2011 Status Report for the Makua and Oahu Implementation Plans

December 2011

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EXECUTIVE SUMMARY

The Oahu Army Natural Resources Program (OANRP) totals 50 personnel comprised of support staff, a fence crew, three resource management crews, and a nursery / seed bank management crew. Staff levels in Fiscal Year (FY) 2011 were similar to those in FY2010, though there has been staff turnover and replacement hiring is ongoing for several vacant positions. Funding decreased in FY2011 with OANRP receiving $2.94 million for the Makua Implementation Plan (MIP) and $2.35 million for Oahu Implementation Plan (OIP). Given the current federal budget battles in Congress, OANRP is waiting to fill new positions until the budget outlook is clearer.

This status report (report) serves as the annual report for participating landowners, the U.S. Fish and Wildlife Service (USFWS), and the Implementation Team (IT) overseeing the MIP and OIP. The reporting period for this report is September 1, 2010, to September 30, 2011; subsequent reports will summarize activities conducted within the fiscal year of October 1 to September 30. This year OANRP used summaries of the scheduling database to guide field actions more efficiently and to analyze time expenditures by program objectives. This detailed tracking allows senior staff to realign and reprioritize program goals to achieve more effective conservation.

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

OANRP just completed implementing its seventh year of the MIP Addendum (completed in 2005, original finalized in 2003) and the fourth year of the OIP (completed in 2008). The MIP Addendum emphasized management for stability of three Population Units (PUs) per plant taxon in the most intact habitat and 300 individuals of *Achatinella mustelina* in each Evolutionarily Significant Unit (ESU). Both issued by the USFWS, the original Makua Biological Opinion (BO) in 2007 and amended BO in 2008 require that the Army provide threat control for all Oahu elepaio (*Chasiempis sandwichensis*) pairs in the Makua action area, stabilization for 28 plant and one snail species, 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 several extant Koolau *Achatinella* species. As an example, the Army's requirement for elepaio is to conduct predator control for 75 nesting pairs.

Table 1 presents a status summary for all 28 plant species in the MIP organized by stabilization goals of 25, 50, 75, or 100 mature plants in each PU. Table 2 presents similar information for all 23 OIP plant species organized by stabilization goals of 50, 75, 100, or 150 mature plants in each PU. Stabilization goals and number of tracked PUs for a particular species depends on life history characteristics and threat levels from Army operations. The total number and life stages of plants in 2011 are listed for each PU; PUs are sorted from highest to lowest by total number of plants in 2011 per species. The total number of plants in 2010 and since the IPs were completed (2003 for the MIP and 2008 for the OIP) are presented for trend comparisons within the past year and over the long-term. Overall, the total number of plants for MIP species was 22,899 in 2011, a 7% increase from 2010 and an 89% increase from 2003 (Table 1). For OIP species, the total number of plants was 4,685 for 2011, a 1% increase from 2010 and a 6% increase from 2008 (Table 2). Note: the baseline number of some PUs is unknown and denoted by a question mark in Tables 1 and 2. For other PUs, baseline is expressed as a range because initial surveys were

*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.*

imprecise and the mean of the range was used to calculate relative change. If a population became extirpated, the percent change is expressed as -100%. Conversely, if a population has doubled in size over a given time period, the percent change is expressed as 100%.

Other information included within Tables 1 and 2 enumerate the status of genetic storage, ungulate protection, and number of PUs that have reached stabilization goals. Genetic storage of at least 50 seeds from 50 individuals, or at least three clones in propagation from 50 individuals, is required for each PU. If there are fewer than 50 founders for a PU, genetic storage is required from all available founders. For example, if there are at least 50 seeds from five individuals, or at least three clones in propagation from five individuals, then the "% Completed of Genetic Storage Requirement" listed in the tables is 10%. Genetic storage for reintroduced populations is not required because those populations originate from other populations with their own genetic storage requirement. PUs with population sizes of "0" and a genetic storage requirement of "n/a (reintroduction)" denote reintroductions that are planned but have yet to be conducted. The number of seeds in genetic storage was adjusted for this year's report and approximates the remaining number of viable seeds within stored collections. Viability rates for most collections were estimated prior to storage. For untested collections, seed viability was approximated from best available information.

Protection from ungulates is currently expressed in Tables 1 and 2 as either absent (0%), partial, or complete (100%). For next year's report, OANRP will quantify what "partial" ungulate protection means; in this year's report, "partial" represents a range between 1% and 99% of plants in the PU protected from ungulates. There are four MIP taxa with a goal of 25 mature plants in each PU. Two species currently have four of four PUs at or above the stabilization goal, one species has two of three PUs at or above the stabilization goal, and the other species has one of three PUs at or above the stabilization goal. The size of the PU relative to its stabilization goal is expressed singularly for each PU and collectively for each species. Overall, 42 of 100 PUs are at or above stabilization goals for MIP species (Table 1) and 14 of 65 PUs are at or above stabilization goals for OIP species (Table 2).

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
Four Species with a Goal of 25 Mature Plants in each Population Unit													
Chamaesyce celastroides var. kaenana	Kaena	1,475	579	896	0	300	392%	375-525	228%	92%	100%	Yes	*4 of 4*
	Puaakanoa	148	132	16	0	148	0%	157	-6%	38%	100%	Yes	
	Makua	127	125	2	0	127	0%	40	218%	98%	100%	Yes	
	Kaena East of Alau	31	28	3	0	27	15%	26	19%	34%	100%	Yes	
Chamaesyce herbstii	Kapuna to Pahole	177	65	112	0	152	16%	170	4%	22%	100%	Yes	*1 of 3*
	Makaha	151	1	124	26	169	-11%	0	15000%	n/a (reintro)	100%	No	
	West Makaleha	0				0		0		n/a (reintro)	100%	No	
Nototrichium humile	Waianae Kai	257	204	53	0	304	-15%	200-320	-1%	4%	Partial	Yes	*4 of 4*
	Kaluakauila	233	198	35	0	233	0%	200-400	-22%	4%	100%	Yes	
	Kaimuhole and Palikea Gulch (Kihakapu)	57	53	4	0	59	-3%	54	6%	34%	0%	Yes	
	Makua (south side)	41	40	1	0	63	-35%	120-140	-68%	0%	Partial	Yes	
Pritchardia kaalae	Ohikilolo	1,150	78	1,060	12	1,113	3%	165	597%	14%	100%	Yes	*2 of 3*
	Ohikilolo East and West Makaleha	209	0	209	0	209	0%	0	20800%	n/a (reintro)	100%	No	
	Makaleha to Manuwai	114	102	10	2	114	0%	141	-19%	18%	Partial	Yes	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
17 Species with a Goal of 50 Mature Plants in each Population Unit													
Alectryon macrococcus var. *macrococcus*	Makaha	86	85	1	0	70	23%	77	12%	0%	Partial	Yes	*1 of 4*
	Kahanahaiki to West Makaleha	42	35	7	0	42	0%	8	425%	0%	Partial	No	
	Makua	21	21	0	0	20	5%	15	40%	2%	Partial	No	
	Central Kaluaa to Central Waieli	20	14	6	0	23	-13%	53-58	-64%	0%	Partial	No	
Cenchrus agrimonioides var. *agrimonioides*	Kahanahaiki to Pahole	569	348	97	124	528	8%	37	1438%	62%	Partial	Yes	*2 of 3*
	Central Ekahanui	205	125	41	39	148	39%	20	925%	38%	Partial	Yes	
	Makaha and Waianae Kai	13	13	0	0	8	63%	12	8%	8%	Partial	No	
Cyanea superba ssp. *superba*	Kahanahaiki	1,482	56	321	1,105	400	271%	1	148100%	67%	100%	Yes	*3 of 4*
	Pahole to Kapuna	318	105	164	49	313	2%	0	31700%	n/a (reintro)	100%	Yes	
	Makaha	105	1	104	0	95	11%	0	10400%	n/a (reintro)	100%	Yes	
	Central and East Makaleha	0				0		0		n/a (reintro)	100%	No	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
17 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Cyrtandra dentata	Pahole to Kapuna to West Makaleha	1,430	577	615	238	1,430	0%	300	377%	100%	Partial	Yes	*2 of 4*
	Kahanahaiki	240	64	176	0	207	16%	97	147%	44%	100%	Yes	
	Kawaiiki	115	17	59	39	85	35%	50	130%	0%	0%	No	
	Opaeula	101	35	66	0	28	261%	26	288%	0%	Partial	No	
Dubautia herbstobatae	Ohikilolo Mauka	424	415	9	0	388	9%	1,300	-67%	0%	100%	Yes	*2 of 3*
	Ohikilolo Makai	358	358	0	0	358	0%	700	-49%	0%	100%	Yes	
	Makaha	38	36	0	2	37	3%	?		18%	Partial	No	
Flueggea neowawrae	Kahanahaiki to Kapuna	74	7	67	0	71	4%	6	1133%	4%	100%	No	*0 of 4*
	Makaha	43	11	32	0	35	23%	5	760%	2%	Partial	No	
	Central and East Makaleha	5	5	0	0	5	0%	6	-17%	6%	0%	No	
	Manuwai	0	0	0	0	0		1	-100%	0%	100%	No	
Gouania vitifolia	Keaau	61	60	1	0	61	0%	0	6000%	n/a (reintro)	0%	Yes	*1 of 3*
	Makaha	0				0		0		n/a (reintro)	0%	No	
	Makaleha or Manuwai	0				0		0		n/a (reintro)	0%	No	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
17 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Hedyotis degeneri var. *degeneri*	Kahanahaiki to Pahole	309	145	131	33	490	-37%	161	92%	74%	Partial	Yes	*1 of 3*
	Central Makaleha & West branch of East Makaleha	70	29	41	0	60	17%	47	49%	58%	0%	No	
	Alaiheihe and Manuwai	24	19	4	1	23	4%	60	-60%	48%	Partial	No	
Hedyotis parvula	Ohikilolo	262	100	157	5	188	39%	67	291%	148%	100%	Yes	*2 of 3*
	Halona	151	97	35	19	151	0%	64-79	111%	112%	100%	Yes	
	East Makaleha	0				0		0		n/a (reintro)	0%	No	
Hibiscus brackenridgei ssp. *brackenridgei*	Kaimuhole to Palikea Gulch	171	13	153	5	171	0%	8	2038%	56%	0%	No	*0 of 4*
	Makua	76	48	28	0	88	-14%	7	986%	28%	Partial	No	
	Keaau	10	3	7	0	10	0%	?		10%	0%	No	
	Haili to Kawaiu	9	6	3	0	1	800%	4	125%	16%	0%	No	
Melanthera tenuifolia	Kamaileunu & Waianae Kai	1,449	883	269	297	1,449	0%	1,285-1,955	-11%	0%	0%	Yes	*3 of 3*
	Ohikilolo	1,117	1,109	8	0	1,233	-9%	2,016	-45%	14%	100%	Yes	
	Mt. Kaala NAR	300	300	0	0	300	0%	250	20%	0%	100%	Yes	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
17 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Phyllostegia kaalaensis	Makaha	1	0	1	0	1	0%	0	100%	n/a (reintro)	100%	No	*0 of 4*
	Pahole	0				0		10-15	-100%	4%	100%	No	
	Keawapilau to Kapuna	0				0		4	-100%	2%	100%	No	
	Manuwai	0				0		0		n/a (reintro)	100%	No	
Plantago princeps var. *princeps*	Halona	72	29	43	0	72	0%	50-100	-4%	32%	0%	No	*0 of 4*
	Ekahanui	62	23	35	4	73	-15%	23	170%	68%	100%	No	
	North Mohiakea	28	10	16	2	28	0%	30	-7%	22%	Partial	No	
	Ohikilolo	11	11	0	0	11	0%	14	-21%	16%	100%	No	
Schiedea kaalae	Kaluaa and Waieli	156	153	3	0	78	100%	2	7700%	n/a (reintro)	100%	Yes	*3 of 4*
	South Ekahanui	102	102	0	0	28	264%	0	10100%	26%	100%	Yes	
	Pahole	82	59	17	6	62	32%	3	2633%	4%	100%	Yes	
	Maakua	10	10	0	0	10	0%	4	150%	8%	Partial	No	
Schiedea nuttallii	Kahanahaiki to Pahole	155	135	20	0	267	-42%	47-48	226%	60%	100%	Yes	*1 of 3*
	Makaha	30	30	0	0	21	43%	0	2900%	n/a (reintro)	100%	No	
	Kapuna-Keawapilau ridge	0				0		3	-100%	0%	100%	No	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
17 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Tetramolopium filiforme	Ohikilolo	3,163	2,551	592	20	3,145	1%	5,000	-37%	8%	100%	Yes	*1 of 4*
	Waianae Kai	39	30	8	1	46	-15%	0	3800%	n/a (reintro)	Partial	No	
	Kalena	15	9	0	6	15	0%	?		14%	100%	No	
	Puhawai	2	1	1	0	5	-60%	12	-83%	8%	100%	No	
Viola chammisoniana ssp *chammisoniana*	Ohikilolo	426	403	22	1	445	-4%	250	70%	4%	100%	Yes	*2 of 4*
	Makaha	71	59	12	0	39	82%	50	42%	0%	Partial	Yes	
	Halona	44	41	3	0	44	0%	3	1367%	10%	0%	No	
	Puu Kumakalii	44	44	0	0	44	0%	20	120%	24%	100%	No	
Two Species with a Goal of 75 Mature Plants in each Population Unit													
Cyanea longiflora	Pahole	118	62	53	3	138	-14%	114	4%	86%	100%	No	*0 of 3*
	Kapuna to W Makaleha	59	37	22	0	59	0%	66	-11%	34%	100%	No	
	Makaha and Waianae Kai	10	3	7	0	11	-9%	7	43%	8%	100%	No	
Hesperomannia arbuscula	Pualii	63	0	63	0	24	163%	0	6200%	n/a (reintro)	100%	No	*0 of 4*
	Pahole NAR	59	0	59	0	15	293%	7	743%	0%	100%	No	
	Makaha	6	3	3	0	6	0%	14	-57%	2%	100%	No	
	Haleauau	1	1	0	0	1	0%	?		0%	100%	No	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
Five Species with a Goal of 100 Mature Plants in each Population Unit													
Cyanea grimesiana ssp. *obatae*	Palikea (South Palawai)	134	107	27	0	128	5%	28	379%	26%	100%	Yes	*1 of 4*
	Pahole to West Makaleha	98	41	57	0	59	66%	13	654%	16%	100%	No	
	Central Kaluaa	41	24	17	0	41	0%	2	1950%	2%	100%	No	
	Makaha	1	1	0	0	1	0%	?		2%	100%	No	
Delissea waianensis	Kaluaa	523	256	267	0	325	61%	1	52200%	10%	100%	Yes	*3 of 4*
	Ekahanui	277	175	102	0	290	-4%	14	1879%	8%	100%	Yes	
	Kahanahaiki to Keawapilau	224	189	34	1	218	3%	10	2140%	16%	100%	Yes	
	Manuwai	0				0		0		n/a (reintro)	100%	No	
Neraudia angulata	Kaluakauila	118	118	0	0	128	-8%	0	11700%	n/a (reintro)	100%	Yes	*1 of 4*
	Makua	75	73	1	1	91	-18%	31	142%	12%	100%	No	
	Waianae Kai Mauka	20	16	4	0	20	0%	46	-57%	2%	0%	No	
	Manuwai	0				0		12	-100%	4%	100%	No	
Sanicula mariversa	Keaau	351	11	300	40	351	0%	141	149%	6%	100%	No	*0 of 3*
	Kamaileunu	326	18	307	1	991	-67%	26	1154%	64%	100%	No	
	Ohikilolo	38	3	35	0	115	-67%	143	-73%	0%	100%	No	

Table 1. Status summary of 28 Plant Species for Year 7 of Makua Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2003	Relative Change since 2003	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
Five Species with a Goal of 100 Mature Plants in each Population Unit (cont.)													
Schiedea obovata	Keawapilau to West Makaleha	1,320	257	574	489	1,502	-12%	3	43900%	142%	Partial	Yes	*2 of 3*
	Kahanahaiki to Pahole	656	272	320	64	846	-22%	0	65500%	10%	100%	Yes	
	Makaha	0				0		0		n/a (reintro)	100%	No	
TOTALS for all MIP Plant Species		**22,899**	**12,112**	**8,152**	**2,635**	**21,328**	**7%**	**12,130**	**89%**				***42 of 100***

Table 2. Status summary of 23 Plant Species for Year 4 of Oahu Implementation Plan

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2008	Relative Change since 2008	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
15 Species with a Goal of 50 Mature Plants in each Population Unit													
Abutilon sandwicense	Makaha Makai	123	71	51	1	106	16%	106	16%	28%	0%	Yes	*2 of 4*
	Kaawa to Puulu	123	52	69	2	121	2%	130	-5%	0%	0%	Yes	
	Ekahanui and Huliwai	43	14	29	0	52	-17%	44	-2%	0%	Partial	No	
	Kaluakauila	7	0	7	0	13	-46%	4	75%	0%	100%	No	
Chamaesyce rockii	Kawainui to Koloa and Kaipapau	52	37	13	2	52	0%	77	-32%	0%	0%	No	*0 of 3*
	Helemano	23	22	1	0	8	188%	8	188%	0%	100%	No	
	Waiawa and Waimano	18	15	3	0	15	20%	15	20%	0%	0%	No	
Cyanea acuminata	Makaleha to Mohiakea	146	103	43	0	146	0%	118	24%	0%	Partial	Yes	*2 of 3*
	Helemano-Punaluu Summit Ridge to North Kaukonahua	79	59	13	7	79	0%	79	0%	8%	0%	Yes	
	Kahana and South Kaukonahua	2	2	0	0	2	0%	2	0%	0%	0%	No	
Cyanea crispa	Kahana and Makaua	14	7	7	0	14	0%	6	133%	6%	0%	No	*0 of 3*
	Wailupe	6	5	1	0	6	0%	6	0%	10%	0%	No	
	Kawaiiki	4	2	2	0	6	-33%	6	-33%	0%	0%	No	

Table 2. Status summary of 23 Plant Species for Year 4 of Oahu Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2008	Relative Change since 2008	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
15 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Cyanea koolauensis	Kaipapau, Koloa and Kawainui	86	64	16	6	77	12%	82	5%	0%	0%	Yes	*1 of 3*
	Opaeula to Helemano	21	13	8	0	21	0%	13	62%	0%	Partial	No	
	Kaukonahua	16	14	2	0	16	0%	12	33%	0%	0%	No	
Cyanea st.- johnii	Waimano	19	14	5	0	19	0%	19	0%	8%	100%	No	*0 of 3*
	Ahuimanu-Halawa Summit Ridge	11	8	3	0	11	0%	34	-68%	6%	100%	No	
	Helemano	5	4	1	0	5	0%	6	-17%	6%	100%	No	
Cyrtandra subumbellata	Punaluu	201	201	0	0	201	0%	200	0%	0%	0%	Yes	*1 of 3*
	Kahana	15	8	7	0	15	0%	15	0%	0%	0%	No	
	Kaukonahua	0				0		3	-100%	0%	0%	No	
Cyrtandra viridiflora	Helemano and Opaeula	58	40	12	6	58	0%	66	-12%	8%	Partial	No	*0 of 3*
	Kawainui and Koloa	20	16	4	0	20	0%	27	-26%	2%	0%	No	
	South Kaukonahua to Kipapa Summit	2	2	0	0	2	0%	2	0%	0%	0%	No	
Eugenia koolauensis	Pahipahialua	460	50	33	377	460	0%	292	58%	2%	100%	Yes	*2 of 3*
	Kaunala	293	54	108	131	307	-5%	147	99%	0%	100%	Yes	
	Oio	54	22	17	15	54	0%	74	-27%	1%	100%	No	

Table 2. Status summary of 23 Plant Species for Year 4 of Oahu Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2008	Relative Change since 2008	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
15 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Gardenia mannii	Lower Peahinaia	32	31	1	0	38	-16%	38	-16%	0%	Partial	No	*0 of 3*
	Helemano and Poamoho	14	14	0	0	14	0%	18	-22%	0%	0%	No	
	Haleauau	4	4	0	0	4	0%	2	100%	2%	Partial	No	
Hesperomannia arborescens	Kaukonahua	256	76	56	124	256	0%	249	3%	0%	0%	Yes	*2 of 4*
	Kamananui to Kaluanui	185	93	74	18	116	59%	113	64%	0%	0%	Yes	
	Lower Opaeula	27	18	9	0	24	13%	24	13%	0%	0%	No	
	Palikea Gulch	0				0		0		n/a (reintro)	100%	No	
Huperzia nutans	Kahana & No. Kaukonahua	5	5	0	0	5	0%	6	-17%	0%	0%	No	*0 of 3*
	Koloa and Kaipapau	5	3	2	0	5	0%	3	67%	0%	0%	No	
	South Kaukonahua	1	1	0	0	1	0%	1	0%	0%	0%	No	
Melicope lydgatei	Kawaiiki and Opaeula	25	25	0	0	42	-40%	43	-42%	0%	Partial	No	*0 of 2*
	Kaiwikoele-Kawainui Ridge	3	3	0	0	3	0%	3	0%	1%	0%	No	
Pteris lidgatei	South Kaukonahua	6	6	0	0	6	0%	6	0%	0%	0%	No	*0 of 3*
	Helemano	4	0	2	2	4	0%	4	0%	0%	100%	No	
	Kawaiiki	3	3	0	0	3	0%	3	0%	0%	100%	No	

Table 2. Status summary of 23 Plant Species for Year 4 of Oahu Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2008	Relative Change since 2008	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
15 Species with a Goal of 50 Mature Plants in each Population Unit (cont.)													
Viola oahuensis	Helemano and Opaeula	331	163	146	22	331	0%	329	1%	0%	Partial	Yes	*2 of 3*
	Koloa	76	58	12	6	45	69%	51	49%	0%	0%	Yes	
	Kaukonahua	11	11	0	0	25	-56%	25	-56%	0%	0%	No	
One Species with a Goal of 75 Mature Plants in each Population Unit													
Myrsine juddii	Kaukonahua to Kamananui-Koloa	470	470	0	0	455	3%	455	3%	2%	Partial	Yes	*1 of 1*
Six Species with a Goal of 100 Mature Plants in each Population Unit													
Labordia cyrtandrae	East Makaleha to North Mohiakea	97	84	13	0	102	-5%	102	-5%	18%	Partial	No	*0 of 2*
	Manana	1	1	0	0	1	0%	1	0%	0%	0%	No	
Lobelia gaudichaudii ssp. *koolauensis*	Waiawa to Waimano	200	0	200	0	200	0%	200	0%	0%	0%	No	*0 of 3*
	Kipapa	120	0	100	20	120	0%	120	0%	0%	0%	No	
	Kaukonahua	31	1	29	1	31	0%	50	-38%	6%	0%	No	
Phyllostegia hirsuta	Haleauau to Mohiakea	18	12	6	0	18	0%	18	0%	4%	0%	No	*0 of 3*
	Hapapa to Kaluaa	12	3	8	1	14	-14%	27	-56%	4%	Partial	No	
	Laie and Puu Kainapuaa	0				0		0		n/a (reintro)	100%	No	

Table 2. Status summary of 23 Plant Species for Year 4 of Oahu Implementation Plan (cont.)

Plant Species	Population Unit (PU)	2011 Plants				# Plants in 2010	Relative Change since 2010	# Plants in 2008	Relative Change since 2008	% Completed of Genetic Storage Requirement (reintro = reintroduction)	% of Plants in PU Protected from Ungulates	Is PU at Goal?	Overall PUs at Goal for Species
		Total	# mature	# immature	# seedlings								
Six Species with a Goal of 100 Mature Plants in each Population Unit (cont.)													
Phyllostegia mollis	Kaluaa	19	18	1	0	24	-21%	49	-61%	2%	100%	No	*0 of 3*
	Ekahanui	2	2	0	0	4	-50%	36	-94%	2%	Partial	No	
	Pualii	0				0		0		n/a (reintro)	100%	No	
Sanicula purpurea	Schofield-Waikane Trail Summit	40	2	38	0	42	-5%	27	48%	0%	0%	No	*0 of 3*
	Poamoho Trail Summit	30	3	25	2	24	25%	24	25%	0%	0%	No	
	North of Puu Pauao	21	0	21	0	21	0%	21	0%	0%	0%	No	
Stenogyne kanehoana	Kaluaa	68	10	58	0	64	6%	79	-14%	2%	100%	No	*0 of 3*
	Haleauau	1	1	0	0	1	0%	1	0%	2%	100%	No	
	Makaha	0				0		0		n/a (reintro)	100%	No	
One Species with a Goal of 150 Mature Plants in each Population Unit													
Schiedea trinervis	Kalena to East Makaleha	666	200	185	281	695	-4%	694	-4%	102%	Partial	Yes	*1 of 1*
TOTALS for all OIP Plant Species		**4,685**	**2,220**	**1,441**	**1,024**	**4,624**	**1%**	**4,415**	**6%**				***14 of 65***

Overall, five MIP (5%) and one OIP (2%) PUs have become extirpated since their respective IP was completed. Of tracked populations, 21 MIP (23%) and 21 OIP (34%) PUs have declined, while 61 MIP (66%) and 21 OIP (34%) PUs have increased. Significantly, 30 MIP (33%) PUs have increased more than five-fold since 2003 (Table 3).

