-situ* sites) until adequate amounts of mature seeds can be collected and stored. Currently, seeds can be stored for 5 years without any detected reduction in viability. Once adequate seed collections are secured in storage, the living collections can be reduced or eliminated. While this has not emerged as a priority in recent years, a concerted effort could be made if given sufficient resources. Collection trips will be prioritized in the next few years to secure collections from Army Action Area fire-threatened PUs and other small outside Action Area PUs if additional founders are needed to supplement MFS PUs. Collections from MFS sites will need to be maintained in the nursery until those sites are stabilized and have sufficient population structure. This will ensure that stock is available for additional outplanting if the sites continue to decline. This way, reintroductions can be conducted with a larger number of founders kept in the living collection. Additional monitoring is scheduled for sites within the Action Area to track population trends and for the outplanting sites to monitor for causes of decline and new seedlings and immature plants. Weed control will continue within the Kaluakauila, Manuwai, Ohikilolo and Waianae Kai Mauka MUs as described in the Ecosystem Management Unit plans to achieve and maintain all stability goals.

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Nototrichium humile

- **Distribution:** Endemic to the Hawaiian Islands, endemic to O`ahu, Maui. *Nototrichium humile* occurs in the Waianae Mountains of Oahu, where it is found throughout the mountain range, on both the windward and leeward sides. The only record of the species beyond the Waianae Mountains is a specimen collected in the 1970s on the south slope of Haleakala, Maui. This site has not been relocated since. Recorded elevations for this species range from 60-700 m (200-2,300 ft). It was first collected on Oahu at Kaena Point by William Hillebrand and then not again until Otto Degener collected it on the south side of upper Makua Valley in 1931 (Degener, 1932).

- **Population trends:** The population units of *N. humile* have not been monitored enough historically or recently to determine population trends. However, there have been no reports of obvious declines in numbers since OANRP monitoring began in 1997. The species often occurs on cliffs, and the individuals growing on the cliffs are protected to various degrees from cattle, feral ungulates, invasive alien weeds, and fire.

- **Habitat:** *Nototrichium humile* can be found growing on gulch slopes or in gulch bottoms in the understory of dry forests dominated by trees such as *lama* (*Diospyros sandwicensis*) and/or *lonomea* (*Sapindus oahuensis)*, or in dry shrublands closer to the ridge tops. The species can also be found on open dry cliffs and cliff ledges sparsely vegetated with shrubs and grasses. Small groups of plants or isolated plants can sometimes be found as outliers in mesic habitats. The species is usually found on north facing slopes.

Modified from: MIT 2003, Wagner et. al. 1999

Nototrichium humile

Taxonomic background: According to Wagner et. al. (1999), three species are described in the endemic Hawaiian genus *Nototrichium*. The two besides *N. humile* are *N. sandwicensis*, which occurs on all of the main Hawaiian Islands, and the newly described *N. divaricatum* of northwestern Kauai. Other entities have been recognized from Oahu in the past. Recently, collections from the Keawapilau Gulch PU and individuals in cultivation at local botanic gardens have been recognized as being similar to plants described in Flora Hawaiiensis (Degener) as *N. viride* var. *subtruncatum* (see photos below). These plants should be studied to determine if they represent another taxon. Plants from Waianae side of Kolekole Pass with short (15-30mm) and narrow (<15mm) leaf blades were described by Sherff and Degener in 1950 as *N. humile* var. *parvifolium* (image at left from Degener 1932). Collections from the Mt. Kaala trail in Schofield Barracks in 1927 and subsequent collections from Mokuleia were described as *N. humile* var. *subrhomboideum*. These plants were distinguished as being more narrow and having a subrhomboidnally, oblong-lanceolate base.

Threats: *Nototrichium humile* is one of the more fire-threatened Makua target taxa because of its occurrence in the lower, drier reaches of the Waianae Mountains. Other major threats to *N. humile* include feral goats and pigs, and alien plants.

Modified from: MIT 2003, Wagner et. al. 1999, Degener 1932

Selected Historic Collections of *N. humile*

Area	Year	Collector	Pop. Reference Code/Notes
Kaena Point	1851-1871*	Hillebrand, W.	Holotype
Mt. Ka`ala Trail from Schofield Barracks	14-Aug-1927	*MacDaniels*	(var. *subrhomboideum)*
Waianae Valley (near Kolekole Pass)	26-Apr-1931	Degener, O.	(var. *parvifolium*) From SM website
Makua Valley	25-Nov-1932	Fosberg, F.R.	
Near Pahole Gulch, Mokuleia	14-May-1950	Degener, O.	
Kamokunui Gulch	17-Jul-1955	St.John, H.	
Kaluakauila Gulch	24-Oct-1976	Obata, J.K.	MMR-A
Koiahi Gulch (MMR)	07-Nov-1976	Obata, J.K.	MMR-E
Kaluakauila Gulch	16-Jun-1985	Lau, J.	MMR-A
Keaau Valley	09-Jul-1985	Obata, J.K.	KEA-A
Keeau Valley	09-Apr-1987	Obata, J.K.	KEA-B
Keawaula Valley	28-Apr-1987	Perlman, S.	KAE-A
Nanakuli Valley, south side	10-Jul-1987	Perlman, S.	NAN-A?
Kaluakauila Gulch	15-Oct-1989	Welton, P.	
Waianae Kai near Puu Kawiwi	15-Dec-1991	Obata, J.K.	WAI-A
Waianae Kai	03-May-1992	Obata, J.K.	WAI-B

* No date given. These are the years William Hillebrand was collecting on Oahu (Wagner, 1990)

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

Map removed to protect location of rare species. Available upon request.

Morphological Variation in *Nototrichium humile*

(Above) *Nototrichium "subtruncatum"* (Kaena and/or Kuaokala type) has been in collections of botanical gardens on Maui since before 1982, and on Oahu since the mid 1980's. This plant is at Waimea Botanical Garden. (pers. comm. J. Lau 2013)

(**Photo above**) *Nototrichium "subtruncatum"* (**Mokuleia type from Keawapilau PU**). **Photo of the wild plants at the with** branches and leaves more delicate than those of the Kaena and/or Kuaokala plants (pers. comm. J. Lau 2013)

(Photo at Left; top inflorescence)

(top) *Nototrichium "subtruncatum"* (Mokuleia type from the Keawapilau PU). Cultivated clone 1: Showing spikes without long hairs (unlike *N. sandwicense*); flowers lanceoloid (unlike *N. humile*). (pers. comm. J. Lau 2013)

(bottom inflorescence) *N. humile* (pers. comm. J. Lau 2013)

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU in?	Management Units for Threat Control
Kaluakauila	in situ	MMR	Kaluakauila
Makua (South Side)	in situ	MMR	Ohikikilolo
Manuwai	Reintroduction*	None	Manuwai
Waianae Kai	in situ	None	Waianae Kai Makai
Genetic Storage Population Units			
Kahanahaiki	in situ	MMR	Kahanahaiki I & II
Kaimuhole and Palikea Gulch	in situ	None	None
Keaau	in situ	MMR	None
Keawapilau	in situ	None	None
Keawaula	in situ	MMR	None
Kolekole	in situ	None	Mikilua PU fence (Navy)
Makaha	in situ	MMR	Kamaili
Makua (East Rim)	in situ	MMR	None
Nanakuli	in situ	None	None
Punapohaku	in situ	MMR	None
Puu Kaua (Leeward side)	in situ	None	None
No Management			
Kealia	in situ	None	n/a
Pahole Gulch	in situ	None	Pahole

*= outplanting not started yet

Habitat Characteristics at Manage for Stability Population Units

PU	*in situ* Population Reference Code	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Average Annual Rainfall (mm)
Kaluakauila	MMR-A,J,L,M,N	1200-1400′	Moderate - Steep	Intermediate - Closed	Gulch Bottom – Mid Slope	North-Northwest	987.7 – 1046.5
Makua (South Side)	MMR-D,E,I	1700′	Steep-Vertical	Open-Intermediate	Lower Slope	North & East	1230.0 – 1338.8
Manuwai	To be determined when reintroduction site is selected in 2013-2014						
Waianae Kai	WAI-A-D	1950′	Moderate & Vertical	Open – Intermediate	Gulch Bottom – Upper Slope	Varies	1478.0 – 1618-7

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

Associated Species at Manage for Stability Population Units

PU	PRC	Canopy	Understory
Kaluakauila	MMR-A,J,L,M,N	AleMol, DioSan, ErySan, EupHae, GreRob, LeuLeu, PleFor, PolSan, PsiCat, PsiGua, PsyOdo, RauSan, SapOah, SchTer	AdiRad, AgeRip, ArtAus, CarMey, DioSan, EugRei, HypPec, IpoCai, LanCam, LeuLeu, MicStr, NesSan, PasSub, PluCar, RivHum, SidFal, SolAme, UroMax
Makua (South Side)	MMR-D,E,I	unknown	AdiRad, AgeRip, AlySte, BleApp, CarMey, KalPin
Manuwai	To be determined when reintroduction site is selected in 2013-2014		
Waianae Kai	WAI-A-D	AbuGra, AcaCon, AleMol, CasEqu, CorFru, ElaBif, GreRob, HibArnArn, LeuLeu, MelAze, PipAlb, PisSan, PlaSan, PsiCat, PsiGua, PsyOdo, RauSan, SapOah, SchTer, SpaCam, SyzCum, TooCil	Ageade, AgeRip, AlySte, BleApp, CanGal, CorFru, Dodvis, HypPec, Kalpin, Lancam, LeuLeu, Melmin, NeoWig, MicStr, OplHir, PasEdu, PasSub, PimDio, PluZey, RivHum, SalCoc, SapOah, SchMan, SchTer, UroMax

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

Population Structure

- Data is scant as populations are relatively large and infrequent monitoring prevents much analyses of the population structure at most sites. More intensive monitoring is needed to determine the existing structure and what may be needed to support stability targets. Since populations have been observed to be relatively stable when compared with other MIP taxa, intensive monitoring has not been a priority.

- There have only been two observations of seedlings out of 38 surveyed wild sites. One was from the Punapohaku gulch site in 2003 that had over 150 mature plants and then consequently burned and currently only has 11 plants. The only other site, observed in 2013, is Punapohaku east branch, which is by far the largest surveyed population. It was estimated to have 300 mature, 100 immature, and 100 seedlings. This was only an estimate and should be confirmed by further monitoring at the site. Considering the low seed set in this species, this data could suggest that large numbers of trees may be necessary for, or indicative of healthy, stable populations.

Population Estimate History at Selected Sites

Population Monitoring History									
	1999	2004	2005	2006	2009	2010	2011	2012	2013
Manage For Stability Population Units (number of matures/immatures/seedlings)									
Makua (MMR-E)	50/0/0							37/2/0	
Waianae Kai (WAI-A)		200/0/0		200/0/0	175/100/0	180/48/0			
Genetic Storage Population Units (number of matures/immatures/seedlings)									
Kahanahaiki (MMR-C)		7/2/0	9/0/0	6/6/0		8/3/0			
Palikea Gulch (ALI-C)			50/4/0					29/3/0	26/1/0
Palikea Gulch (ALI-A)	7/3/0				2/1/0			2/0/0	
Keawapilau			5/0/0		3/0/0		2/0/0		1/0/0
Keawaula		138/5/0				35/6/0			
Punapohaku (MMR-K)		150/0/0					150/50/0		300/100/100

Monitoring has been infrequent at most sites but a decline was documented in smaller populations. The large decline at the Palikea Gulch ALI-C site is due to browsing by goats. Most large sites have been relatively stable. The decline at the Keawaula site was due to a fire that killed many individuals. The larger MFS PUs were monitored less frequently because they have been protected from threats and are well above stability targets. This includes the Kaluakauila PU, which has never been completely monitored and not at all since 2005. The Waianae Kai PU is difficult to monitor given the terrain and large number of plants. Instead, the original estimate of 200 was retained for several years until updates were made in 2009 and 2010. Because these PUs have many more plants than the required minimum of 25, staff time has been dedicated to threat control at this sites. Much more time would need to be spent monitoring these sites to get an accurate census of the population or determine if it is stable.

Monitoring Plan

- As discussed in the Population Estimate History section, only estimates have been made for the number of plants at the larger PUs. Most sites have not been thoroughly monitored. As time allows, sites in MFS PUs will be monitored using the Hawaii Rare Plant Restoration Group (HRPRG) Rare Plant Monitoring Form (RPMF) to record population structure and the age class, reproductive status and vigor of all known plants. The sites will be searched for new plants and all new plants being collected from will be tagged. If there is any threat to the health and safety of plants due to repeated monitoring and/or tagging, reductions in the number of tagged individuals will be made so that no harm is done to the plants. This monitoring data will serve to document the populations at the remaining sites to guide *in situ* threat management and genetic storage needs. As much as possible, more thorough monitoring will be conducted at the primary MFS sites in the coming five years. The priority for monitoring will be the PUs within the Makua Action Area (Kaluakauila and Makua (South side).

- At sites that are designated as Genetic Storage, monitoring will be less frequent but more thorough at the smaller PUs. At sites with less than fifty mature plants, all individuals will be accounted for using the RPMF. For sites where there are a large number of plants, a monitoring plan should be developed to track a subset of plants to determine if that can be used to indicate population trends.

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

Reproductive Biology Table

	Observed Phenology	Reproductive Biology		Seeds	
Population Unit	Reproductive	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
Kaluakauila	year-round	Hermaphroditic?	biotic or abiotic?	0-1	No
Makua (South Side)	year-round	Hermaphroditic?	biotic or abiotic?	0-1	No
Manuwai	year-round	Hermaphroditic?	biotic or abiotic?	0-1	No
Waianae Kai	year round	Hermaphroditic?	biotic or abiotic?	0-1	No

- No seasonal patterns in phenology have been observed by OANRP. Inflorescences often have buds, flowers, immature and mature fruit at the same time.
- Little is known regarding the reproductive biology of *N. humile* despite extensive observations of inflorescences by OANRP staff. Typically, buds are observed near the apex(tip) of the inflorescence, followed by flowers and fruit lower on the stalk. Large collections, however, of the bottom halves of inflorescences, in both large and small populations, have produced very few seeds, and determining whether or not a seed is present can be destructive. OANRP has not observed floral visitors or anther dehiscence of *N. humile*. Wagner et. al. (1999) states that flowers are perfect.
- Anecdotally, seeds have been collected by botanists on Oahu and stored refrigerated and germinated several years later. Seeds are likely orthodox or at least withstand desiccation. There can be one seed per fruit (Wagner et.al. 1999, one ovule), but observed seed set is so low that over 99% of the fruit do not contain a seed.

Nototrichium humile

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.
clones (plants)	*in situ* populations	nursery living collections	unknown	not initiated	clones as living collections

Genetic Storage Plan Comments:

- The potential for seed storage for this taxon is unknown. Due to the uncertainty of the potential for seed storage, the high fire-threat and small size (less than 10 plants) of many PU, clones via cuttings were collected and plants have been maintained clonally as a living collection for genetic storage and to provide propagules for some outplanting. Collections of the Kaimuhole and Palikea Gulch PU and the Kahanahaiki PU have been established at Waimea Botanical Garden as a *inter situ* site. These collections serve as the genetic storage collections for these PU and will be a source of cuttings for the outplanting at the Manuwai PU. Seed collections have been made from the planting of the Kahanahaiki PU stock, but had very low seed set. More collections are needed to determine if these collections can serve as a source for seeds to collect for storage. As space allows, new *inter situ* sites will be established at Waimea Botanical Garden and other sites. These sites can be used to continue to provide stock for outplanting, seeds for storage and may have the benefit of being more efficient to manage over a longer period than the nursery living collections.

- Genetic storage goals will be met by maintaining clones from wild populations in nurseries or in *inter situ* sites at botanical gardens. A large bulk collection of mature viable seed is needed for storage condition testing before genetic storage collections can be made, but this has so far been unavailable. Further research into seed set could be conducted by sowing large amounts of fruit to estimate seed set for each PU, and then collecting enough fruit for genetic storage collections to reach the seed storage goals per plant (50). But this should only be conducted with more certainty of proper seed storage conditions. Once seed collections are known to be secured in storage, the living collections will be outplanted or used to establish inter-situ sites in botanical gardens.

- Collections from PUs with no outplanting planned (GSC PUs) will be maintained in nursery living collections for a maximum of three years until they can be established in inter-situ sites such as botanical gardens, other nurseries or with partner agencies. The stock from these PUs may be needed to supplement outplantings (Manuwai PU). Once the founders are established in the outplanting or inter situ sites, seeds will be collected and stored.

Propagation of *Nototrichium humile*

Small plants 2 months after cuttings were taken, rooted and transplanted

Plants ready for outplanting about 4 months after cutting

Nursery Living Collection

Optimal material for rooting cuttings= Thin, green healthy pieces 4-6" long

Root nodules on nursery plants grown from cuttings

Reintroduction Plan

Manage for Stability Population Units	Reintroduction Site(s)	Number of Plants	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population	Plant Size	Pot Size
Manuwai	ANU-A*	150	Outplants grown from cuttings of mature wild plants	ALI-A ALI-C IMU-A	43	30-100 cm	.5 gallon 'shorty'

*= reintroduction not started yet

Outplantings will be conducted using nursery plants grown from wild collected clones from the Palikea Gulch and Kaimuhole Gulch plants. Outplantings will be conducted in the winter (January-March) in sites selected by staff from OANRP 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. The outplanting will be done over two seasons to test planting sites and replace dead plants.