Table 3. Relative Change in Number of Total Plants in Population Units (PUs) since the Implementation Plan for Makua (MIP) and Oahu (OIP) were Completed

Relative Change in Number of Total Plants	MIP	% of MIP PUs	OIP	% of OIP PUs	
-100%	5	5%	1	2%	Completely extirpated
-51 to -99%	8	9%	5	8%	Declining
-50 to -1%	13	14%	16	26%	
No change	0	0%	18	30%	No change
1 to 50%	11	12%	12	20%	Increasing
51 to 100%	3	3%	7	11%	
100 to 500%	17	18%	2	3%	Significantly increasing
Over 500%	30	33%	0	0%	
Unknown	5	5%	0	0%	
Tracked populations	92		61		
Planned reintroductions	8		4		
Total populations	100		65		

Within the last year, no MIP or OIP PUs became extirpated. Of currently tracked populations, 22 MIP (25%) and 13 OIP (22%) PUs declined, while 35 MIP (40%) and 11 OIP (18%) PUs increased. Significantly, 7 MIP (8%) and 1 OIP (2%) PUs at least doubled in size (Table 4).

Table 4. Relative Change in Number of Total Plants in Population Units (PUs) over the Past Year for Makua (MIP) and Oahu (OIP) Implementation Plans

Relative Change in Number of Total Plants	MIP	% of MIP PUs	OIP	% of OIP PUs	
-100%	0	0%	0	0%	Completely extirpated
-51 to -99%	3	3%	1	2%	Declining
-50 to -1%	19	22%	12	20%	
No change	30	34%	36	60%	No change
1 to 50%	23	26%	8	13%	Increasing
51 to 100%	5	6%	2	3%	
100 to 500%	6	7%	1	2%	Significantly increasing
Over 500%	1	1%	0	0%	
Currently tracked populations	87		60		

OANRP collected from 105 sites of 33 IP species (collections were made on multiple occasions for some of these sites) and completed 1,120 rare plant observations during this reporting period. Overall, 16 MIP (20%) and 38 OIP (62%) distinct PUs currently do not have any genetic storage in either seed storage or clone propagation. A distinction was made that reintroduced PUs do not require genetic storage themselves as they originate from genetic storage of other PUs. As a result, the total number of distinct PUs is 81 for the MIP and 61 for the OIP. Some PUs have exceeded their 100% genetic storage goal. Collectively, 15 MIP (19%) and 1 OIP (2%) PUs have reached between 51% and 150% of their genetic storage capacity goal (Table 5).

Table 5. Completed Percent of Genetic Storage Requirement for all Plant Taxa Population Units (PUs) in Makua (MIP) and Oahu (OIP) Implementation Plans

Completed % of Genetic Storage Requirement for all Population Units	MIP	% of MIP PUs	OIP	% of OIP PUs
0%	16	20%	38	62%
1 to 10%	26	32%	20	33%
11 to 25%	13	16%	1	2%
26 to 50%	11	14%	1	2%
51 to 75%	8	10%	0	0%
76 to 150%	7	9%	1	2%
Distinct Population Units	81		61	
Reintroductions from other stock	19		4	
Total Number of Population Units	100		65	

For the MIP, OANRP completed construction of the 300-acre Manuwai Management Unit (MU) fence this year. Supplemental fencing was installed in the Waianae Kai MU to protect the Waianae Kai Makai PUs of *Nototrichium humile* and *Neraudia angulata* and OANRP are confident that goats can no longer penetrate this MU. For the OIP, OANRP completed construction of the Manuwai MU fences that protect a total of 300 acres of dry and mesic forest habitat and PUs of OIP and MIP taxa. This fence was

extremely challenging to construct due to slope and substrate and will be similarly challenging to manage for weeds. In addition, two PU fences were completed to protect *Cyanea st. johnii* populations at Halawa and Waimano. Seventy percent of the Lower Opaeula Management Unit, which will protect 25 acres of wet forest habitat for OIP taxa, is complete and OANRP expects full completion by the end of the 2011 calendar year. This fence has been built in partnership with Koolau Mountains Watershed Partnership staff. Additionally, OANRP contracted the construction of the Lihue MU fence in Schofield Barracks West Range, more than one-quarter of the fence perimeter has already been built, and ungulate removal from within this 1,800-acre unit is underway. In addition, OANRP has staged all fencing materials for the Koloa MU with the help of the Army's Aviation Brigade, a contractor has begun clearing the fence line, and 17% of the fence has been constructed to date. When completed, the Koloa fence will protect 180 acres of wet forest, eight endangered and two proposed endangered plant taxa, and one *Achatinella* population. Overall, 63 MIP (63%) and 17 OIP (26%) plant taxa PUs have 100% protection from ungulates. Conversely, 15 MIP (15%) and 35 OIP (54%) currently have no protection from ungulates (Table 6).

Table 6. Plant Taxa Population Units (PUs) Protected From Ungulates in Makua (MIP) and Oahu (OIP) Implementation Plans

Population Units Protected From Ungulates	MIP	% of MIP PUs	OIP	% of OIP PUs
100% protection	63	63%	17	26%
Partial protection	22	22%	13	20%
0% protection	15	15%	35	54%
Total Population Units	100		65	

For the MIP the past year, OANRP spent 4,218 person hours over 356 visits conducting ecosystem weed control across 61 ha (of 724 total ha, 8.4%) designated as Weed Control Areas. In addition, OANRP spent 410 person hours over 181 visits targeting incipient invasive species across 31 ha of designated Incipient Control Areas. In total, OANRP spent 4,628 person hours over 537 visits controlling weeds across 92 ha. For the OIP the past year, OANRP spent 896 person hours over 50 visits conducting ecosystem weed control across 37 ha (of 200 total ha, 18.5%) designated as Weed Control Areas. In addition, OANRP spent 256 person hours over 100 visits targeting incipient invasive species across 132 ha of designated Incipient Control Areas. In total, OANRP spent 1,151 person hours over 150 visits controlling weeds across 169 ha. In addition, OANRP out-planted 992 individuals of several taxa in the MIP, eight individuals of one taxa (*Stenogyne kanehoana*) in the OIP, and 264 individuals of taxa overlapping the OIP and MIP. Across all species, 42 MIP (42%) and 14 OIP (22%) PUs are currently at or above stabilization goals (Table 7). At a species level, seven MIP (25%) and 14 OIP (61%) species currently do not have any PU at or above stabilization goals. Conversely, 13 MIP (46%) and five OIP (22%) species currently have at least two PUs at or above stabilization goals (Table 8).

Table 7. Plant Taxa Population Units (PUs) at or above Stabilization Goals for the Makua (MIP) and Oahu (OIP) Implementation Plans

Overall Number of Population Units at or above Stabilization Goal	MIP	% of MIP PUs	OIP	% of OIP PUs
At or Above	42	42%	14	22%
Below	58	58%	51	78%
Total Population Units	100		65	

Table 8. The Total Number of Population Units at or above Stabilization Goals per Plant Taxa in the Makua (MIP) and Oahu (OIP) Implementation Plans

Number of Species with an Overall Number of Population Units at or above Stabilization Goals	MIP	% of MIP species	OIP	% of OIP species
Zero Population Units	7	25%	14	61%
Exactly 1 Population Unit	8	29%	4	17%
Exactly Two Population Units	7	25%	5	22%
Three or Four Population Units	6	21%	0	0%
Total Species	28		23	

For Oahu elepaio in the OIP, OANRP increased the number of nests with rat protection from 87 in 2010 to 99 in 2011 (Table 9). The number of documented fledgings increased in all four locations and the average number of documented fledgings per number of Oahu elepaio pairs with rat protection increased from 1.14 in 2010 to 1.48 in 2011. The increased success this year may largely be attributable to a new OANRP Elepaio Management Specialist who monitored field work of contractors in addition to performing field work himself. Successful nesting in the past may not have been detected by less effective monitoring. In addition, greater oversight of contractors resulted in higher quality of rat trapping and baiting which presumably resulted in more effective predator control.

Table 9. Number of Documented Fledgings per Number of Pairs with Rat Protection for Oahu Elepaio in the Oahu Implementation Plan

Location	Number of Oahu Elepaio Pairs with Rat Protection		Number of Documented Fledglings		Number of Documented Fledgings per Number of Oahu Elepaio Pairs with Rat Protection	
	2010	2011	2010	2011	2010	2011
Ekahanui	30	30	3	26	0.10	0.87
Moanalua	17	21	7	9	0.41	0.43
Palehua	18	17	4	16	0.22	0.94
Schofield Barracks West Range	22	31	25	46	1.14	1.48
Totals	**87**	**99**	**39**	**97**	**0.45**	**0.98**

Table 10 presents the status summary for the Waianae *Achatinella mustelina* in the MIP and Table 11 presents the status summary for six species of Koolau *Achatinella* spp. in the OIP. The goal of all populations in both IPs is 300 total snails across all age classes. Populations of *A. mustelina* in the MIP have been genetically assigned to one of six Evolutionary Significant Units (ESUs), while an analogous term Geographic Unit (GU) is used instead for Koolau taxa because the same level of genetic analyses have not been done for those snails populations and thus they are distinguished by geographic location rather than genetics.

Across all populations in the MIP, *A. mustelina* decreased 9% over the past year from 2,752 to 2,513 total snails. Conversely, since the MIP was originally finalized, *A. mustelina* has increased 287% from a baseline of 650 total snails (Table 10). Across all populations for the six OIP species, *Achatinella* spp. declined 11% over the past year from 1,722 to 1,531 total snails. Conversely, since the OIP was completed, those same species have increased 18% from a baseline of 1,297 total snails (Table 11).

For *A. mustelina* in the MIP, one fewer population this year is at or above the goal of 300 snails due to a decrease over the past year in ESU E at Ekahanui. OANRP suspect *Euglandina rosea* predation contributed to the decline. Also during this reporting period, OANRP partners collected a Jackson's chameleon (*Chamaeleo jacksonii*) at ESU D1 (Kaluaa and Waieli). This is the first managed portion of an ESU to have a documented Jackson's chameleon population. On a positive note, a new population of *A. mustelina* was discovered within ESU C that contributed to a 274% increase in total numbers over the past year (Table 10).

OANRP is currently in the process of completing construction of three fenced areas for snails that will exclude both vertebrate and non-vertebrate predators (aka snail jails). Two of the snail jails are located in the Waianaes (Puu Hapapa, ESU D1, and Puu Palikea, ESU F; Table 10), while the other is located at Poamoho in the Koolaus. The Poamoho snail jail will offer immediate conservation benefit to an *A. sowerbyana* population that declined 56% this past year (Table 11). Of note, OANRP acknowledges the participation and funding support from the USFWS for the snail jail at Puu Palikea, which will be used to protect both listed and non-listed snail species.

Table 10. Status summary of *Achatinella mustelina* for Year 7 of the Makua Implementation Plan

Evolutionary Significant Unit (ESU)	Population	2011 Snails				# Snails in 2010	Relative Change since 2010	# Snails in 2003	Relative Change since 2003	# of Snails from Population at University of Hawaii Lab	% of Snails in Population Protected from Ungulates	Is Population at Goal?	Overall Populations at Goal for Species
		Total	# Adult	# Sub-adult	# Juvenile								
ESU A	Kahanahaiki/ Pahole	293	211	41	41	391	-25%	105	179%	2	100%	No	*4 of 8*
ESU B	B1: Ohikilolo	391	301	55	35	372	5%	300	30%	6	100%	Yes	
	B2: East/ Central Makaleha	453	283	101	69	471	-4%	40	1033%	1	0%	Yes	
ESU C	Alaiheihe/ Palikea/ Schofield Barracks West Range	172	101	57	14	46	274%	50	244%	26	Partial	No	
ESU D	D1: North Kaluaa to Schofield Barracks South Range, Kaala	380	184	91	105	380	0%	86	342%	370	Partial	Yes	
	D2: Makaha	188	132	35	21	166	13%	17	1006%	5	100%	No	
ESU E	Puu Kaua/ Ekahanui	178	145	26	7	464	-62%	12	1383%	7	100%	No	
ESU F	Puu Palikea/ Mauna Kapu	458	323	87	48	462	-1%	40	1045%	6	100%	Yes	
Totals		**2,513**				**2,752**	**-9%**	**650**	**287%**	**423**			***4 of 8***

Table 11. Status summary of Six *Achatinella* spp. for Year 4 of the Oahu Implementation Plan

Snail Species	Geographic Unit (GU)	Population	# Snails in 2011	# Snails in 2010	Relative Change since 2010	# Snails in 2008	Relative Change since 2008	# of Snails from Population at University of Hawaii Lab	% of Snails in Population Protected from Ungulates	Is Population at Goal?	Overall Populations at Goal for Species
Achatinella apexfulva	GU A	Poamoho Trail	0	0		0	0%	1	0%	No	*0 of 1*
Achatinella bulimoides	GU A	Punaluu Cliffs	5	5	0%	2	150%	7	0%	No	*0 of 1*
Achatinella byronii/ decipiens	GU A	East Range	6	6	0%	6	0%	0	0%	No	*1 of 5*
	GU B	Puu Pauao	16	16	0%	16	0%	0	0%	No	
	GU C	Poamoho	259	259	0%	69	275%	0	0%	No	
	GU D	Punaluu Cliffs	7	7	0%	3	133%	0	0%	No	
	GU E	North Kaukonahua	445	445	0%	175	154%	4	0%	Yes	
Achatinella lila	GU A	Poamoho Summit	15	15	0%	39	-62%	455	0%	No	*0 of 3*
	GU B	Peahinaia Summit	11	11	0%	11	0%	0	Partial	No	
	GU C	Opaeula-Punaluu Summit	66	66	0%	45	47%	0	0%	No	
Achatinella livida	GU A	Crispa Rock	86	86	0%	60	43%	0	0%	No	*0 of 3*
	GU B	Northern	9	9	0%	5	80%	0	Partial	No	
	GU C	Radio	37	37	0%	83	-55%	62	0%	No	
Achatinella sowerbyana	GU A	Kawainui Ridge	0	0		2	-100%	0	0%	No	*1 of 7*
	GU B	Kawaiiki Ridge	30	29	3%	3	900%	0	0%	No	
	GU C	Opaeula-Helemano	357	370	-4%	344	4%	9	100%	Yes	
	GU D	Poamoho Summit and Trail	140	319	-56%	302	-54%	0	0%	No	
	GU E	Poamoho Pond	35	35	0%	90	-61%	0	0%	No	
	GU F	Poamoho-North Kaukonahua Ridge	2	2	0%	2	0%	0	0%	No	
	GU G	Lower Peahinaia	5	5	0%	40	-88%	8	Partial	No	
Totals			**1,531**	**1,722**	**-11%**	**1,297**	**18%**	**546**			***2 of 20***

Overall, zero MIP (0%) and one OIP (5%) populations have become extirpated since their respective IP was completed. Of tracked populations, zero MIP (0%) and five OIP (25%) have declined, while eight MIP (100%) and nine OIP (45%) have increased. Significantly, four MIP (50%) and one OIP (5%) populations have increased more than five-fold since their IP was completed (Table 12).

Table 12. Relative Change in Number of Total Snails in Populations since the Implementation Plans for Makua (MIP) and Oahu (OIP) were Completed

Change in Number of Total Snails in Populations since IP was Completed	MIP	% of MIP Populations	OIP	% of OIP Populations	
-100%	0	0%	1	5%	Completely extirpated
-51 to -99%	0	0%	5	25%	Declining
-50 to -1%	0	0%	0	0%	
No change	0	0%	5	25%	No change
1 to 50%	1	13%	3	15%	Increasing
51 to 100%	0	0%	1	5%	
100 to 500%	3	38%	4	20%	Significantly increasing
Over 500%	4	50%	1	5%	
Total populations	8		20		

Within the last year, no MIP or OIP populations became extirpated. Of currently tracked populations, four MIP (50%) and two OIP (10%) declined, while three MIP (38%) and one OIP (5%) increased. Significantly, one MIP (13%) population at least doubled in size (Table 13).

Table 13. Relative Change in Number of Total Snails in Populations over the Past Year for Makua (MIP) and Oahu (OIP) Implementation Plans

Relative Change in Number of Total Snails in Populations in Past Year	MIP	% of MIP Populations	OIP	% of OIP Populations	
-100%	0	0%	0	0%	Completely extirpated
-51 to -99%	1	13%	1	5%	Declining
-50 to -1%	3	38%	1	5%	
No change	1	13%	16	84%	No change
1 to 50%	2	25%	1	5%	Increasing
51 to 100%	0	0%	0	0%	
100 to 500%	1	13%	0	0%	Significantly

Over 500%	0	0%	0	0%	increasing
Currently tracked populations	8		19		

There are no goals for numbers of snails held at the University of Hawaii lab (See Appendix ES-3 for summary of captive propagation numbers). Having some individuals from all populations *ex situ* does offer protection against detrimental stochastic events. Eight MIP (100%) and seven OIP (35%) populations have at least one individual at the University of Hawaii lab (Table 14).

Table 14. Number of Snails at the University of Hawaii Lab from Populations in the Makua (MIP) and Oahu (OIP) Implementation Plans

Number of Snails from Population at University of Hawaii Lab	MIP	% of MIP Populations	OIP	% of OIP Populations
0	0	0%	13	65%
1 to 10	6	75%	5	25%
11 to 25	0	0%	0	0%
26 to 50	1	13%	0	0%
51 to 100	0	0%	1	5%
More than 100	1	13%	1	5%
Total populations	8		20	

Overall, five MIP (63%) and one OIP (5%) populations have 100% protection from ungulates (Table 15). Across all snail taxa, four MIP (50%) and two OIP (10%) populations are currently at or above the stabilization goal of 300 total snails per population (Table 16). The only *Achatinella* species in the MIP has four populations currently at or above the stabilization goal, while four OIP *Achatinella* spp. (67%) do not currently have any populations at or above the stabilization goal (Table 17).

Table 15. Snail Taxa Populations Protected From Ungulates in Makua (MIP) and Oahu (OIP) Implementation Plans

Populations Protected From Ungulates	MIP	% of MIP Populations	OIP	% of OIP Populations
100% protection	5	63%	1	5%
Partial protection	2	25%	3	15%
0% protection	1	13%	16	80%
Total Populations	8		20	

Table 16. Snail Taxa Populations at or above Stabilization Goal for the Makua (MIP) and Oahu (OIP) Implementation Plans

Overall Number of Populations at or above Stabilization Goal	MIP	% of MIP Populations	OIP	% of OIP Populations
At or Above	4	50%	2	10%
Below	4	50%	18	90%
Total Populations	8		20	

Table 17. The Total Number of Populations at or above Stabilization Goal per Snail Taxa in the Makua (MIP) and Oahu (OIP) Implementation Plans

Number of Species with Populations at or above Stabilization Goal	MIP	% of MIP species	OIP	% of OIP species
Zero Populations	0	0%	4	67%
Exactly One Population	0	0%	2	33%
Exactly Two Populations	0	0%	0	0%
Exactly Three Populations	0	0%	0	0%
Exactly Four Populations	1	100%	0	0%
Total Species	1		6	

Vegetative Monitoring and Ecosystem Restoration Management

Vegetation monitoring transects were installed this year in the Manuwai MU; a total of seven MUs now have monitoring in place. In addition, OANRP re-monitored the Palikea MU this year, three years after the initial monitoring, and obtained approval to conduct monitoring in the Kapuna MU. Ecosystem Restoration Management Unit Plans (ERMUPs) were written this year for the following three MUs: Koloa, Manuwai, and Kaluaa/ Waieli. OANRP now has 17 prepared ERMUPs for the highest priority and large MUs (with the exception of Opaeula). The remaining 12 of 29 total ERMUPs will be prepared once OANRP initiates fencing for those MUs.

Landowner/Agency Communications

This year was a landmark year for OANRP in the realm of real estate agreements. A 20-year license agreement was signed between the Army and Kamehameha Schools (KS) on 1 November 2010 allowing OANRP to commence fencing plans amongst other conservation management activities on KS property. In addition, the Army and the landowner of the Koloa MU (Hawaii Reserves, Inc.) signed a three-year license agreement in November 2010 allowing construction to begin on the Koloa fence unit. The Army also signed a Memorandum Of Understanding (MOU) in November 2010 with the Honolulu Board of Water Supply to continue conservation work in Makaha Valley. This four-year agreement covers fence construction of the Makaha Subunit II and Kamaili MUs. In April 2011, the Army obtained a new six-month right of entry permit to monitor *Hibiscus brackenridgei* populations on Dole Food Company land;

renewal is currently pending. The Army also continues to work cooperatively under a MOU with the U.S. Navy for work in Lualualei Naval Magazine.

In July 2011, a MOU was signed between the Army and the State of Hawaii, Department of Land and Natural Resources (DLNR). With this basic agreement in hand, the Army will continue to negotiate a more detailed real estate agreement, such as a right of entry or license. Currently, the Army holds a Natural Area Reserves Special Use Permit, a State of Hawaii Threatened and Endangered Plant Species Permit, and, just this last year, obtained a Conservation District Use Permit (issued 20 January 2011). Issues pending negotiation under the real estate agreement include user fees and how to navigate the annual state permitting requirement.

Honouliuli Preserve is managed by DLNR, Land Division; The Division of Forestry and Wildlife has a right of entry to conduct natural resource protection on the property. The Army applied for an access permit from the Land Division in May 2010 and has not yet received this permit. An endowment for Honouliuli Preserve which was established with money donated by the Nature Conservancy of Hawaii will be used to fund firebreaks and road maintenance.

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

Fire

This reporting period was uneventful with regard to fires as no major fires occurred in or near OIP and MIP MUs. Unfortunately, OANRP staff trained and ready to respond to wildland fires will not be recertified by the Army Wildland fire crew due to the fire crew's budget shortfall and associated staff limitations. OANRP will, however, be available in the event of a fire to help direct firefighting efforts toward valuable natural resources. Additionally, OANRP can sponsor helicopter resources for firefighting when IP assets are in jeopardy.

Nursery Sanitation

Since November 2008, OANRP has been contending with an infestation of five alien snail taxa in the shade-houses at Pahole and Schofield. Considering the potential consequences of introducing alien snails to natural areas, OANRP made the decision not to reintroduce plants until they were considered "snail-free". This severely affected production, delayed reintroduction projects, and required the diversion of hundreds of hours of staff time to clean the facilities, search infested benches, and develop control techniques. All snails have since been eradicated from the nursery facilities and reintroductions are back on track. Dr. Robert Cowie (UH Zoology) is contracted from Fall 2011 through Spring 2012 to conduct alien snail surveys at all OANRP facilities and some cooperating private nurseries. OANRP will work with Dr. Cowie to conduct life cycle trials and develop protocols to prevent accidental introductions of snails and slugs to management areas.

Drosophila

Last year, OANRP finalized and submitted stabilization plans for two taxa of Hawaiian picture-wing flies (*Drosophila substenoptera* and *Drosophila montgomeryi*, see Appendices ES-4 (a-b)). OANRP developed cost estimates and submitted them for funding in FY 2012. The first step in executing these plans will be to hire an Entomologist to provide implementation oversight. Although funding is not yet

secured for Drosophila stabilization, OANRP will continue surveying to find three PUs to manage per taxon to achieve stabilization goals. OANRP hosted Dr. Karl Magnacca this past year to conduct surveys to locate extant sites for these taxa. A third field location of *D. substenoptera* was detected at Mt. Kaala at 2,900 feet along the Waianae Kai trail near where this taxon had been detected in 1998. Surveying efforts will continue until a third PU for managing *D. montgomeryi* is also located.

Research

During this reporting period, OANRP funded numerous research projects related to management of MIP and OIP taxa. In addition, the OANRP Research Specialist continued slug and ant research and management; slug work this year was focused on field application of Sluggo for protection of susceptible 'manage for stability' plant populations. This past year the OANRP Research Specialist also supported external researchers, such as Dr. Norine Yeung's research of the invasive predatory garlic snail (*Oxychilus alliarius*). The intent of this research is to determine garlic snail distribution and abundance within native *Achatinella* tree snail habitat and to elucidate their role as a predator of *Achatinella* tree snails. A report summarizing findings of this research is expected in January 2012 and will be included as an Appendix in next year's report.

In addition, OANRP funded Dr. Brendan Holland's research of Jackson's chameleons and their role as predators of native *Achatinella* tree snails. Findings thus far include information about the Jackson's chameleon's home range size and gut retention of tree snail shells (See Appendix ES-3). In addition, Dr. Holland investigated the interaction between the predatory snail, *Euglandina rosea*, and the leopard slug, *Limax maximus*. Another exciting research project funded by OANRP is 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 (see Appendix ES-5). Other projects related to rare plants will be finalized in the coming year including Lauren Weisenberger's work with the breeding biology of *Schiedea*, Dr. Cliff Morden's genetic investigations of *Chamaesyce*, Melody Euaparadorn's breeding biology research of *Chamaesyce celastroides* var. *kaenana*, and Richard Pender's research of *Cyanea superba* subsp. *superba* and *Delissea waianaeensis*.

Infrastructure

Designs for the OIP office building and Seed Conservation Laboratory were finalized in August 2011. Construction for both buildings is scheduled to begin as early as this winter. With the addition of these buildings, OANRP will have the space necessary to increase staffing to full OIP and MIP levels pending satisfactory resolution of the current federal budget crisis.