Nototrichium humile at Waimea Botanical Garden

Stabilization Goals Update for MFS PUs

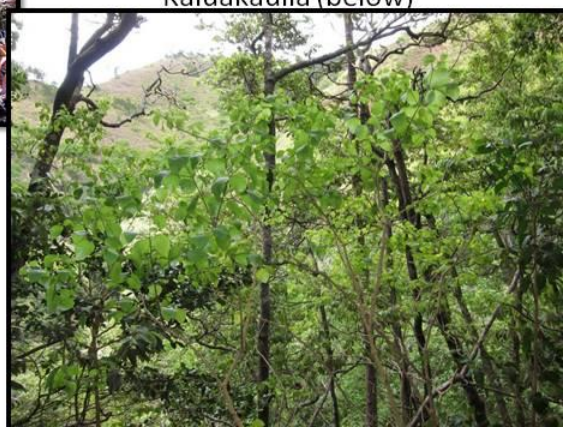
PU	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does population structure support long-term population stability?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are Genetic Storage goals met?
Kaluakauila	Yes	No	Yes	Partial	No	No	No	No	No
Makua (South Side)	Yes	No	Partial*	Yes	No	No	No	No	No
Manuwai	No	No	Yes	Yes	No	No	No	No	n/a
Waianae Kai	Yes	Yes	Partial	Yes	No	Partial	No	No	No

*(Goats controlled in the Makua PU and pigs are excluded from a few sites by small fences)

Threats to *Nototrichium humile*

Fire damage at Punapohaku (above)

Close proximity to fire prone areas at Kaluakauila (below)



5 Year Action Plan for Manage for Stability PUs

Proposed Actions for the following years:					
Manage for Stability Population Units	**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 2016- September 2017**	**OIP YEAR 11 October 2017 – September 2018**
Kaluakauila	•Monitor •Collect mature fruit for genetic storage		•Monitor •Collect mature fruit for genetic storage		•Monitor •Collect mature fruit for genetic storage
Makua (South Side)		•Monitor •Collect mature fruit for genetic storage		•Monitor •Collect mature fruit for genetic storage	
Manuwai	•Begin reintroduction •Monitor	•Monitor •Complete reintroduction	•Monitor •Collect mature fruit for genetic storage	•Monitor	•Monitor •Collect mature fruit for genetic storage
Waianae Kai		•Monitor •Collect mature fruit for genetic storage		•Monitor •Collect mature fruit for genetic storage	

5 Year Action Plan for Genetic Storage PUs

Proposed Actions for the following years:					
Genetic Storage Population Units	**MIP YEAR 10 October 2013 – September 2014**	**MIP YEAR 11 October 2014 – September 2015**	**MIP YEAR 12 October 2015 – September 2016**	**MIP YEAR 13 October 1 2016- September 2017**	**MIP YEAR 14 October 1 2017- September 2018**
Kahanahaiki	•Monitor		•Monitor		•Monitor
Kaimuhole and Palikea Gulch		•Monitor		•Monitor	
Keaau		•Monitor/Collect			
Keawapilau	•To be Determined				
Keawaula			•Monitor/Collect		
Kolekole	•To be Determined				
Makaha		•Monitor		•Monitor	
Makua (East Rim)	•Survey (no plants currently known)				
Nanakuli	•To be Determined				
Punapohaku			•Monitor		•Monitor/Collect
Puu Kaua (Leeward side)	•To be Determined				
Kealia	•Survey (no plants currently known)				
Pahole Gulch	•Survey (no plants currently known)				

Genetic Storage Population Units that are not located within the Makua Military Reservation or Schofield Barracks Action Area and not used for outplanting at MFS PUs will not be monitored or managed, and no genetic storage collections will be made. These PUs are Keawapilau, Kolekole, Nanakuli and Kealia. Genetic Storage PUs within Action Areas will be monitored more frequently and surveys will be conducted only as time allows at sites where no plants are currently known.

Management Discussion for *Nototrichium humile*

The overall strategy for this taxon will be to focus on maintaining the MFS PUs at Kaluakauila, Makua and Waianae Kai Makai with threat control and to outplant clones of the Kaimuhole to Palikea Gulch PU stock to establish the Maunuwai PU. These PUs will be monitored for threats and to document population structure biennially. Clones (cuttings) have and will be collected from wild sites to establish a nursery living collection for genetic storage and as stock plants to produce outplants for the Manuwai PU. The genetic storage goals will be met using the nursery living collection until collections are established at botanic gardens (or other *inter situ* sites), or when mature seeds can be collected and stored. Efforts to develop a non-destructive methodology for assessing seed set prior to future collections will continue. Collection trips will be prioritized in the next few years to secure collections from Army Action Area fire-threatened PUs. Once seed collections are secured in storage, the living collections can be reduced or eliminated. While this has not emerged as a priority in recent years, a concerted effort could be made if given sufficient resources. Additional monitoring is scheduled for sites within the Action Area and for the outplanting site in the Manuwai PU. Weed control will continue within the Kaluakauila, Manuwai, Ohikilolo and Waianae Kai Makai MUs as described in the Ecosystem Management Unit plans achieve and maintain all stability goals.

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Nototrichium humile

- **Scientific name:** *Nototrichium humile* Hillebr.
- **Hawaiian name:** Kului
- **Family:** Amaranthaceae (Amaranth family)
- **Federal status:** Listed endangered in 1991
- **Requirements for MIP Stability**
  - 4 Population Units (PU)
  - 50 reproducing individuals in each PU (long-lived perennial; Dioecious, Large percentage of non-flowering/ fruiting plants)
  - stable population structure
  - threats controlled
  - complete genetic representation of all PUs in storage

- **Description and biology:**
  - **Habit**- Shrubs; stems erect to decumbent, 1-5 m long, openly branched, sparsely pubescent with short appressed hairs.
  - **Leaves**- Leaves ovate to oblong, 3-9 cm long, 2-5 cm wide (juvenile leaves or leaves of young flowering plants narrower than those of mature plants), moderately pubescent with short appressed hairs, becoming glabrate with age, margins entire, apex obtuse to rounded, base cuneate to truncate, petioles 4-8 mm long.

Modified from: MIT 2003, Wagner et. al. 1999

Nototrichium humile

- **Description and biology continued:**
  - **Flowers-** Flowers broadly ovoid, in slender spikes 3-14 cm long, ca. 4 mm or less in diameter, peduncles 0.5-1.5 cm long; sepals ovate, ca. 3 mm long, pubescent with short appressed to spreading hairs, subtended by a very broadly ovate, scarious bract ca. 1 mm long, ca. 1.5-2 mm wide, persistent on the rachis, bracteoles cordate to ovate, keeled, ca. 1 mm long, deciduous with the calyx and fruit.

    Flowering is generally heaviest in the spring and summer. It is not known if the plants are self-compatible. Pollination vectors for the species are unknown. The fruits mature a few weeks after flowering. The seeds have no obvious dispersal mechanisms. Based on observations of particular individuals of this species, the plants live for at least one or two decades (Lau pers. comm. 2000).

  - **Fruit-** Fruit ca. 2 mm long, enclosed by the calyx.

  - **Seeds**- unknown (*OANRP has seen few seeds. Of the seeds that have been seen, they are black at maturity and approximately 2mm in diameter)

Modified from: MIT 2003, Wagner et. al. 1999. * = not in original MIP

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-3. This chapter will update the status of snails in captive propagation at the UHTSCL and OANRP actions taken with these collections. OANRP has prepared a draft PCSU technical report on the development and implementation of the predator proof fences at Hapapa, please refer to Appendix 3-1. For more information on OANRP native vegetation restoration efforts at the enclosures at Hapapa and Palikea refer to Appendix 3-2 and 3-3.

3.2 REINTRODUCTION OF LAB POPULATIONS

As stated by OANRP in last year's annual report, snails populations in the UHTSCL that have been in a steady decline and have very small numbers were returned to either enclosures or their predator controlled original habitat. It was determined by the IT (including UHTSCL Staff) that these lab populations are not suitable for long term captive propagation and that the best outcomes for the few remaining individuals would be return to the wild. None of the snails returned were wild collected. They were descendents from early collections. The following table shows where seven different populations were returned; two populations were returned to snail enclosures, and the other five back to their population areas or nearby. The only snails that remain in the lab are from Ohikilolo. OANRP staff plan to return these in October 2013.

Table 1: Summary of UHTSL Snail Reintroductions

Species	Cage/ Population/ ESU	Date Collected	# Snails Collected	Date Returned	# Snails Returned	Return Location	Notes
A. mustelina	Palikea Lunch/ PAK-H/ ESU-F	6/25/2005	10	5/1/2013	4	Palikea Enclosure/ PAK-P	Returned to the enclosure.
A. mustelina	Ekahanui Honouliuli/ EKA-E/ ESU-E	3/5/2003	10	6/9/2013	6	EKA-A	EKA-E was greatly declining. Returned to EKA-A with stable population. within rat control grid.
A. mustelina	Makaha/MAK-A/ ESU-D2	4/10/2003	10	4/26/2013	3	MAK-A	Returned to original population within rat control grid.
A. mustelina	Ohikilolo Makai MMR-F/ ESU B1	7/31/2003					To be returned in October 2013
A. mustelina	Ohikilolo Mauka/MMR-E/ ESU-B1	7/31/2003					To be returned in October 2013

A. mustelina	Schofield West/ SBW-A/ ESU-C	2/13/2003	10	6/29/2013	13	SBW-B	SBW-A was greatly declining. Returned to SBW-B with stable population within rat control grid.
A. mustelina	Schofield South/SBS-C/ ESU-D1	4/16/2003	10	5/9/2013	10	KAL-G	Returned to the enclosure.
A. mustelina	Ka'ala S-ridge/LEH-A ESU-B2	1/29/2003	10	4/29/2013	1	LEH-A	Returned to original population.
A. sowerbyana	Peahinaia/OPA-N	8/6/1996	10	7/24/2013	1	Hypalon/ Opa-F	Returned to nearest protected population since original wild population is no longer extant

3.3 SHORT TERM LAB ROTATION

There is a stated requirement for the maintenance of captive populations of *Achatinella* within the MIP and OIP. For the past few years the IT has been discussing the best way to satisfy this requirement and utilize the UHTSCL in the most effective way. Historically, the UHTSCL was utilized as a long term *ex situ* storage site to keep populations safe from threats in their wild habitats, and to serve as a genetic storage backup in case of *in situ* catastrophes or population collapse. Unfortunately, over the past ten years a negative pattern has emerged with lab populations. When snails were brought into the lab they tended to reproduce and their populations increased in numbers for the first two to three years, after which adults began to die and the total number of snails slowly decreased to few or none. UHTSCL has expended considerable effort to understand this decline and to prevent and reverse it, see Appendix ES-3. Significant attention has been given to snail lab diets; this research is on-going. While it may not be feasible to hold the snails at the lab for extended periods of time, the lab is still considered the safest place for many vulnerable populations where threats are not controlled. In the wild, environmental factors and predators have also contributed to documented population declines.

OANRP proposed a short term lab rotation plan within last year's annual report and at IT meetings. This plan balances the need for *ex situ* population storage with poor long term performance in the UHTSCL. Under this new strategy, snails were collected from four sites and brought into the lab for captive rearing. Snails will then be returned within one to two years in order to prevent the *ex situ* death of the adult reproducing snails that were brought into captivity and while allowing the *ex situ* population size to increase. This method is expected to maximize the benefits of the lab including the ability to sustain higher levels of juvenile survivorship than in the wild, while avoiding the lab decline by returning the snails to the field before declines occur. Snails from these four populations were collected from Evolutionarily Significant Units (ESU) that do not currently have enclosures (Table 2). At the completion of the first rotation released individuals will be monitored and the entire process evaluated before additional snails are collected.

Table 2: Short Term Lab Rotation

Species	Population/ESU	# Snails	Date Collected	NOTES
A. mustelina	Ekahanui Honouliuli/EKA-C/ ESU-E	**10**	6/9/2013	

Species	Population/ESU	# Snails	Date Collected	NOTES
A. mustelina	Makaha/MAK-A/ ESU-D2	**10**	4/22/2013	
A. mustelina	East Makaleha/LEH-C/ ESU-B2	**10**	7/2/2013	In lieu of Ohikilolo since no *E. rosea* threat at Ohikilolo.
A. mustelina	Schofield West/SBW-A/ ESU-C	**10**	6/29/2013	
TOTALS		**40**		

CHAPTER 4: OAHU ELEPAIO

4.1 OIP ELEPAIO MANAGEMENT 2013

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 summarizes Elepaio reproduction results at each of the sites currently being managed, and provides recommendations for improving the Elepaio program. This section also lists and discusses the terms and conditions for the implementation of reasonable and prudent measures outlined in the 2003 Biological Opinion.

4.1.2 Methods

Monitoring

Throughout the nesting season, from early January to late June, each 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. Nest success (successful nests/active nests) was calculated by the number of successful nests per the number of active nests. Active nests are nests known to have had eggs laid in them as determined by observations of incubation. Reproductive success (fledglings/managed pair) was measured as the average number of fledglings produced per 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 vocal 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

For the 2013 breeding season, the use of a combination of Victor® rat traps and Ramik® mini-bars placed inside protective bait stations was abandoned at SBW, Moanalua Valley and Palehua due to concerns related to bait efficiency/dynamics, bait longevity and expense. This type of rodent control was replaced with small-scale trapping grids containing only Victor® rat snap traps baited with peanut butter. Each

grid, deployed throughout the territory of an Elepaio pair, was equipped with 12 snap traps that 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 found on the trap. Traps were cleaned with a wire brush after each capture so previous captures were not counted twice. Rodent control was conducted for the duration of the Elepaio nesting season. In addition to the snap trap grids at North Haleauau (SBW), 15 Goodnature® A24 automatic rat traps were introduced in 15 individual Elepaio territories in order to collect more data on the functioning of the traps. The results of this trial are discussed in the Rodent Management chapter. At Ekahanui, a large-scale rat trapping grid containing 620 snap traps was deployed in 2011 for management of all Elepaio territories in the management unit. Traps at all four sites were checked and rebaited once a week for the first month (December) , then once every two weeks for the rest of the breeding season (January – June). The frequency of re-baiting in December is higher in order to kill as many rodents as possible before Elepaio nesting begins, thus giving the birds the best chance at having successful nests. In 2013, Pono Pacific was contracted to conduct rodent control and monitoring of Elepaio at Moanalua. At SBW, Ekahanui and Palehua, they were contracted to conduct rat control only. OANRP conducted monitoring of birds at SBW, Ekahanui and Palehua. OANRP also assisted in monitoring Elepaio at Moanalua.

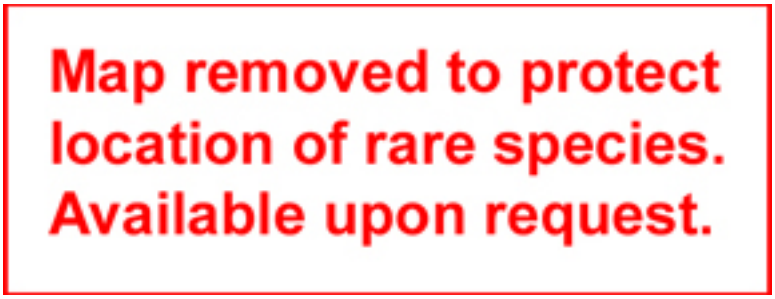
4.1.3 Results

With 105 Elepaio pairs managed during the 2013 breeding season, the OANRP exceeded the 75 pairs required for species management. The number of managed pairs has increased over the years due largely to population growth at Ekahanui. Since 2008, pairs found within the management unit have increased 47%. This increase was observed within the established large-scale trapping grid, therefore, the number of managed pairs has increased without additional cost and labor expenses. The results of management conducted for each area during the 2013 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. The map denotes all of the territories that were baited. Second, the data is presented in tabular form with the number of territories that were single or contained pairs. The table also presents the number of paired territories in which rodent control was conducted, the number of active nests observed, total successful and failed nests, how many fledglings were observed, and the ratio of fledglings per pair. Rodent control data and a summary of results are also presented.

Elepaio foraging for insects in Ohia.

Schofield Barracks West Range

Schofield Barracks West Range Territory Occupancy Status and Rat Control 2013



Schofield Barracks West Range Site Demographic Data

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

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (sufficient time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored in SBW, 50% (9/18) were successful in producing 10 fledglings, while 50% (9/18) of the active nests failed. Another 18 fledglings were found in 15 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 six fledglings were observed in territories not protected from rats.

Rodent Control Results

Since replacing all bait station grids with snap trap grids for the 2013 nesting season, the number of traps in SBW has nearly doubled since 2012. Trapping efficiency has increased overall: 3.2 rats per trap were killed total in 2013 compared to 2.6 rats per trap in 2012. Considering that only 10.7% of the total bait put out in 2012 was "taken" and the Elepaio had a relatively successful year despite limited access for monitoring, OANRP suspects that the snap trap grids are adequate for rodent control. It should also be mentioned that these results occurred despite having limited access to Baby Water, Banana, and North Haleauau gulches. Regular access was granted to Mohiakea gulch and consequently at least twice as many rats per trap were caught in Elepaio territories there than in the other gulches (5.0 rats/trap overall). This is likely because the bait on the traps at Mohiakea was refreshed more often, thereby attracting more rats than the traps at the other SBW sites where bait was likely absent for long stretches of time. Additionally, because snap traps are rendered ineffective when sprung (either by a rodent or accidentally), many traps at the other SBW sites were likely ineffective for longer periods of time than the Mohiakea traps.

Schofield Barracks West Range Rodent Control Data

SBW	# Traps	# Rats in Traps	Rats/Trap	Total # Bait Deployed	Total % Bait Take
2012	192	501	2.6	13260	10.7%
2013	372	1176	3.2	0	N/A

Summary

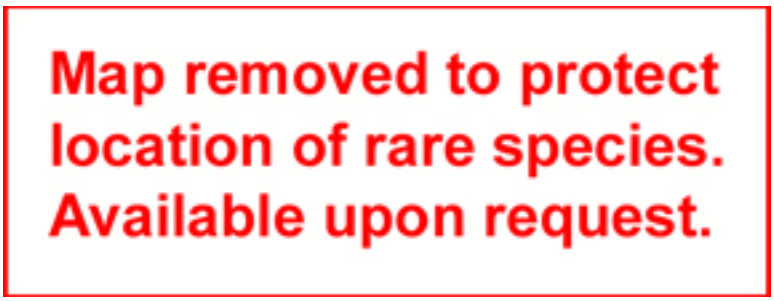
Despite having limited access in SBW to conduct rat control and monitoring, this season was a productive year for the resident Elepaio population. Again, like the previous year, 28 fledglings were observed, while the number of pairs and single males was higher than any prior breeding season.

It is likely that access to SBW will again be reduced for the 2014 breeding season. Full-time training by the Army during weekdays will limit our ability to manage this Elepaio population to the extent that we were able to in previous breeding seasons. We will continue to conduct rodent control and monitor the birds on weekends and holidays with this restricted access to SBW.

Schofield Barracks West Range.

Honouliuli Forest Reserve - Ekahanui

Ekahanui Territory Occupancy Status and Rat Control 2013



Ekahanui Site Demographic Data

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

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 65% (17/26) were successful, producing 20 fledglings, 35% (9/26) of active nests failed. Three nests had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Nine fledglings were found in eight managed pairs where no nesting had been observed (family groups). A total of 29 fledglings were observed in territories benefiting from rodent control management.

Rodent Control Results

No significant changes were made to the Ekahanui trapping grid between 2012 and 2013. However, over 250 more rats were caught in 2013 than in 2012. Even with this increase, the number of rodent kills compared to other management areas is low considering the number of traps in the grid. A small trial was conducted in a portion of the trapping grid to answer whether or not hanging traps in trees catches more rats than when the traps are housed in wooden boxes on the ground. Preliminary results of this trial indicate that more rats may be caught if traps are in trees. For the 2014 Elepaio nesting season, there will be an alteration to the baiting grid at Ekahanui: the majority of the Victor® rat traps inside the grid will be removed from their protective wooden boxes and placed higher off the ground on limbs of nearby trees. The majority of traps on the perimeter of the grid will remain in the wooden boxes on the ground. Refer to the Rodent Management Chapter for more information on this trial and the changes to the grid.

Ekahanui Rodent Control Data

EKA	# Traps	# Rats in Traps	Rats/Trap	Total # Bait Deployed	Total % Bait Take
2012	619	520	0.8	0	N/A
2013	620	774	1.2	0	N/A

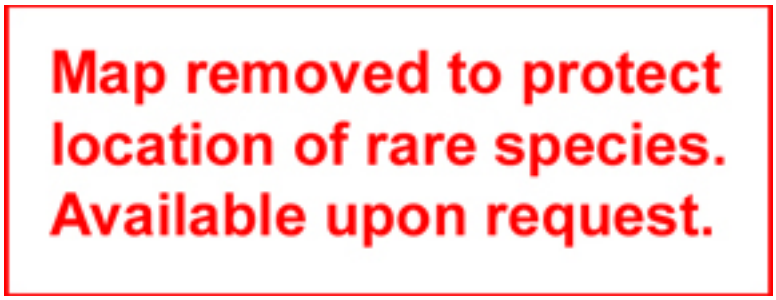
Summary

This was a very successful breeding season at Ekahanui. There were multiple record highs at this management site including number of pairs, successful nests and fledglings observed. Since 2012, eight new pairs have been detected at Ekahanui. Successful active nests increased to 65% and there were 11 more fledglings found in 2013 than in the previous year. Ideal seasonal weather and increased monitoring time may have been a factor in the above average breeding season at Ekahanui.