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Appendices:

CHAPTER 1: ECOSYSTEM MANAGEMENT

Notable projects from the 2010-2011 reporting year are discussed in the Project Highlights section of this chapter. Note that this reporting year is 13 months (1 September 2010 through 30 September 2011), while previous reporting years were 12 months. In future, reporting years will return to 12 months (see the Executive summary for more information).

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 a minimum of discussion. For full explanations of project prioritization and field techniques, please refer to the 2007 Status Report for the MIP and OIP.

In 2008-2009, Ecosystem Restoration Management Unit Plans (ERMUP) were written for eight MUs: Ekahanui, Helemano, Kaala, Kahanahaiki, Kaluakauila, Ohikilolo (Lower Makua), Ohikilolo (Upper), and Palikea,. In 2009-2010, six additional ERMUPs were written, for Kaena, Kahuku Training Area, Lower Ohikilolo, Makaha, Pahole, and Upper Kapuna. Please refer to the 2009 and 2010 Status Reports for the MIP and OIP for copies of these plans. The ERMUPs detail all relevant threat control in each MU over the next five years. The ERMUPs are working documents; OANRP has modified them slightly since last year, and can provide them on request. They will not be included in Status Reports until they are complete and need to be rewritten to include another five years. This year, three additional ERMUPs were written for the following MUs: Kaluaa and Waieli, Manuwai, and Koloa. These plans are included here, following the Weed Control Program highlights.

1.1 PROJECT HIGHLIGHTS

1.1.1 Ungulate Control Program

Summary

- The OANRP was able to complete the Manuwai Subunit I/II MU fence and the *Cyanea st.-johnii* PU fences at Waimano and Halawa, the Waianae Kai [*Neraudia angulata* WAI-A] PU fence, and the *Schidea kaalae* PU fences at Kualoa in the 2011 reporting year.

- At this time, Koloa (750/4,434 m), Lihue (3,406/12,240 m), and Lower Opaeula (1110/1606 m) MU fences have been partially completed.

- All totaled, about 8,200 m of fence were built during the reporting year, enclosing about 362 acres (the partially completed units acreage are not reported here).

- Cultural resource 106 surveys have been completed for (OIP) Kaipapau, Kawailoa, Manana, South Kaukonahua I/II and North Kaukonahua fence lines.

- An MOU between the Army and DLNR has been signed but a real estate access agreement needs to be signed and an annual user fee provided prior to any other new fences being constructed on State lands (units listed in tables). There are also concerns about the long-term capability of fence monitoring and maintenance that need to be addressed.

- A programmatic Conservation District Use Permit (CDUP) was obtained during this reporting period that covers all of the conservation management actions that the Army wants to accomplish.

- A three-year license agreement between the Army and Hawaii Reserves Inc. (Koloa), a four-year license agreement between the Army and the City and County of Honolulu Board of Water Supply (Kamaili and Makaha Subunit II) and a 20-year license agreement between the Army and Kamehameha Schools were signed during this reporting period. These agreements allow the Army to conduct conservation management on lands owned by the licensees.

- OANRP is proposing to finish the partially completed fences listed above and initiate and/or complete construction on at least three of the following fences; Kawailoa, Lihue, Makaha Subunit II, Kamaili, and Kahanahaiki Subunit II by end of the next reporting period.

- OANRP proposes to complete the 106 cultural surveys for fence lines at Huliwai, KawaiikiI/II, Lower Opaeula II, Lower Poamoho, Poamoho II, North Halawa during FY12.

- Ungulates were removed from Ekahanui.

- Piglets were able to breach the Kahanahaiki Subunit I fence but were unable to survive. Piglets are still able to breach the fences at Kapuna Upper, Pahole, and Kahanahaiki so the fences are being retrofitted with skirting.

- With the completion of the perimeter fence, hunting operations have been initiated at Manuwai. To date, two boars and two sows have been removed.

- A couple of small pigs were able to breach the fence at Kaluaa/Waieli II due to a tree fall but were subsequently snared.

OIP/MIP Management Unit Status

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

Fence panels along rocky outcropping.

MIP Management Unit Status

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
ARMY LEASED AND MANAGED LANDS													
Kahanahaiki	Kahanahaiki I	Yes	Yes	64/64	1998					7	0	Complete.	None
	Kahanahaiki II	No	No	0/30	2012		X			6	0	Proposed for construction in 2013 but may be promoted to 2012 if other fences can't be built on time. Snaring is performed to reduce pig pressure.	Pig
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002					3	0	Complete. Fence is in need of some modification but still pig-free.	None
L. Ohikilolo	L. Ohikilolo	Yes	Yes	70/70	2000					2	0	The Ohikilolo ridge fence and the strategic fence are both complete. Since July 2006, 11 goats have been able to breach the fence. All have been removed and the fence was modified to prevent more ingress. No pigs have been observed.	Pig
L.Opaeula	L.Opaeula	Partial	No	0/26	2011	X	X		X	1	3	Fence is about ¾ complete.	Pig
Ohikilolo	Ohikilolo	Partial	No	3/574	2002 2013					10	0	Ohikilolo ridge fence is complete, excluding goat ingress from south. Six smaller ungulate free PU fences are also complete. Goats were eliminated from Makua in 2002. A large rock fall that damaged the ridge fence has been repaired and no goats have been observed or caught in snares. A route has yet to be determined for the closure of the Ohikilolo MU to exclude pigs.	Pig
Puu Kumakalii	Puu Kumakalii	No	-	-	-	-	-	-	-	2	0	None needed but will be partially included within the proposed Lihue fence.	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES													
E. Makaleha	E. Makaleha	No	No	0/231	2014		X			7	3	Cultural 106 surveys completed. Awaiting signing of Army-State real estate agreement. Limited goat control has been conducted in the past.	Pig/Goat Cattle
Ekahanui	Ekahanui I	Yes	Yes	44/44	2001					6	3	Complete.	None
	Ekahanui II	Yes	Yes	165/159	2009					5	1	Complete and ungulate free. The completed fence is several acres larger than the original proposed MU fence. Repairs were done to the river crossing after large storm.	None
Haili to Kealia	Haili to Kealia	No	-	-	-	-	-	-	-	1	0	As per DOFAW staff 'no fence needed'	None
Kaena	Kaena	No	-	-	-	-	-	-	-	1	0	None	None
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999					4	3	Completed by TNCH. There have been several breaches and a total of 15 pigs have been removed. Skirting was installed around the existing fence to deter incursions. The completed fence is several acres larger than the original proposed MU fence.	None
	Kaluaa/Waieli II	Yes	Yes	25/17	2006					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			1	0	Completed and ungulate free. The completed fence is larger than the original proposed MU fence. Repaired river crossing after large storm.	None

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs		Notes	Current Threats
										MIP	OIP		
Keaau	Keaau	No	No	0/33	2014		X			1	0	Proposed fence for *Gouania vitifolia* and *Hibiscus brackenridgei* ssp. *mokuleianus*. Supplemental EA to the MIP and Cultural 106 surveys are complete. Awaiting signing of Army-State real estate agreement.	Pig/Goat/ Cattle
Keaau/Makaha	Keaau/Makaha	Yes	Yes	1/3	2009		X			1	0	Complete and ungulate free.	None
Manuwai	Manuwai I	Yes	No	166/166	2011		X			7	1	Complete. Ungulate removal is on-going, to date a total of 4 pigs have been removed. Repaired fence at stream crossing after large storm.	Pig/Goat
Napepeiaoolelo	Napepeiaoolelo	Yes	Yes	1/1	2009		X			1	1	Complete.	None
Pahole	Pahole	Yes	Yes	215/215	1998					16	0	Complete.	None
Palikea	Palikea I	Yes	Yes	23/21	2008					2	0	Complete. Subunit II has been abandoned in favor of Napepeiaoolelo. The completed fence is a couple of acres larger than the original proposed MU fence.	None
	Palikea IV	No	-	-	-	-	-	-	-	1	0	None	None
	Palikea V	No	-	-	-	-	-	-	-	1	0	None	None
Kapuna Upper	Kapuna I/II	Yes	Yes	32/182	2007					1	0	Complete.	None
	Kapuna III	Yes	Yes	56/182	2007					5	0	Complete.	None
	Kapuna IV	Yes	No	342/224	2007					8	0	Complete, but NARS staff are continuing pig eradication campaign by alternating between volunteer hunts and snaring.	Pigs
Waianae Kai	Waianae Kai	Yes	Yes	9/9	2010		X			2	0	Complete and ungulate free.	None
	Gouvit	Yes	Yes	1/1	2008					1		Complete and ungulate free	None
	Nerang Mauka	Yes	Yes	1/1	2011		X			2		Complete and ungulate free.	None
W. Makaleha	W. Makaleha	Partial	No	7/93	2014		X			7	0	Cultural 106 surveys are complete. Awaiting signing of Army-State real estate agreement. Limited goat control has been conducted in the past. The *Schiedea obovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free.	Pig/Goat
BOARD OF WATER SUPPLY													
Kamaileunu	Kamaileunu	Yes	Yes	5/2	2008	X	X			1	0	Both of the *Sanicula mariversa* PU fences at Kamaileunu and Kawiwi are completed and ungulate free.	None
Makaha	Makaha I	Yes	Yes	85/96	2007					10	1	Complete and ungulate free.	None
	Makaha II	No	No	0/66	2012	X	X		X	4		Completed 106 surveys. Slated for construction in 2012. Completed *Cyanea longiflora* PU fence.	Pig/Goat
DOLE FOOD COMPANY, INC.													
Alaiheihe and Kaimuhole	Alaiheihe and Kaimuhole	No		0/100	2020	X				4	0	An ROE is complete for rare plant monitoring. OANRP has scoped out a line and a 106 survey is partially complete. At this time, Castle and Cooke is unwilling to discuss any fencing and are looking to sell the land. OANRP is hopeful if there is a sale then the new landowner will be interested in working towards mutually beneficial goals.	Pig/Goat/ Cattle

OIP Management Unit Status

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
ARMY LEASED AND MANAGED LANDS															
Kaala-Army	Kaala	Yes	Yes	183/183	2012		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, awaiting signing of real estate agreement prior to construction. The proposed Lihue fence will connect to this unit.	Pig
Kaunala	Kaunala	Yes	Yes	5/5	2006						1			Complete.	None
Kawaiiki I/II	Kawaiiki I/II	No	No	0/11	2017	X			X			2		OIP EA, CDUP and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
Kawailoa	Kawailoa	No	No	0/7	2012	X	X		X		1			OIP EA, 20 year license agreement, 106 cultural survey and CDUP complete.	Pig
Lihue	Lihue	Partial	No	4/1800	2011		X			4	6			25% of the fence perimeter has been constructed. Six PU fences complete.	Pig/Goat
Poamoho	L. Poamoho	No	No	0/156	2014	X			X		1			OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
	Poamoho II	No	No	0/60	2016	X			X			2		OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
L. Opaeula II	L. Opaeula II	No	No	0/24	2016	X			X		1			OIP EA and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
Oio	Oio	Yes	Yes	4/4	2006						1			Complete.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	273/273	2007						1			Complete. Two pigs were able to breach Opaeula fence in 2010 but were promptly captured with assistance from KMWP.	None
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006						1			Complete.	None
S. Kaukonahua	S. Kaukonahua I	No	No	0/95	2013		X				3	3	1	OIP EA and 106 cultural surveys complete. Snaring is performed to reduce pig pressure.	Pig
	S. Kaukonahua II	No	No	0/95	2015		X					2		OIP EA and 106 cultural surveys complete.	Pig
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES															
Huliwai	Huliwai	No	No	0/1	2013						1			OIP EA complete, awaiting 106 cultural surveys	Pig
Ekahanui	Ekahanui III	Yes	Yes	8/8	2010		X				1			Complete and ungulate free.	None
Kaipapau	Kaipapau	No	No	0/273	2012		X				4	1		OIP EA and 106 surveys complete. Awaiting signing of Army-State real estate agreement.	Pig
Kaleleiki	Kaleleiki	Yes	Yes	2/2	1998						1			Completed by DLNR. May need to expand existing fence.	None

Management Unit	Management Unit Fence	Fence	Ung. Free	Acreage Prot/Prop	Est. Year	CDUP	106	MOU/ ROE/ RA	License Agree.	# MFS PUs				Notes	Current Threats
										MIP	OIP				
											T1	T2	T3		
Manana	Manana	No	No	0/19	2012		X				1			OIP EA and 106 surveys complete. Awaiting signing of Army-State real estate agreement.	Pig
Manuwai	Manuwai II	Yes	No	138/138	2011		X			1	1			Complete. Ungulate removal is ongoing with 12 pigs removed so far.	Pig/Goat
N. Kaukonahua	N. Kaukonahua	No	No	0/31	2014		X				3	1		OIP EA and 106 cultural survey complete. Awaiting signing of Army-State real estate agreement and amendments to the Army's lease.	Pig
Poamoho	Poamoho I	No	No	0/5	2015						1	4		OIP EA is completed. Awaiting signing of Army-State real estate agreement and 106 surveys.	Pig
	Poamoho III	No	No	0/18	2016							1	1	OIP EA is completed. Awaiting signing of Army-State real estate agreement and 106 surveys.	Pig
	Poamoho IV	No	No	0/2	2016							1		OIP EA is completed. Awaiting signing of Army-State real estate agreement and 106 surveys.	Pig
Wailupe	Wailupe	No	No	0/22	2019							1		OIP EA complete, awaiting 106 cultural surveys. Awaiting Army-State real estate agreement and 106 surveys.	Pig
Waimano	Waimano	Yes	Yes	4/4	2011		X				1			Complete and ungulate free.	None
N. Pualii	N. Pualii	Yes	Yes	20/20	2004					1	1			Complete.	None
	BOARD OF WATER SUPPLY														
Kamaili	Kamaili	No	No	0/7	2012	X	X		X		1			OIP EA, cultural resource surveys, license agreement and CDUP are complete.	Pig/Goat
	HAWAII RESERVES INC.														
Koloa	Koloa	Partial	No	0/160	2011	X	X		X		4	2		OIP EA, cultural resource surveys, license agreement and CDUP are complete. Construction has begun on the unit.	Pig
	KAMEHAMEHA SCHOOLS														
Waiawa	Waiawa I	No	No	0/136	2017	X			X			1	1	OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
	Waiawa II	No	No	0/136	2019	X			X			1		OIP EA, CDUP, and 20 year license agreement complete. Awaiting 106 cultural survey.	Pig
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION															
North Halawa	North Halawa	Partial	No	.5/4	2015	X					1			Built small unit around *Cyanea st-johnii* PU. Larger unit still planned for area. Awaiting completion of 106 cultural survey for larger unit.	Pig
KUALOA RANCH INC.															
Kahana	Kahana	Partial	No	1/23	2018	X						1		Built small units around *Schidea kaalae* PU. OIP EA is complete. Awaiting completion of 106 cultural survey for larger unit.	Pig
U. S. FISH AND WILDLIFE SERVICE															
Kipapa	Kipapa	No	No	0/4	2019	X							1	OIP EA is complete. Awaiting completion of 106 cultural survey.	Pig

1.1.2 Environmental Outreach

Sections

1. VOLUNTEERS
2. EDUCATIONAL MATERIALS
3. INTERNSHIPS & OUTREACH STAFF
4. TROOP EDUCATION
5. OUTREACH EVENTS
6. PUBLIC RELATIONS
7. OUTREACH PROGRAM RECOGNITION
8. --*APPENDIX*--

Volunteers

During the reporting period 1-September, 2010 – 30-September, 2011 the OANRP Outreach Program expanded and developed additional volunteer-based projects at appropriate sites within OIP and MIP management areas, and at the two OANRP baseyards. Table 1 summarizes project trips. See Appendix 1-1 for photographs of project trips.

- Total volunteer hours for field days = 4194*(includes driving time to and from trailhead, safety briefing, hiking time to and from work site, and gear cleaning time at end of day)*
- Total volunteer hours at work site =1231 *(includes actual time spent weeding, planting, or monitoring)*
- Total field volunteer trips = 76
- Total baseyard volunteer hours = 618
    - Baseyard projects:
        - Propagule processing
        - Nursery maintenance
        - Baseyard landscaping
        - Outreach material preparation and filing
- Maintained a volunteer database of 965 total volunteers and communicated regularly with active volunteers on a daily basis.
- Worked with RCUH/PCSU staff to develop a RCUH Volunteer application and approval process. Developed a RCUH Volunteer Application, a Reference Addendum Form, and a Quarterly Reporting Procedure to satisfy RCUH reporting requirements. *Note: In order to refine the RCUH volunteer application process, OANRP Outreach elected to halt volunteer service trips during the month of October, 2010.*

Table 1. Volunteer field trips for FY 2011.

Management Unit	Projects	Total Number of Trips
Kahanahaiki	Invasive weed control	19
	School Group Stewardship Plots	5
	Common native field nursery set-up	2
	Trail maintenance in chipper site	3
	Common native plant monitoring & seed collection	1
	Weed-Whack invasive grass on re-veg road	1
Kaala	Sphagnum moss control & boardwalk construction	6
	Boardwalk construction only	4
	Invasive weed control (kahili ginger)	3
	Incipient weed control	3
	Sphagnum moss control only	2
Palikea	Incipient weed control	3
	Invasive weed control	2
Makaha	Invasive weed control	7
	Rare Plant Monitoring and Fence Check (with Orange Team)	1
West Makaleha	Invasive weed control	4
KTA- Pahipahialua	Invasive weed control	1
	Invasive weed control/Common native transplants	1
Kaluaa	Invasive weed control	2
	Re-introductions	1
Kaluakauila	Fence Maintenance (with Orange Team)	3
Kaena-East of Alau	Invasive weed control	1
Pahole Access Road	Weed-Whack Invasive grass along road-side	1

Educational Materials

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

- Displays:
  - "Save Species, Grow Natives" – three-panel display poster focusing on importance of growing native species in Hawaii, used in conjunction with a hands-on planting native seed planting activity for the Forests, Oceans, Climate and Us (F.O.C.U.S.) event at Sea Life Park in July;
  - "OANRP Overview" – a three-panel display highlighting the natural resources that OANRP manages on Oahu, threats to these resources, and what the OANRP does to protect them, used for Earth Day events during the month of April;
  - "*Chromolaena Odorata*" – a poster describing the threat of this incipient weed at Kahuku Training Area and tips for preventing the spread of seeds, designed to be posted at Kahuku Motor Cross Track;
    - http://manoa.hawaii.edu/hpicesu/DPW/chrodo_poster.pdf
  - "Oahu's Endangered Fruits" – a pictorial display highlighting fruits from 15 endangered plant species managed by OANRP, used at various events throughout the year.

- Signage:
  - "Protecting Endangered Species" sign – an informational sign about OANRP's use of snap trap grids to control rats, and details about the various endangered species that are threatened by rats, signs will be placed on fence lines in areas where trap-out grids are in place;
  - "Snail Enclosure" sign – an informational sign that explains the purpose of snail enclosure fencing, signs will be placed on snail enclosure fence-lines at locations within the Waianae and Koolau management units.
- Brochures & Flyers:
  - "*Chromolaena Odorata*" – a flyer describing this incipient weed, ways to prevent its spread, and contact information to report sightings;
    - http://manoa.hawaii.edu/hpicesu/DPW/chrodo_flier.pdf
  - Revision of Army Natural Resources Program brochure, Oahu Army Natural Resources brochure, and Environmental Compliance Officer Class brochure
    - http://www.garrison.hawaii.army.mil/sustainability/NaturalResources.aspx
- Presentations:
  - "Notes from the field: Science based management for Oahu's endangered species," a presentation for U.H. Conservation Biology Class, graduate level;
  - "Conservation Careers and Internship Opportunities with OANRP," presentation for Undergraduate Internship Class in UH Natural Resources and Environmental Management Dept.;
  - "Hiking Safety 101," a presentation for soldiers at the Safety Stand-Down at Schofield.
- Other:
  - Collaborated with DPW staff to create a OANRP web presence on the USAG-HI Environmental Division website.
    - http://www.garrison.hawaii.army.mil/sustainability/NaturalResources.aspx
  - Active participants in the Partnership to Protect Hawaii's Native Species (PPHNS), a collaborative working group between OANRP and other federal and state agencies (e.g. USFWS, CGAPS, DLNR) to educate the public about the devastating effects of rats on Hawaii's native species, and options to help control this threat. Outcome from 2011 include the development of:
    - flyer, "Frequently Asked Questions and Answers - Rodent & Mongoose Control for Conservation Purposes: The Hawaii Joint Federal-State Programmatic EIS."
    - text and images for a draft brochure published by Conservation Council for Hawaii on rat damage to Hawaii's native species

    OANRP Outreach provided input, photos, text, and editing for both of these publications and for the PPHNS website;
  - Active participants on the planning committee for the 2011 Hawaii Conservation Conference;
  - Planning Committee member for the "Navigating My Course" workshop, a three- day educational experience for young women interested in pursuing careers in conservation in Hawaii.

Internships and Outreach Staff

Developed internships at OANRP and with cooperating agencies and organizations.

- Hosted three teams of interns from Hawaii Youth Conservation Corp (HYCC), providing hands-on natural resource training for 31 youth. Together, HYCC interns contributed a total of 1240 volunteer hours in June;

- Evaluated and scored 59 applicants, interviewed 11 applicants, and awarded six individuals with 12-week, paid OANRP summer internships. OANRP Outreach coordinated orientation and training for these interns and then placed them with field, nursery, and fence crews to gain valuable career skills and experience in the field of natural resource management;
- Evaluated and scored 25 applicants, interviewed 5 applicants, and awarded one individual with a 12-month AmeriCorps Internship with OANRP. Intern has been placed with a natural resource field crew;
- Evaluated and scored 45 applicants, interviewed 6 applicants, and hired one individual as an Environmental Outreach Specialist (to replace the second specialist, who resigned in July 2011). OANRP Outreach coordinated orientation and training for this new staff.

Troop Education

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

- Implemented a 45 min. presentation for the eight Environmental Compliance Officer (ECO) training courses held on Oahu in FY2011; approximate number of soldiers attending = 293 (presentation is constantly revised to relay current information on potential threats to natural resources on Army lands, such as the recently discovered *Chromolaena odorata* in KTA);
- Developed and presented a 45 min. presentation on Hiking Safety to 400 soldiers during the two-day Schofield Safety Stand-Down;
- Coordinated and led two volunteer groups consisting of soldiers from the 523rd Engineering Company (Schofield Barracks) on service projects controlling invasive grasses in Kahanahaiki and along the Pahole Access Road.

Outreach Events

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

- Total # of outreach activities = 18
- Total # of people served (approximated) = 2740

Table 2. Outreach activities for FY 2011.

Event	Approx. # of people served	Audience
University of Hawaii Intern Class (NREM Dept.)	30	Undergraduate students
Malama Learning Center	35	H.S. Students and families
University of Hawaii Conservation Biology Class	16	Graduate Students
Kaena Pt. Predator Proof Fence Outreach	75	General Public
Agriculture and Environmental Awareness Day	200	Elementary Students (grade 4 & 5)
Kamehameha Schools Career Day	60	Middle School Students

Army Earth Day Festival-Schofield	400	Military Families
University of Hawaii Earth Day Festival	100	UH Students
Army Fun Festival-Schofield	200	Military Families
Windward Community College Botany Class	22	Undergraduate Students
Endangered Species Day-Honolulu Zoo	100	General Public
Hawaii Trail & Mountain Club Trail Access Support	15	HTMC trail clearing members
F.O.C.U.S. Event at Sea Life Park	200	General Public
Volunteer Appreciation Hike	12	Dedicated volunteers
Hawaii Conservation Conference (HCC) –Sustainable Connections Session-Presenters	100	College and H.S. Students
HCC Emerging Professional Session-Panel Participants & Discussion Group Facilitators	75	College and H.S. Students
HCC Display in Exhibit Area	1000	Conference Attendees
HCC Display for Open House Session	100	General Public
Total number of people served	**2740**	

Public Relations

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

Articles:

Title	**Publication**	**Print Date**
▪ Volunteers Help Protect Oahu's Native Forest With DPW	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2010/09/30/volunteers-help-protect-oahu%E2%80%99s-native-forest-with-dpw/	1-Oct-10
▪ Schofield's Rainwater Harvesting Project Yields Water, Energy Savings	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2010/10/22/schofield%e2%80%99s-rainwater-harvesting-project-yields-water-energy-savings/	21-Oct-10
▪ Tiny Alien Snails Put Natural Resource Workers in a Salty Situation ▪ Alien Snails Found in Plant Nurseries-Can we Keep Them Out of Our Forests? ▪ Volunteers Lend a Hand to Help Nioi Habitat ▪ Extent of Threats Posed By Non-Native Garlic Snail (*Oxychilus alliarius*) Still Unknown	EMP, Vol 51 http://manoa.hawaii.edu/hpicesu/DPW/EMP_Fall_2010.pdf	1-Nov-10
▪ Army Hawaii Helps Acquire Land to	Kui Ka Lono (DPW, USAG-HI)	Jan-11

Protect Endangered Bird, Enable Training	Public Works Digest http://www.imcom.army.mil/hq/kd/cache/files/9DD8185A-423D-452D-4B052E27801E693A.pdf	Nov/Dec-10
▪ Oahu Army Natural Resources Reintroduces Native Plants, Saves Snails, Protects Flies	Public Works Digest http://www.imcom.army.mil/hq/kd/cache/files/9DD8185A-423D-452D-4B052E27801E693A.pdf	Nov/Dec-10
▪ Paintball, Woodchips Part of Environmental Discussion	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2011/02/24/paintball-woodchips-part-of-environmental-discussion/	24-Feb-11
▪ Special Local Needs Registration for *Sluggo* Approved in the State of Hawaii Through 2015 ▪ Fire Contrtol Efforts Blossom to Protect the Endangered Mao Hau Hele (*Hibiscus brackenridgei* subsp. *mokuleianus*) ▪ A Strategic Partnership for the Conservation of Oahu's Rarest Plants and Animals-The Makua Implementation Team	EMP, Vol 52 http://manoa.hawaii.edu/hpicesu/DPW/EMP_Spring_2011.pdf	1-Apr-11
▪ Hawaii Confronts Invasive Superweed on Kahuku Training Area	Public Works Digest http://www.imcom.army.mil/hq/kd/cache/files/55DE4014-423D-452D-43DC08DD25DF8940.pdf	May/Jun-11
▪ Protecting Resources: Hawaii Confronts Invasive Superweed in Kahukus	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2011/06/24/protecting-resources-hawaii-confronts-invasive-superweed-in-kahukus/	23-Jun-11
▪ Schofield Revitalization Effort Protecting Native Plants	KITV http://www.kitv.com/video/28503476/index.html	7-Jul-11
▪ Oahu Endures First Contact With New Invasive Weed, *Chromolaena* ▪ ALERT! *Chromolaena odorata* ▪ Homeland Defense for Kahuli ▪ Up-and-Coming Conservationists: Q & A with the OANRP's New Hires and Summer Interns	EMP, Vol 53 http://manoa.hawaii.edu/hpicesu/DPW/EMP_Summer_2011.pdf	1-Aug-11
▪ Forces Combine to Manage One of Oahu's Rare Natural Gems	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2011/10/06/forces-combine-to-manage-one-of-oahu%e2%80%99s-rare-natural-gems/	27-Oct-11

- Edited/produced/distributed the Ecosystem Management Program (EMP) Bulletin, a quarterly newsletter highlighting achievements made by the Army Environmental Division both on Oahu and Hawaii Island. The EMP is distributed to a comprehensive list of state, non-profit, federal,

and educational institutions, and OANRP volunteers. Articles from this publication are frequently picked up by other Army publications.