A newly banded subadult Elepaio.

Palehua

Palehua Territory Occupancy Status and Rat Control 2013



Palehua Site Demographic Data

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

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 69% (11/16) were successful in producing 15 fledglings, while 31% (5/16) nests failed. Six fledglings were found in five managed pairs where no nesting had been observed (family groups). A total of 21 fledglings were observed in territories benefiting from rodent control management.

Rodent Control Results

Since replacing all bait station grids with snap trap grids for the 2013 nesting season, the number of traps at Palehua has more than doubled since 2012. The number of rats killed by snap traps in 2013 more than tripled. Trapping efficiency has increased overall: 2.2 rats per trap were killed total in 2013 compared to 1.8 rats per trap in 2012. Considering that only 7.5% of the total bait put out in 2012 was "taken" and there was an increase in the number of fledglings observed in 2013, OANRP suspects that the snap trap grids are adequate for rodent control.

Palehua Rodent Control Data

HUA	# Traps	# Rats in Traps	Rats/Trap	Total # Bait Deployed	Total % Bait Take
2012	72	126	1.8	5652	7.5%
2013	180	393	2.2	0	N/A

Summary

Like Ekahanui, the Palehua site had a terrific breeding season. Palehua added a pair since last season and 69% of the active nests produced fledglings. An incredible 21 fledglings were observed this year, boosting the ratio of fledglings per managed pair above one for the first time ever at this management unit.

Nesting Oahu Elepaio.

Moanalua Valley

Moanalua Territory Occupancy Status and Rat Control 2013

Moanalua Site Demographic Data

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

[1] Nest containing eggs or nestlings.
[2]Percentage of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

Of the active nests monitored, 82% (14/17) were successful in producing 15 fledglings, 18% (3/17) failed. Six 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 17 fledglings were observed in territories benefiting from rodent control management. One fledgling was observed in a territory not protected from rats.

Rodent Control Results

Since replacing all bait station grids with snap trap grids for the 2013 nesting season, the number of traps at Moanalua has quadrupled since 2012. The number of rats killed by snap traps in 2013 more than tripled even though more rats per trap were killed in 2012 than in 2013. Considering that only 16.6% of the total bait put out in 2012 was "taken" and there was an increase in the number of fledglings observed in 2013, OANRP suspects that the snap trap grids are adequate for rodent control.

Moanalua Rodent Control Data

SBW	# Traps	# Rats in Traps	Rats/Trap	Total # Bait Deployed	Total % Bait Take
2012	72	483	6.7	10603	16.6%
2013	312	1576	5.1	0	N/A

Summary

Moanalua Valley had a much improved breeding season in 2013. More Elepaio pairs were observed than any previous year. Successful active nests also reached an all-time high at 82%. The number of fledglings also increased by four over the 2012 season.

Adult Elepaio with fledgling.

4.1.4 OIP Summary

Management Action Highlights 2013

- Conducted rodent control in a total of 105 territories with pairs at four management sites.
- Following the 2012 breeding season OANRP removed all Protecta® rodent bait stations from Elepaio territories in SBW, Moanalua and Palehua. In each territory that contained a pair, a new grid system was established consisting of 12 Victor® snap traps placed within the territory boundary. Results of rat control using this new method are discussed in the previous results section for each individual site. An overall summary of 2013 rodent control data in comparison with rodent control data from 2012 is presented and discussed below.
- Fifteen Goodnature® A24 automatic rat traps were introduced and tested as a management tool in territories throughout North Haleauau gulch at SBW. The results of this trial are discussed in the Rodent Management chapter.
- The table below summarizes the number of managed pairs and reproductive output since 2006.

Summary of Elepaio Management Table

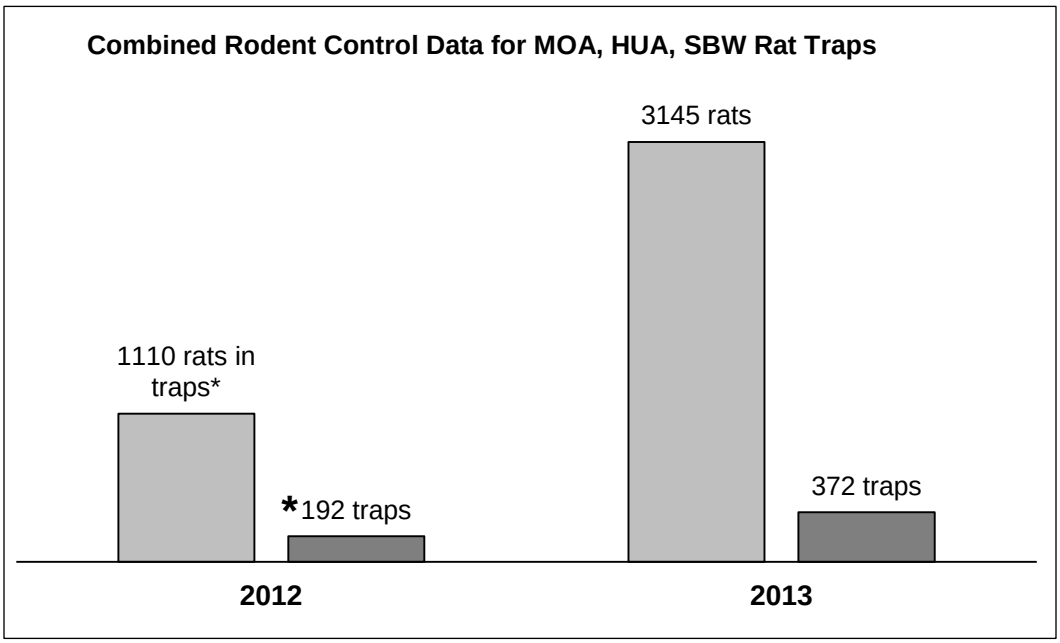
Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings
2013[1]	105	51	38	95
2012[1]	97	38	22	65
2011[1]	94	47	34	96
2010[1]	87	18	15	39
2009[2]	81	29	24	60
2008[3]	74	25	20	56
2007[3]	78	18	26	46
2006[4]	69	11	17	33

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

Summary of Rodent Control Data

Overall, the new small-scale trapping grids within each managed Elepaio territory at SBW, Moanalua, and Palehua appear to be effective at reducing rodent populations to a level that allow for Elepaio nesting success at least as well as the former rodent control method. Refer to the figure below for data on overall trap catches and the total number of traps at Moanalua, Paleahu, and SBW in 2012 compared to 2013. The number of rats killed from Ramik® bait in bait stations in the past is unknown because the lethal dose for a rat varies widely for individual rats depending on factors such as age, size, sex, and species (see the 2012 OANRP Status Report for more information). It has been documented by Katie Swift (USFWS, pers. comm. 2012) 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. Slugs and insects are also responsible for a large amount of "bait take." In 2012, there were 29,515 blocks of Ramik® deployed, but only 3,598 blocks were "taken." Therefore, if all the bait take was by black rats (not likely), and all individuals consumed a lethal dose (somewhat unlikely), the range in the number of rats killed by bait in 2012 was approximately 1,199 to 7,196 individuals. Clearly, it is difficult to determine how many rats can be killed from 16 bait blocks in a bait station. It should also be mentioned that only 12.2% of the total bait deployed in 2012 was recorded as "taken," which equates to approximately $4,500 worth of uneaten Ramik®. The use of bait stations is a much more expensive rodent control method and the results are

difficult to determine. Furthermore, in June of 2013, the Special Local Needs label for Ramik® bait expired and the new label will have new stipulations that will likely preclude the use of bait stations at most sites that OANRP manages due to impracticality and overall cost.



Management Actions 2014

- 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 bird movements and population growth of the species. This includes a follow-up survey of South Haleauau gulch in SBW to update the original survey that was conducted in 2010.
- Conduct rodent control and Elepaio monitoring at Ekahanui, SBW, Palehua and Moanalua to meet required 75 managed pairs.
- Continue to use snap trap grids consisting of 12 Victor® traps per Elepaio territory for rodent control at SBW, Palehua, and Moanalua. Based on the data from 2013, OANRP is confident that these small grids are at least as effective for rodent control in territories as the previous bait station and snap trap grids.
- For the 2014 breeding season at Ekahanui, there will be an alteration to the large-scale trapping grid: the majority of the Victor® rat traps inside the grid will be removed from their protective wooden boxes and placed higher off the ground on limbs of nearby trees. The traps on the perimeter of the grid will remain in the wooden boxes on the ground. The new placement of traps will be more accessible and attractive to rats traveling within the forest canopy. For further information, see the Ekahanui section of the Rodent Management Chapter.

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 2012-2013]

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*.

[Two deceased Oahu Elepaio nestlings and one fledgling were collected this year and turned over to the B.P. Bishop Museum. At Palehua, one nestling was found still in a nest (pictured below), another on the ground underneath the nest. A deceased fledgling was also found on the ground near a nest at N. Haleauau gulch in SBW. A necropsy was performed by the USGS Biological Resource Division National Wildlife Health Center-Honolulu Field Station on the fledgling recovered in N. Haleauau. On microscopy, there was evidence of pneumonia and atrophy of the liver. Microscopic lesions pointed to pneumonia of unknown origin as cause of death.]

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 2013

4.2.1 Background

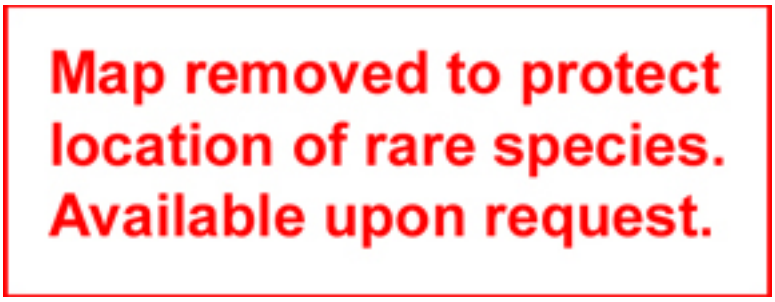
The initial Biological Opinion (BO) that triggered the development of the Makua Implementation Plan (MIP) was issued in 1999. At that time, the Oahu Elepaio (*Chasiempis ibidis*) was not listed as an endangered species, but the 1999 BO did include recommendations related to Elepaio. These included conducting 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.

Hungry nestlings awaiting food from their parents.

Makua Territory Occupancy Status and Rat Control 2013



Makua Site Demographic Data

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

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).
[4]Total number of occurrences where pairs were observed with fledglings in which no nests were found.
[5]Total number of fledglings observed from successful active nests and family groups.
[6]The ratio of fledglings per managed pair.

Reproductive Results

During two site visits on 28 November 2012 and 11 July 2013, no pairs were observed. Two single males were found in separate territories during each visit. No nests or fledglings were observed. A breeding pair of Elepaio has not been observed in Makua Valley since the 2009 breeding season.

4.2.3 MIP Summary

Management Actions 2013

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

Management Actions 2014

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

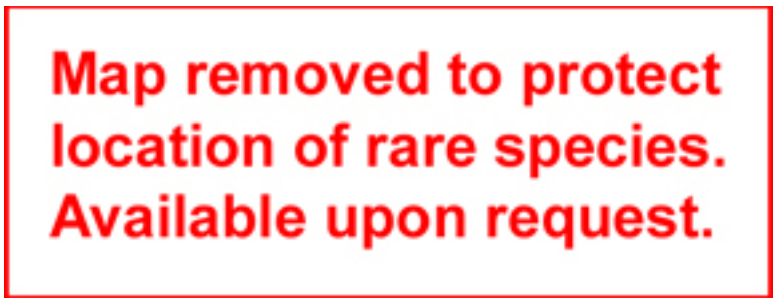
Adult Elepaio feeding 2 nestlings.

CHAPTER 5: *DROSOPHILA* SPECIES MANAGEMENT

5.1 BACKGROUND

No insects were included in the original OIP plan, as none were listed endangered at the time. In 2006, the U.S. Fish and Wildlife Service (USFWS) listed 11 species of endemic *Drosophila* pomace flies as endangered and one as threatened under the Federal Endangered Species Act. In 2008, critical habitat was designated for all species. Five of these species (*D. aglaia*, *D. hemipeza*, *D. montgomeryi*, *D. obatai*, and *D. substenoptera*) presently occur or historically occurred in the OIP and/or MIP action areas; the sixth Oahu species, *D. tarphytrichia*, is historically known from several management units in the southern Waianae range. Most had not been seen in decades, but recent survey data were lacking. In 2009, *D. montgomeryi* and *D. substenoptera* were discovered on Army land above Schofield Barracks West Range near Puu Kalena. Subsequently, stabilization plans for these two species were prepared and were approved by the USFWS in 2012 for incorporation into the OIP. These plans call for the management or establishment of three population units (PUs) of each species, with restoration of host plants and threat control at each unit.

Historic collections of endangered *Drosophila* in and adjacent to OIP and MIP action areas.



This is the first year that *Drosophila* have been included in OANRP management. Actions have focused primarily on surveying existing management units (MUs) for additional populations of the listed species, monitoring known populations to track their stability over time, and conducting systematic surveys of the action areas in preparation for re-consultation with the U.S. Fish and Wildlife Service. This chapter reviews the results of approximately six months of surveys in both the Waianae and Koolau mountains, between April and September 2013. Due to restrictions on range access and prioritizing the search for new sites, the Puu Kalena site was not visited during this time.

5.2 METHODS

Many species of Hawaiian *Drosophila*, including the picture wing group to which all of the endangered species belong, are readily attracted to baits of fermented banana and mushrooms (Kaneshiro et al., 1977). The two baits

Drosophila montgomeryi (right) next to the more common, sympatric species *D. ambochila*, which breeds in *Pisonia* spp. (papala kepau). Note that *D. montgomeryi* has narrow dark brown stripes on the thorax, and the mark in the middle of the leading edge of the wing is longer than broad (arrows); in *D. ambochila*, the thorax is all pale brown and the mark in the middle of the wing is nearly round.

are spread on a cellulose sponge which is hung from a tree in a cool, shaded, sheltered site, and checked for flies after about an hour. Depending on the quality of the site (based on shade and density of host plants) and the density of baiting spots, surveys consist of setting out 16-32 sponges in groups of four or eight. Baits are checked at least every hour, as flies do not necessarily stay at baits for long periods. The greatest activity is during the cooler hours before 10 AM and after 2 PM, but flies may appear at any time. Direct quantification of *Drosophila* populations is extremely tenuous, as populations may fluctuate not only seasonally but from day to day. However, repeated surveys yield useful data on long-term trends.

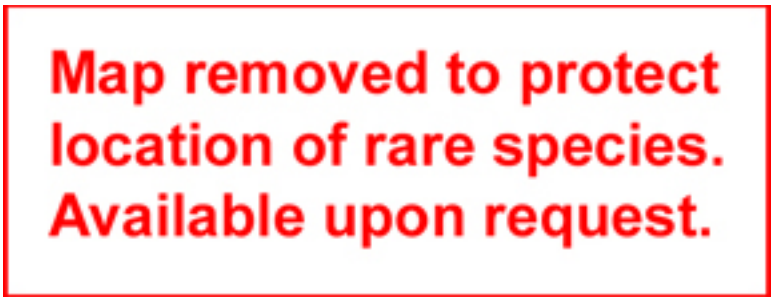
5.3 RESULTS

5.3.1 *Drosophila montgomeryi*

Drosophila montgomeryi is a small yellow-brown species which breeds in rotting bark of *Urera kaalae* and *Urera glabra* (opuhe; Magnacca et al., 2008). It is currently known from three sites, which are considered to be two population units (one in Puu Kalena and two in Kaluaa-Waieli).

Puu Hapapa

This site was monitored five times. It consists of a small grove of outplanted *Urera kaalae* and several larger scattered *U. glabra* within a larger restoration area, including a predator-free snail enclosure.



Distribution of *Drosophila montgomeryi* observations in 2013, with known *Urera* spp. sites and all survey points in the Waianae range.

Drosophila montgomeryi were present only once, at the beginning of September. Unusually, this was during a hot and dry period when other flies here and at other sites were found in low numbers. It did occur approximately five weeks after a treefall knocked over several *U. kaalae*; however, no flies were seen attracted to the dead branches, which appeared to be too dry to support *Drosophila*.

Kaluaa & Waieli Gulch

The known site for *D. montgomeryi* in Central Kaluaa gulch 1 is only about 700 m from Puu Hapapa and is considered part of the same PU. This site was visited twice; a single *D. montgomeryi* was found in June, and no picture wing *Drosophila* at all were found in August during the dry season. Priority was given to searching the other branches of Kaluaa Gulch and adjacent Waieli for *D. montgomeryi*. *Urera glabra* was found in three of these (North, Central gulch 3, and Waieli), but no flies were present at any.

Other sites

Finding at least one new population of *D. montgomeryi* is a priority goal. The only other site it is recently known from is in Schofield West Range, South Haleauau Gulch near Puu Kalena. This site has not been surveyed since 2009, and is not marked as a 2013 observation on the map above. *Urera* is widespread but relatively uncommon and scattered, and *U. glabra* is not tracked as a rare plant; consequently, its full distribution is unknown (*U. kaalae* is nearly extinct in the wild, though it has been extensively outplanted by TNCH). Reproduction is low or nonexistent at most sites. In addition to the branches of Kaluaa

Gulch, three of the six other sites where *Urera* is known to occur were surveyed: Pahole Gulch, Ekahanui, and Palikea. Two others, Pualii and Palawai, contain outplanted *U. kaalae*; these have not yet been surveyed. All locations with host plant species will continue to be surveyed, especially in light of the low recent numbers at the known Puu Hapapa and Kaluaa sites.

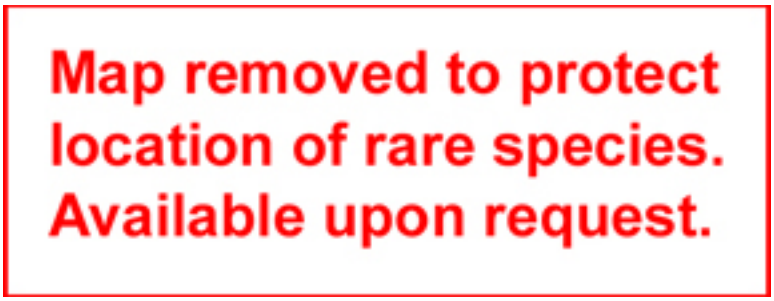
5.3.2 *Drosophila substenoptera*

This is the only listed endangered *Drosophila* for which there are currently three known PUs – Palikea, South Haleauau, and Kaala. As noted for *D. montgomeryi*, the South Haleauau/Puu Kalena site has not been visited since 2009 and is therefore not marked on the map below. Based on collection records, it requires moderately tall, non-boggy wet forest with its host plants, *Cheirodendron* spp. (olapa) and *Tetraplasandra oahuensis* (ohe mauka) (Magnacca et al., 2008). While these three populations represent nearly the entire historic range of the species in the Waianae Mountains, the majority of older specimens come from the Koolau range, where it has not been seen since 1972.