- http://manoa.hawaii.edu/hpicesu/dpw_emb.htm

Outreach Program Recognition

Received national recognition of OANRP Outreach program and volunteers.

- Registered and planned volunteer work days in Pahipahialua MU, Kahuku Training Area (KTA) (Sept. 2010) and at Kaala (Sept. 2011) for National Public Lands Day. Received cash awards totaling $7818 to purchase supplies including: volunteer hand-tools and gloves; two 55 gallon drums of St. Gabriel's Moss Killer Concentrate (for *Sphagnum palustre* moss control at Ka'ala); and several hundred feet of wire mesh (to be used in the construction of the new Ka'ala boardwalk). Volunteer work days were promoted on National Public Lands website.
- Nominated three OANRP volunteers for the President's Volunteer Service Award. Two volunteers were eligible for the Silver Level Award and one for the Bronze Level. Volunteers received presidential pins and certificates of appreciation.

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

1.1.3 Weed Control Program

MIP/OIP Goals

The stated MIP/OIP goals for weed control are:

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

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

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

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. In this document, data is summarized for the reporting period of 1 September 2010 through 30 September 2011 (thirteen months).

This year, staff spent 5,778 hours controlling weeds across 259 ha. This includes both incipient and ecosystem control efforts. Staff also conducted surveys on all primary Training Range roads and MU access roads. In the coming year, secondary Training Range roads will be also be surveyed. Some surveys of landing zones (LZs) used by both the Army and OANRP operations were conducted; all military LZs will be prioritized for surveys in the coming year.

Incipient Control Areas

Incipient control efforts are tracked in Incipient Control Areas (ICAs). Each ICA is drawn to include one incipient taxon; the goal of control is eradication of the taxon from the ICA. ICAs are primarily drawn in and around MU. Those not located in/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 (for example, *Morella faya* in Kaluaa). Many ICAs are quite small, but a few, like those for *Angiopteris evecta* in Kapuna or *Chromolaena odorata* in Kahuku, are quite large. Typically, ICA areas are swept over and over again, until eradication has been achieved and staff are reasonably confident that there is no remaining seed bank. The goal of ICA efforts is to achieve local eradication of the target species. OANRP currently manages about 60 taxa in approximately 180 ICAs.

Of the total 259 ha swept, ICA efforts covered 164 ha. ICA efforts have not been reported in this format in previous annual reports, so we cannot comment as to whether the area swept is greater or less than in previous years. Staff spent 665.5 hours on ICA management and conducted 281 visits to 130 ICAs. Note that in some areas, several small ICAs can be treated in one field day. The majority of effort was spent on the following ICA projects:

MU	Taxon	# ICAs	# of Visits	Effort (person hours)	Notes
Kaala Army and NARS	*Crocosmia x crocosmiifolia*	4	4	24	Minimal staff time is used on this outreach project. Volunteers are used to keep this taxon out of the Kaala bog. Efforts have been successful in reducing the numbers of plants found along the boardwalk over time.
	Juncus effusus	4	6	49.5	Minimal staff time is used on this outreach project. Volunteers assist with controlling this taxon along the boardwalk. *J. effusus* is a high priority target at Kaala. Efforts have been successful in reducing the numbers of plants found along the boardwalk over time.
	Sphagnum palustre	3	18	104	Control of this invasive moss began in earnest this year and is discussed in detail in the Invasive Species Updates, below. Volunteers have provided most of the effort on this project so far. *Sphagnum* has been treated along more than 400m of the 700m boardwalk. As control moves to moss off the boardwalk, staff will play a larger role in control.
Upper Kapuna	*Angiopteris evecta*	3	7	25.5	There are several large infestations of this fern in Kapuna. Staff have successfully controlled most of the mature plants, and plan on visiting the ICAs for a thorough sweep once a year to control recruitment.
KTA no MU	*Acacia mangium*	4	10	37.6	Planted in KTA as erosion control. This fast-growing *Acacia* has the potential to hybridize with koa. Several of the ICAs for this taxon are large, and require almost a full day to treat thoroughly. No mature plants have been seen for at least five years, but seedlings and immature trees are still found, suggesting a persistent seed bank exists.

MU	Taxon	# ICAs	# of Visits	Effort (person hours)	Notes
	Chromolaena odorata	6	7	92	New species to OANRP. Control efforts are described in detail in the Invasive Species Updates below and Appendix 1-2 (a-c). Control efforts include partner agency time but do not include survey time.
	Melochia umbellata	6	16	46.7	This high priority target is found on Drum Road. It has a persistent seed bank, and regular control must be conducted to prevent it from maturing and setting additional seed. There are currently no known mature plants. Since it occurs along a well-used road, the threat of it moving to new locations on vehicles is high. All ICA sites but one were swept this year. Few plants were found in the one off-road site.
Palikea	*Crocosmia x crocosmiifolia*	4	9	43.8	Minimal staff time is used on this outreach project. Volunteers control this taxon in and around the exclosure. All ICAs were swept.

While the goals for all ICAs are the same, the rate of visitation required to achieve this varies widely. Some ICAs, such as those for *Ehrharta stipoides*, must be visited at least quarterly, as this cryptic grass grows and matures very quickly. In contrast, for *Angiopteris evecta* ICAs, once initial knockdown is complete, ICAs need only be swept once every year or two, as ferns take a while to mature. In general, ICA efforts are considered successful if visits are frequent enough to detect and control plants before they mature, and if there is a downward trend in total numbers of plants found on each visit. In the OARNP database, specific reports can be generated which detail this information at each ICA; these reports include the dates of the last mature and non-mature plants found, overall effort spent, and population trend graphs. Please see these reports for a more complete picture of ICA status.

Weed Control Areas

Ecosystem control efforts are tracked in Weed Control Areas (WCAs). WCAs generally track all control efforts which are not single-species based. Note that WCAs are not necessarily drawn to encompass all of a MU, although in some MUs, like Makaha and Manuwai, the entire MU has been divided into WCAs. Each WCA is prioritized based on a variety of factors including, presence of rare taxa, potential for future rare taxa reintroductions, integrity of native forest, invasive species presence, and fire threat. Different WCAs have different goals. For example, in Manuwai, WCAs on the northern end of the exclosure are prioritized for control of fuels but little else, while WCAs in the central portion of the exclosure (which have high-quality patches of native forest) will be managed intensively for rare plant reintroductions. The goals and priorities for weeding in a particular WCA are detailed in the appropriate ERMUP. For some low-priority WCAs, no control may be planned for many years. WCAs drawn outside of MUs typically provide a way of tracking effort at genetic storage rare plant sites, or along access trails and roads. OANRP does not necessarily plan to control 100% of the acreage in a WCA every year. Visitation rates and goals are further elucidated in the ERMUPs. See the 2009 Status Update for the Makua and Oahu Implementation Plans, Appendix 1-2, for information on control techniques.

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 2010 report is included for reference. 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).

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. It can be difficult to compare effort spent between WCAs/MUs, as the goals for each site vary. These database reports, as well as the ERMUPs, provide a more detailed look into the each MU and each WCA, and are recommended to the IT/FWS.

This year, WCA efforts covered 95 ha, an increase over last year (60.25 ha). Also, staff spent 5,113 hours over 406 visits at 139 WCAs. This is an increase over the 2009-2010 report year (3,255.9 hours, 353 visits) and the 2008-2009 report year (2,652.4 hours, 267 visits). While part of this increase is likely due to the longer than usual report period (thirteen months), this steady rise is partly the result of a concerted effort to spend more time on weed control over the past year. However, staff recognize that significantly more effort is needed to reach IP goals at all MUs and that capacity issues persist regarding the overall efficacy of weeding efforts in the highly degraded Waianae Mountains.

MU WCA Weed Control Summary, 2010/09/01 through 2011/09/30

Management Unit	2011 Report Year					2010 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	Area weeded (ha)	# Visits	Effort (person hours)	Area weeded (ha)	# Visits	Effort (person hours)	
Alaiheihe and Kaimuhole	79.14	2.44	0.52	1	4	0	0	0	No comprehensive weed management plan in place for this MU yet; perimeter of MU not finalized. Effort this year was for road maintenance.
Alaiheihe Upper No MU	N/A	108.5m^2	101 m^2	1	3	0	0	0	Control was conducted around a GSC rare plant population.
Ekahanui	87.50	16.04	1.64	11	136.5	2.6	23	202.5	Control efforts focused around rare species locations, particulary reintroductions.
Ekahanui No MU	N/A	4.82	1.08	1	10	3.94	4	17.5	Limited weed control is conducted outside the MU. This effort is along trails and roads to maintain/improve ease of access to the MU and minimize weed spread.
Haili to Kealia I and II	12.8	2.14	0	0	0	0.73	2	8.5	One of the *Hibiscus brackenridgii* reintroduction sites was abandoned. OANRP is re-evaluating goals for these MUs.
Helemano	60.62	61.01	11.36	13	141	2.79	2	38	Staff focused on weeding the eastern (summit) end of the MU.
Helemano South No MU	N/A	46.24	0.46	1	15	0	0	0	Control conducted for *Leptospermum scoparium* with the Koolau Mountains Watershed Partnership (KMWP).
Huliwai No MU	N/A	620.65 m^2	50.22 m^2	1	0.5	43 m^2	1	1	Weed control focused around rare taxa.
Kaala Army	49.02	42.28	13.42	13	420	5.22	21	355.5	*Hedychium gardnerianum* continues to be the primary weed target at Kaala. Volunteer effort was used to sweep part of the area closest to the boardwalk.
Kaala NAR	20.03	4.56	0	0	0	0	0	0	OANRP will assist with *H. gardnerianum* control on NARS land as asked.
Kaena	6.42	2.73	1.02	3	67.5	1.69	4	97	Weed control focused around rare taxa.

Management Unit	2011 Report Year					2010 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	0.14	0.18	4	116	0	0	0	This area is at high risk from fire. Staff focused control on expanding the weeded buffer around the small, known rare plant site. The large numbers of hours spent at this sit is do to one large volunteer trip with the Youth Conservation Core (YCC).
Kahanahaiki	25.45	27.19	10.47	71	997.25	4.53	68	814.35	No chipper operations were conducted in Kahanahaiki, but volunteers and staff both performed follow-up control in the chipper area. Staff also swept several native-dominated portions of the MU (these are swept every few years). Together, these activities account for part of the high level of effort in Kahanahaiki.
Kaleleiki	1172 m^2	7959 m^2	1536 m^2	1	19.5	2355m^2	1	7.5	More *Eugenia koolauensis* plants were found at this site, and the area of the MU needs to be increased to include all known plants.
Kaluaa and Waieli	80.97	82.9	3.43	35	262.6	1.46	19	186	Control efforts focused around rare taxa locations. A significant amount of time was spent on the Hapapa Bench clearing the area for a snail exclosure. Volunteer trips were planned to this MU for the first time. See the Kaluaa and Waieli ERMUP for a description of planned control actions
Kaluaa No MU	N/A	3.84	0.96	4	39	11m^2	1	1	Limited weed control is conducted outside the MU. Control is targeted around rare taxa that fall outside the Kaluaa and Waieli MU and the access road to the Kaluaa trailhead.
Kaluakauila	41.68	9.53	3.45	15	99	2.90	17	91.75	Control efforts focused on grass control and *Leucaena leucocephala* control around rare taxa. The ridgeline fuelbreak was maintained.
Kamaili	2.57	1.84	0	0	0	381m^2	1	1	No control was performed at this MU this year.
Kapuna Upper	172.35	177.47	2.22	23	240.5	1.12	18	138.5	Control efforts continued to focus around rare taxa and reintroductions. Staff began assisting NARS staff with some State-led projects.
Kaunala	1.98	1.99	0.18	3	65.4	0.24	5	61.75	Staff efforts focused around rare taxa, and volunteer efforts began in areas with no *E. koolauensis*.

Management Unit	2011 Report Year					2010 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	Area weeded (ha)	# Visits	Effort (person hours)	Area weeded (ha)	# Visits	Effort (person hours)	
Lihue	714.05	6.21	1.83	9	105.5	0.03	2	1	OANRP increased weed control efforts in the Lihue area to take advantage of increased availability of SBW, and to control weeds in newly completed PU fences.
Makaha	60.87	35.26	2.54	27	253.3	1.43	17	178.5	Weed control efforts continue to focus around rare plant sites in the southern part of the exclosure.
Makaha No MU	N/A	7.85	2.18	3	8	0.07	1	2	Control efforts focused on trail clearing, although some clearing was done around a *Neraudia angulata* population.
Manuwai	122.49	122.49	0.47	5	17.5	500m^2	1	3	The Manuwai fence was completed this year. All weed control effort to date has been fence clearing. See the Manuwai ERMUP for a discussion of the weed control plan for this area.
MMR No MU	N/A	28.17	4.44	4	56	0.76	4	17	Minimal work is done outside of MUs in MMR. This year, time was spent maintaining the 'Reveg' Road, on the border of Kahanahaiki, and conducting weed control in the area adjacent to Ohikilolo (Lower Makua)
Nanakuli No MU	N/A	4.04	0.81	1	2	0	0	0	This is the Halona ridgeline, an area between the Palikea and Palikea IV MUs. Control efforts here focus on *Sphaeropteris cooperi*, to remove mature plants seeding into the neighboring MUs.
Napepeiauolelo No MU	N/A	9253 m²	0	0	0	663 m²	1	1	There is a small population of *Hesperomannia arbuscula* at this site, as well as a patch of native-dominated forest. Control in this area is a priority for the coming year.
Ohikilolo	232.54	110.34	5.35	20	464	2.50	18	160.3	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; several additional trips were made to this area. Most of this MU is steep cliff, where standard weed control techniques are not feasible.

Management Unit	2011 Report Year					2010 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 Lower	28.75	4.44	3.72	15	274	3.62	25	245.5	Staff were able to reduce the number of visits to Lower Ohikilolo, but maintaining fire breaks around the rare taxa here continues to be labor-intensive.
Opaeula Lower I	10.15	10.15	0.14	3	39.25	0	0	0	The Opaeula Lower fence is currently being constructed. All weeding efforts this year were done to facilitate fencing and open LZs.
Oio	1.33	1.63	0	0	0	1.54	4	68	No control was done at this site this year. Due to the poor health of the *E. koolauensis* population at this site, OANRP has been hesitant to commit many resources to this site.
Opaeula	49.55	48.07	0	0	0	2.52	1	22	Almost all of the Opaeula exclosure has been swept once. This year, staff decided to switch efforts to an initial sweep of Helemano exclosure. Follow-up control will be conducted at Opaeula in the future.
Pahipahialua	5995 m^2	5995 m^2	1263 m^2	4	65	295 m^2	3	40.5	Staff efforts focused around rare taxa, and volunteer efforts continued in areas with no *E. koolauensis*.
Pahole	87.96	30.19	2.36	21	256.5	4.48	30	106.05	Control efforts continue to focus around rare taxa sites. This year, efforts were more site-intensive.
Pahole No MU	N/A	8.65	7.78	5	77.1	7.13	5	43	Control outside of the MU is limited to a reintroduction site, a *Montanoa hibiscifolia* site outside the exclosure, the Nike facility and the Pahole road. Staff continue to maintain the road for safety and ease of access.
Palawai No MU	N/A	1.45	1.41	6	37.6	9.28 m^2	1	0.1	This area immediately abuts the Palikea MU. Control efforts here focus on *Sphaeropteris cooperi*, to remove mature plants seeding into the adjacent MU.
Palikea	9.95	10.52	2.64	49	457.65	3.46	24	175.4	Staff spent significant time (193.5 hours) in this MU clearing area for a snail exclosure. Volunteers assist with some control efforts in this MU.
Poamoho No MU	N/A	94.67	9.18	2	49.5	0	0	0	Control efforts in this area focus on *Leptospermum scoparium* and keeping invasive weeds such as *Arthrostemma ciliata* off the Poamoho access road.

Management Unit	2011 Report Year					2010 Report Year			Comments
	MU area (ha)	Total WCA area (ha)	Area weeded (ha)	# Visits	Effort (person hours)	Area weeded (ha)	# Visits	Effort (person hours)	
Puaakanoa	10.70	0.70	0.51	6	82	0.34	4	38	Weed control efforts focused on fuel reduction around the *Chamaesyce celastroides* var. *kaenana*. Fire is a major threat to the MU.
Pualii North	7.99	3.30	0.51	4	34.5	0.88	7	36.5	OARNP focused control efforts around rare taxa sites and reintroductions.
Puu Kumakalii	5.63	4.83	0	0	0	26m²	1	1	Little weed control is possible in this steep, cliff-dominated MU.
SBE No MU	N/A	4.1	0.1	1	.5	0.07	2	1	Control efforts focus on maintaining weed free areas at the East Baseyard, to reduce the potential for staff to act as weed vectors.
SBW No MU	N/A	1.55	1	3	10	1.46	5	14	Control efforts focus on maintaining weed free areas at the West Baseyard, to reduce the potential for staff to act as weed vectors.
Waianae Kai	3.66	1.15	0.31	5	18.2	0	0	0	Conrol efforts focused around rare taxa.
Waianae Kai Neraudia Mauka	5289 m²	2.59	0	0	0	94 m²	1	5	This MU fence is currently being constructed. The forest in this area is degraded. Control efforts will begin in earnest in the coming year.
Waianae Kai NoMU	N/A	3.65	85 m²	3	1.34	0	0	0	Control was performed around GSC rare plant populations.
West Makaleha	38.11	2.62	1.28	12	177.25	0.29	9	62.5	Weed control efforts focused around rare taxa in the Three Points fence.
West Makaleha No MU	N/A	0.32	0	0	0	728m²	1	0.5	Control is conducted here to keep the access trail open, as needed.
TOTAL	N/A	1038.5	98.3	406	5113.4	60.25	354	3243.7	Some WCAs are not intended to be controlled every year, particularly those in sensitive habitat. Others, like the ones in Lower Ohikilolo which facilitate fuel break maintenance, are maintained quarterly and are swept in their entirety. Via the ERMUPs, staff hope to more accurately show how priorities are set for different WCAs over a multi-year time period.

Effort data for the 2010-2011 report year is summarized in the table below. Only the twenty MUs with the highest levels of effort in this time period were included. 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. Effort is used to indicate where the majority of staff time was spent. 2009-2010 data is included table to demonstrate the increase in effort spent on weed control.

Effort Spent in Select MUs, 2010/09/01 through 2011/09/30

Management Unit	2011		2010	
	Effort (person hours)	Ranking	Effort (person hours)	Ranking
Kahanahaiki*	997.25	1	840.85	1
Ohikilolo	464	2	148.3	8
Palikea*	457.65	3	175.4	7
Kaala Army*	420	4	357.5	2
Ohikilolo Lower	274	5	245.5	3
Kaluaa and Waieli*	262.6	6	186	5
Pahole	256.5	7	106.5	10
Makaha*	253.3	8	180.5	6
Kapuna Upper	240.5	9	138.5	9
West Makaleha*	177.25	10	62.5	13
Helemano	141	12	38	17
Ekahanui*	136.5	11	202.5	4
Kaena East of Alau*	116	13	0	20
Lihue	105.5	14	1	19
Kaluakauila	99	15	91.75	12
Puaakanoa	82	16	38	18
Pahole No MU	77.1	17	43	15
Kaena	67.5	18	97	11
Kaunala*	65.4	19	61.75	14
Pahipahialua*	65	20	40.5	16

* = volunteers contribute to control efforts in these MUs

Kahanahaiki continues to be the MU where most weed control is performed. In part, this is due to the high level of volunteer effort in this MU. OARNP plans to continue to use volunteers in Kahanahaiki, but also hopes to utilize volunteer assistance more in other MUs, such as Kaluaa and Waieli. This is the first year significant weed control has been performed in Lihue, Helemano, and Kaena East of Alau. Overall, time spent weeding increased in all MUs except Kaena and Ekahanui. At Kaena, the reduction in efforts is in part due to the success of previous control efforts in removing woody weeds such as *Leucaena leucocephala*. For both MUs, part of the reduction is due to the decision to prioritize efforts at other sites.

Vegetation Monitoring: Palikea Three-Year Analysis

This year, vegetation monitoring was conducted in the the Palikea MU for the second time. For a full analysis of vegetation monitoring at Palikea, see Appendix 1-3.

Weed Survey Updates: New Finds

No new significant weed pests were discovered on landing zones, or at camp sites. Significant weed pests were discovered at three weed transects this year.

- WT-MMR-08, Lower Ohikilolo Ridge (fenceline). *Passiflora suberosa* was found at one location along this transect. While common across Oahu, *P. suberosa* is not widespread at Ohikilolo Ridge. This plant was handpulled. Any time this taxon is found on Ohikilolo, it is a priority for control. This weed transect has been discontinued, as it is no longer being monitored for ungulate sign. Instead, staff are directed to note any unusual weeds seen along this fenceline during regular fence checks.
- WT-MMR-13, Ohikilolo Saddle (fenceline). *P. suberosa* and *P. foetida* were found along this transect. While both species are common across Oahu, neither is widespread on Ohikilolo Ridge. However, *P. suberosa* was also observed during vegetation monitoring on Ohikilolo; staff observations suggest that this taxa is spreading in the northern Waianae mountains. Both *Passiflora* taxa will be controlled along the fenceline whenever seen. This weed transect has been discontinued, as it is no longer being monitored for ungulate sign. Instead, staff are directed to note any unusual weeds seen along this fenceline during regular fence checks.
- WT-Kapuna-01, Mokuleia Trail (trail). This is the first year this weed transect has been read. It will be monitored annually in the future. Three species of note were seen along the trail, *Ehrharta stipoides, Triumfetta semitriloba*, and *Begonia hirtella*. *E. stipoides* is well known from the trail, and is controlled by OANRP and NARS staff. *T. semitriloba* is known from scattered locations across the Kapuna MU, and is controlled wherever it is found. Little is known about how invasive *B. hirtella* may be. It is relatively common, showing up in gulch habitats across Oahu. The related taxa *B. foliosa* is a widespread understory weed at Kaala/Haleauau, but *B. hirtella* does not appear to exhibit the same propensity for forming large mats, and no control is planned for it at this time.

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

- RS-Kaluaa-01, Kaluaa Access Road: *Ardesia elliptica* was observed along the road. It is known from several areas nearby, and is not a high candidate for control at this time.
- RS-KTA-05, Kahuku Bravo Road: This is the second year this road has been surveyed. One significant pest was found along the road this year, *Chromolaena odorata*. This taxon is highly invasive. See Invasive Species Updates, below, and Appendix 1-2 for a full discussion of *C. odorata* management efforts.
- RS-LKN-01, Lower Kaala NAR Access Road: This is the first time this road has been surveyed. Many of the alien taxa along this road are common pasture weeds and trees popular for forestry plantings. There are some Cupressaceae and Pinus species along the road; these should be collected and submitted to Bishop Museum for positive identification, as some taxa in these families are invasive. *Ehrharta stipoides* was noted along the road. This is a very cryptic grass. The identification will be verified in the coming year, and if confirmed, control methods will be evaluated.
- RS-Makaha-01, Makaha Access Road: Several new taxa were seen along the Makaha road this year, including *Achyranthes aspera, Dicliptera chinensis*, and *Schefflera actinophylla*. All are invasive, potentially habitat-altering weeds. *A. aspera* is known from more makai sections of Makaha; staff will ensure that this does not move onto the Makaha access trail. *D. chinensis* may also be known from makai sections of Makaha; OANRP is not familiar with the distribution of this taxon. Keeping *D. chinensis* off the access trail will also be a priority. *S. actinophylla* is a bird-dispersed tree. It is common on the windward side of the Waianaes in the Kaluaa region, and also is a popular ornamental tree across the island. *S. actinophylla* should be controlled if seen in the Makaha MU.

- RS-MOKFR-01, Mokuleia Forest Reserve Road: This is the first time this section of road has been surveyed. This road survey covers the road running from the Peacock Flats gate to the Mokuleia trailhead. One significant weed was noted along the road, *Cirsium vulgare*. This thistle is known from a few other OANRP managed areas. It grows quickly, fruits prolifically, has wind dispersed seeds, and has sharp, thorny leaves. Staff pulled five plants. Since the *C. vulgare* were found on the Peacock Flats campground, OANRP is not planning on conducting control, but NARS staff were notified of the find immediately.

Several significant weed species were noted incidentally during other field work, and were recorded on Target Species forms (introduced last year).

- Central and East Makaleha, *Verbesina encelioides*. Staff driving the Kaala Road noted *V. encelioides* growing out of two gravel piles. While *V. encelioides* is known from low-lying areas from Kaena to Waialua, it is not known from the Kaala Road/Makaleha area. ICAs were created to track efforts at both gravel piles, which were subsequently treated with pre-emergent herbicides. If the gravel piles hosted *V. encelioides*, they could also host other, more invasive weeds. The piles are monitored and treated as necessary.
- Kahuku, *Mezoneuron latisiliquum*. This *Caesalpinia decapetala* (cat's claw) relative was found along the Opana radar tracking station road, just below KTA. Little is known about this taxon, but preliminary research by OED and Hawaii Weed Risk Assessment staff suggests that it is not highly invasive. The *M. latisiliquum* is growing along a fenced, abandoned field, and may have been planted by farmers as green barrier; it has not spread much beyond the fenceline. It is viney, thorny, and produces many flowers and fruit. At the request of HPWRA staff, OANRP attempted to collect ripe seed pods to determine if it produces viable seed, however, most of the fruit were predated. Less than a dozen seeds were collected; they are now being tested for viability.
- Manuwai, *Pterolepis glomerata*. This common Koolau summit weed was discovered along the newly constructed Manuwai fenceline. Keeping this Melastome out of the Waianae Mountains is a priority for OANRP. It is highly likely that *P. glomerata* was introduced to the area via OANRP staff, gear, or fence material. An ICA was created to track control efforts at the site. Monitoring/control is ongoing, and is discussed in the Manuwai ERMUP.
- Schofield Barracks, Haleauau, *Erythrina poeppigiana*. Please see the Invasive Species Updates section below for a discussion of *E. poeppigiana*.
- Waianae Kai, *Ehrharta stipoides*. This invasive grass was noted along the Waianae Kai primary access trail. All plants observed were controlled. An ICA was created to track control efforts at the site. Monitoring/control at the ICA is ongoing.

Invasive Species Updates

Chromolaena odorata, Devil Weed

- On 11 January 2011, OANRP identified *C. odorata* in KTA, near the Opana radar tracking station. This species is a new State record and is on the State Noxious Weed List. It has a Hawaii Weed Risk Assesment (HWRA) score of 34, suggesting it has many invasive characteristics, has been extensively researched, and should be considered for control.
- Joint surveys by OANRP, OISC, HDOA, OED, the State, and MCBH revealed that the infestation of *C. odorata* includes four gulches, including two outlier sites. Despite the fact that the infestation is much bigger than expected, the threat posed by this taxon is considerable, and OANRP and OISC agree that *C. odorata* is an important target. Please see Appendix 1-2 for a draft management plan and a full description of *C. odorata* survey results.

Cordia alliodora, Ecuador Laurel, Salmwood

- The invasive tree *C. alliodora* is known from two locations on Oahu: Makaha and Waimea Valleys. It exhibits strongly invasive characteristics, and has the potential to become a major forest canopy pest. While the infestation at Waimea Valley is extensive, staff are most concerned with the Makaha site, as it is located approximately 2km from the Makaha MU. Last year, OANRP and BWS staff conducted a survey of the *C. alliodora* infestation in Makaha. The survey delineated the extent of the infestation, which centered around the Kaneaki Heiau. The total size of the infestation is approximately 33.4 acres. See the 2010 Status Update for the MIP and OIP for a discussion of *C. alliodora*.
- In the coming year, OANRP will conduct control method trials on *C. alliodora*. Staff at Waimea Valley agreed to allow staff to use the Waimea infestation as the trial location. This will allow staff to test a variety of techniques and herbicides; herbicide use on BWS (Makaha) land is restricted, making it a less desirable study site.
- Once one or several control techniques are selected, staff will coordinate with BWS and OISC to develop a control plan and implement it. Buy in from community members and the heiau organization is vital. The site is very accessible to volunteer groups, and a majority of control could be done using volunteer assistance. If federal funds are spent removing plants from the heiau portion of the infestation, a Section 106 consultation will be required.
- Staff may also map the infestation again, to determine how far and how quickly it has spread in the last two years.

Corynocarpus laevigatus, Karakanut

- No control work was done on *C. laevigatus* at Palehua in the past year. There are several elepaio territories in and around the infestation. Past consultations with Dr. Eric VanderWerf indicated that some parts of the infestation could be controlled with a minimum of impact to elepaio. Due to the slow spread exhibited by *C. laevigaus*, staff felt that there was no rush to begin control.
- Staff plan to implement initial control of *C. laevigatus* in the coming year. Possible partner agencies for this project include OISC, Waianae Mountains Watershed Partnership (WMWP), and the Gill-Olson Trust. Control will be conducted with the OANRP Natural Resource Avian Conservation Specialist, to ensure that elepaio habitat is not altered significantly. Initial control will target outlier trees and specifically identified trees in the infestation hotspots.
- OANRP and partners will work towards creating a plan for growing and planting common native trees to supplement *C. laevigatus* and provide additional habitat for elepaio. No removal beyond initial control will be conducted until such a plan has been created, reviewed by Dr. VanderWerf and other elepaio experts, and implemented.

Erythrina poeppigiana, Coral tree

- This plant was originally found by Oahu Early Detection (OED) during their road survey of the civilian streets of Schofield several years ago. OED identified one mature tree planted on Trimble Road. This taxon is uncommon on Oahu, but is known from Lyon Arboretum, where it has been observed to naturalize widely. It has a HWRA score of 12, suggesting it has many invasive characteristics and should be considered for control. Some of its concerning characteristics include: produces alkaloids which may be toxic to some animals, grows via suckering and from seed, forms a persistent seed bank, has wind-dispersed seed, and readily hybridizes with other *Erythrina*
- This year, a short survey turned up juvenile trees on Trimble Rd, indicating that *E. poeppigiana* is naturalizing at this location.

- In addition, another *E. poeppigiana* site was discovered this year, in Haleauau gulch, SBW. This site is located in a wild area, unlike the Trimble tree. The Haleauau infestation is located close to the firebreak road, and appears to be spreading mauka. Most individuals seen were small, likely immature, trees. However, incidental observations of the site during an aerial survey indicate that there are several large, emergent, mature trees in Haleauau.
- Surveying the full extent of the infestations at both the Trimble and Haleauau sites is a priority in the coming year. Likely, both sites will be targeted for control.

***Erythrina poeppigiana* on Trimble Road**

Miscanthus floridulus, Sword Grass

- This invasive grass was found during surveys for *C. odorata* in KTA. A new State record, it is on the State Noxious Weed list, and has a HWRA score of 18, which indicates that it has many invasive characteristics. The HWRA indicates that *M. floridulus* is invasive on many Pacific islands, including Guam, where it forms dense monocultures. In addition, it is fire tolerant, fruits prolifically, has alleleopathic qualities, and can reproduce vegetatively. Seed testing indicates that under natural conditions, seeds only retain the ability to germinate for six months, however seeds may be wind, water, and animal dispersed. Fortunately it is susceptible to treatment with herbicides.
- Only 3-5 individual plants were found in KTA. All were widely spaced, single large clumps. However, incidental observations during an aerial survey indicate that many more plants may be located in Pahipahialua gulch, to the east of the known plants.
- Surveying the full extent of the infestation is a priority for the coming year. Aerial surveys may greatly assist in this. Since *M. floridulus* overlaps with *C. odorata*, joint ground surveys can be conducted for both taxa.
- Once the extent of the infestation is better known, a control plan needs to be developed for the taxon. The confirmed locations can easily be treated, and should be prioritized for control. If *M. floridulus* is found in Pahipahialua gulch, novel control techniques may need to be developed to treat plants in steep areas.

- It is highly likely that both *M. floridulus* and *C. odorata* were introduced to KTA via military training, as both taxa are common on Guam, and soldiers from Guam have been known to train in KTA. OANRP will contact Guam environmental staff to discuss these recent finds.

***Miscanthus floridulus* in KTA**

Tibouchina herbacea, Cane Tibouchina

- On 6 August 2008, OANRP discovered *Tibouchina herbacea* on the Koolau summit trail in the Poamoho region. Several agencies are involved in control efforts, including OANRP, the Oahu Invasive Species Committee (OISC), the Koolau Mountain Watershed Partnership (KMWP), and the State. OISC is the lead agency on *T. herbacea* control efforts.
- Since 2008, plants have only been found at four closely spaced locations, including the original plant. All four sites are marked in the field with PVC, are within 50m of each other, and are on the windward side of the Poamoho summit trail.
- OANRP staff did not find any additional *T. herbacea* this year. However, staff from partner agencies located and killed 34 immature *T. herbacea*.
- OISC also conducted buffer surveys at Poamoho. No additional *T. herbacea* were found on these surveys.

Invasive Species: Seed Research

Seed characteristics were studied for three alien species: *Chromolaena odorata, Juncus effusus* and *Lantana camara*. OANRP plans to conduct similar such trials on additional alien species in the coming years. These data are highly useful in scheduling visits to control sites and maximizing weed control effort.

- *Chromolaena odorata*. A soil seed bank test was initiated this year to test the longevity of seeds buried in the ground for up to five years. The first bags were recovered after three months (October 2011).
- *Juncus effusus*. A five year field seed viability study is underway for this taxa at Kaala. Seed bags that were buried for two years were retrieved and seed viability was assessed. Viability has not declined, and is around 90%. Viability for all assays (fresh and from soil) is around 90-100%. The study will continue for another three years. So far, results suggest that eradicating *J. effusus*

from ICAs at Kaala will take many years, as a persistent seed bank (seeds persist more than two years) is formed.

- *Lantana camara*. A five year laboratory soil seed bank potential study was completed this year. The seed for this study was collected at Ohikilolo in 2005. Seeds were kept imbibed and in the dark at ambient in-situ temperatures. Seeds began to germinate in the dark only after the three year viability check. This led to a slight (but insignificant) decline in viability, as seeds that germinated in the dark died prior to the five year viability check. Average seed viability is 48%. These results suggest that while staff may not see *L. camara* recruitment in weeded areas for the first few years following control of mature plants, staff should expect to see recruitment for more than five years following initial control.

Invasive Species Projects: *Sphagnum palustre* Control

Control of *S. palustre* at Kaala began in earnest this year. These efforts are directed by the draft control plan in Appendix 1-4 of the 2010 Year End Report. St. Gabriel's mosskiller, applied at a 10% dilution in water, is effective in controlling the moss. Last year, staff observed poor control after one spray effort. It is thought that this was due to incomplete treatment. In order to be effective, a full liter of St. Gabriel's solution must be applied to each meter squared of moss. This year, OANRP ensured that all applicators fully understood the control technique, and incidental observations suggest that control has been much more successful.

One of the earliest control plots were revisited this year (see photos below). The sphagnum in one plot was still dead, and part of the plot had been colonized by native plants and mosses. This plot was treated around three years ago. While this recovery may seem slow, it is nonetheless an encouraging sign that little other management needs to be done to restore this area besides removing the alien moss.

Recovery of Kaala Vegetation in Treated S. palustre

Nertera granadensis spreading across top left side of plot.

Metrosideros polymorpha and *Broussasia arguta* seedlings and young native mosses growing on dead *S. palustre*.

In preparation for a concerted control effort this year, staff built a temporary water catchment along the boardwalk and installed photopoints to monitor efficacy of treatment. Control is on-going at three *S. palustre* Incipient Control Areas. The status of control efforts are outlined in the table below:

ICA code	# of Visits	Effort (person hours)	Notes
Kaala-SphPal-01	2	1.5	This ICA lies along the radio tower road and fenceline. Follow-up control has been conducted with the NARS Weed Control Specialist. This area often has standing water, which reduces the efficacy of the St. Gabriel's spray. Multiple treatments necessary.
Kaala-SphPal-02	7	42	This ICA lies along the boardwalk corridor, on the State NARs side. Control efforts began near the trailhead, and end approximately 330m out along the boardwalk, about half its total length. A combination of volunteer and staff labor were used in this area. In the next year, staff and volunteers plan to finish spraying the boardwalk corridor
Kaala-SphPal-03	8	57.5	This ICA encompasses the entire core *S. palustre* infestation on the Army side of the boardwalk. Only the boardwalk corridor has been treated thus far. The area from the trailhead to the 400m mark on the boardwalk has been treated with a combination of volunteers and staff. In the next year, completing treatment of the boardwalk corridor is first priority. Then, efforts will shift towards control of the rest of the ICA.

Photopoints are effective is showing large-scale change. In the series below, the June 2011 photo shows healthy, green *S. palustre* on both sides of the old boardwalk. The October 2011 photo shows treated, brown *S. palustre* flanking the newly replaced boardwalk. In the lower right corner of the October photo is a small blue patch; this is a spot treatment of *S. palustre* that was missed in the initial treatment.

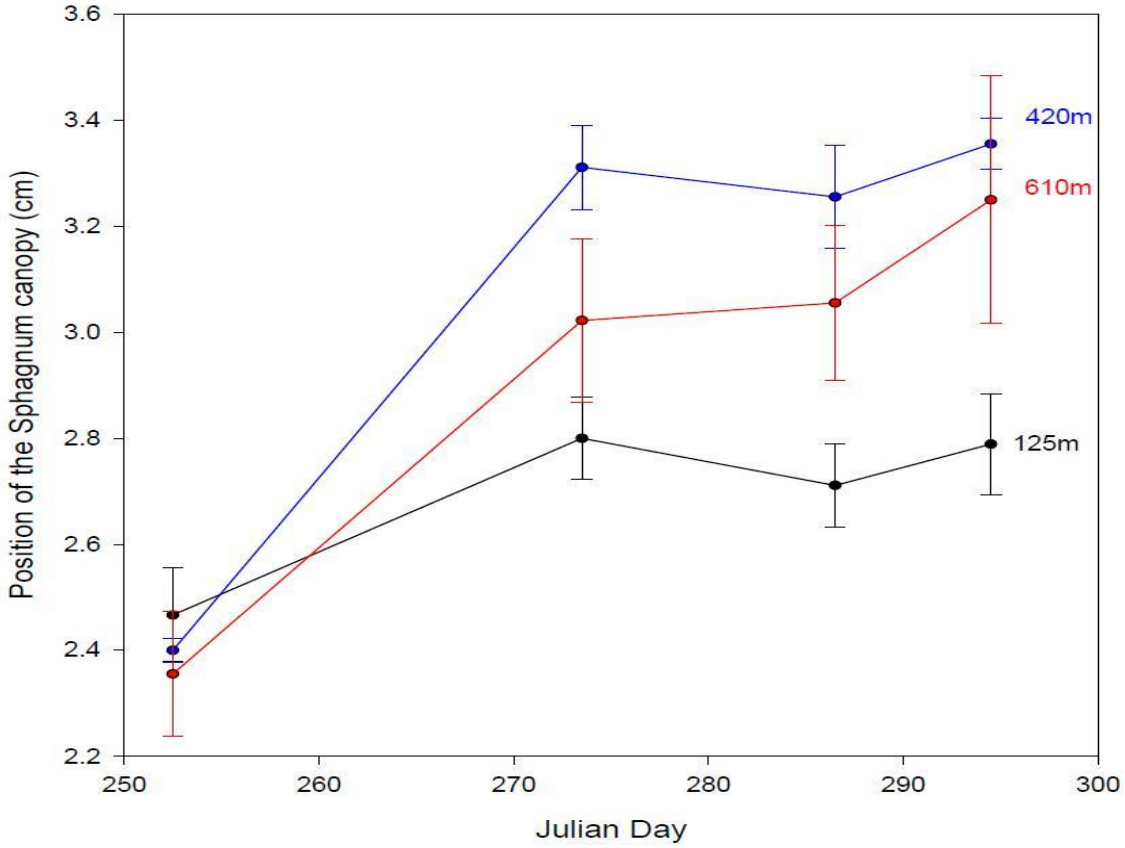
Photopoint Series:

June 2011

October 2011

Sphagnum palustre Research

- This year, OANRP began a small cooperative project with Dr. David Beilman (University of Hawaii Manoa, Geography Department) to determine Sphagnum impacts on nutrient cycling.
- At Kaala *Sphagnum palustre* growth was measured since 9 September 2011 using the 'cranked wire' method (Clymo 1970; Vitt 2009). Linear growth was measured at 27 locations along the infestation area at boardwalk positions 125m, 420m, and 620m. Preliminary measurements show an average growth (in length) that ranges from 0.3 to 1.6cm (mean = 0.7 cm) over 42 days (see graph below). If the growth trend continues, this would be, on average, about 6 cm yr^{-1}, which is twice the growth (in length) that Hotchkiss & Vitousek (2001) reported for the same species within its native range on Kohala, Big Island. The controls over productivity are being explored, particularly the influence of canopy shading and light limitation.



- In addition, soil gas flux collars were installed at three locations along the boardwalk to monitor greenhouse gas fluxes (CO^2, CH^4 and N_2O) in dark chambers to investigate the influence of the *Sphagnum* invasion on ecosystem function. Preliminary data from the first gas sampling on 30 September 2011 shows that CO^2 flux to the atmosphere in invaded sites (around 2000 mg-CO^2 m-2 min-1) was reduced by about half compared to flux rates of native soils (around 4500 mg-CO^2 m-2 min-1). On this day and time, native soils were acting as a CH^4 sink, whereas the presence of *Sphagnum* at invaded locations showed a very modest CH^4 source to the atmosphere. N_2O flux was more than three times higher in native soil locations compared to invaded sites. These results suggest that, in addition to affecting plant community composition, the invading *Sphagnum* is strongly influencing ecosystem processes including soil respiration, methanogenesis, and nitrogen cycling.

- This project is on-going and expected to conclude in December 2011.

Weed Control Projects: Chipper

Last year, staff conducted very aggressive *P. cattleianum* control in Kahanahaiki MU, using a chipper to mulch slash from dense monocultures. A complete description of the project can be read in Appendix 1-5 of the 2010 Year End Report. The goals of this project are to reduce alien vegetation cover, make headway towards meeting the 50% alien cover or less MIP goal in Kahanahaiki, foster recruitment of native pioneers, restore the area to native-dominated vegetation, and restore habitat for rare taxa.

No additional clearing and chipping was done this year, due to logistical challenges. Instead, follow-up weed control was performed by staff and volunteers in the area. The primary colonizers of this open space were natives *Acacia koa*, *Scaevola gaudichaudiana*, and *Carex meyenii*, and a variety of weeds, including *Crassocephalum crepidioides, P. cattleianum, M. minutiflora, Emilia sonchifolia, C. hirta, R. rosifolius,* and others. Interestingly, *A. koa* was one of the first pioneer species in the chipper area, and very little other recruitment of natives or weeds was seen in the first 3-4 months after clearing.

The original chipper operation was timed to coincide with the senescence of the *P. cattleianum* seed bank, 3-6 months after fruiting. This strategy did likely reduce the formation of large *P. cattleianum* seedling beds. However, staff observed significant re-growth of cut stumps. This is not totally surprising; in clearcutting projects it can be difficult to ensure that each and every stump (some can be the diameter of a pencil) is treated. Also, stumps may not be treated for an hour or more after they are cut and this may also reduce herbicide efficacy. In future operations, staff will prepare for this by planning more aggressive follow-up treatment, or experimenting with other herbicide techniques.

Trials conducted in previous years suggested that seed broadcasts of *Bidens torta* have high germination in Kahanahaiki. Staff sprinkled *B. torta* across the chipper area at several different times during the year. These broadcast efforts were successful in introducing *B. torta* to the area, and some dense patches of *B. torta* continue to thrive.

Next year, OANRP plans to continue this aggressive *P. cattleianum* removal project. Two areas adjacent to the current chipper area have been scoped for control. OANRP plans to hire several part-time temporary hires to perform the clear-cutting and chipping. Maintenance of both the new and old chipper areas is also planned, and is critical for long-term success of this project.

Photopoints were installed throughout the chipper area to document vegetation change. The following three series of photos show the drastic change this area underwent, and the progress of recovery efforts. In general, the first photo of the series shows the initial, *P. cattleianum* dominated state of the area. The second photo, taken three months after clearing, shows the success of the clear-cutting efforts. The third photo, taken a year after initial clearing, shows the growth of native taxa like *A. koa, A. oliviformis,* and *B. torta*, as well as the recovery of *P. cattleianum*.

Photopoint Series 1:

June 2010

September 2010

July 2011

Photopoint Series 2:

June 2010

September 2010

July 2011

Photopoint Series 3:

June 2010

September 2010

July 2011

Restoration Techniques: Common Native Reintroduction

For many MUs, weed control efforts may benefit significantly from the reintroduction of common native species. OANRP's common reintroduction program is still in its seedling stage. A variety of techniques are being considered, including: contracting private nurseries to grow plants (outplanting), growing plants with OANRP staff (outplanting), using field nurseries to grow plants (outplanting), broadcasting seed, and transplanting wild seedlings. Staff have already experimented with some of these techniques, albeit not always rigorously. Some of the challenges OANRP faces in creating a common reintroduction program are determining the most cost-effective, efficient, and successful reintroduction strategies for particular sites, developing the staff capacity to manage contracts, and managing sanitation issues (particularly with regards to alien greenhouse snails). In order to address these challenges, OANRP is collecting data on existing common native reintroduction projects and designing small trials.

The following is a short list priority actions for the coming year:

- *Seed broadcast:* Test the efficacy of seed broadcasts. Use the same simple trial design used for the *Bidens torta* seed sow trial. Document success and failures. Maintain record sheet for all seed broadcast inputs for WCAs.
- *Outplantings*: Monitor existing outplantings. Analyze data to determine which taxa had high survivorship and high growth rates. Make recommendations on which species to pursue in an outplanting program.
- *Transplantings*: Monitor existing transplantings. Analyze data to determine which taxa had high survivorship and high growth rates. Make recommendations on which species to pursue in transplanting.
- *Field Nursery*: A trial field nursery was installed last year. For unknown reasons, both the *Acacia koa* in the field nursery and the *A. koa* grown in the greenhouse had low germination and high mortality. In the greenhouse, symptoms consistent with koa wilt were observed on OANRP will complete the trial and evaluate the inputs required for both field and greenhouse nurseries this year. Make recommendations as to whether a second trial is worthwhile.
- *Utility of plantings*: Staff set up a small trial in KTA last year to look at the effect of common native plantings on alien plant understory vegetation cover levels in this weed- dominated area. This trial should be continued, and additional trial sites (such as Puu Hapapa) will also be considered.

Range Maintenance, Construction, and Stryker Transformation Projects

OANRP continues to provide support to DPW and Range Control requests. This year, no new, major construction projects were routed to OANRP for review.

- DPW. OANRP provided feedback to DPW regarding necessary sanitation of derelict vehicles to be moved on to SBMR for use as targets.
- U.S. Army Corps of Engineers. OANRP assisted with two research projects, conducted by the US Army Corps of Engineers. Both sought to identify methods of replacing *Panicum maximum* with other low-stature grasses on Army training ranges. OANRP assisted with these projects by providing space for a series of grass seed ball plots, spraying another study site with herbicide several times, and taking photos of various plots for the head researchers.
- CALIBRE, Integrated Vegetation Management Plan. In late 2010, Range Control received federal funding for a vegetation management project for the training ranges. The primary thrust of this project was to create/treat firebreaks on Schofield Barracks and Makua Military Reservation to minimize fire danger to threatened and endangered species. The project was

written broadly, and also included development vegetation management plans, testing of aerial spray techniques, and experimentation with various herbicide mixes. While Range Control was the lead office on the project, OANRP was able to include some specific tasks in the overall project scope. These included testing the efficacy of the TimberMark® aerial ball sprayer on a variety of weed targets, spraying several remote fuel breaks, and treatment of several invasive species patches with aerial boom spraying. Please see Appendix 1-4 and 1-5 for a full discussion of this project.

Interagency Coordination

Oahu Early Detection (OED)

- OED continues to provide species identification services to OANRP. By being able to get identification for unknown species, OANRP has greatly improved weed survey results. OANRP will continue to provide funding to OED for their identification work.
- Over the past year, OANRP has submitted 42 samples to OED. The table below summarizes the most concerning species out of these samples.