Waianae Range

Monthly monitoring at Palikea indicates that the population there remains similar to when it was previously visited in 2009. It occurs at least throughout the section north of Palikea peak; in 2009 it also occurred in the southern portion inside the *Cyanea grimesiana* exclosure, but has not been found there this year. Elsewhere in that section the habitat is not as suitable, but it has not yet been thoroughly explored. Large fluctuations in numbers of individuals at bait sponges was observed, with a flush in the wet period of late May. The numbers of *D. substenoptera* were somewhat correlated with those of the common species *D. punalua*, which breeds in the leaf axils of *Freycinetia arborea* (ieie), but not with those of another endangered species, *D. hemipeza*, or two other non-endangered species, *D. crucigera* and *D. gradata*, except in that numbers of all dropped off during the dry months of August and September (see table below). Although these other species are much more widespread and are common elsewhere, *D. substenoptera* is actually the most abundant picture wing species at Palikea.

Drosophila substenoptera in characteristic wing-waving stance. This species closely resembles *D. hemipeza*, which is also endangered. They co-occur at Palikea, but can be readily distinguished by the marks on the two crossveins of the wings, which are in line in *D. hemipeza* and separated in *D. substenoptera*.



Distribution of *Drosophila substenopera* observations in 2013, with *Cheirodendron* spp. sites partially indicated and all survey points in the Waianae range.

Palikea *Drosophila* Numbers (daily maximum seen across 20 bait sponges)

Species	Status	Total	early May	late May	July	Aug	Sept
substenoptera	endangered	31	2	18	8	2	1
hemipeza	endangered	15	6	5	2	1	1
punalua	common	21	2	10	5	0	3
crucigera	common	7	3	1	0	2	1
gradata	uncommon	4	0	0	3	1	0

At Kaala, numbers were very low (only one from three sites surveyed), but only three survey days were spent here and the steep terrain is extremely difficult to cover effectively. Therefore, we expect that the population there is greater than indicated. The habitat zone for *D. substenoptera* is below the summit bog, on the steep slopes just above and below the cliffs that surround the peak on most sides. While this is a relatively narrow band, much more exists than has been or can be visited. As noted under *D. montgomeryi*, the South Haleauau site was not visited, and the current status of *D. substenoptera* there is uncertain. Since *Cheirodendron* occurs along much of the summit ridge between Puu Kalena and Kaala, these may form a single continuous population.

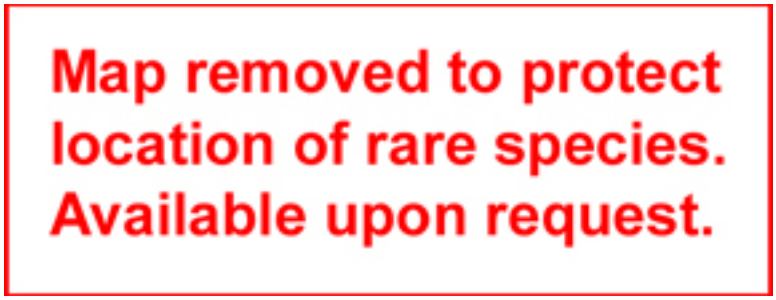
Koolau Range

The majority of historical collections of *D. substenoptera* are from the Koolau range, but it has not been seen there since 1972. However, collection effort in that time has been limited due to the difficulty in accessing areas of intact habitat for this species. Thus far, surveys in the Koolau Mountains for *D. substenoptera* have been limited due to higher priority being given to surveys in the Waianae for new sites for *D. montgomeryi* and *D. obatai*. Koloa MU has been surveyed three times and Lower Opaeula once with no *D. substenoptera* found, despite both sites appearing to be suitable habitat. Waimano MU was also checked but found to be unsuitable, consisting of short-stature, open forest with no *Cheirodendron* and relatively few *Tetraplasandra*. Finding Koolau populations is a high priority for this species; Helemano, Opaeula, Poamoho, and Kaukonahua have yet to be surveyed, and Lower Opaeula and Koloa will be revisited multiple times given the extremely high quality of habitat there.

5.3.3 *Drosophila obatai*

Until 2011, when it was found in Manuwai Gulch MU, *Drosophila obatai* had not been seen since 1971. This species breeds in rotting stems of *Pleomele* spp. (halapepe). Two species of *Pleomele* are present on Oahu, *P. forbesii* and *P. halapepe*. The former was recently listed as endangered but is not definitively associated with *D. obatai*, while the latter, like *Urera glabra*, is more frequent and widespread but still

Drosophila obatai, Palikea Gulch. The small basal wing mark, dusty gray thorax, and frequent spur vein mutations in the wing (one is visible in the anteroapical mark of the left wing) are diagnostic for this species, and shared with its sister species *D. sodomae* of Maui and Molokai.



Distribution of *Drosophila obatai* observations in 2013, with *Pleomele* spp. sites and all survey points indicated in the Waianae range and Kahuku.

relatively uncommon and scattered. *Pleomele* generally experience very low rates of reproduction, probably due to rats feeding on the seeds. Furthermore, in areas wet enough to sustain *Drosophila* breeding, broken branches are often able to re-root and continue growing, limiting the amount of rotting plant material available for the flies. Although the hardy and long-lived *Pleomele* are better able to persist in disturbed habitats than many other native plants, including important *Drosophila* hosts such as *Clermontia* and *Charpentiera*, many of those that remain now occur in relatively dry, open sites that are unsuited for *Drosophila*. In addition to *D. obatai*, two or three other species of picture wing *Drosophila* on Oahu breed on *Pleomele*: *D. gymnophallus*, *D. psilophallus*, and possibly *D. aglaia*. None of these have been seen for several decades.

All historic collections of *D. obatai* came from the northeast slope of Kaala between East Makaleha and Puulu gulches (except for two collections in the southeastern Koolau range) during 1970–71. This year, in addition to two locations in Manuwai, *D. obatai* was found at two additional sites within the OIP action area: Palikea Gulch in lower Kaala NAR, and central Pulee Gulch ("Coffee Gulch"). Since this is the first discovery of this species within an action area, consultation with USFWS will occur before further management steps are taken.

5.3.4 Other Rare *Drosophila*

During the course of surveys, six additional rare *Drosophila* were found in OANRP management units. Four of these – *D. flexipes*, *D. neogrimshawi*, *D. paucicilia*, and *D. pilimana* – were found around Kaala, either near the summit or on the eastern slopes in the same habitat as *D. obatai*.

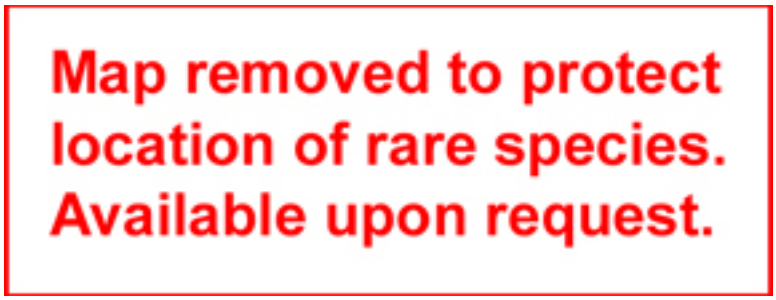
Non-Target Rare *Drosophila* Observed During Surveys

Species	Sites	Max. No.
flexipes	Manuwai	1
hemipeza	Palikea	6
neogrimshawi	Kaala	1
paucicilia	Manuwai	2
pilimana	Manuwai, Kaala	5
nr. *truncipenna*	Koloa	6

Drosophila paucicilia (left) and *D. flexipes* (right), together on a bait sponge at Manuwai Gulch.

Drosophila flexipes and *D. paucicilia* both breed in fermenting sap fluxes of *Sapindus oahuensis* (lonomea). Although this tree is relatively common in remnant mesic and dry forest, it often occurs at lower elevations where ants prevent *Drosophila* from living. In addition, the sap flux habitat is increasingly rare as a drier climate results in stressed trees that produce less flowing sap. Since 1977, only two individuals of *D. flexipes* have been seen (in Lualualei Valley in 2009 and Makaha in 2010), and *D. paucicilia* has been entirely absent. Both were seen together in Manuwai MU, close to where *D. obatai* was found.

Drosophila hemipeza is the only listed endangered species on Oahu that is known to be extant but does not occur on Army lands, although historically it occurred at Kahuku Training Area and in West Makaleha Gulch adjacent to Makua. The only current locality is at Palikea MU, where the population appears to have been stable for several years. It has been reared from *Cyanea*, *Lobelia*, and *Urera*, all of which are present at Palikea.



Observations of six non-target rare *Drosophila* species during the 2013 survey season.

Drosophila neogrimshawi is the only *Clermontia*-breeding species on Oahu. Although never very common, it was formerly widespread in the Koolau range. As numbers of *Clermontia* appear to have declined, these flies have also disappeared, and they have not been seen since 1972. This record from Kaala is the first from the Waianae range since 1916.

Drosophila pilimana was formerly one of the most widespread and abundant *Drosophila* species on Oahu, found at almost every collecting site. Since the mid 1970s it has declined dramatically for unknown reasons, and only a handful have been seen since then. It is still regularly seen at Kaala – both at the wet summit and at Manuwai Gulch to the east – but not elsewhere. Remarkably, despite considerable effort in rearing, the breeding host(s) of *D. pilimana* and its relatives on Kauai and Maui Nui (which remain common) are unknown.

The most remarkable find from 2013 was the discovery of an undescribed species at Koloa MU. This species most closely resembles *D. truncipenna* of Maui, but is unlike any other Hawaiian *Drosophila*. It is clearly a member of the *hamifera* species group, all the other members of which occur on Maui Nui. It is the first new picture wing *Drosophila* found on Oahu since 1975. At present it is known only from Koloa, where *Drosophila* collecting was never previously conducted. All other members of the *hamifera* group breed in *Cyanea*, and it likely persists there due to the relatively high abundance of *Cyanea* in the fenced unit. One striking feature of the species is that it possesses a stub of an extra crossvein in the wing (visible in the photo, slightly basal of the main posteroapical crossvein). This was seen in both wings of all 7 individuals observed, indicating that it is not a chance mutation but a fixed character.

Drosophila neogrimshawi, at Kaala.

Drosophila nr. *truncipenna,* an undescribed species discovered at Koloa.

5.4 FUTURE WORK

The upcoming year will involve continued surveys as well as the start of active management for *Drosophila*. Many sites are still inadequately surveyed or have not been visited at all; as systematic monitoring at known sites for *D. montgomeryi* demonstrate, detection can be highly sporadic. In addition, as outlined in the stabilization plans for *D. montgomeryi* and *D. substenoptera*, monitoring for predatory alien species (namely ants and *Vespula*) will begin, with steps for control if warranted and practical. A stabilization plan for *D. obatai* will be prepared in consultation with the U.S. Fish and Wildlife Service. The invasive drosophilid *Zaprionus indianus* will also be investigated as a potential competitor to native species. Several sites are currently under investigation as possible reintroduction sites for captive-reared populations. This technique has not previously been used with *Drosophila* but has great potential due to their high reproductive capacity in the lab and the existence of isolated patches of host plants (some of which are currently larger and more intact than those where the flies persist) which would probably not be naturally colonized by the small wild populations. Habitat improvement by vegetation restoration is a longer-term project that must be carefully balanced. While invasive plants such as *Schinus terebinthifolius* prevent reproduction of host plants and their continued presence is incompatible with the ultimate survival of the *Drosophila*, they also provide a cool, shady environment. Extensive, abrupt removal of alien plants can result in a hotter, drier microclimate that negatively impacts *Drosophila* populations before desirable native plants can regrow. Finding the appropriate balance between these two needs will be a major task in the future.

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CHAPTER 6: RODENT MANAGEMENT

OANRP has managed MIP and OIP species that are subject to rodent predation with various strategies since 1997. This chapter discusses rodent control methods utilized over the past reporting year and also highlights recent changes. Specifically, this chapter has five main sections: Section 6.1provides an overview of the current rodent control program and discusses recent changes, Section 6.2 reports on the status of the large-scale trapping grids at Kahanahaiki, Palikea, and Ekahanui, Section 6.3 provides results of an investigation into data quality for trapping grids, Section 6.4 highlights recent bait trials for traps, and Section 6.5 discusses the new Goodnature® A24 automatic rat traps.

6.1 OANRP Rodent Control Program Summary

OANRP manages some species only seasonally (e.g., *Chasiempis ibidis* or 'Oahu Elepaio' during the nesting season), while other species are protected year-round (e.g., *Achatinella* spp.). The methods of rodent control that OANRP currently utilizes for rodent control are limited to using kill-traps (Victor® traps, Ka Mate™ traps, and Goodnature® A24 traps) and predator exclosures. The use of bait stations with the rodenticide Ramik® (0.005% diphacinone) was utilized prior to June 8, 2013, when the Ramik® pesticide label expired.

Rat control in 2013 consisted of deploying small Victor® snap trap grids around resources, maintaining large-scale trapping grids consisting of Victor® or Ka Mate™ traps, constructing predator exclusion fences, and until August, collecting data from a Goodnature® A24 trap temporary research grid (Table 1). More Goodnature® traps will be installed across MUs over the next year. OANRP contracts Pono Pacific to conduct rat control during Elepaio nesting season (December – June) at Ekahanui, Kahanahaiki, Moanalua, Palehua, and Schofield Barracks West Range (SBW).

Table 1. Current rat control strategies utilized by OANRP as of October 2013.

MU/Area	Primary Spp. Protected	Control Method	Description	# Traps	Trap Type	Deployment	Interval
Ekahanui	*A. mustelina*	Trapping Grid	Many small grids	47	Victor w/out boxes	Year-round	4-6 weeks
Ekahanui†	*C. ibidis*	Trapping Grid	Large-scale grid	620	Victor w/ & w/out boxes[i]	Annual: Dec-June	2 weeks
Kahanahaiki	*A. mustelina*	Predator Exclosure	Constructed 1998	--	--	Year-round	--
Kahanahaiki†	*A. mustelina*, *C. superba*	Trapping Grid	Large-scale grid	464	Victor w/ boxes	Year-round	2 weeks
Kamaohanui	*A. mustelina*	Trapping Grid	One small grid	60	Ka Mate	Year-round	6 weeks
Koloa***	*A. livida*	Trapping Grid	Three small grids	76	Victor w/ boxes	Year-round	--
Makaha	*A. mustelina*	Trapping Grid	One small grid	30	Victor w/out boxes	Year-round	6 weeks
Moanalua†	*C. ibidis*	Trapping Grid	Many small grids*	312	Victor w/out boxes	Annual: Dec-June	2 weeks
Ohikilolo	*A. mustelina*, *P. kaalae*	Trapping Grid	Many small grids	47	Victor w/ boxes	Year-round	6 weeks
Opaeula***	*A. sowerbyana*	Trapping Grid	Many small grids	91	Victor w/ boxes	Year-round	--
Pahole	*C. superba*	Trapping	A24 Automatic	45**	Automatic	Oct '12 -	Varied

		Grid**	traps		traps	Aug '13	
Palehua†	*C. ibidis*	Trapping Grid	Many small grids*	180	Victor w/out boxes	Annual: Dec-June	2 weeks
Palikea	*A. mustelina*	Predator Exclosure	Constructed 2012	--	--	Year-round	--
Palikea-Mauna Kapu	*A. mustelina*	Trapping Grid	One small grid	15	Victor w/ boxes	Year-round	6 weeks
Palikea†	*A. mustelina*	Trapping Grid	Large-scale grid	189	Ka Mate	Year-round	2 weeks
Poamoho	*A. sowerbyana*	Predator Exclosure	Under Construction	16	Victor w/ boxes	Year-round	6 weeks
Poamoho***	*A. sowerbyana*	Trapping Grid	One small grid	16	Victor w/ boxes	Year-round	--
SBW- N. Haleauau‡	*A. mustelina*	Trapping Grid	One small grid	28	Victor w/out boxes	Year-round	6 weeks
SBW†	*C. ibidis*	Trapping Grid	Many small grids*	372	Victor w/out boxes	Annual: Dec-June	2 weeks
W. Makaleha	*C. grimesiana*	Trapping Grid	One small grid	28	Victor w/out boxes	Year-round	6 weeks
Waieli-Hapapa	*A. mustelina*	Trapping Grid	One small grid	38	Victor w/out boxes	Year-round	6 weeks
Waieli-Hapapa	*A. mustelina*	Predator Exclosure	Constructed 2011	--	--	Year-round	--

* *Each managed Elepaio (C. ibidis) territory has 12 traps installed ~12 m apart in trees.*

** *Temporary grid designed to investigate traps; a new grid of A24s will be installed in November 2013*

*** *Beginning in October 2013, OANRP will discontinue maintenance of these grids due to lack of funding for Tier 2 and Tier 3 species. The Oahu Snail Extinction Prevention Program will conduct rodent control at these sites.*

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

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

i *The majority of traps have been removed from the wooden boxes and placed in trees.*

Over the past two years, OANRP has phased out the use of bait stations due primarily to concerns related to bait efficiency/dynamics, bait longevity, and expense. Please refer to Chapter 6 of the 2012 OANRP Status Report for more details about these issues. As a result of many discussions within OANRP and with the US Fish and Wildlife Services, in 2012 OANRP removed 76% of the total number of bait stations deployed across MUs and replaced them with small snap trap grids (OANRP 2012). Over the past year, OANRP continued this process and removed the last remaining bait station grids, replacing them with snap trap grids.

Primarily, the changes in 2013 consisted of modifying the rodent control method in Elepaio territories from using grids that combined bait stations and snap traps to small grids of 12 snap traps centered on the core area used for nesting. Many territories are adjacent to one another; therefore, the small grids are somewhat continuous in some areas (see Elepaio Management Chapter for more information). The remaining MUs with bait station grids were replaced with snap traps over the course of the year; the last MUs to have their bait stations removed were Ekahanui and Ohikilolo.

OANRP does not plan on returning to the use of bait stations when the new label is approved due to the aforementioned concerns. Additionally, when the new Ramik® label is approved, it will have stricter stipulations and grid design requirements (Swift, pers. comm. 2013) that will likely preclude the use of Ramik® at most sites (i.e., the grid design and maintenance requirements may be impractical to meet).

A new tool for rat control recently became available from New Zealand: self-resetting rat traps called A24s created by Goodnature® Ltd. A24s are useful for rat control at more remote sites because the traps are designed to be set out for months without servicing, resulting in cheaper maintenance costs (see Appendix 6-1 for details). Remote sites that require access by helicopter may be especially ideal for A24s. OANRP is planning on installing A24s in the near future at several MUs and at many sites in the Koolau mountain range for protection of Kahuli tree snails.[1] These plans are discussed in Section 6.5. Having a new tool available for rat control in Hawaii is especially helpful since the use of bait stations is not an available or feasible option.

OANRP is continually researching and assessing rat control methods to determine the most effective strategies for the protection of natural resources.

6.2 Large-Scale Trapping Grid Updates

OANRP maintains three large-scale trapping grids in three management units (MUs) in the Waianae mountain range. The first grid at Kahanahaiki was installed in May 2009, the second grid at Palikea was installed in September 2010, and the third grid was installed at Ekahanui in January 2011. These grids are designed for large-scale lethal trapping for rats (*Rattus* sp.) across MUs. The overall goal is to reduce rat activity within an MU to a level that benefits the endangered plants, *A. mustelina* (Oahu tree snail), *C. ibidis* (Oahu Elepaio), native insects, and the native ecosystem as a whole. The grids are designed to target rats because they are the largest rodent threat to the natural resources OANRP protects (Mosher 2010, Shiels 2010). Mice have a much smaller home-range size than rats and the grids are not designed for effective trapping of mice. Consequently, this section discusses rat kills and rat activity only, although mice and mongooses are periodically killed in the trapping grids as well. The trapping grids follow the New Zealand Department of Conservation's (DOC) current best practices for kill trapping rats (NZ DOC 2005), however the grids vary in design, size, maintenance protocols, and trap type (discussed below). For more information about how these three trapping grids are designed, maintained, and monitored, refer to the 2011 Status Report (OANRP 2011).

Rat activity was monitored using tracking tunnels at least once a quarter inside each grid as well as outside (at a control site) for two years. OANRP determined that sufficient data had been collected to determine any differences inside and outside of the trapping grids after two years. In the Kahanahaiki grid, there was consistently less rat activity inside the trapping grid than outside the grid (control site was Pahole NAR). At Palikea, two years of rat activity data consistently showed less rat activity inside the trapping grid than in the control area (Kaaikukai). However, at Ekahanui, the tracking tunnel data did not show any clear trends or differences in rat activity inside the trapping grid versus outside (North Ekahanui). One reason for this may be that inside the Ekahanui grid there were 59 tunnels and in North Ekahanui there were only 16. This difference in sampling size is not ideal for comparison. Another factor is that the habitat in North Ekahanui is very different than the habitat inside the trapping grid. Rat activity is still monitored using tracking tunnels every quarter at each grid. However, there does not seem to be a clear correlation between trapping data and rat activity in tracking tunnels. Shiels (2010) also found no correlation between rat activity in tracking tunnels and estimates of rat abundances. Additionally, there was no correlation between rat activity in tracking tunnels and rat kills by automatic rat traps (see Appendix 6-1 for more information). OARNP continues to monitor rat activity with tracking tunnels on a quarterly basis inside each trapping grid. The utility of tracking tunnels for ongoing

[1] OANRP will not be actively managing Koolau snail sites beginning October 2013 due to a loss of funding for the management of Tier 2 and Tier 3 species. The Oahu Snail Extinction Prevention Program is taking over rodent control actions and snail management at these sites.

monitoring is uncertain; however, it has been recommend to continue to monitor rat activity using tracking tunnels (Peters, pers. comm.). According to Blackwell et al. (2002), using multiple methods for assessing rat densities increases the confidence in observed population trends and the overall quality and quantity of information gained. There have been no significant correlations found in trapping data and tracking tunnel data at any of OANRP's grids; however, OANRP plans to geographically assess tracking tunnel data in conjunction with trapping data to determine trends or "hotspots" across the grids.

In New Zealand, DOC uses tracking tunnels inside and outside of large trapping areas (> 200 ha) to assess efficacy of rodent control. They have also defined a 'damage threshold' at which rat activity in tracking tunnels must remain below in order to achieve management goals for a species (Hill pers. comm. 2011). OANRP has not been able to determine a damage threshold for rat activity in tracking tunnels that corresponds to management goals. Perhaps the trapping grids OANRP installed are too small or are otherwise unable to maintain a reduced population of rats inside the grid. Consequently, the tracking tunnel data likely reflects rat activity from new rats that are constantly moving into the trapping area, causing large fluctuations in tracking tunnel data. Additionally, the ability of a single rat to track multiple tracking tunnels makes the index susceptible to changes in activity and rodent abundance (Blackwell et al. 2002).

Instead of using rat activity in tracking tunnels to determine a 'damage threshold,' OANRP relies on trap catch data to indicate when increased trapping effort is necessary. The 'threshold' number of rat kills was selected for each grid by observing the number of rats killed in a two week period when seasonal high spikes occurred. Typically, rat catches remain below the threshold number; but when the threshold number is exceeded, the traps are baited and checked weekly until two consecutive weekly checks are completed with rat catches below the threshold number. Thereafter, twice monthly baiting resumes. The threshold number is used as a rough guideline for current management strategies. Each trapping grid is assessed separately for trends in the data and for determining the threshold number.

OANRP has looked at resource response since the trapping grids have been installed in a number of projects; thus far, all of these projects indicate a positive response overall (discussed in OANRP 2011). However, each grid has unique characteristics/successes/issues that spark questions and allow for testing and trialing of baits, trap types, and trap deployment techniques in order to improve rodent control efficacy and be more efficient with staff time. Because rat ecology is likely very different in Hawaii than in New Zealand, OANRP needs to tailor DOC's best practice guidelines to suit Hawaii's conditions.

OANRP has experienced difficulties and conditions that are not shared in New Zealand. For example, bait removal by slugs and other invertebrates is a major issue that is not experienced to the same degree in New Zealand. Additionally, it is possible that black rats (*R. rattus*) in Hawaii spend more time in trees than black rats in New Zealand (Peters, pers. comm. 2013). One question OANRP asked over the past year is whether or not it is rat control is improved by housing snap traps inside a protective box (typically placed on the ground) or whether uncovered snap traps mounted directly to trees is just as effective, if not more effective. Perhaps the rats would encounter the traps more easily if they were in trees and slugs would not encounter them as easily. DOC's best practice includes housing Victor® traps inside wooden boxes placed on the ground in order to exclude non-target species, guide target species, prevent accidental triggering, and maintain the integrity of the trap from weather (NZ DOC 2005). Recent trials in Ekahanui indicate that catch-rates may increase if traps are removed from the boxes and mounted off the ground in trees (discussed below in Ekahanui Trapping Grid section). OANRP is investigating this question further in Ekahanui over the next year and will use the results to help inform a best practice guide for OANRP's trapping grids.

Another question is whether Victor® traps are the best trap or if there are other types of traps that may prove to be more effective. The Palikea grid consists of metal Ka Mate™ snap traps that were deployed in

order to experiment with that style of trap and compare the trapping efficacy to Victor® snap traps; they are deployed without wooden boxes because they have less risk of being accidentally triggered. More experimentation with Ka Mate™ traps will occur over the next year. Automatic rat traps are a new type of trap that OANRP has recently tested and appears to be very promising; OANRP will expand the use of these traps to investigate their utility.

Additionally, OANRP will assess trapping data using GIS to ascertain any geographical trends and identify areas in need of more traps or areas where traps can be removed. Essentially, the reason for the differences between the grids and the objective for conducting these trials is to synthesize the data in order to define OANRP's best practice protocols for trapping grids. Adaptive management is essential and the best practice protocols will continue to evolve and employ varied methodologies.

In the sections below, summaries of recent trends in trapping data for each grid are assessed, the current management practices are discussed, and management considerations and changes for the coming year are highlighted. The data presented for each grid represent data collected since installation of the grid, unless otherwise stated.

6.2.1 Kahanahaiki Trapping Grid

The Kahanahaiki grid covers 65 acres (26 ha) of the Kahanahaiki MU. The grid is composed of 464 Victor® snap traps that are housed in protective wooden boxes on the ground; the perimeter consists of 234 traps spaced 12.5 meters apart and the interior contains 246 traps on transects and trails at a spacing of 25 meters apart. Since January 2012, Pono Pacific has maintained the grid from January to June and for the rest of the year OANRP staff resumes maintenance. All traps are typically checked and rebaited every two weeks unless more than 30 rats are caught on a single check; this number correlates to approximately 6.5% of the total number of traps and is used as the 'threshold' number.

As of October 3, 2013, the entire grid has been checked a total of 151 times and has killed 3,961 rats and 1,029 mice (Fig. 1). On average, 75 rat-kills have been recorded each month; the seasonal high spikes throughout the year are likely the reason the monthly average is so high. The average number of rats killed in a check is 24. Over the years, some annual trends have emerged. Catch rates in mid to late summer are typically the lowest of the year and catch rates are typically the highest in early winter. One possible explanation for this trend is that during the summer months, rats may not have to scavenge as much due to an abundant food source from strawberry guava fruits and therefore are not as inclined to visit the bait on snap traps. After the fruiting season ends in the fall, there is a boom in rat activity (possibly due to higher birth rates as a consequence of increased food consumption) and increased scavenging for food. This increase in the rat population without the supply of strawberry guava fruit causes more rats to be caught in snap traps. A second spike in catch rates has also been observed in March/April. These fluctuations correspond to previously documented trends; Shiels (2010) found that April-May and October-December tended to be the months with the greatest numbers of black rats at three study sites in the same region (including Kahanahaiki). Tomich (1981) also documented two seasonal peaks in reproduction: August to November and Februrary to June. As seen in the Palikea grid, there were more high spikes in 2011 than in any other years. Rat population densities likely vary from year to year based on a variety of environmental factors.

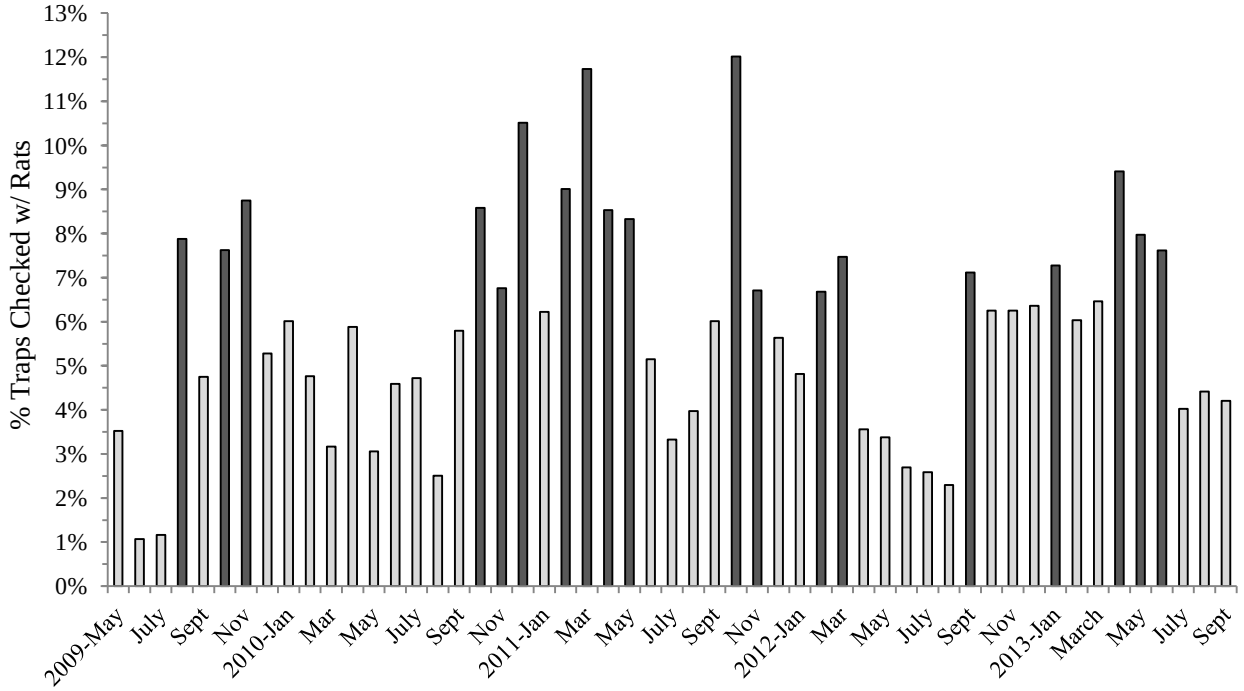

Figure 1. Percent of total traps checked each month at Kahanahaiki with rat catches.
Dark gray bars represent months when the 'threshold' number of rats was exceeded.

OARNP continues to monitor rat activity with tracking tunnels on a quarterly basis inside the trapping grid. The tracking tunnels have been run 36 times total and the average rat activity in tunnels is 23.3% (±12.2%). The average rat activity each year has ranged from 17.8% to 29.9%.

Management Considerations for 2014

OANRP has begun to assess individual trap catch data to determine which areas of the grid catch the most rats and which areas catch the least. The grid was designed with traps spaced more closely together on the perimeter of the grid with the intention to stop rats from outside the grid from reaching the interior; however, data indicate that the traps on the interior catch more rats than on the perimeter. One reason for this could be that the trapping grid is not successful enough at keeping rat numbers low enough inside the grid in order to observe the perimeter traps creating a barrier; in this case, the grid would have to be larger, be maintained more frequently to ensure there is fresh bait available, and/or have more traps added to increase rat control. Kahanahaiki is a relatively skinny MU and rats can likely cross from one side of the trapping grid to another in a day. Another reason more rats may be caught in the interior traps could simply be that there are far more interior traps than perimeter traps and the interior traps cover a large distance. More analysis is needed to optimize the grid and OANRP is discussing alternatives; a GIS layer will be created to synthesize trapping data in order find geographical trends and identify areas in need of more traps or areas where traps can be removed.

OANRP is considering installing a grid of Goodnature® A24 automatic rat traps across the MU instead of maintaining the snap trap grid. As discussed in Appendix 6-1, a grid of A24s across the MU will be more cost-effective because A24s require less frequent maintenance than snap traps. A24s may also prove to be a more effective method of rat control because they are multi-kill devices. Installing a grid of A24s would provide another opportunity to investigate the functionality of A24s. Tracking tunnels will also be monitored inside and outside of the A24 grid to monitor changes in rat activity.

OANRP continues to test new baits to use on snap traps that will minimize slug and ant consumption and render traps more effective (see "Bait Persistence Trials" section).

6.2.2 Palikea Trapping Grid

The Palikea grid covers an area of 21 acres (9 ha) (Fig. 11). The grid consists of 180 Ka Mate™ traps; there are 98 traps on the perimeter of the MU spaced 12.5 meters apart and 82 traps in the interior of the MU spaced 25 meters apart along trails. Unlike the Ekahanui and Kahanahaiki grids, the Palikea grid consists of Ka Mate™ traps without boxes instead of Victor® traps in boxes. Ka Mate™ traps were deployed in order to experiment with that style of trap and compare the trapping efficacy to Victor® snap traps. Ka Mate™ traps are set by wedging hard bait, such as coconut, underneath the trigger. The bait is held in place by tension and the trap cannot trigger until the bait is removed. The traps are deployed without wooden boxes because they have less risk of being accidentally triggered. This grid is run by the contractor Pono Pacific year-round. All traps are typically checked and rebaited every two weeks unless more than 30 rats are caught on a single check; this number correlates to approximately 16.6% of the total number of traps and is used as the 'threshold' number.

As of October 3, 2013, a total of 1,630 rats and 183 mice have been recorded in the grid (Fig. 2). On average, approximately 24 rat kills are recorded each time the grid is checked. Yearly trends are not as distinct in the Palikea grid as in the Kahanahaiki grid but the summer catch rates are still relatively low compared to fall/early winter catch rates. In October 2011 a record of 237 rats were recorded in the grid (the traps were baited and checked weekly). As seen at Kahanahaiki, there were more high spikes in 2011 than in any other years. Rat population densities likely vary from year to year based on a variety of environmental factors.

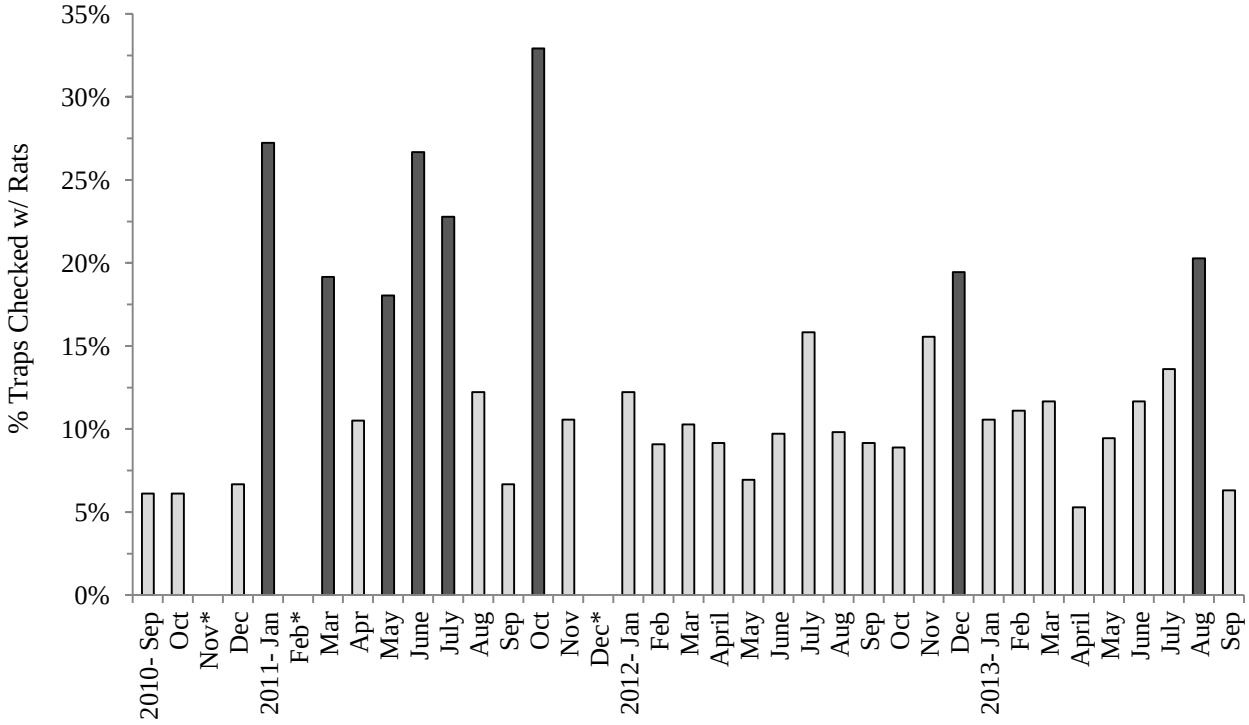

Figure 2. Percent of total traps checked each month at Palikea with rat catches.
*Dark gray bars represent months when the 'threshold' number of rats was exceeded. * indicate months that the grid was not checked.*

It is also remarkable that this grid catches more rats per trap (0.13 rats/trap) per check than the Kahanahaiki grid and Ekahanui grid (approximately 0.06 rats/trap and 0.09 rats/trap, respectively), although it is the smallest grid with the fewest traps. The Palikea grid is roughly a third the size of the grid at Kahanahaiki, yet the grids catch around the same number of rats in each check. Therefore, the threshold number to indicate spikes in rat numbers is the same at Palikea as it is at Kahanahaiki (30 rats caught in a two week period). Furthermore, the difference between the average tracking tunnel rat activity inside the trapping grid at Palikea versus the average rat activity at the control site (Kaaikukai) was greater than at any other trapping grid. Therefore, the Palikea grid appears to have the most noticeable effect on reducing rat activity relative to outside the grid.