Highlights from OED Species Identification:

Taxa	Location	Threat	Discussion
Chromolaena odorata	KTA	Very High	• New State record. • On State Noxious Weed list. • Control plan discussed in Appendix 1-2
Erythrina poeppigiana	Schofield Barracks, SBW	High	• Uncommon on Oahu. • See discussion in Invasive Species Updates above.
Miscanthus floridulus	KTA	High	• New State record. • On State Noxious Weed list. • See discussion in Invasive Species Updates above.
Dovyalis hebecarpa	SBS, Nanakuli	Medium	• This species is an OED target. It was identified from two locations, one in Nanakuli, and another in SBS. *D. hebecarpa* appears to be naturalized at both sites. • During OED's survey of the civilian roads of SBW, they did note *D. hebecarpa* at several locations on base. • This taxon will be evaluated for control.
Nephrolepis biserrata	Kaluaa & Waieli	Medium	• Uncommon on Oahu. • This fern was collected from two locations in Kaluaa. It may hybridize with other *Nephrolepis*, and has a distinct, large growth form. Control is planned for the coming year, and is discussed in the Kaluaa and Waieli ERMUP.
Senna spectabilis	SBW	Medium	• This species is an OED target. It is known from ornamental plantings around the island, including plantings at Schofield. It is not known to be naturalizing widely • Naturalized plants of various size classes were found off of a SBW access road. There were several taxa commonly used in ornamental/residential plantings in the area, and it is likely that *S. spectabilis* was orginially planted here. • Surveys will be conducted to determine how widespread it is. Control plans will be made after the survey is completed.
Schinus molle	SBW	Medium	• This species is an OED target. It is known from ornamental plantings around the island, including plantings at the

Taxa	Location	Threat	Discussion
			shopping center at Schofield. It is not known to be naturalizing widely • One plant was found next to the *E. poeppigiana* on Trimble road. It is not yet known if it is naturalizing. • Surveys will be conducted to determine if it is naturalizing. Control plans will be made after the survey is completed.
Mezoneuron latisiliquum	KTA	Low	• New island record. • This species was found on a road survey and is discussed in the Weed Survey Updates section above.
Begonia vitifolia	Manuwai	Unknown	• This taxa was found during vegetation monitoring in Manuwai gulch. Little is known about it. Some *Begonia* are known to be invasive and potentially ecosystem altering, such as *B. foliosa*, while others appear not to have major habitat effects. • Additional research will be done on this taxa, and it will be controlled wherever seen in Manuwai (see Manuwai ERMUP for additional information).
Dietes iridioides	Manuwai	Unknown	• This taxa was found along the fenceline in Manuwai. It was collected and grown till it flowered, allowing its identity to be confirmed. It is not highly invasive, and is usually more of an ornamental weed. Its remote location, and the fact that a second infestation was found in neighboring Alaiheihe gulch is somewhat concerning. • Control will be implemented around this small infestation, and is discussed in the Manuwai ERMUP.
Polystachya concreta	Kaluaa & Waieli, Peahinaia Lower	Unknown	• This taxa has been found at multiple locations over the years. This year, it was collected in Kaluaa and Peahinaia Lower. • At the Peahinaia Lower MU staff noted that this epiphyte was ubiquitous, and was even found on the endangered taxa, *Melicope lydgatei*. • OANRP in not sure what threat this taxa poses, but it is concerning to find it on endangered species. Generally, epiphytes are relatively benign to their hosts. • It seems likely that pollinators for this and other orchids exist, and may be promoting the spread of this and other orchid species.

Oahu Invasive Species Committee (OISC)

- OANRP continues to participate actively with OISC, attending OISC planning, strategy and control meetings, sharing data and updates on incipient species of interest found on Army land, (such as *Melochia umbellata, Buddleia madagascariensis,* and *Acacia mangium*) and occasionally conducting work swaps. This year, OANRP assisted with *Delairea odorata* control efforts in a work swap.
- OISC is an active partner in *C. odorata* control efforts, assisting with survey and control efforts and outreach.
- OISC is the lead agency for *Tibouchina herbacea* control efforts.
- Last year, OISC and OANRP joint-authored a paper titled "*Eleutherodactylus coqui* Control on O'ahu: Successful Control of an Incipient Invasive Amphibian" for the 2010 Island Invasives:

Eradication and Management Conference. After many iterations, the final paper proof has been approved, and publication in the conference proceedings is planned for the end of 2011/beginning of 2012.

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

- OARNP continues to collaborate with Dr. James Leary on various weed control projects. These projects are summarized below.

Incision Point Application (IPA)

- Dr. Leary developed the IPA technique over the past year, and has been installing trials with it across the state. IPA is a simple way of treating woody weeds, particularly trees. A hatchet, or other knife, is used to make several cuts through the cambium of a weedy tree; the tree is not girdled. Ultra-small doses of full-strength herbicide (0.5 or 1mL) are applied to each cut. The benefit of this technique is that it requires a minimal amount of gear and herbicide. Literally hundreds of trees can be treated with one liter of herbicide. Also, each tree can be treated very quickly, as time-consuming girdling or felling is not required.

IPA Treatment Technique

- Dr. Leary developed a standard IPA trial design. One species is treated per trial. Five herbicides are used for each trial: triclopyr (Garlon 4), glyphosate (Round-up), imazapyr (Polaris, Stalker), aminopyralid (Milestone), and aminocyclopyrachlor (MAT 28). Four individuals are treated per herbicide, for a total of twenty individuals in each trial. He has been working with agencies across the state to install trials on a variety of weed species. OANRP has been involved with some of these trials, and has collaborated with NARS staff on installation.
  - *Schefflera actinophylla*. Trial installed March 2011, Kapuna. Results are still pending, but monitoring by NARS staff in October 2011 indicate that all chemistries were effective except triclopyr.
  - *Syzigium cumini*. Trial installed March 2011, Kapuna. Results are still pending, but monitoring by NARS staff in October 2011 indicate that aminocyclopyrachlor was most effective.
  - *Toona ciliata*. Trial installed September 2011, Kaluaa. Results pending.
  - *Acacia confusa*. Trial installed September 2011, Kaluaa. Results pending.

- *Corymbia citriodora*. Trial installed September 2011, Kaluaa. Results pending.

- Using the results of these trials, Dr. Leary is developing a guide for resource managers, which will indicate the susceptibility of a variety of species to these five chemistries.
- Before Dr. Leary formalized the IPA design, OANRP collaborated with him on some less comprehensive IPA trials. In these early tests, only Milestone was used, not the full complement of herbicides.
  - *Grevillea robusta*. Trial installed November 2010 at KTA. Ten trees were treated. All received four cuts. Five trees were treated with 1mL Milestone per cut, five with 0.5mL per cut. In February 2011, all ten trees were fully defoliated except for one, which had a few leaves left, and all but one had green cambiums. This trial should be monitored again to determine if the treated trees died completely. However, Dr. Leary has installed a full IPA on this taxon elsewhere.
  - *Leucaena leucocephala*. Trial installed November 2010 at KTA. Two size classes of trees were treated, small (height 1-1.5m, diameter 2.5-4.1cm) and large (height 1.5-3m, diameter 3.9-8.6cm). Ten individuals were in each size class, for a total of 20 trees. All the small size class trees were treated with 1 or 2 cuts, with 0.5mL Milestone applied per cut. All ten of the small trees were defoliated in February 2011. All of the 2 cut trees had brown cambiums and were dead, while the some of the trees which received 1 cut still had green cambium. All the large size class trees were treated with 2 cuts, with either 0.5mL or 1mL of Milestone applied per cut. All ten of the large trees were defoliated in February 2011. All of the 1mL trees had brown cambiums and were dead, while some of the trees which received 0.5mL still had green cambium. It was expected that all of the treated trees would die, and incidental observations indicate that this happened. Milestone is very effective on *L. leucocephala*.

***L. leucopehala* treated with Milestone**

November 2010 February 2011

  - *Schefflera actionphylla*. Trial installed August 2010 at KTA. Only six trees were treated. This trial has been discontinued, as Dr. Leary installed full IPA trials in 2011 at Kapuna. Preliminary results from the trial indicate that *S. actinophylla* is somewhat susceptible to

Milestone, with smaller trees exhibiting total defoliation and larger trees exhibiting partial defoliation.

- *Syzigium cumini*. Trial installed August 2010 at KTA. Twelve trees were treated. This trial has been discontinued, as Dr. Leary installed full IPA trials in 2011 at Kapuna. Preliminary results from the trial indicate that *S. cumini* is somewhat susceptible to Milestone, with smaller trees exhibiting partial defoliation. Large trees exhibited no symptoms of herbicide treatment.

Herbicide Ballistic Technology (HBT)

- OARNP continues to work with Dr. Leary on developing and testing HBT. This method, currently being researched and tested by Dr. Leary, involves focused delivery of small amounts of herbicide to target plants via paintball equipment. Please refer to the 2009 and 2010 MIP and OIP Status Reports full a full description of HBT. Staff are working with Dr. Leary primarily on two species, *Psidium cattleianum* (KTA) and *Hedychium gardnerianum* (SBW).
- *Psidium cattleianum* (KTA). Several HBT trials were conducted on *P. cattleianum*. All trials had low numbers of replicates, however the purpose of the trials was to help narrow down the most important factors in making HBT treatments successful on this taxon. In this, they have been very valuable.
  - Directionality. Installed May 2010, this trial involved applying triclopyr projectiles to shrubby *P. cattleianum* from four different angle combinations to determine the importance of treatment direction. The entire profile of the vegetation (ie, not just the highest branches or just the lowest branches) was treated. While only one of the plants in this trial died completely, the trial did indicate that the angle of treatment was not critical to effective control.
  - Cocktail. Installed November 2010, this trial involved applying three types of projectiles to shrubby *P. cattleianum* to look at the efficacy of various chemistries. The three projectiles used were triclopyr, imazapyr, and a cocktail of the two. None of the treated plants died. The trial strongly suggested that imazapyr and triclopyr/imazapyr cocktail projectiles did not perform as well as triclopyr projectiles.
  - Rate and Concentration. Installed February 2011, this trial involved testing two concentrations of triclopyr projectiles (4% and 16%) and three application rates (4, 8, and 12 projectiles) on shrubby *P. cattleianum*. None of the treated plants died, as of September 2011. The plants receiving the 16% concentration projectiles exhibited somewhat stronger herbicide symptoms than the plants targeted with the 4% projectiles. Of the 16% projectile plants, there was no major difference between the three application rates.
  - Basal. Installed May 2010, this trial involved applying projectiles to the basal bark of non-shrubby *P. cattleianum*. This trial was not marked rigorously, but strongly suggests that this technique is effective with triclopyr projectiles, but not imazapyr projectiles
  - Summary. Together, these trials suggest that triclopyr projectiles should be pursued for *P. cattleianum*, that the direction of control does not matter, that 16% dilution or more projectiles are more effective that 4% dilution projectiles, and that delivering herbicide as close as possible to basal bark may improve success. OARNP is working with Dr. Leary to develop additional trials in the coming year. Staff feel that although progress is slow, this technique has merit and would be extremely useful in targeting select weeds.
- *Hedychium gardnerianum* (SBW). Last year, OANRP scoped the extent of the *Hedychium gardnerianum* infestation in the mauka portion of SBW. The area of the infestation is large (approx 62 ha), but limited, and much of the infestation is located on the steep cliffs of Kaala. OANRP is looking for novel techniques to treat these remote plants. HBT (imazapyr) efficacy on *H. gardnerianum* was demonstrated in one small trial on Kauai, prompting OARNP to investigate

this option with Dr. Leary. In November 2010, OARNP and Dr. Leary conducted a trial aerial HBT treatment of *H. gardnerianum*. Thirty cliffside patches were treated in about half an hour, using 800 imazapyr (2.2%) projectiles. The trial ran smoothly from a logistical perspective. The treated area was monitored in September 2011. Unfortunately staff were unable to positively locate many treated plants. Staff flew through the treated area, and did note some distinct, yellowing *H. gardnerianum* patches. Imazapyr is a slow-acting herbicide, and full results may not be visible for two years. This was the case on Kauai, where little damage was seen on treated *H. gardnerium* until 200 days after treatment, with full effects seen at around 900 days after treatment. The September 2011 monitoring flight was almost 300 days after initial treatment, so more damage should have been visible. It was interesting to note that no non-target impacts were observed in the treatment zone, although these too may not manifest for some time. OARNP will continue to monitor the November treatment, but the cliffs of Kaala are not an ideal study site, given that plants cannot be definitively GPSed and revisited. Staff recommend that comprehensive trials of HBT efficacy on *H. gardnerianum* be conducted at another site.

- *Sphaeropteris cooperi* (SBW). During the *H. gardnerianum* SBW operation, OANRP and Dr. Leary also treated *S. cooperi*. Dr. Leary has treated *S. cooperi* extensively on other islands. In an hour, 87 *S. cooperi* were treated with 1,850 projectiles. In September 2011, OARNP flew through the treatment zone. A few treated *S. cooperi* were seen, but staff were concerned that many of the ferns in the treatment area appeared to be healthy. Further discussion of this with Dr. Leary is required.
- Dr. Leary re-submitted a proposal to the DOD Legacy office to further fund HBT research. OANRP will continue to support him in this process.

1.2 ECOSYSTEM RESTORATION MANAGEMENT UNIT PLANS

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

1.2.1 Kaluaa and Waieli

Ecosystem Restoration Management Unit Plan

MIP Year 8-12, Oct. 2011 – Sept. 2016

MU: Kaluaa and Waieli

Overall MIP Management Goals:

- Form a stable, native-dominated matrix of plant communities which support stable populations of IP taxa.
- Control ungulate, rodent, arthropod, slug, snail, fire, and weed threats to support stable populations of IP taxa. Implement control methods by 2014.

1.2.1.1 Background Information

Location: Southern Waianae Mountains

Land Owner: State of Hawaii

Land Manager: U.S. Army

Acreage: 154 acres

Elevation Range: 1,800-2,883ft

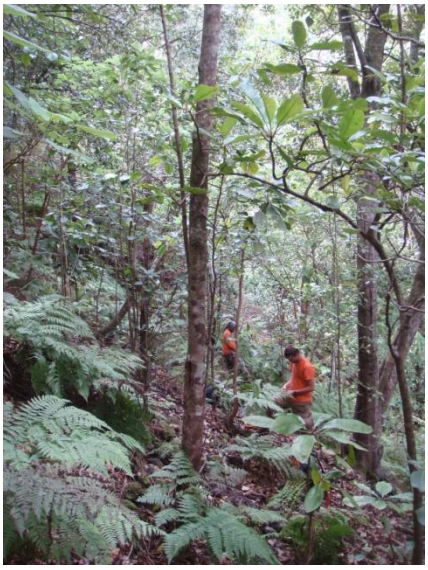
Description: The Kaluaa and Waieli MU is located in the Honouliuli Forest Reserve. The area is accessed via dirt roads through agricultural lands. The unit can be accessed either from the south through Actus Property and the QTR-2 gate or via South Range access roads from Kolekole Pass Road. There is one landing zone which is used to access the portion of the MU near Puu Hapapa. Terrain within the Kaluaa and Waieli MU is varied ranging from gradual slopes to vertical cliffs. Mesic mixed forest is the vegetation type across the Kaluaa and Waieli MU though the dominant native trees vary by aspect and elevation.

Native Vegetation Types:

Waianae Vegetation Types
Mesic mixed forest
Canopy includes: *Acacia koa, Metrosideros polymorpha, Nestegis sandwicensis, Diospyros* spp., *Pouteria sandwicensis, Charpentiera* spp., *Pisonia* spp.,*Psychotria* spp., *Antidesma platyphylum, Bobea* spp. and *Santalum freycinetianum*. Understory includes: *Alyxia oliviformis, Carex* spp., *Bidens torta, Coprosma* spp., and *Microlepia strigosa*
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

Kaluaa and Waieli MU from east, the prominent peak on right is Puu Hapapa.

Kaluaa from Puu Hapapa looking south



Mesic forest within MU

Typical Waianae crest vegetation within MU

Mesic gulch vegetation typical of Kaluaa and Waieli MU

MIP/OIP Rare Resources:

Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Alectryon macrococcus* var. *macrococcus*	KAL-A,B,C ELI-A,B Reintro KAL-E	Central Kaluaa to Central Waieli	MFS	Both
Plant	*Cyanea grimesiana* ssp. *obatae*	KAL-B Reintro KAL-C,D, E	Central Kaluaa	MFS	Both
Plant	*Delissea waianaeensis*	KAL-B Reintro KAL-C,D,E	Kaluaa	MFS	Both
Plant	*Plantago princeps* var. *princeps*	Reintro ELI-A	Waieli	Manage Reintroduction for Storage	Reintro
Plant	*Phyllostegia mollis*	KAL-D Reintro KAL-B,C	Kaluaa	MFS	Both
Plant	*Phyllostegia hirsuta*	KAL-A ELI-A,B,C	Hapapa to Kaluaa	MFS	Wild/ Future Reintro
Plant	*Schiedea kaalae*	KAL-A (extirpated) Reintro KAL-B,C	Kaluaa and Waieli	MFS	Reintro
Plant	*Stenogyne kanehoana*	KAL-A Reintro KAL-B,C,D	Central Kaluaa	MFS	Reintro
Insect	*Drosophila montgomeryi*	n/a	Kaluaa and Waieli	MFS	Wild
Snail	*Achatinella mustelina*	KAL-A	ESU-D1	MFS	Wild

MFS= Manage for Stability

Other Rare Taxa at Kaluaa and Waieli MU:

Organism Type	Species	Status
Plant	*Clermontia persicifolia*	SOC
Plant	*Cyanea calycina*	PE
Plant	*Cyanea pinnatifida*	Endangered
Plant	*Cyanea superba*	Endangered
Plant	*Cenchrus agrimonioides* var. *agrimonioides*	Endangered
Plant	*Diellia falcata*	Endangered
Plant	*Exocarpos gaudichaudii*	SOC
Plant	*Gardenia brighamii*	Endangered
Plant	*Melicope christophersenii*	PE
Plant	*Notocestrum longifolium*	PE
Plant	*Panicum beecheyi*	SOC
Plant	*Platydesma cornuta* var. *decurrens*	PE
Plant	*Pteralyxia macrocarpa*	PE
Plant	*Pleomele forbesii*	PE
Plant	*Schiedea hookeri*	Endangered
Plant	*Schiedea pentandra*	SOC
Plant	*Solanum sandwicense*	Endangered
Plant	*Tetramolopium lepidotum* subsp. *lepidotum*	Endangered
Plant	*Urera kaalae*	Endangered
Bird	*Chasiempis ibidis*	Endangered
Insect	*Drosophila ambochila*	Endangered
Insect	*Hylaeus sp.*	SOC
Snail	*Amastra micans*	SOC
Snail	*Amastra spirazona*	SOC
Snail	*Laminella sanguinea*	SOC
Snail	*Cookeconcha sp.*	SOC
Snail	*Endonta sp.*	SOC
Snail	*Auriculella ambusta*	SOC

Other Rare Taxa Directly Adjacent to Kaluaa and Waieli MU:

Plant	*Abutilon sandwicense*	Endangered
Plant	*Cryptocarya mannii*	SOC
Plant	*Gardenia mannii*	Endangered
Plant	*Melicope cinerea*	SOC

SOC=Species of Concern
PE= Proposed Endangered

Rare Resources at Kaluaa and Waieli

Locations of Rare Resources within the Kaluaa and Waieli MU:

MU Threats to MIP/OIP MFS Taxa:

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes, MU fenced.
Rats	*A. mustelina, C. grimesiana, D. waianaensis, A. macrococcus*	Yes	No	Yes, predator-proof fencing and diphacinone bait combined with rat snap traps.
Black twig borer (BTB) *Xylosandrus compactus*	*Alectryon macrococcus* var. *macrococcus*	Yes	No	Repellents under investigation, traps not very effective.
Predatory snails *Euglandina rosea*	*Achatinella mustelina*	Yes	No	Physical barrier (enclosure), to protect *Achatinella* from predators under construction.

Jackson's chameleon	*Achatinella mustelina*, *D. montgomeryi* and birds	Yes	No	Yes, physical barriers and hand capture.
Vespula pennsylvanica	*D. montgomeryi*	Yes	No	Manual destruction of nests. Toxicants may harm *Drosophila*.
Ants	*D. montgomeryi*	Yes	No	No, as toxicants may harm *Drosophila*
Slugs	*C. grimesiana*, *D. waianaeensis*, *P. princeps*, *P. hirsuta* , *P. mollis*, *S. kaalae*, *S. kanehoana*	Yes	No	Yes, Sluggo bait available for use.
Weeds	All	No	Yes	Yes. For steep cliff areas, herbicide ballistic technology being tested.
Fire	All	No	Yes	Yes, fuel pre-suppression.

Management History

- 1860s-80s : Area severely degraded by overgrazing by unmanaged herds of cattle. James Campbell purchases Honouliuli and drives more than 30,000 head of cattle off the slopes and lets the land "rest."
- 1925: Honouliuli Forest Reserve established for watershed protection purposes.
- 1930s-50s: Division of Forestry and Civilian Conservation Corps builds roads, trails and fences and continues removal of feral goats and cattle; plants 1.5 million trees in the Honouliuli Forest Reserve mainly below the 1800' elevation.
- 1940s: Area below the contour trail in Kaluaa actively farmed and used for ranching (Leilehua Ranch).
- 1940s-50s: Area below the contour trail first used by the Army for training.
- 1970's: *Clidemia* first introduced to the Waianae Mountains in the South Kaluaa contour trail area.
- 1972: One individual of *Drosophila montgomeryi* was recorded from Kaluaa Gulch
- 1990-2009: Honouliuli Preserve managed by TNC
- 1996: TNC installed 1/8th acre Ti Leaf Flats fence; *Delissea waianaeensis, Cyanea pinnatifida* were the first TNC endangered plant reintroductions.
- 2000-2007: TNC management consisted of installing an extensive catchment system, trail construction, project stewardship plots, field nursery, reintroduction of several thousand endangered and common natives, rat control for snail and elepaio protection, and volunteer hunting program.
- 2001: 100 acre Central Kaluaa fence completed by TNC staff, volunteers and contractor John Hinton.
- 2002: OANRP first begins using the Central Kaluaa fence area for endangered reintroductions as part of the MIP plan.
- 2003: Extensive archeological surveys in the area below the boundary of the TNC preserve document numerous cultural and historical sites.

- 2004: US Army acquires the South Range Acquisition Area from James Campbell Estate for a second qualifying training range in the South Range area (now known as SRQTR2). Area mostly consists of old pineapple fields but also some portions of the forested area as a buffer safety zone.
- 2006: 25 acre Hapapa/North Kaluaa fence completed by TNC, volunteers, and OANRP staff.
- 2009-2010: Army Compatible Use Buffer Program purchases Honouliuli Preserve with assistance from State and private partners primarily for endangered species management. Title transfers to the State of Hawaii for management as a forest reserve with other uses as well including recreational hiking and hunting.
- 2010: *Drosophila montgomeryi* was documented by Karl Magnacca at one site in Kaluaa gulch and at a second site near the summit of Puu Hapapa (2640 ft. elevation).
- 2010: OANRP completes construction of 42 acre Waieli and North Kaluaa fence and all pigs removed.
- 2011: A contracted company completes the 0.25 acre snail enclosure at Puu Hapapa

1.2.1.2 Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Primary Objective: To maintain all areas within fenced units as pig free.

Strategy:

- Eradication in the MU.
- Consider need to construct strategic ungulate fencing to protect the South Range side of Puu Hapapa.
- Population reduction just outside the MU with State permission. Encourage DLNR to reduce pressure below MU via public hunting.

Monitoring Objectives:

- Conduct perimeter fence checks quarterly and monitor for pig ingress.
- Monitor for pig sign while conducting other management actions in the fence.
- Monitor high priority gulches for ungulate sign biannually.
- Annually monitor interior fencelines.
- Monitor pig sign atop Hapapa in conjunction with regular rat control visits.

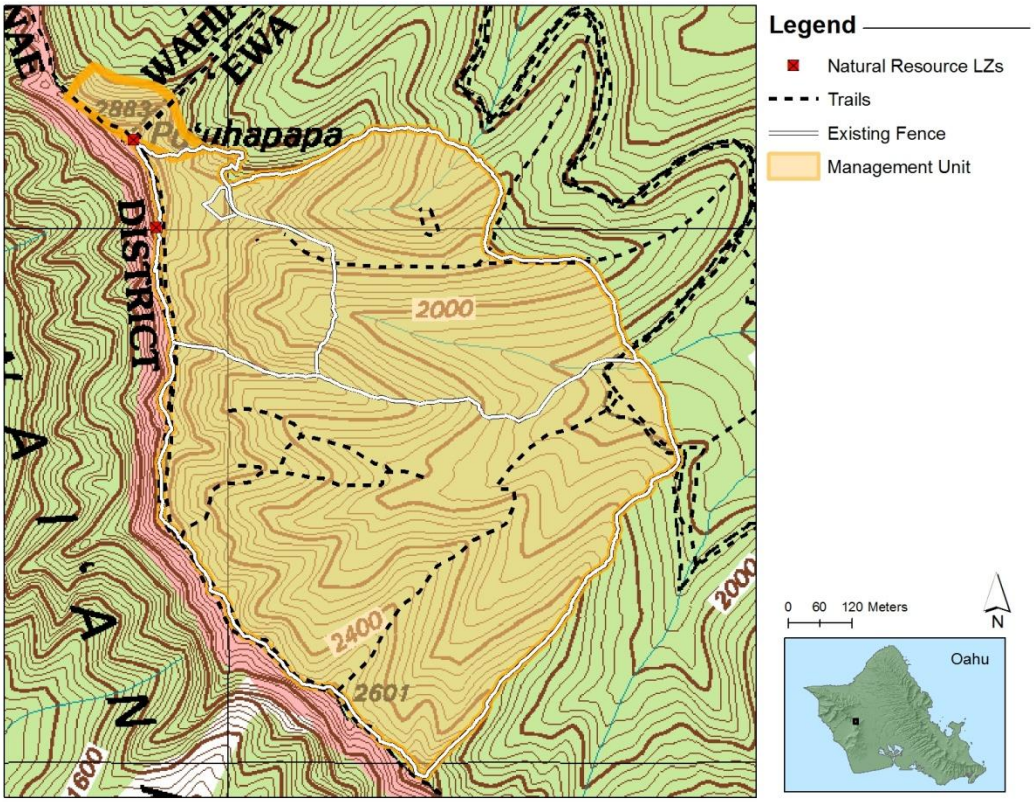
Management Responses:

- If any pig activity is detected in the MU, implement snaring program or conduct control hunts with permission from the State of Hawaii.
- After one year of ungulate monitoring atop Hapapa decide if strategic fencing should be built.