There are several factors that may be influencing these trends. First, there may be a higher density of rats at Palikea than at the other two sites. Another explanation is that because Palikea is the only MU where the grid consists entirely of Ka Mate™ traps, it may indicate Ka Mate™ traps are more effective at killing rats than Victor® traps (see OANRP 2011 for results of a trial comparing trap types).

OARNP continues to monitor rat activity with tracking tunnels on a quarterly basis inside the trapping grid. The tracking tunnels have been run 20 times and the average rat activity in tunnels is 15.7% (±12.1%). The average rat activity in 2011 was 20.3%, 14.5% in 2012, and 9.4% to date in 2013.

Management Considerations for 2014

As with the other grids previously discussed, OANRP will create a GIS layer to synthesize trap catch data is needed to determine which areas are consistently catching higher numbers of rats in order to optimize grid design and ensure greater protection for rare resources. Ka Mate™ traps will continue to be used at Palikea but there will be continued investigation on the performance of Ka Mate™ traps relative to Victor® traps. Alternative baits to coconut will also be trialed. Pono Pacific will continue to run the grid through 2014.

6.2.3 Ekahanui Trapping Grid

The Ekahanui grid covers an area of 177 acres (72 ha). The grid consists of 620 Victor® snap traps that are housed in protective wooden boxes on the ground or placed in trees without boxes; there are 225 traps on the perimeter of the MU and 394 traps in the interior of the MU, all spaced 25 meters apart. All traps are checked twice per month until the end of the nesting season (June). The off-season is from July to November each year. In the 2011 off-season, the entire grid was baited once a month and then a subset of the traps (150) was baited a second time each month to control rodents around populations of *Achatinella mustelina*. In the 2012 and 2013 off-season, the subset of traps was baited only once a month; it was determined that running the entire grid once a month was not necessary during the off-season. In 2013, the subset of traps was modified to include areas with traps that were previously maintained by OANRP in order to be more efficient with staff time. The grid is maintained by the contractor Pono Pacific. There are no clear trends to indicate a 'threshold' number of rats caught that would signal the need to increase effort.

As of October 3, 2013, approximately 2,524 rats and 22 mice have been recorded in the grid (Fig. 3). On average, 106 rat-kills are recorded each month during the Elepaio nesting season (December – June) when the entire grid is checked twice monthly. Trapping data in months were only the subset of traps are baited is not meaningful to examine as OANRP maintained bait stations with Ramik® bait in those areas as well (until the label expired). Only 5.8 rats were caught per check of the 150 traps in 2012. In the summer of 2013, most of the traps were removed from the wooden boxes and placed in trees, which seemed to increase the number of rats killed; these changes are discussed below. The trapping data overall do not

show any clear yearly trends. It should be noted that the number of traps checked in a month varies widely from 1,500 to fewer than 150 depending on whether or not it is the nesting season.

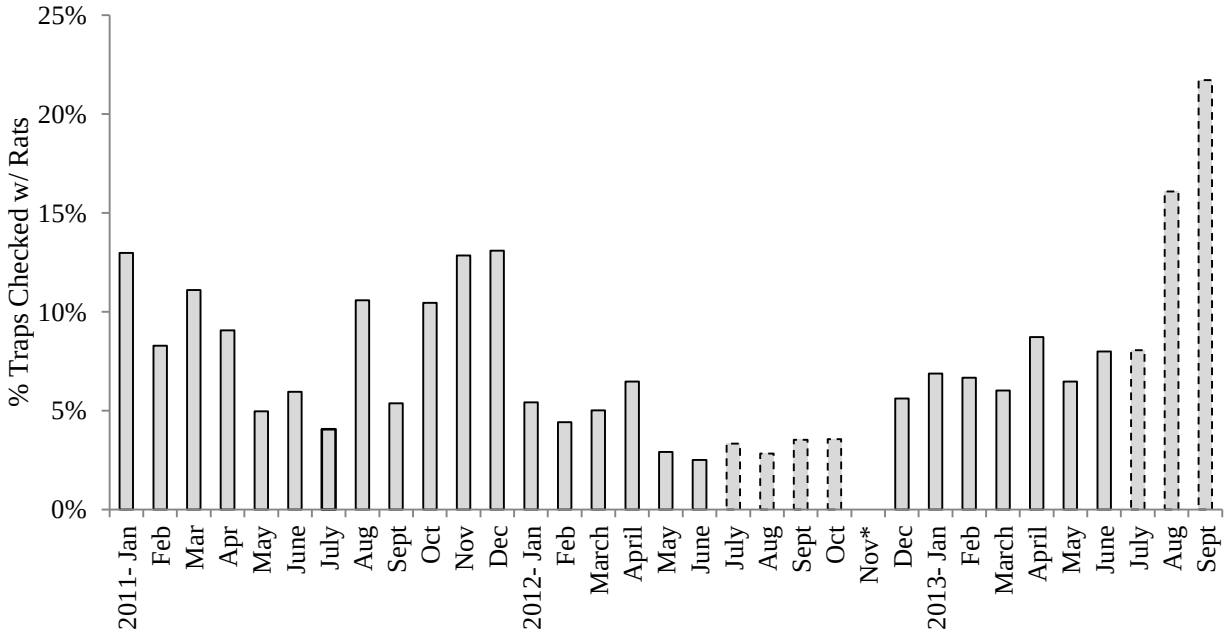

Figure 3. Percent of total traps checked each month at Ekahanui with rat catches.
Bars with solid outlines represent data collected when the entire grid is checked; bars with dashed outlines indicate 'off-season' trapping when only 150 traps are checked monthly. In 2011, the entire grid was baited during the off-season one time a month plus the additional 150 traps a second time each month. indicate that the grid was not checked that month. The high percentages of traps with rats in August and September of 2013 are likely related to recent modifications made to the grid.*

Over the past year, OANRP began to ask whether or not the traps in wooden boxes on the ground were more effective than traps uncovered in trees. This question arose because catch-rates at Ekahanui and at Kahanahaiki (also has traps in boxes) are overall lower than catch-rates at Palikea (Ka Mate™ traps uncovered) and are also lower than catch-rates in the small trapping grids in Elepaio territories (consisting of 12 uncovered Victor® traps in trees). It was also discussed that perhaps rats would encounter the traps more often and slugs would encounter the traps less often (to eat the bait) if they were in trees. The boxes add to the overall cost of installing grids and also add considerable difficulty when deploying or even checking the traps. It is possible that boxes placed in trees might be the most beneficial, but because the boxes are bulky and relatively heavy, it can be very difficult to find suitable trees in which to mount them. There are a small number of boxes with traps in trees scattered opportunistically throughout the Ekahanui grid, however, there is limited data to conduct analyses on whether or not this method is more effective. OANRP would like to test whether or not covering traps that are mounted in trees is beneficial in order to test all variations of trap deployment, but is first going to trial traps in trees uncovered.

As a first step to investigate the question, in May of 2013 a subset of traps (41 traps or 6.6% of total traps) in one area of the grid were removed from the wooden boxes on the ground and mounted above the ground directly on trees or logs to test whether or not the bait lasted longer and to discover if it would increase rat catches. The results from this trial indicate that placing traps off the ground uncovered may improve rat control: previously, the 41 traps in this trial typically caught three or fewer rats but after being hung in trees they caught 8-18 rats in the months of May and June which represented 17-45% of all rats caught in the entire grid. If this trend holds true over time and across the entire grid, the number of rats

caught could dramatically increase if more traps were hung on trees. Bait longevity, however, did not seem to be affected by moving the traps into trees. Based on this initial trial, OANRP moved the majority of traps inside the interior of the grid from boxes on the ground into trees. OANRP will continue to monitor trapping data but believe this is likely why there were high spikes in rat catches in August and September of 2013. In order to collect data for traps in boxes on the ground to compare with the traps in trees, the traps on the perimeter of the grid will remain in the wooden boxes on the ground for the time being. Finding suitable trees to install traps along the fenceline on the perimeter of the grid will likely be more challenging. Theoretically, the new placement of traps will be more accessible and attractive to rats traveling within the forest canopy and will improve overall trapping efficacy and efficiency.

OARNP continues to monitor rat activity with tracking tunnels on a quarterly basis inside the trapping grid during the nesting season. The tracking tunnels have been run 17 times and the average rat activity is 11.6% (±5.8%). The average rat activity each year has ranged from 10.5% to 12.4%.

Management Considerations for 2014

During the 2014 Elepaio nesting season, OANRP will assess trapping data to determine whether or not there has been a significant increase in trapping efficacy with the traps in trees in comparison to past data and to the traps that remain in the wooden boxes on the perimeter of the grid. Further analysis of individual trap catch data is needed to determine which areas are consistently catching higher numbers of rats in order to optimize the grid design. OANRP continues to test new baits to use on snap traps that will minimize slug and ant consumption and render traps more effective (see "Bait Persistence Trials" section 6.4). Pono Pacific will continue to run the grid through 2014.

6.3 Trapping Data Quality Analysis

OANRP conducted an interesting investigation on the quality of data reported by the contractor, Pono Pacific, who maintains all trapping grids in managed Elepaio territories. Pono Pacific staff record data, rebait, and reset all traps (over 860) every two weeks. All trapping grids maintained by Pono are Victor® rat traps. OANRP staff monitor Elepaio nesting success during this period and often opportunistically rebait and reset traps when necessary. Starting in February, OANRP staff began to record detailed notes when there was evidence of a kill: when a carcass or any hair was observed on a trap (sometimes only a few hairs), the data was recorded but the trap was not reset. This data was later compared to the data received from Pono Pacific after they had visited the site in order to quality control their performance and to assess the overall accuracy of the kill data. The interval between OANRP staff recording data and Pono visiting the site varied widely across the study period (from 1 – 30 days with an average interval of approximately 11 days); the wide range in intervals between checks was primarily due to the fact that access to SBW was limited to one to two weekends a month. Although this analysis has only been conducted this one time, it would be useful to conduct the same study on OANRP staff.

Results from this informal study indicate that Pono Pacific reported 65.0% of the rat kills that OANRP staff observed (147 out of 226). The majority of the kills missed by Pono Pacific staff were recorded as 'sprung' traps with no signs of a kill. On only six occasions did Pono make a detectable error in reporting the data (recording a trap as 'unsprung' when OANRP staff observed it sprung with a kill). These six errors are likely a mistake in recording or entering the data; however with the total number of traps checked each month (over 1,720), the error rate in data reporting appears to be very low.

The implications of this project indicate that many more rats are being killed in trapping grids than are indicated by the data (in this study 35% of rat kills were missed). Indeed, there are many predators and scavengers in Oahu's forests that have been documented to remove 50% of observed rat carcasses after two to three days (see Appendix 6-1 for more information about scavenging). It is interesting to note that

theoretically, all rat kill data from OANRP's trapping grids could actually be increased by 35% to more accurately represent the number of rats killed.

Most importantly, the results of this project reiterate the need for careful inspection of traps for signs of kills and then ensuring that any sign of a kill is cleaned off the trap before setting again so as not to make the mistake of recording the kill a second time (Fig. 4).

Figure 4. An 'unsprung' trap with rat hair present on the 'kill bar'.
When traps are not adequately cleaned prior to resetting, the quality of future data may be affected. Photo courtesy of Pono Pacific, Ltd.

6.4 Bait Persistence Trials for Victor® Traps

One issue that needs to be overcome in order to improve rodent control using Victor® traps (or any type of trap) is bait persistence in the field. The bait in Goodnature® A24s seems to persist longer than in snap traps due to the fact that a larger quantity of bait is used and because the bait compartment is less accessible to slugs (especially larger slugs) than the bait on a snap trap. In trapping grids, bait can be removed from Victor® traps within 24 hours, typically by slugs (Fig. 5). 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. Finding a longer lasting bait could also greatly increase the efficacy of rat control efforts and increase benefits to natural resources.

Figure 5. Slugs (*Limax maximus*) consuming peanut butter on Victor® traps.

Many types of potential baits have been trialed in the past 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, fish oil, cinnamon paste, various scented waxes, commercial baits for squirrels, and more. OANRP has had very little success in deterring slugs with zinc tape, salt or by elevating traps (OANRP 2010). 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.

In 2012, OANRP experimented with a peanut butter-scented wax product from Pest Control Research (PCR), a New Zealand company (www.pestcontrolresearch.co.nz). The company molded the wax to fit Victor® snap traps perfectly (Fig. 6).

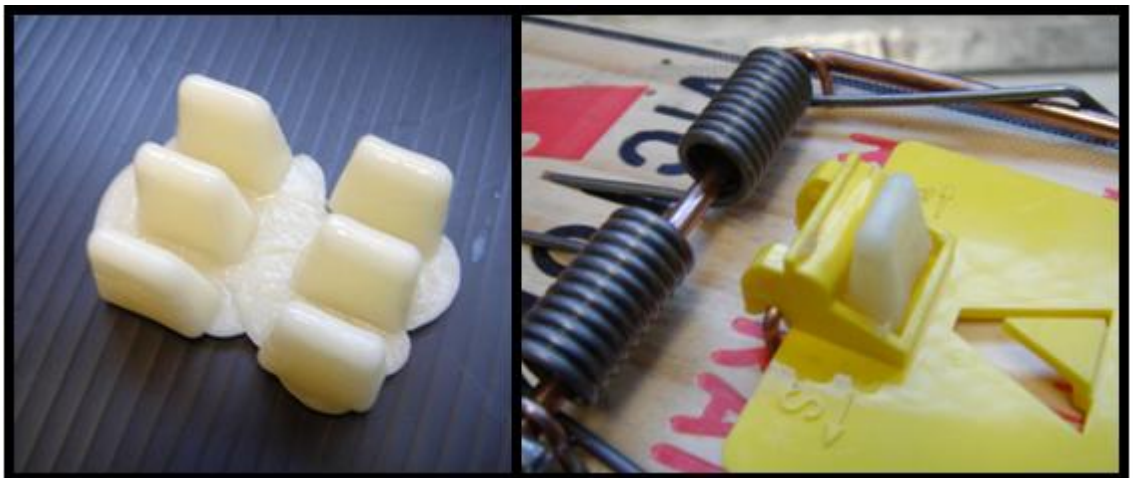

Figure 6. Peanut butter scented wax bait purchased from PCR (New Zealand) for Victor® rat traps.

From January - May, 2013, approximately half of all Victor® traps in managed Elepaio territories (over 860 traps in total) received a piece of New Zealand wax in addition to peanut butter (or other bait such as Nutella®) when they were baited (two times each month). The hypothesis was that the traps with both baits would kill more rats over time because after the first bait (e.g., peanut butter) was removed by something other than a rat and left unsprung with no bait, the traps would still have the wax bait and be more attractive to rats than traps that had no bait left. However, the results of the trial indicated that the presence of the wax on half the traps had no influence on overall catch-rates. Data were analyzed several different ways but the results were consistent: overall, the traps with wax did not catch more rats than traps with only peanut butter.

The results of the trial with the New Zealand wax were disappointing but spurred new experimentation with wax-based baits. OANRP began creating peanut butter infused beeswax cups (Fig. 7). Coconut oil was also an ingredient; however it was not consistently measured. A food preservative, potassium sorbate, was also added to the 'wax cups' to increase their resistance to mold and improve their overall longevity. The beeswax cups were experimented with in the Goodnature® A24 traps in Pahole (see Appendix 6-1) but also systematically tested in the Kahanahaiki snap trap grid on September 9 and September 23, 2013.

Figure 7. Peanut butter, coconut oil, and preservative infused beeswax cups.
Left: The wax chunks were homemade in cupcake tins or ice cube trays. Right: A black rat killed by a trap baited with peanut butter beeswax.

Qualitative observations clearly indicated that the preservative made a remarkable difference in increasing the longevity of the wax cups. Data from the bait trials in the A24s at Pahole showed that the wax cups were as attractive to rats as regular peanut butter (with or without an added preservative). See Appendix 6-1 for more information. On September 9 (Trial 1) and on September 23 (Trial 2), peanut butter beeswax chunks were placed on approximately every other trap in the Kahanahaiki trapping grid and regular peanut butter was used on the rest of the traps (consisting of 464 Victor® traps; Fig. 8). Results from these trials indicate that the longevity of the beeswax is significantly better over a two week period than peanut butter (Table 2). Longevity is indicated by the percent of traps that had bait present when checked. Furthermore, the peanut butter infused beeswax appears to be relatively attractive to rats. Trial 1 had proportionally more rats killed in traps with the beeswax bait than in traps baited with peanut butter

(PB). However, in the second trial, the reverse occurred with proportionally more rats being killed in traps baited with PB.

Table 2. Results from peanut butter beeswax versus peanut butter bait trials.

		Trial 1	Trial 2
BEESWAX	# Traps w/ bait	249	240
	# Rats	12	16
	% Traps w/ rats	4.8%	6.7%
	% Traps w/ bait present	50.6%	44.6%
PB	# Traps w/ bait	211	223
	# Rats	8	26
	% Traps w/ rats	3.8%	11.7%
	% Traps w/ bait present	6.2%	9.0%

Regular peanut butter has been found by OANRP to be the most attractive bait despite its persistence issues. However, the results from these bait trials are very promising in that the peanut butter beewax is also attractive to rats and has much better longevity. It may be the most promising alternative bait discovered so far. More testing is occurring to confirm these results.

Over the next year, OANRP will begin using the peanut butter beeswax more extensively. To maximize bait attractiveness to rats and longevity, OANRP will experiment with using the peanut butter beeswax as supplemental bait; all traps will be baited with a piece of 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 (e.g., peanut butter) is present and will remain baited with the wax after the peanut butter has been removed by insects or slugs.

OANRP will also experiment more with adding food preservatives to peanut butter to increase longevity. Wax concoctions appear to be more resistant to slugs/ants but may not be necessary in trapping grids that are visited more frequently (e.g., traps in Elepaio territories during the nesting season) since more rats were caught at Kahanahaiki in a two week period with regular peanut butter.

Using peanut butter beeswax cups in combination with peanut butter on snap traps 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.

6.5 Goodnature® A24 Automatic Rat Trap Projects

The Goodnature® A24 self-resetting kill-trap from New Zealand is a new tool for rat control in natural areas (Fig. 8). These traps are powered by compressed CO_2 and can reset automatically up to 24 times before the CO_2 canister needs to be replaced. They are designed to be baited with a long-lasting attractant and set out for months without servicing. A24s appear to be a more effective, humane, and safe way to conduct rat control. Additionally, they may significantly reduce long-term costs because they are designed to be maintained less often than bait stations or traditional snap traps. The traps also kill stoats (*Mustela erminea*; not found in Hawaii) and mongooses (*Herpestes javanicus*).

Figure 8. Goodnature® A24 Automatic rat trap with CO_2 cartridge and digital counter. *Photo taken at Pahole NAR.*

In partnership with Kalaupapa National Historical Park and collaboration with the State of Hawaii Department of Land and Natural Resources, OANRP maintained a grid of 45 Goodnature® A24 traps at Pahole Natural Area Reserve, from October 2012 to August 2013. The overall aim of this project was to investigate the utility of automatic traps in Hawaiian forest settings. Specific project objectives were: testing a specific grid layout, monitoring resource response to the effects of the A24 grid, monitoring changes in rat activity after installation of the grid, experimenting with various baits, and creating guidelines to help develop a best practice protocol.

A technical report that discusses the details of the project, a discussion of the results, and implications of the study is included as Appendix 6-1. There are also suggestions and tips included for use of traps.

OANRP also installed one A24 per Elepaio territory in North Haleauau gulch at Schofield Barracks West Range (SBW) in 15 consecutive territories. The primary reason for installing A24s at this site was that access to SBW was severely restricted during the past Elepaio nesting season. From January to March no access was permitted to SBW; from April-June access was granted one to two weekends per month. Installing A24s was an attempt to try to improve rat control efficacy during the nesting season.

In 13 territories at North Haleauau, one A24 trap was installed in the center of an existing grid of 12 snap traps. The snap traps ran throughout the length of each territory and were spaced approximately 12 meters apart. In two territories, A24s were placed in the center of the territory as the sole method of rat control (no snap traps).

The 15 A24s in North Haleauau did not kill as many rats per trap as the 45 A24s in Pahole. On average, the North Haleauau A24s killed 0.96 rats per trap each month. In contrast, the Pahole A24s killed 1.53 rats per trap per month. The number of traps with counters to record data varied each month from 12 to 14 at North Haleauau. When counters were not available to install on a trap, no data was collected. A

total of 53 rats were recorded in five checks from April to June (Fig. 9). One mongoose carcass was also found.

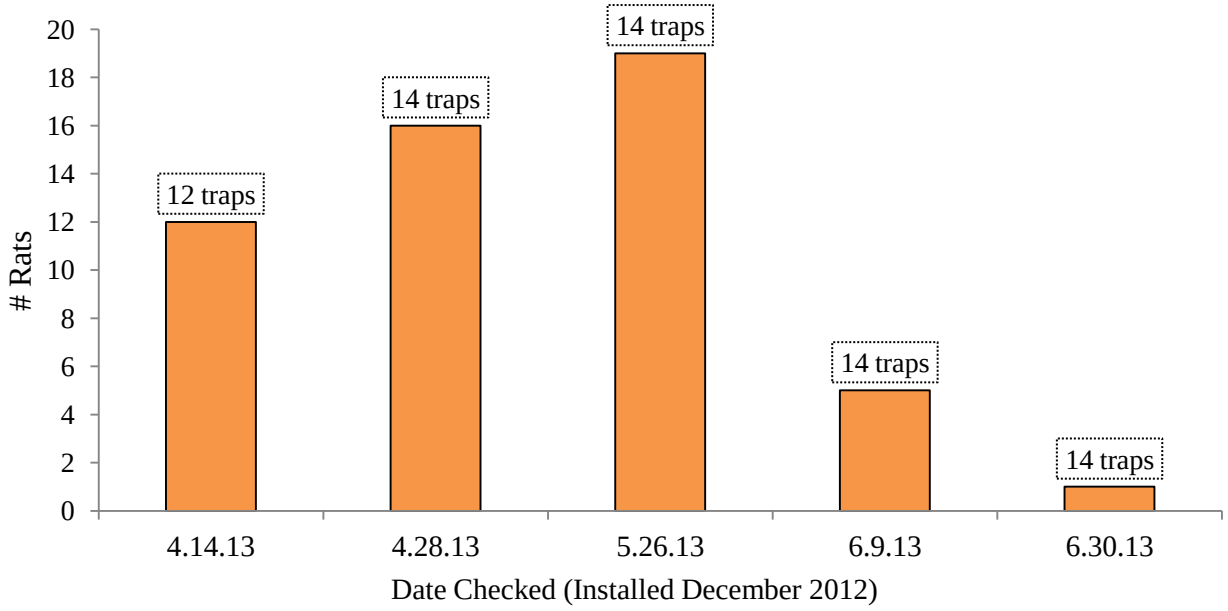

Figure 9. The number of rats killed by A24s in North Haleauau, Schofield Barracks West Range.

One possible reason the A24s did not perform as well in North Haleauau is that in the majority of Elepaio territories there were also snap traps grids. OANRP found the small snap trap grids to be effective for rat control in order to achieve Elepaio nesting success (see Elepaio chapter). Perhaps more rats would have been killed by A24s if they had been the sole device in those territories. There was no noticeable difference in the performance of the two traps that were the sole rat control method in their respective Elepaio territories. It possible that there are differences in the rat populations at Pahole versus North Haleauau, but the habitats of the two areas are similar (i.e., mesic forest, gulches, abundant strawberry guava) so it is assumed that any differences in rat populations or behavior are minimal. It is also possible that the relatively small number of A24s installed in North Haleauau limited the quality of data collected. Finally, the fact that the A24s in North Haleauau did not have their bait refreshed as often as the A24s in Pahole likely affected the overall attractiveness of the North Haleauau traps.

Overall, OANRP has learned a great deal about these new traps over the past year. OANRP considers the utility of A24s to be the greatest at remote sites that require helicopter access or are otherwise difficult to access. A24s will be installed in the near future at remote sites including Ohikilolo, East Makaleha, and at many sites in the Koolau mountain range for protection of Kahuli tree snails.[2] As mentioned, OARNP is also considering installing a grid of A24s in Kahanahaiki across the MU instead of maintaining the snap trap grid. Gaining a new tool for rat control in Hawaii is especially valuable because there are limited options available and OANRP is optimistic about the use of these new traps.

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[2] As previously mentioned, OANRP will not be actively managing Koolau snail sites beginning October 2013 due to a loss of funding for the management of Tier 2 and Tier 3 species. The Oahu Snail Extinction Prevention Program is taking over rodent control actions and snail management at these sites.

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CHAPTER 7: INVERTEBRATE CONTROL PROGRAM

Summary

This chapter describes the status and outcome of actions carried out under the direction of the Oahu Army Natural Resource Program (OANRP) Research Specialist which, this year, focused on the control of invasive slugs (*Pulmonata, Stylommatophora*) and ants (*Hymenoptera, Formicidae*). The installation of refuge traps for the purpose of detecting alien snails and slugs around the Nike greenhouse is also discussed.

7.1 SUMMARY OF SLUG CONTROL ACTIONS OCT. 2012-SEPT. 2013

Background: Slugs can cause dramatic declines in the survival of rare native Hawaiian plants (Joe & Daehler 2008). Control of slugs using the organic molluscicide Sluggo® (trademark omitted from the rest of this document; Neudorff, Germany) was shown to encourage seedling germination and recruitment among certain rare plant species**,** including a species each in the genus *Cyanea* and *Schiedea* (Kawelo *et al*. 2012). In 2010 Sluggo was approved for forest use by the Hawaii Department of Agriculture under a Special Local Needs (SLN) permit No: HI–100004 valid through Oct. 2015. This SLN has, for the first time, made slug suppression or elimination possible around rare plants in the wild. In response, OANRP has expanded its slug control program to protect seven species in four Management Units (MUs) across an area equal to 2.3 acres in total. Most of the species are within the genera *Cyanea* (or its family, Campanulaceae) and *Schiedea* (Table 1), with the assumption that congeners may similarly benefit from the application of Sluggo. One additional species, *Phyllostegia mollis*, was added because slug herbivory has been observed. These species received Sluggo treatments at a rate of 1 lb. Sluggo per 184m^2 per month (Table 1).

Table 1. List of rare plant species treated monthly with Sluggo

MU	Plant species treated (Population Reference Code)	Treatment area* (m^2)	Sluggo (lbs./month)
Ekahanui	*Cyanea grimesiana* subsp. *obatae* (EKA-C) , *Delissea waianaeensis* (EKA-D), *Phyllostegia mollis* (EKA-D), *Schiedea kaalae* (EKA-D)	4,232	23
Puu Palikea	*C. grimesiana* subsp. *obatae* (PAK-A & PAK-B)	2,220	12
Kahanahaiki	*C. superba* subsp. *superba* (MMR-E & MMR-H), *S. nuttallii* (MMR-E), *S. obovata* (MMR-C & MMR-G)	1,650	9
West Makaleha	*C. longiflora* (LEH-B), *S. obovata* (LEH-A & LEH-C)	1,196	6.5

*The treatment area was not necessarily contiguous, rather it is the combined treatment area for the MU

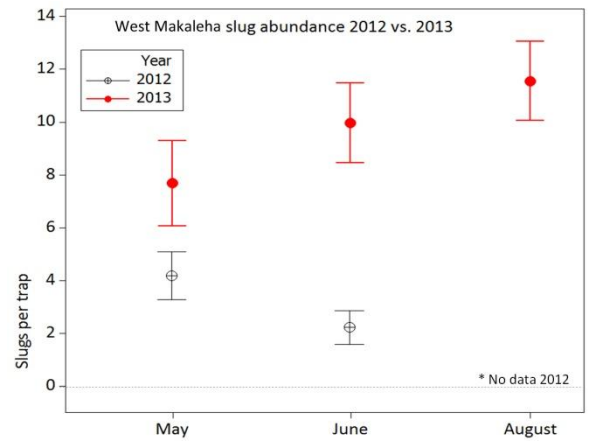
Costs associated with Sluggo application within each MU's are listed in Table 2.

Table 2. Annual cost (by MU) for Sluggo treatments (Oct. 2012-Sept. 2013)

MU	Lbs. of Sluggo	Cost of Sluggo (@ $61.25/25 lb.)	Staff hours	Cost for staff (@ 40 K/year)
Ekahanui	276	$676.20	120	$2,500
Puu Palikea	144	$352.80	120	$2,500
Kahanahaiki	108	$264.60	60	$1,250
West Makaleha	78	$191.10	60	$1,250
Grand total: $8,985				

Pest species monitoring: Slugs become more active with increased rainfall and forest floor moisture (Nystrand & Granström, 1997). Accordingly, OANRP staff have observed slug abundance drop to undetectable levels during the dry season (June-August) and see it generally begin to rise at the onset of the wet season (Oct.-April; Joe 2006; OANRP 2007). We regularly use measures of relative slug abundance (methods described in next paragraph) to trigger the initiation of Sluggo treatments so that it coincides with high pest numbers ($\geq$3 slugs per trap) and cease when slug numbers drop (<3 slugs per trap). Generally, Sluggo is not needed after May due to dry conditions; however, this year slug numbers remained high enough to require treatment year round (Figure 1: A-C).

Relative slug abundance was measured using baited pitfall traps (McCoy 1999) consisting of ten 9-oz. glass jars, placed in holes so that their openings were level with the soil surface and baited with six oz. of beer. Traps were scattered throughout each treatment site at least two meters from the nearest trap and at least two meters from the edge of the Sluggo application area. At each Management Unit (MU), treatment and control sites were established no closer than 30 meters and no further than 100 meters from one another. Control sites roughly mirrored the size of each treatment site, which varied by MU. Traps were set for two weeks, after which any captures were recorded. Due to constraints on time and labor, relative slug abundance was monitored most often at West Makaleha where research into the effect of increasing the treatment buffer around rare plants was under investigation (results to be discussed in Section 7.2). In May, June, and July, traps were baited at Ekahanui and Palikea at the onset of the dry season to determine whether Sluggo could be discontinued. Slug numbers at the control (no treatment) sites were higher across all three MUs in May and June 2013 compared to 2012, and remained unusually high through August (Figure 1: A-C.). As a result, Sluggo treatment continued through August and September 2013.



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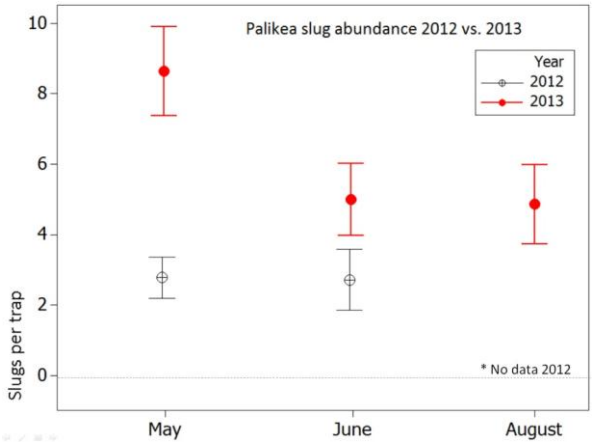

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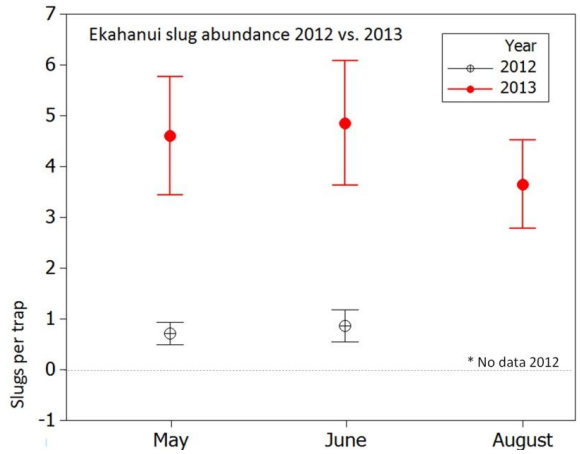

C.

Figure 1. Shown above is slug abundance in the control sites for 2013 vs. 2012 (bars are ± 1 SEM). Pest numbers are higher in the summer of 2013, requiring continued Sluggo treatment through September.
A. Slug abundance at West Makaleha MU.
B. Slug abundance at Palikea MU.
C. Slug abundance at Ekahanui MU.

Expansion of slug control in 2014: In the coming year, three additional sites are scheduled to receive Sluggo. The rare plants present at these sites have all received Sluggo treatments in other MU's previously (Table 3).

Table 3. Sites selected for slug control in 2013-2014. Estimated time required per month for Sluggo application is also shown.

MU	Plant species treated (Population Reference Code)	Treatment area (m^2)	Sluggo required per treatment (lbs.)	Est. staff hrs. (per month)
Pahole	*Cyanea superba* subsp. *superba* (PAH-A), *Schiedea nuttallii* (PAH-D & PAH-E)	3,000	16	5
Makaha	*Cyanea longiflora* (MAK-A & MAK-B), *Schiedea nuttallii* (MAK-	1,000	6	10

	A)			
Upper Kapuna	*Schiedea kaalae* (KAP-A)	706	4	5

Measuring success: Of interest to OANRP is the resource response to slug control. While we can confirm that slugs reduce the survival and germination of *C. superba* and *S. obovata* when they are at an extremely young age (2-6 months, Joe & Daehler 2008), these experiments do not tell us what effect slug control is having on adult plants or on the individual plant populations listed in Tables 1 and 2. In general, these plants are monitored once a year. Of the 11 populations undergoing slug control (Table 1) two *C. grimesiana* populations (PAK-B in Palikea and EKA-C in Ekahanui) had seedlings for the first time following Sluggo application. Though this may be due to Sluggo application, the lack of a control group (for comparison) means the positive effect of other management actions, such as weeding, rat trapping and the continous augmentation of plant populations with new adults, cannot be ruled out as the cause. Also, because monitoring is carried out with uneven effort, perhaps seedlings present prior to slug control were simply missed. For these reasons, it would be pure speculation to conclude the gains in seedlings were due exclusively to slug control.

We can improve monitoring for plant populations not yet treated (Table 2). If surveyed thoroughly prior to Sluggo application, then year afterward with consistent effort, we would expect positive gains in seedling recruitment. To isolate the effect of slug control from other management actions, we would like (when possible) to sow fruit from target plant populations inside and outside areas treated with Sluggo. Increased survival of seedling from these sows within the treatment areas would indicate slug control has had a beneficial effect.

7.2 Optimal Sluggo Application at West Makaleha MU

Background: In 2011 we set up an experiment to determine whether Sluggo applied at the label rate once a month (monthly) provides equal slug suppression when applied every two weeks (bimonthly). These two rates were chosen because the label states (italicized emphasis added): "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." We manage sites that are fairly remote. The cost of slug control is doubled if crews must treat plants every two weeks when only a single application per month is required to significantly suppress slugs in the treatment area.

Results indicated that a longer interval between Sluggo applications (monthly vs. bimonthly treatments) provided adequate slug control in the two largest sites (Ekahanui and Palikea) but was insufficient at West Makaleha. We could not determine whether Sluggo application was less effective at West Makaleha because the treatment area was too small (144 m^2), or because slug numbers were, overall, consistently higher than at the other two sites or both (OANRP 2012).

This year, we wanted to build upon previous findings. In particular, we aimed to determine whether increasing the size of the West Makaleha treatment site to 368 m^2 (more than double the original size) would prevent slug incursion even when Sluggo was only applied monthly. We refer to this treatment as the monthly large area treatment (MLAT). The two other treatments completed in 2011-2012 are referred to as the bimonthly (Sluggo applied two times per month) small area (BSAT) and the monthly small area treatment (MSAT). We then compared reductions in slug numbers due to the three treatments against one another to see which was most effective.

Methods: We used counts of slugs at baited traps checked every two weeks in treatment and control sites as a measure of relative slug abundance (section 7.2). Slugs were counted at the treatment and control sites two times per month while Sluggo was applied once per month (MLAT) in the middle of the month. The MLAT study began on 10/15/2012 and ended on 4/15/2013 although we continued to apply Sluggo throughout the summer. The BSAT and MSAT tests took place the previous year (Figure 2).

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) at a particular time. For each monitoring event, changes due to the treatment were calculated by subtracting the mean number of slugs found in the treatment area from the mean number of slugs in the control area. Sample sizes therefore depended on the number of monitoring events. For the MLAT study, there were 12 monitoring events. Within the MSAT and BSAT groups there were nine monitoring events (OANRP 2012).

Analysis: Statistical analyses were performed with Minitab Release 16 software of Minitab Inc. (Ryan *et al.* 2005). Significance during hypothesis testing was characterized by p-values less than 0.05. Datasets were significantly non-normal so non-parametric tests were used. The reduction in slug numbers due to the MLAT vs. the other two treatments (MSAT & BSAT) were compared using three Wilcoxon–Mann–Whitney U tests (MWU)**,** followed by a Bonferroni adjustment for multiple comparisons (3 total: MLAT vs. BSAT, MLAT vs. MSAT**,** and BSAT vs. MSAT).

Results: The number of slugs recorded at the treatment and control sites in the small and large treatment areas over time are shown in Figure 2. Also shown are the duration and timing of each of the three treatments. The bimonthly small treatment application (BSAT) began in Oct. 2011 and continued through Jan. 2012**,** followed by the monthly small area treatment application (MSAT) which ended in June 2012. The monthly large area treatment (MLAT) ended in April 2013. It can be seen that slug numbers were much higher in the control areas in the spring of 2013 than they were at the same time in 2012.