Maintenance Issues

- Maintain fences
- Conduct fence checks after storm events with emphasis on gulch crossings.
- Install signs where MU fence is visible from trails to inform the public about purpose and goal of fence.

Ungulate Management at Kaluaa and Waieli MU



1.2.1.3 Weed Control

Weed Control actions are divided into 4 subcategories:

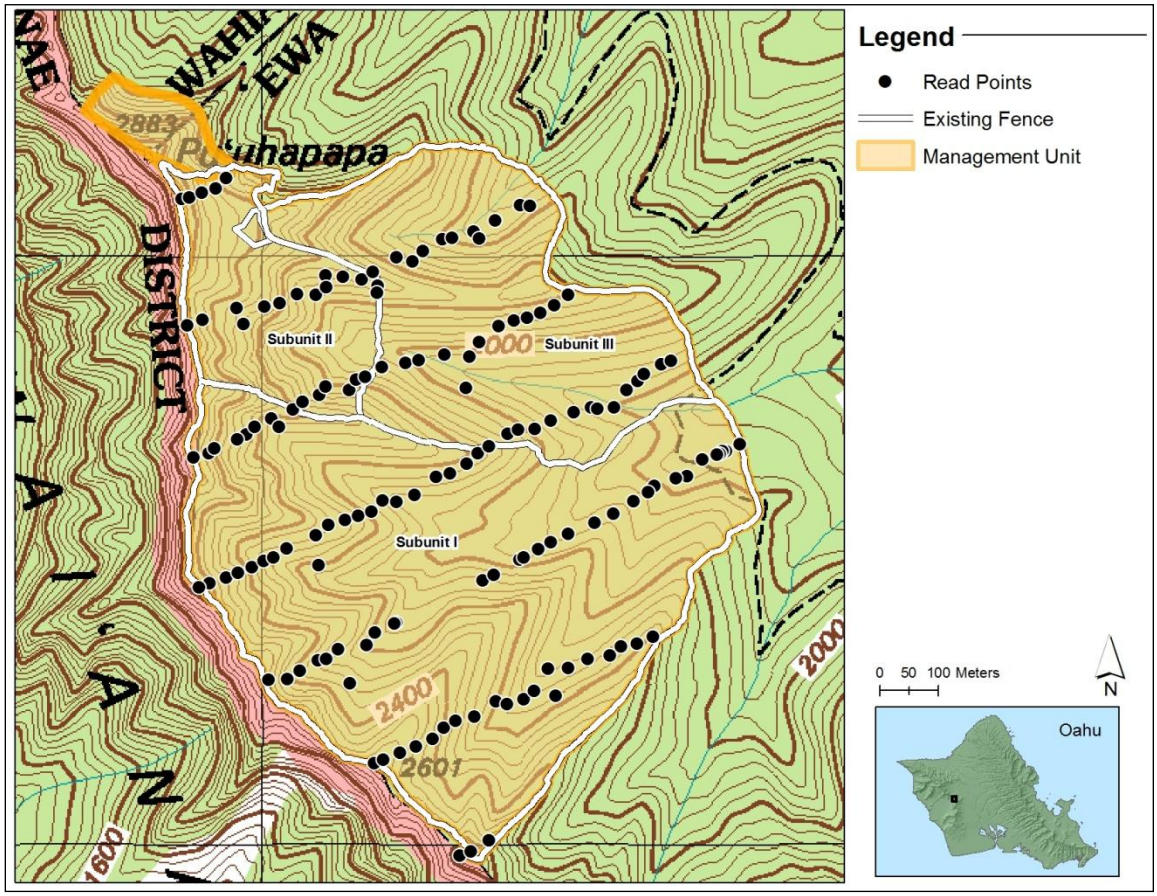
1) Vegetation Monitoring
2) Surveys
3) Incipient Taxa Control (Incipient Control Area - ICAs)
4) Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP/OIP requirements.

<u>Vegetation Monitoring for the Kaluaa MU</u>

From July - September of 2010 vegetation monitoring was conducted for the Kaluaa and Waieli management unit (MU). The total effort including commute time was 280 hours. In the next few months the vegetation monitoring sub-committee will be meeting to set the monitoring interval for this MU. The vegetation monitoring data will provide NRP with trend analysis on the percent cover for alien vegetation in the understory and canopy, invasion and spatial distribution of priority weed species, and species richness. Since the MU vegetation monitoring protocol was designed in order to address two separate MIP management goals, the following analysis is divided into two separate sections. The statistical thresholds used for both sections were copied directly from the Makua Implementation Plan

Vegetation Monitoring



Note: Areas inaccessible due to steep terrain and sections with thick uluhe were excluded from the sampling due to concerns of human impact.

Section 1: Alien Percent Cover Goal

Alien Percent Cover Management Objective: Assess if the percent cover for alien understory and canopy is 50% or less across the entire management unit. For more discussion on this objective refer to Makua Impementation Plan, chapter 10, table 10.1.

Sampling Objectives:

Be 95% sure of detecting a 10% change in percent cover for both alien understory and canopy.

The acceptable level of making a Type 1 error (detecting a change that did not occur) is 10% and a Type 11 error (not detecting a change that did occur) is 20%.

Vegetation Monitoring Protocol: Refer to the monitoring section in the 2008 year-end report.

Analysis: Baseline data collected for the Kaluaa MU in 2010 showed that the mean percent alien vegetation cover was 44% in the understory and 61% in the canopy (refer to MU % vegetation cover table

below). In the understory, the alien percent cover met the management goal of 50% or less vegetation cover. In the canopy, the alien vegetation cover was not met.

Management response: If future vegetation monitoring analysis indicates that the alien percent in either the understory or canopy has not been met and are not getting closer to being reached, the weed control strategy will be re-evaluated by the IT.

Statistical Thresholds and Sample Size Considerations: To determine the minimum sample size required to detect a 10% change in alien vegetation cover a post-hoc power analysis was performed. With 80% power and a standard deviation of 36 (used from alien canopy standard deviation baseline dataset) the minimum sample size needed to meet the sampling objectives was 81 plots. In 2010 a total of 149 plots were monitored. Though only 81 plots were needed to detect a change in alien percent cover, more plots were monitored to ensure that there was a large enough sample size to detect change in the frequency of occurrence goal (discussed in section 2).

Section 2: Frequency of Occurrence Analysis

Frequency data was collected for all species that occurred within the Kaluaa MU in 2010. This data will be used to tracking species richness, spatial distribution, and density of dominate species on an MU scale. This analysis will be used by management to help determine if Kaluaa is getting more or less native over time. For a complete list of species recorded during the 2010 monitoring period and the percent of plots they occurred in refer to appendix 1-6.

Species Richness and Vegetation Monitoring Checklist:

From the 2010 dataset a vegetation checklist of the vascular plant species was compiled. Within the canopy; a total of 77 plant species were recorded; 59 (77%) of these species were native and 18 (23%) were alien. In the understory, a total of 173 species were recorded; 113 (65%) of these species were native and 60 (35%) were alien.

Management Objective for priority alien species control:

- Assess the spatial distribution and frequency for all priority 2 alien species.
- Proved an updated priority weed species list for the Kaluaa MU.
- Track species richness for alien species across the MU.

Sampling Objective: 95% confident of detecting 10% change in occurrence of priority 2 alien weed species.

Vegetation Monitoring Protocol: Refer to the monitoring section in the 2008 year-end report.

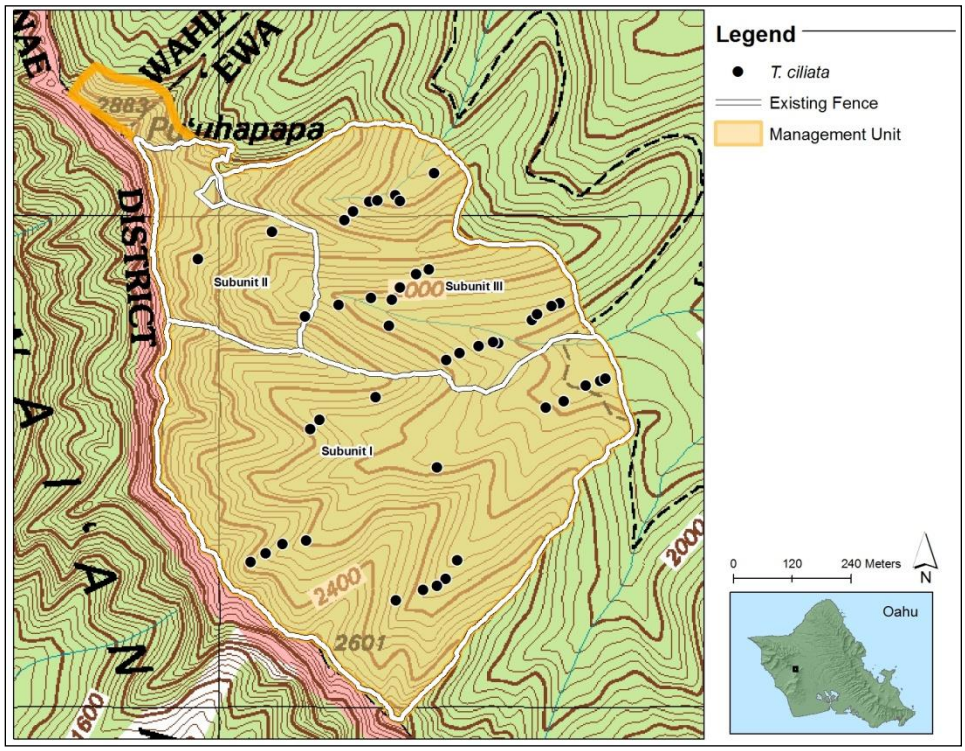
Established Weed Species Discussion: Priority weed species which are of particular interest to NRP due to their ecosystem altering potential are controlled on an MU or WCA scale. For notes on the control strategy for these species refer to the Summary of Target Taxa table in the ICA section of this report.

Two main species from the priority weed list which are targeted for control in all of the WCA's in the next five years are *Psidium cattleianum* and *Schinus terebinthifolius*. Both of these species are established at Kaluaa. The frequency of *Psidium cattleianum* on an MU scale was 38% in the canopy and 45% in the understory. The frequency of *Schinus terebinthifolius* on an MU scale was 68% in the canopy and 63% in the understory. In some areas, these species have created monotypic stands. The management goal for these species is to control them in native forest patches, around rare plant populations, and

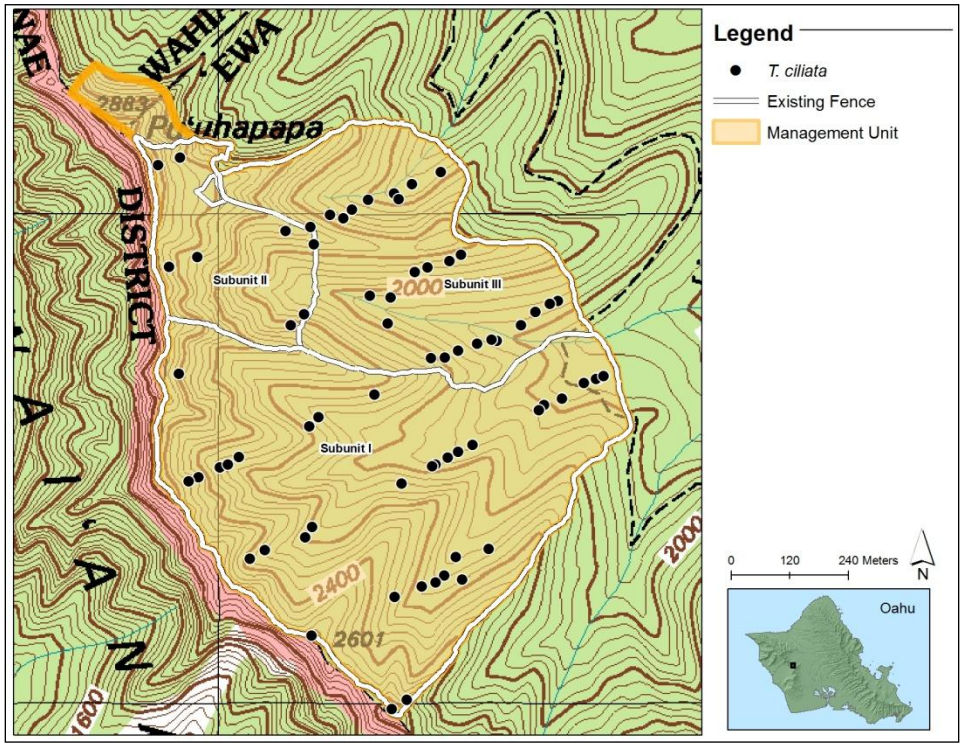
prevent monotypic stands from expanding. Vegetation monitoring will provide NRS with spatial distribution and density trends for these species and will be used to assess priority weed control strategy on an MU scale.

Another invasive tree which is targeted for control on a WCA scale is *Tonna ciliate.* Field biologists from both NRP and TNC have reported this specie spreading rapidly in Kaluaa. It was first established in sub-unit 3 but has since spread into sub-unit 1 and 2. A major challenge of controlling *T. ciliata* is that it grows rapidly in Hawaii, reaching an average height of 10 m after only 8.7 years. In addition, it can mature after six years in open localities and is wind dispersed (Lemmens, 2008). Given this, it will be important to conduct weed sweeps at a minimum of a six year interval, first prioritizing the control of *T. ciliata* within native dominated areas and around PU's. In 2010, the frequency of *T. ciliata* on an MU scale was 31% in the canopy and 49% in the understory. Since the weed control strategy is different between sub-units 1 and 2 and sub-unit 3, it will be informative to track the trend of occurrence within the two areas separately. In the understory the frequency was 34% in sub-unit 1 and 2 combined and 53% in sub-unit 3 which was significant (Chi-Square, P = 0.006). In the canopy, the frequency was 15% in sub-unit 1 and 43% in sub-unit 2 which as significant (Chi-Sqaure, P = 0.00005). As more data is collected, trend analysis will indicate if the current weed control strategy is sufficient at controlling the spread and density for *T. ciliata.* If the trend shows a significant increase in occurrence for this species, weed control strategy will be re-assessed.

Occurrence of *T. ciliata* Canopy*:*



Occurrence of *T. ciliata* Understory*:*



Low Density Priority Two Weed Species Discussion:

An additional benefit of conducting vegetation monitoring was the detection of several low density priority weed species (Refer to list below). NRP treats these species with zero tolerance, so all detected target species found during vegetation monitoring were controlled. Data collected for these species will not be analyzed after re-sampling because actively controlled target species in the sampled area would skew future analysis.

Native Species Frequency Anaylsis:

Target Taxa List	Sample Size	Occurrence of Low Density Taxa
Heliocarpus popayanensis in the Understory	149	2
Heliocarpus popayanensis in the Canopy	149	1
Mallotus phillippenis in the Understory	149	2
Panicum maximum in the Understory	149	2
Spathodea campanulata in the Understory	149	5
Schefflera actinophylla in the Understory	149	3
Setaria palmifolia in the Understory	149	1
Triumfetta semitriloba in the Understory	149	2

Management Objective: Ensure the plant communities within the MUs are stable and native-dominated (MIP.

Sampling objectives: Be 95% certain of detecting a 10% change in occurrence of native species.

Vegetation Monitoring Protocol: Refer to the monitoring section in the 2008 annual status report.

Native Species Frequency Analysis: The most common native tree in both the canopy and understory was *Pouteria sandwicensis*, occurring in 29% of the plots. The next most common native species were *Acacia koa, Metrosideros polymorpha* and *Psychotria mariniana*. For a complete species list refer to Appendix 1-6.

Management response: If there has been significant decline in native species occurrence over time, assess if satisfactory progress is being made to reverse this trend.

Surveys

Army Training?: Yes, training occurs nearby in South Range, QTR 2

Other Potential Sources of Introduction: NRS, public

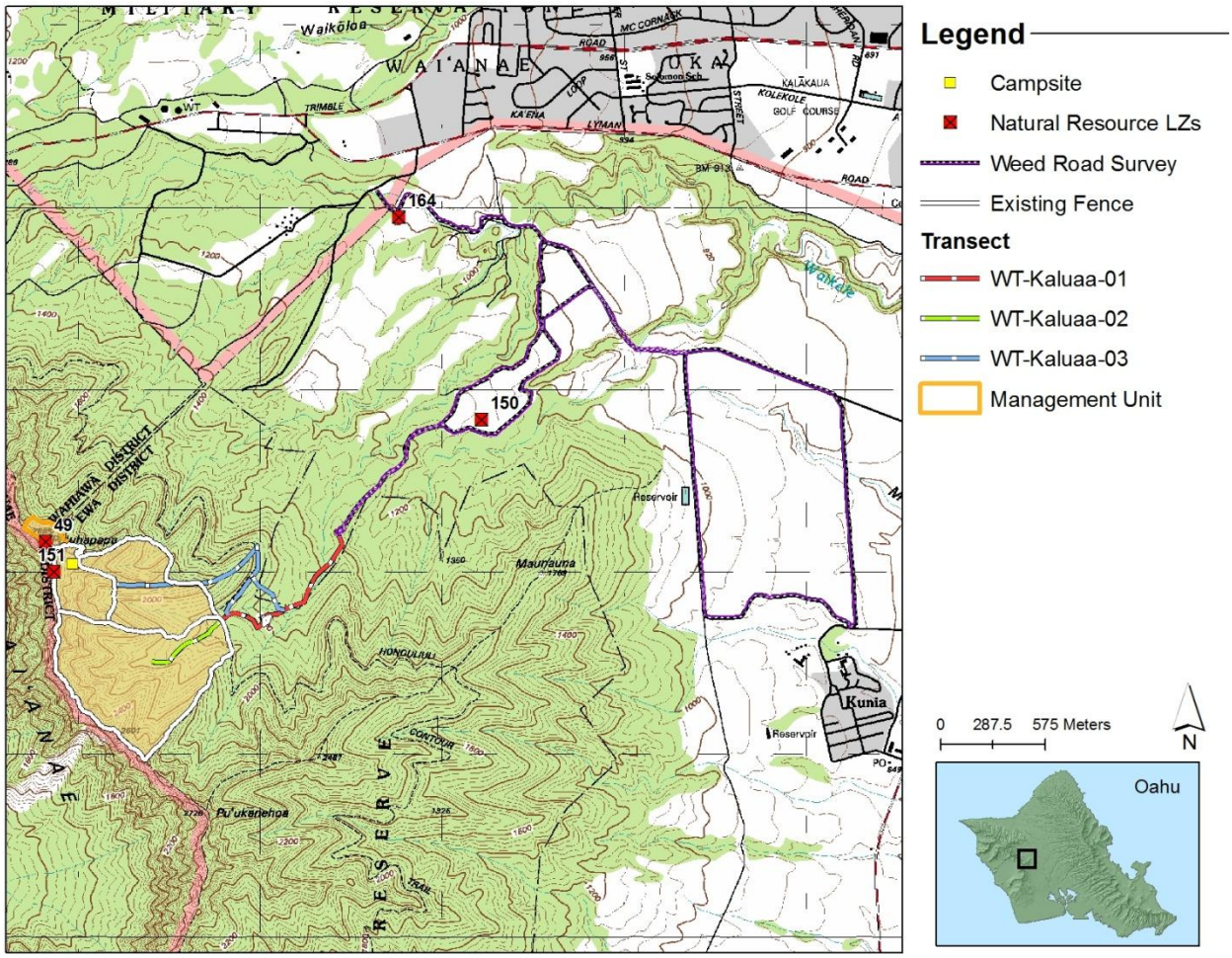
Survey Locations: Roads, Landing Zones, Campsites, Trails, Fencelines, High Potential Traffic Areas.

Management Objective: Prevent the establishment of any new invasive alien plant or animal species through regular surveys along roads, landing zones, camp sites, fencelines, trails, and other high traffic areas.

Monitoring Objectives:

- Quarterly surveys of LZs (if used).
- Note unusual, significant or incipient alien taxa during the course of regular field work particularly when doing fence checks.
- Annually survey contour trail, main Kaluaa gulch trail and the Hapapa access trail for incipient weeds (see map).
- Annually survey Kaluaa access road.

Survey Areas at Kaluaa and Waieli



Surveys are designed to be the first line of defense in locating and identifying potential new weed species. At Kaluaa and Waieli, landing zones are checked when used (not exceeding once per quarter). The only LZs approved for use within this MU are Waieli-TNC Hapapa LZ (151) and SBS Hapapa LZ (49). Relevant LZs for this MU include the Army LZs CAT (164), Dragon X (83) and the OANRP LZs Ekahanui Trailhead LZ (99) and the Kaluaa Trailhead LZ (150). The Kaluaa Trailhead LZ is not currently approved for use, but has been used in the past. These four LZs are not in the MU, however they are used to stage gear and personnel when accessing LZ 151 which is in the MU. Therefore, quarterly surveys for both weeds and invasive insects at these LZs are important. Additionally, the roads leading to the Ekahanui trailhead and CAT LZs are surveyed annually for weeds. The Ekahanui MU plan covers the survey and control of weeds at LZ 99 and for the Ekahanui access road. The Dragon X LZ is used by numerous teams for a variety of flight work and will be surveyed at least once per quarter by whatever team uses it (under jurisdiction of Green Team). The action table in this plan includes quarterly surveys of LZ CAT. In addition to LZ surveys, staff also conducts surveys at the primary shelter/campsite in the MU, along 3 heavily trafficked trails, and along the access roads.

Incipient Control Areas

Management Objectives:

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

Monitoring Objective: Visit ICAs at stated re-visitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.

Management Responses: If unsuccessful in preventing immature plants from maturing, increase ICA revisitation interval.