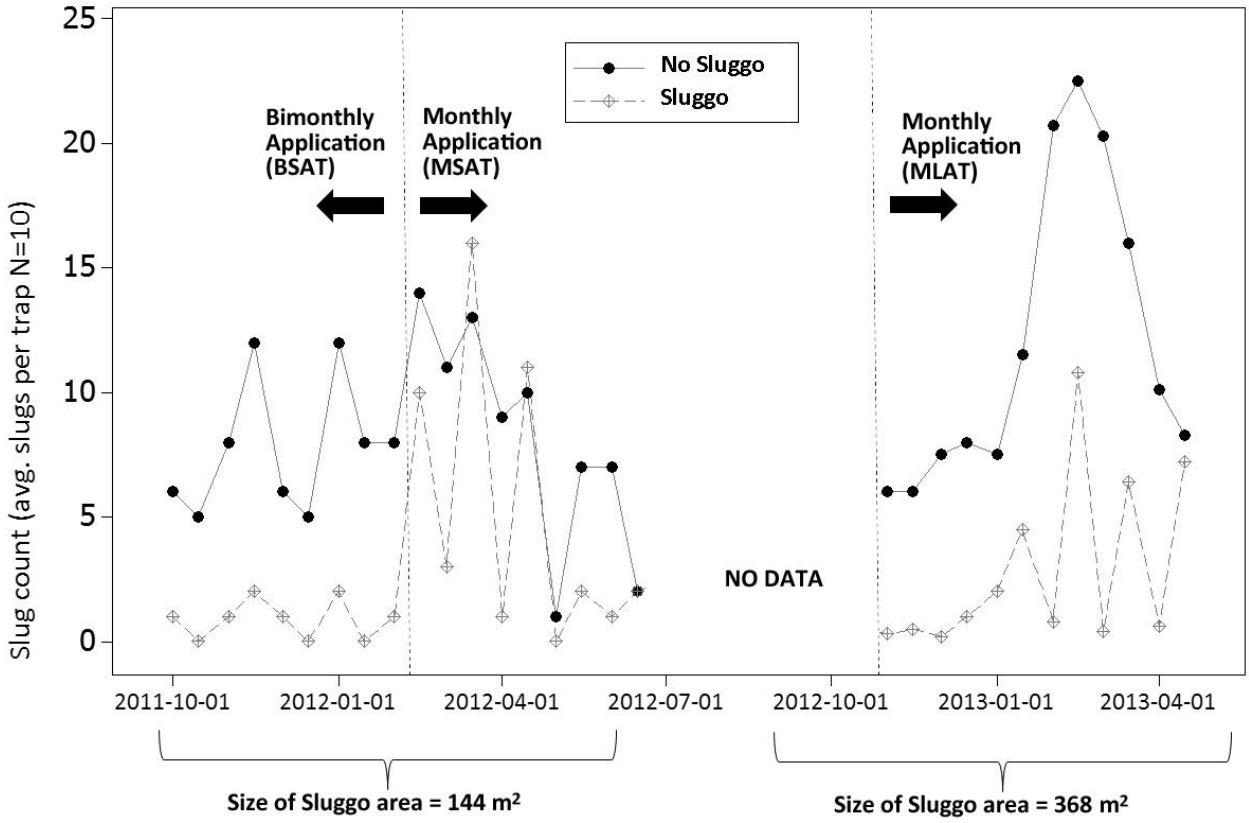

Figure 2. Slug numbers in treatment (Sluggo) and control (no Sluggo) areas are shown over time. Fluctuations in the MSAT and MLAT slug numbers coincide with the monthly Sluggo applications which occurred mid-month (slugs were counted at the same time). For those groups, slugs had recovered somewhat at the time of each Sluggo application.

The greatest reduction in the number of slugs due to treatment were in the MLAT and BSAT groups, with the MSAT group being the least effective (Fig. 3). Thus, increasing the treated area was effective in reducing slug numbers and was roughly equivalent to treating a small area more frequently. Clearly, treating a small area once a month provides only modest slug reduction and the area should be increased to reduce incursions.

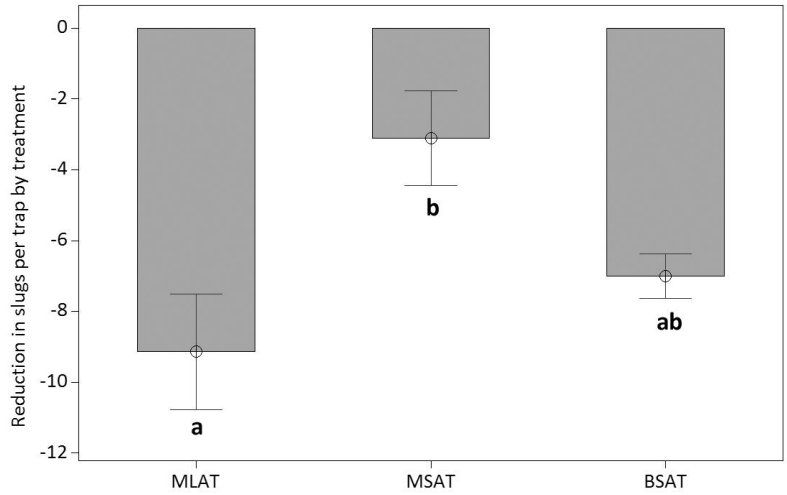

Figure 3. Reduction in slugs (bars are ± 1 SEM) are shown within the three treatment groups. Letters indicate groups that are significantly different from one another (MWU, $P<0.05$). Note that the bimonthly small area treatment (BSAT) does not differ significantly from either other group. The monthly large area treatment (MLAT) significantly reduced slugs over the monthly small area treatment (MSAT).

Conclusion: Expanding the treatment area significantly improved slug suppression at West Makaleha and allowed for a longer interval between treatments. When treating areas ≤ 144 m^2**,** effective slug control can only be achieved by frequent application of Sluggo (every two weeks). Slugs will recover at such sites within one month's time. Sluggo application on individual plants should be avoided in favor of treating a large buffer around all plants in the area.

Future work: We are interested in learning whether Sluggo remains effective when applied less frequently than once a month (*e.g.* every six weeks or two months). Based on our previous work, we believe the longer the interval between treatments, the larger the treatment area must be to prevent slug incursion. Such trials may be attempted in the coming year.

7.3 Survey of Invasive Ant Species

Background: In Hawaii, ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads (OANRP 2010).

As stated in previous reports (OANRP 2011)**,** OANRP conducts annual surveys of invasive ants in high-risk areas using a standard protocol developed by University of Hawaii entomologists (OANRP 2010). Careful monitoring will increase our chances of early detection and eradication. Results from current and past surveys appear in Table 4. Medium-risk species are underlined and low-risk species are in regular italicized font. No high-risk species were detected. Risk was assessed using the factsheets provided by Saurnat (Pacific Invasive Ant Key).

Management Unit	Ants recorded prior to 2013	Ants recorded 2013	Action needed?
Pahole	*Leptogenys falcigera, Paratrechina bourbonica, Solenopsis genimata, S. papuana,*	*Solenopsis papuana, S. geminata, Plagiolepis*	Treatment for *S. geminata* will be attempted using Amdro fire ant bait.

		*alluaudi**	
Kaluakauila	*Anoplolepis gracilipes*, *Cardiocondyla emeryi*, *Ochetellus glaber*, *Paratrechina bourbonica*, *Plagiolepis alludi*, *S. papuana*	*Anoplolepis gracilipes*, *Pheidole megacephala**	Species present are widespread at the elevations found.
Kaala	*Ochetellus glaber*, *S. papuana*, *Tetramorium simillimum*, *Cardiocondyla venustula*, *C. wroughtoni*, *C. minutior*	No ants recorded	No ants detected in 2013. This area is very wet and ants found previously are in low numbers.
Helemano	No ants recorded	No ants recorded	No ants detected. This site will be discontinued.
Kahuku Training Area	*Pheidole megacephala*, *Anoplolepis gracilipes*	*Pheidole megacephala*, *Anoplolepis gracilipes*	Both species present are too widespread for control at the elevations found.
Pahole mid-elevation nursery (Nike site)	*Anoplolepis gracilipes*, *Cardiocondyla obscurior*, *Ochetellus glaber*, *Solenopsis papuana*, *S. geminata*, *Tetramorium bicarinatum*	*Solenopsis papuana*, *S. geminata*, *Ochetellus glaber*	Treatment for *S. geminata* will be attempted using Amdro fire ant bait.
Kaena East of Alau	*Monomorium floricola*, *Ochetellus glaber*, *Solenopsis papuana*, *Tetramorium simillimum*, *T. caldarium*	*Tetramorium simillimum*, *Ochetellus glaber*	All species detected are low-risk
Makaha	*Anoplolepis gracilipes*, *S. papuana*	*Anoplolepis gracilipes*, *Pheidole megacephala**, *Technomyrmex albipes**	All species widespread at parking lot, no ants detected at outplanting sites
Ekahanui	*Solenopsis papuana*, *Plagiolepis alluaudi*, *Technomyrmex albipes*	*Solenopsis papuana*	Species are low risk.
OANRP Baseyards	*Anoplolepis gracilipes*, *Pheidole megacephala*, *Technomyrmex albipes*	*Anoplolepis gracilipes*, *Pheidole megacephala*, *Technomyrmex albipes*	All species are well established. Suppression of ants will take place regularily to prevent accidental transport

Table 4. Above is a list of ant species that were found in each MU. New records for 2013 are indicated with an asterisk*. Medium-risk species are underlined, the rest are low-risk (Pacific Invasive Ant Key, Saurnat).

Ant Control Actions: Three infestations of the *Solenopsis geminata* (tropical fire ant or TFA) were identified and treated in 2011 by State and OANRP staff (infestations were at Pahole Mid-Elevation Nursery, Puu 2210**,** and Peacock Flats Campground). Followup monitoring in 2013 shows TFA has not recurred at Puu 2210, but, after a one-year absence, has been detected at the Peakcock Flats Campground

and at the Pahole Mid-elevation Nursery. In the past**,** TFA has responded well to insecticidal baits containing the active ingredient hydramethylnon. With cooperation from the State DLNR who manage the campground and greenhouse areas, we will reapply this bait as needed. Further monitoring in 2014 is needed to ensure successful eradication.

7.4 Nike/Pahole Nursery Snail Invasion Detection Protocol

Background: In 2012 OANRP contracted Dr. R. Cowie and Dr. N. Yeung from the Pacific Biosciences Research Center at the University of Hawaii at Manoa to develop a protocol for detecting alien snail and slug infestations on plants at the Nike site nursery. As this greenhouse contains plants which will be used for habitat restoration, it is vital that no pests are accidentally introduced into natural areas.

Included in the greenhouse sanitation plan was the establishment of refuge traps around the perimeter of the greenhouse to detect alien snails before they enter. The authors stated: "Approximately 80 plastic containers (length 13 cm, width 10 cm, height 5 cm) will be put into the ground surrounding the nursery, approximately 5 meters out from the nursery and positioned 1 meter apart by OANRP personnel …Each container will have a hole cut out of its bottom, approximately 6 x 4 cm to permit drainage. Each container will contain a piece of lettuce (food) and a piece of cardboard (shelter), each approximately 4 x 4 cm. Containers will be monitored by OANRP personnel every 3-4 days for any snails. Each container should be searched for at least 30 seconds, to ensure finding very small snails. On each occasion the lettuce and cardboard will be dampened as needed. Replace lettuce also as appropriate (if it has dried out or become rotten)." We installed 67 traps according to these specifications (with slight modifications due to materials available) in March of 2013. The placement of these traps is shown in Figure 4.

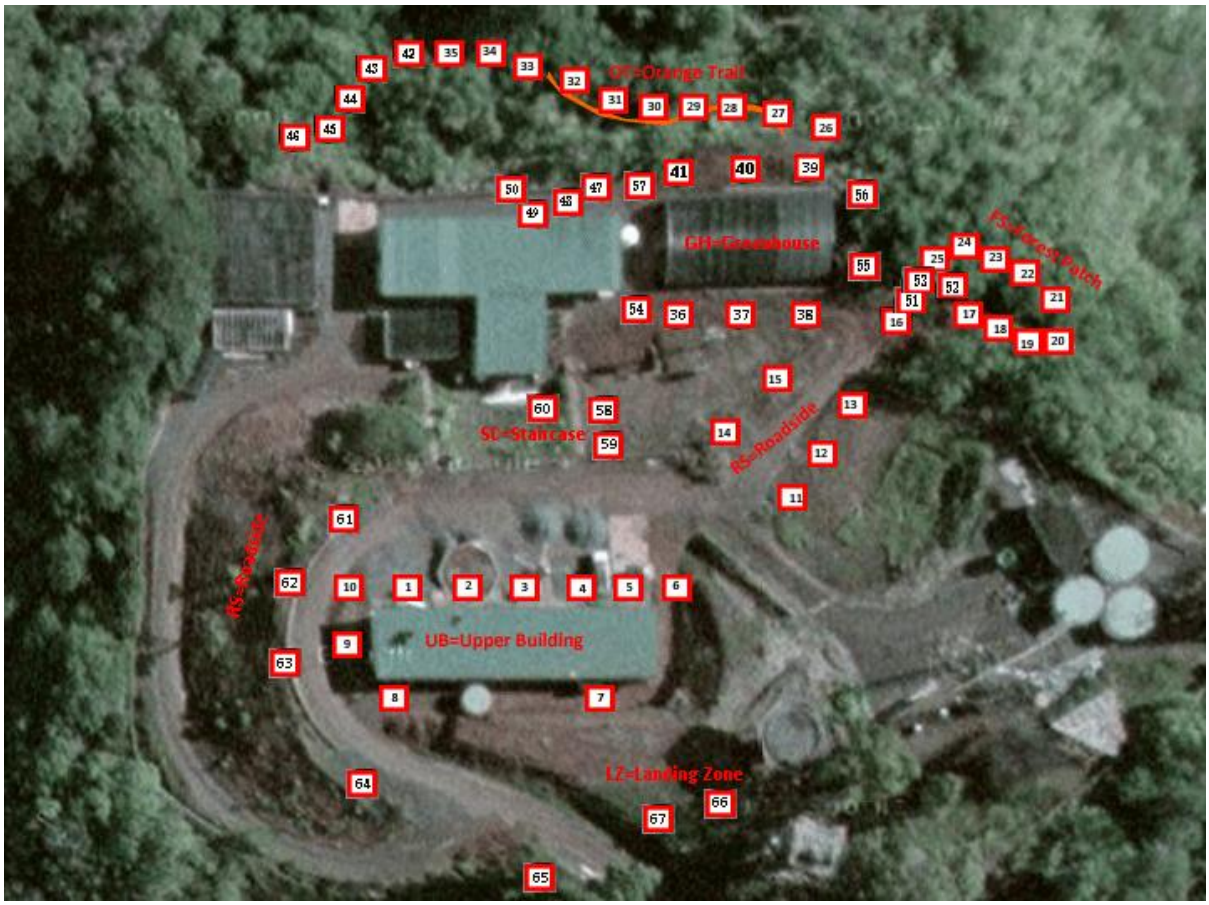

Figure 4. Location of alien snail detection traps at the Nike Site greenhouse

Actions: Traps were baited with lettuce and checked according to the timeline shown in Table 5. Discovered pests also appear in Table 5. The abundance of alien molluscs found in traps dropped between July and Sept. from a mean of three per trap to less than one (Fig. 5). No pests were found in the traps next to the greenhouse, rather, most occurred in the forest patch, along the orange trail and at the upper building (Fig. 6). As no pests were detected adjacent to the greenhouse, no special actions were needed. If pests were detected, molluscicide needs to be applied within and directly outside the greenhouse. Plants with pests should be placed on separate benches with salt troughs on the legs to prevent movement of pests. In the future, refuge traps will be baited and checked prior to outplanting as well as quarterly.

Date	Action	Alien snails and slugs found
March 14, 2013	Traps baited	N/A
March 19, 2013	Traps checked, re-baited	*Deroceras laeve, Zonatoides arboreus*
March 27, 2013	Traps checked	*Allopeas gracile, Deroceras laeve, Zonatoides arboreus*
June 27, 2013	Traps baited	N/A
July 1, 2013	Traps checked	Tornatellidinae*, *Allopeas gracile, Deroceras laeve, Zonatoides arboreus, Limax maximus, Veronicella cubensis*
Sept. 28, 2013	Traps baited	N/A
Sept. 30, 2013	Traps checked	*Allopeas gracile, Deroceras laeve, Zonatoides arboreus, Limax maximus, Veronicella cubensis*

Table 5. Alien snail and slug species found in refuge traps. *Origin not known.

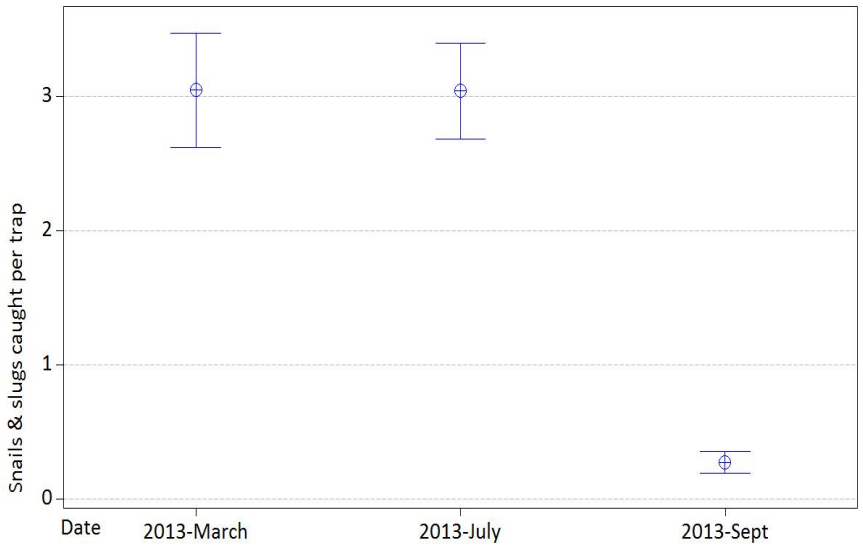

Figure 5. Average number of alien molluscs caught per trap over time. Bars are ± 1 SEM.

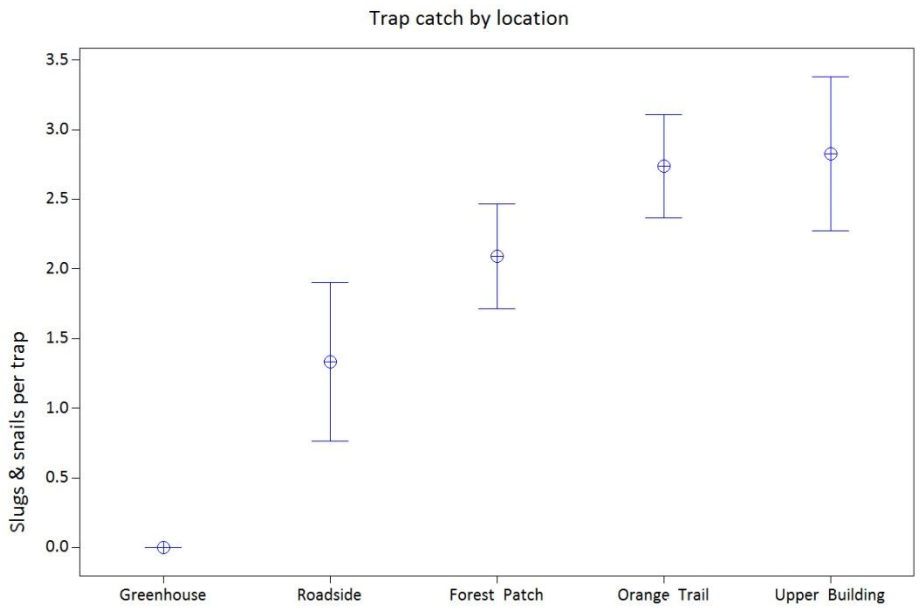

Figure 6. Number of alien molluscs caught per trap by location. Bars are ± 1 SEM.

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