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

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

Summary of Target Taxa

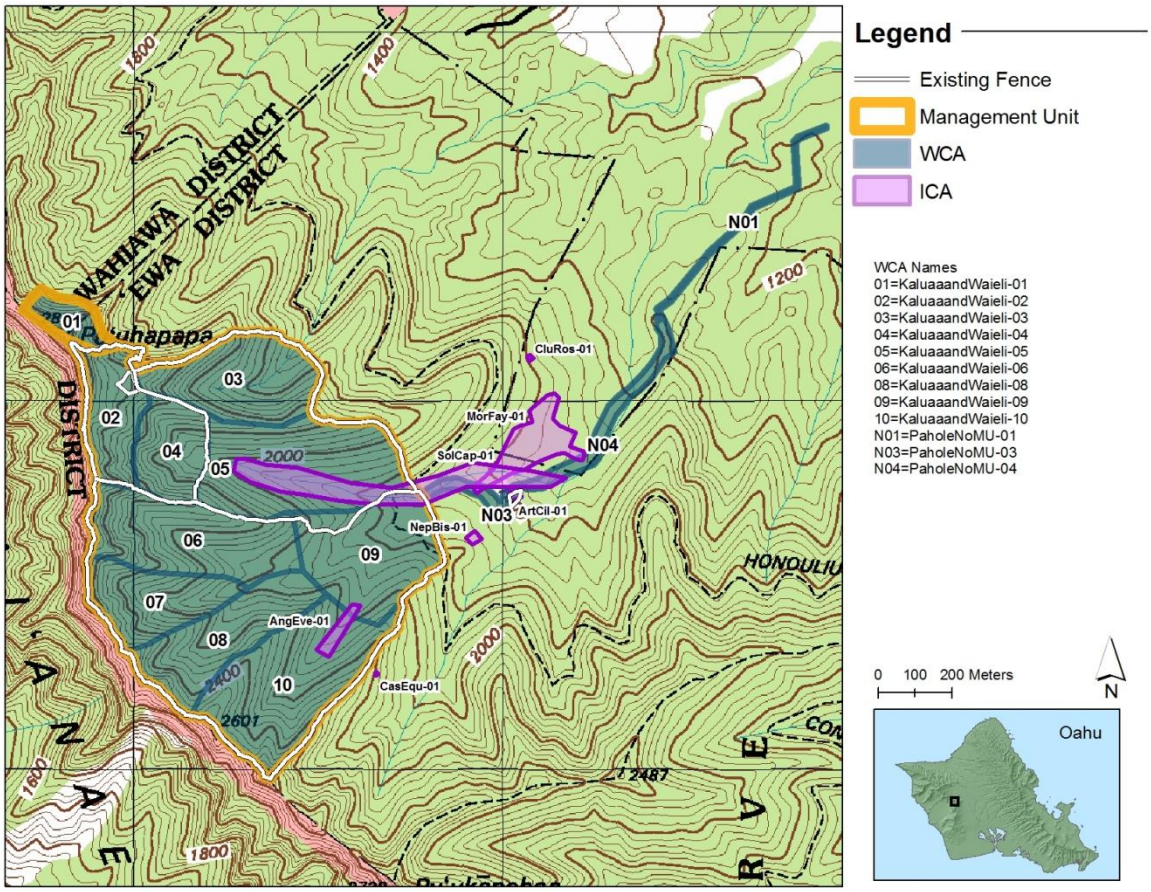
Taxa	MIP weed mgmt code		Notes	No. of ICAs
	Original	Revised		
Ardesia elliptica	0	2	Below MU fence, concentrated in South Kaluaa. Pretty widespread. Keep it out of the fence.	0
Angiopteris evecta	1		In South-Central Kaluaa gulch. Always keep on look out for this in gulches within MU.	1
Arthrostemma ciliata	n/a	1	Concern from sanitation perspective. Only 1 plant known; it was a small mature next to the trail just below the ti leaf fence.	1
Casurina equisitifolia	0	1	Only one location known on South fenceline. Combine control visits with fenceline checks.	1
Clusia rosea	0	1	1 monstrous mature located on contour trail below Kaluaa. Difficult to control. Research control techniques.	1
Dicliptera chinensis	0	2	Concern from sanitation perspective. Not known inside MU. Control along access trail to prevent spread into MU. Naturally roundup resistant.	0
Erigeron karvinskianus	2	2	Control in WCAs. Target in cliff and bench areas in habitat for MFS plant taxa.	0
Falcataria	n/a	1	Treat as part of WCA work. Kill all mature trees within fence. Well	0

Taxa	MIP weed mgmt code		Notes	No. of ICAs
	Original	Revised		
moluccana			established below MU.	
Ficus sp.	0	1	Banyan gulch. Treat as part of WCA work. Kill all mature trees within fence. Established below MU. Research reliable control techniques.	0
Fraxinus uhdei	2	0	Not detected in MU monitoring. No antecdotal observations near or within MU.	0
Grevillea robusta	2	2	Widespread across MU. In vegetation monitoring, taxa occurred in 17.45% of plots in the canopy and in 15.44% of plots in understory. Control in WCA sweeps. Priority to kill matures. Lower priority than *Toona ciliata*.	0
Heliocarpus popayensis	2	2	In vegetation monitoring, taxa occurred in 0.67% of plots in the canopy and in 1.34% of plots in the understory. Concentrated in the northern part of the unit, North Kaluaa and Hapapa bench. Target matures as a priority and in canopy weed sweeps across WCAs. Literature search for reliable control technique.	0
Mallotus phillipinensis	1	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the understory. Abundant in Lualualei, so expect to see re-invasion. Seedling/saplings are observed across the MU. Target all mature trees. Control saplings and seedlings in WCA sweeps.	0
Melia azedarach	0	1	In vegetation monitoring, taxa occurred in 0.67% of plots in the understory, which is one plot of 149 total plots. Treat in WCA work. One plant observed was below Hapapa bench. Melia observed in fields below MU.	0
Montanoa hibiscifolia	0	1	Large population exists to the southeast of the MU. Priority to keep from establishing within the exclosure.	0
Morella faya	0	1	Eradicating from area around carnation trail to prevent spread into MU. No recruitment observed. Maintain control work in ICA.	1
Neonotonia wightii	1	0	Not widespread in or around MU. Note any locations, if found, and evaluate for control.	0
Nephrolepis biserrata	n/a	1	Not detected in MU monitoring. Control as an ICA along the south fenceline ridge so staff don't spread it along trails. Also established on the steep uluhe face on the north side of catchment ridge; this site is difficult to access, and has not yet been designated an ICA. Conduct surveys to delineate extent off of catchment ridge. Become familiar with ID. Research control techniques.	1
Panicum maximum	2	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the understory. Control along trails and in priority restoration habitats. Treat in WCAs. Consider installing catchment in North Kaluaa near old fenceline for control of alien grasses located in that region.	0
Schefflera actinophylla	1	1	In vegetation monitoring, taxa occurred in 2.01% of plots in the understory. Bird dispersed and well established below MU, so could come up anywhere. Target matures as a priority and in canopy weed sweeps across WCAs. Follow up on IPA trials to identify reliable control technique.	0
Solanum capiscoides	n/a	1	Current ICA large, but only small numbers seen in ICA in past. Sweep biannually.	1
Setaria palmifolia	2	2	In vegetation monitoring, taxa occurred in 0.67% of plots in the understory, which is one plot of 149 plots. Occurs in the gulch bottoms. Keep off trails. Along access trail from parking area to contour trail. Treat in WCA work. One known location from Hapapa bench area which should be checked	0

Taxa	MIP weed mgmt code		Notes	No. of ICAs
	Original	Revised		
			during WCA weed control.	
Spathodea campanulata	2	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the canopy and in 3.36% of plots in the understory. Target in canopy weed sweeps across WCAs.	0
Sphaeropteris cooperi	0	1	Survey two known locations in Gulch 1 for this taxa when conducting WCA weed sweeps or while conducting other activites along the gulch corridor.	0
Toona ciliata	2	2	In vegetation monitoring, taxa occurred in 48.99% of plots in the canopy and in 30.87% of plots in the understory. Reaches maturity at approximately 6 years old, use this to plan revisitation. Target in canopy weed sweeps across higher elevation WCAs. In lower elevations, consider targeting with volunteers.	0
Trema orientalis	0	1	Not detected in vegetation monitoring. If seen, target in canopy weed sweeps across WCAs.	0
Triumphetta semitrilobata	0	2	In vegetation monitoring, taxa occurred in 1.34% of plots in the understory. Also occurs on the access trail. Control along trails in high concentration areas to limit spread across MU. Target in weed sweeps whenever seen.	0

*occurrence-percent of total plots containing taxa

Incipient and Weed Control Areas at Kaluaa and Waieli



Ecosystem Management Weed Control (WCAs)

MIP Goals:

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

Management Objectives:

- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Reduce alien canopy cover by 5% across the MU in the next 5 years.
- In WCAs within 50m of rare taxa, work towards achieving 25% or less alien vegetation cover in understory and canopy.

Management Response: Increase/expand weeding efforts if MU vegetation monitoring indicates that goals are not being met.

The following is a discussion of unique considerations for managing the Kaluaa and Waieli MU. The habitat overall in this MU is patchy. The habitat along and just below the Puu Kanehoa to Puu Hapapa crestline is largely native. In addition, there are belts of koa canopy which run along prominent ridgelines that are in a relatively good condition, with many native components. The gulches and slopes within the MU are a mix of native and alien forest. Patches of intact diverse mesic forest remain within the unit. MIP and OIP taxa are found across these zones and thus most of the Kaluaa and Waieli MU is important for stabilization of various taxa.

One unique consideration is picture-wing *Drosophila* habitat. Picture wing flies require particular host plants to complete their lifecycles. The endangered *Drosophila montgomeryii* is found within the Kaluaa and Waieli MU and is an OIP stabilization species. Its' host plant is *Urera*. Maggots use rotting plant material from either *Urera glabra* or *Urera kaalae*. Therefore, the remnant patches of these plants should be maintained and expanded. *Urera glabra* should be used as part of the compliment of native trees selected for common native outplanting.

Another unique consideration for this MU is the taxon *Stenogyne kanehoana* which prefers the Koa forest zone along ridges that contain large amounts of *Dicranopteris linearis* (uluhe) in the understory. This habitat requires delicate management to ensure the uluhe is not disrupted. OANRP does not have the capacity to actively restore uluhe through planting and thus should conduct weed control and outplanting very carefully and with minimal impact to the fern cover. Conversations with horticulturists around the state suggest that uluhe is very difficult to propagate.

The final unique consideration for the Kaluaa and Waieli MU is the Puu Hapapa bench habitat (WCA-2). This zone has a unique set of conditions that support numerous rare native tree and ground snail species. In addition, the endangered *Drosophila montgomeryii* occurs here. Rare native ground snails in the genera *Amastra* require unique food. They browse fungi growing in leaf litter from plants in Urticaceae such as *Pipturus albidis* and *Urera* spp. Fortunately, *Urera* is also essential for *D. montgomeryii*. Native *Achatinella* can also live happily on these taxa. A detailed restoration plan for the Hapapa bench is included as Appendix 1-7 to this document. In addition, ground dwelling snails can be impacted by digging activities associated with outplanting and fence construction, which are both planned for the site in the short term. Particular caution should be taken to survey sites prior to conducting digging and tree felling activities.

There are about 7 elepaio birds within the Kaluaa and Waieli MU. While elepaio here are not managed by OANRP, care should be taken to avoid any tree removal during the nesting season. Pairs are still known from the south central gulch area and along the Central Kaluaa southern fenceline. In addition consideration should be paid to preserve forest structure within elepaio territories.

WCA Kaluaa and Waieli-01: SBS side of Hapapa

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *Schinus terebinthifolius* and *Psidium cattleianum* in canopy and understory weeds including *Rubus rosifolius, Clidemia hirta, Erigeron karvinskianus* and *Melinus minutiflora*.

Notes: *Achatinella mustelina* abundant in area. Ground dwelling snails also present (*Laminella sanguinea).* Some of this WCA is steep and difficult to move around. Be aware of native taxa in the area, such as *Lobelia yuccoides* and *Cyanea calycina* present in the area. Weeding effort will focus on removing canopy elements gradually, to minimize changes in light/moisture to this snail area.

WCA Kaluaa and Waieli-02: Hapapa Bench

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Large *Schinus terebinthifolius* and *Psidium cattleianum* in canopy and understory weeds including *Rubus rosifolius, Clidemia hirta, Passifora suberosa, Lantana camara, Christella parasitica, Erigeron karvinskianus* and *Melinus minutiflora*.

Notes: This large WCA is home to several rare plant wild sites and reintroductions sites, as well as to one of the largest populations of *A. mustelina* in the Waianae Mountains. Ground dwelling snails and *Drosophila* are also present. A predator proof fence is currently being constructed around part of the *A. mustelina* population. A Hapapa Bench restoration plan is appended to this document; please refer to it for a detailed account of ecosystem restoration measures planned for the area.

Due to the presence of such a variety of rare and endangered taxa, care must be taken in replacing weeds with natives, and when conducting any ground disturbance. Conduct gradual removal of canopy weeds, focusing on *S. terebinthifolius* and *G. robusta*, to foster native recruitment. Remove understory weeds, focusing on shrubs, herbs, and *C. parasitica.* Snails in the area are using *Psidium* spp, and control of these taxa should be strategic. The entire WCA should be swept for target species, such as *S. campanulata*. At rare plant sites, both understory and canopy control should be conducted.

WCA Kaluaa and Waieli-03: South Waieli

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: *Toona ciliata* canopy dominates this WCA. *Clidemia hirta, Buddelia asiatica, Christella parasitica* and *Rubus rosifolius*.

Notes: Weed control is focused around wild *Alectryon macrococcus* var. *macrococcus* and reintroduced *Delissea waianaensis.* This area will be a priority for control, both to prepare and maintain the reintroduction site. Understory weeds will be targeted, in additional to limited canopy control. This WCA encompasses the south branch of Waieli which is dominated by large *Toona ciliata* with nice remnant patches of *Pisonia* and *Diospyros*. *Achatinella mustelina* present in low numbers. The back wall of the gulch, just below where it abuts the Hapapa bench WCA is very steep and dominated by *Schinus terebinthifolius*. Control of mature *T. ciliata* is priority, as this is likely an important dispersal source for this taxa throughout the MU.

WCA Kaluaa and Waieli-04: North Kaluaa above old fence

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: *S. terebinthifolius* and a variety of understory weeds including *Passiflora suberosa, Rubus rosifolius, Lantana camara, Clidemia hirta* and *Psidium cattleianum.*

Notes: There are reintroductions of *Delissea waianaensis* and *Cyanea grimesiana* ssp. *obatae*. Wild trees of *Alectryon macrococcus* var *macrococcus* are also found within this WCA. In addition, there are a few large *Urera glabra* trees which are appropriate habitat for *Drosophila montgomeryi* although, as of yet, no flies have been observed. The westerly portion of this WCA is very steep and dominated by *S. terebinthifolius* canopy. This area may be managed for incipient canopy weeds using HBT. One mature *Falcataria mollucana* tree was removed from this WCA. The site should be monitored and all recruits treated. *Setaria palmifolia* and *Panicum maximum* are known from within this WCA but are continuous with the populations of these weeds in WCA-3. They should be controlled as a priority in WCA-04 over WCA-03 because of the rare species habitat within this WCA.

WCA Kaluaa and Waieli-05: North Kaluaa below old fence

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% non-native cover

Targets: Mature *T. ciliata* will prioritized for control. *Panicum maximum* and *S. palmifolia* should be controlled to prevent/minimize spread throughout the MU.

Notes: There is a dominant canopy of *Toona ciliata* which will be controlled strategically within this WCA in support of neighboring WCA management. During vegetation monitoring in North Kaluaa, *Mallotus phillipinensis* was observed. This is not well established in the MU thus comprehensive sweeps should be conducted to control it within this WCA. *P. maximum* and *S. palmifolia* are abundant within this WCA and should not be spread throughout the Kaluaa and Waieli MU. Control within this WCA should be concentrated along trails and fencelines. *U. glabra* trees should be maintained and expanded for use by *D. montgomeryii*.

WCA Kaluaa and Waieli-06: Gulch 3

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *S. terebinthifolius* and a variety of understory weeds including *Passiflora suberosa, Rubus rosifolius, Lantana camara, Clidemia hirta*, *Buddelia asiatica*, *Triumphetta semitriloba* and *Psidium cattleianum.*

Notes: High Priority. Weeding in this WCA has been focused around native *Pisonia* patches where there are reintroductions of *Phyllostegia mollis*, *Cyanea grimesiana* spp. *obatae* and *Schiedea kaalae*. Also found in this WCA are wild populations of *D. waianaensis* and *P. mollis*. Habitat on the native slopes contains rock tallus substrate which can be challenging for weed control. Care should be taken to avoid harm to ground snails which have recently been known from Gulch 3. Large *S. terebinthifolius* trees dominate slopes in between remnant native forest patches.

WCA Kaluaa and Waieli-07: Gulch 2

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% native cover.

Targets: Understory: *L. camara, Paspalum conjugatum, R. rosifolius.* Overstory: *S. terebinthifolius*

Notes: This WCA contains a population of *D. montgomeryii* and a substantial patch of *U. glabra* trees. There is also an isolated population of *A. mustelina* found within a *Pisonia* patch and care should be taken not to impact any snails during weed control activities. Maintenance and expansion of *U. glabra* will be a focus within this WCA. The back wall of this MU below the crestline vegetation is nearly 100% *S. terebinthifolius* in places. There are no current plans for MIP or OIP management in this particular zone.

WCA Kaluaa and Waieli-08: Gulch 1

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: Canopy weeds include *Psidium cattleianum* and *S. terebinthifolius*. Understory weeds include *Passiflora suberosa, C. hirta* and *R. rosifolius.*

Notes: This WCA was a core TNC outplanting site which was adopted and expanded by OANRP. *Delissea waianaensis* was been planted in large numbers at the 1A fence site. In addition, TNC plantings

of *Schiedea kaalae* and *Solanum sandwicensis* occur throughout the site. *S. sandwicensis* recruits across this site.

The only wild location of *C. grimesiana* ssp. *obatae* in Kaluaa occurs near the bottom of this WCA. There is an intact canopy of native trees, which include *Acacia koa, Psychotria mariniana, Syzigium sandwichensis* and *Pisonia umbellifera*. Understory weeds, particularly *C. hirta*, grow aggressively in areas where *P. cattleianum* canopy was removed and require substantial maintenance. Encouraging koa and Pisonia recruitment into these sites or common native plantings would likely reduce understory weed prevalence. There is a great deal of room for expansion of the 1A site upslope into neighboring areas with native canopy.

The upper slope below the crestine of catchment ridge is dominated by steep uluhe with an open canopy of *Metrosideros polymorpha*. This area is very difficult to traverse and would be challenging to manage using ground techniques. This area may be best to monitor from one ridge to the north or from the air. Amidst this uluhe belt are patches of *Nephrolepis biserrata*. These *N. biserrata* patches will be monitored and may be controlled as an ICA if feasible management techniques become available.

WCA Kaluaa and Waieli-09: Lower Gulch Gate

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 50% native cover

Targets: *T. ciliata* in the canopy and a variety of understory weeds including *Blechnum appendiculatum* and *Oplismenus hirtellus*.

Notes: This WCA will be the focal site for outreach activities. There are former project stewardship sites located within this WCA. The terrain is conducive to volunteer project weed control. In addition, there is a unique grove of *Pittosporum glabrum, Morinda trimera* and *Psychotria mariniana* within this WCA.

The outreach program will target *T. ciliata* in the upper portions of this WCA to minimize spread into WCA-08. Volunteers will also be used to address the expanding cover of *B. appendiculatum*. Common native reintroductions will be used where necessary to support restoration activities.

Along the ridge crest leading up the catchment ridge, a fairly intact canopy and seed bank of koa remains. This taxon will be used in restoration efforts to replace alien vegetation. A strategy of peeling back the alien vegetation beginning at the koa dominated ridge crest first and moving down slope as koa saplings come up could be employed in restoring this WCA.

WCA Kaluaa and Waieli-10: South Central/Catchment Ridge

Veg Type: Mesic Mixed Ridge

MIP Goal: Less than 25% non-native cover

Targets: *Psidium cattleianum, Clidemia hirta, Passiflora suberosa, Grevillea robusta, Schinus terebinthifolius*

Notes: Target all canopy weeds along catchment ridge to maintain native dominated matrix with care to avoid damaging uluhe understory. Maintain weed free area along south fenceline ridge with particular attention to the *Stenogyne kanehoana* reintroduction. *Achatinella mustelina* are present in low numbers at the back of South Central gulch. Elepaio pairs possibly still present as well. There are some pockets of nice pisonia forest and possible *Drosophila* habitat in *Urera glabra*. It would be beneficial to sweep this WCA for target weeds in the upper elevation area. There also is a wild *P. hirsuta* location in this WCA.

WCA KaluaaNoMU-01: Kaluaa Access Road

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Panicum maximum*

Notes: Alien dominated habitat consisting primarily of forestry plantings with very few native remnants. Control grass/herbaceous weeds, clear downed trees along the Kaluaa access road, from the top of the pineapple fields to the trailhead every 6 months/as needed. Use the power sprayer, chainsaw, weedwhack. End goal is to maintain road as drivable.

WCA KaluaaNoMU-02: CryMan

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Buddelia asiatica, Rubus rosifolius, Toona ciliata*

Notes: Weed control at this site has been conducted in conjunction with OPEP management for *Cryptocarya manii*. No regular weed control trips are planned for this WCA, and any weed control will be conducted during rare plant monitoring trips. Visits are primarily conducted to collect from *Alectryon macrococcus* in the area.

WCA KaluaaNoMU-03: Ti Leaf Flats

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Clidemia hirta, Schinus terebinthifolius, Schefflera actinophylla*

Notes: This WCA includes the exclosure located along the access trail before the contour trail junction within which TNC planted numerous endangered plants. The goal of weed control within this WCA is to ensure continued survival of *Abutilon sandwicensis, and Delissea waianaeensis* reintroductions from which genetic collections are secured. The habitat is alien dominated and most of the native plants within the exclosure were outplanted.

WCA KaluaaNoMU-04: Access Trail

Veg Type: Mesic Mixed Forest

MIP Goal: None

Targets: *Dicliptera chinensis, Setaria palmifolia*

Notes: The trail corridor is managed to minimize the movement of weeds into the MU. Only species of concern that are not well established within the MU will be targeted. In addition, the trail will be kept clear of grass, *D. chinensis*, and fallen trees.

WCA KaluaaNoMU-05: GarMan

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *Clidemia hirta, Psidium cattleianum*

Notes: Weed control will be conducted around the endangered *G. mannii* at this site, in conjunction with rare plant monitoring trips. This *G. mannii* is designated for Genetic Storage Collection, rather than management, hence limited effort will be spent here. Understory weeds and some canopy weeds will be targeted directly around the rare plant to encourage its continued health.

WCA SBSNoMU-02: (Ie ie Patch)

Veg Type: Mesic Mixed Forest

MIP Goal: Less than 25% non-native cover

Targets: *B. asiatica, P. cattleianum, S. terebinthifolius, C. dentata, C. parasitica*

Notes: A small fence protects a patch of *Freycinetium arborescens*, outplanted *Urera glabra*, and *U. kaalae* and a small patch of native forest. *A. mustelina, Amastra micans*, and *L. sanguinea* are known historically from this location, but are not extant. This site is not in an MU, and is not a priority for management. Some weed control may be conducted here in conjunction with other rare taxa monitoring activities. Access to the site is limited, as it lies behind a live fire training range and the area is frequently closed to OANRP.

1.2.1.4 Rodent Control

Species: *Rattus rattus* (black rat, roof rat), *Rattus exulans* (polynesian rat, kiore)

Threat level: High

Control level: Bait station & snap trap grids (localized control)

Seasonality: Year-round

Number of sites: *Achatinella mustelina* site at Puu Hapapa (Hapapa bench and SBS side), 2 bait grids (12 bait stations, 24 snap traps)

Acceptable Level of Activity: Not tolerated within proposed *A. mustelina* snail enclosure, need to determine appropriate rat activity level outside snail exclosure.

Primary Objective: To maintain rat/mouse populations to a level that facilitates stabilized or increasing plant and snail populations across the MU by the most effective means possible.

Management Objective:

- Keep sensitive snail populations safe from rat predation via construction of a predator proof fence (*A. mustelina* enclosure).
- Maintain predator fence to ensure no breaches occur.
- Maintain rat grid every six weeks and reevaluate/reconfigure as necessary following completing of the predator fence.
- Ensure MIP/OIP rare plant resources within the MU are not impacted by rodents.

Monitoring Objectives:

- Monitor ground shell plots for predation of *A. mustelina* by rats.
- Annual or every other year census monitoring of *A. mustelina* populations to determine population trend.
- A snap grid will be set up inside the exclosure. Staff will set up approximately a dozen snap traps within the exclosure along with a dozen tracking tunnels. Consider placing snaps higher in the trees as well as on ground. Chew tabs may also be used to determine presence or absence of rats. The snap traps will be re-baited weekly until no sign is observed on the tunnels and no rats snapped for 3 weeks. Tunnels and chew tabs will be left in place and re-monitored prior to reintroduction of snails.
- After rats have not been found for 21 days, proceed with quarterly sweeps.
- Quarterly searches for evidence of rats within Puu Hapapa enclosure
- Monitor rare plant resources to help guide localized rodent control.
- Presoak tunnels or use old tunnels from elsewhere to remove odors to aid detection. Inside/outside exclosure comparison.

Localized Rodent Control:

- Rats have been known to eat *Plantago* at Ekahanui and Palawai. At other sites, rodent damage has been observed on *C. grimesiana* and *D. waianaensis*. Possibly could impact juvenile *Urera* spp although no predation has been observed. No damage has been observed at Kaluaa sites thus far. Will respond if predation observed in order to facilitate fruit collections. Control rats to maintain *Achatinella* host trees and prevent *Achatinella* predation.
- Bait station and snap trap grids are deployed around *A. mustelina, D. montgomeryi* and *P. princeps* populations and are restocked twice a quarter. Grids are centered around and extend slightly beyond the boundaries of the populations being protected. Monitoring of rat activity via tracking tunnels will be vital in determining whether control is having the desired effect, as will intensive monitoring of the rare snail and plant populations.

Exclosure Maintenance:

- Inspect every 6 weeks and after major wind events.
- Maintain Intellesense automatic notification system of exclosure breaches
- Ideally inspect upon each visit to see if the mesh is compromised along the leading edge, re-bury the edge if need be with dirt and debris.
- Inspect for premature rust/weathering of material such that it would fail.
- Inspect hood, seams, to ensure that rats, Jackson chameleons cannot enter.
- Inspect outlying trees to ensure that rats cannot jump in, trim trees well before that risk presents itself.
- *Euglandina* barriers will require close inspection to ensure continued efficacy.
- Inspect entry system (ladders need to be secure to ensure safety moving in and out of exclosure).
- Devise method to prevent vandalism/snail collection by securing ladders left on the outside.
- Install signs to prevent people from trying to climb walls (Outreach).
- Trails within the exclosure needed to establish designated walking paths as more vegetation is planted and more natural recruitment observed.
- Weeding needed on a continual basis to ensure adequate habitat for *A. mustelina*. This will likely include removing mamaki over time after shade is established to provide a better host species for *A. mustelina.*

1.2.1.5 Predatory Snail Control

Species: Euglandina rosea

Threat level: High

Control level: Localized (Puu Hapapa)

Seasonality: Peak numbers recorded March through June

Number of sites: *Achatinella mustelina* site at Puu Hapapa

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

Primary Objective: Eliminate predatory snails within enclosure and reduce numbers outside enclosure to promote A. mustelina survival.

Management Objective:

- Keep sensitive snail populations safe from predatory snails via construction of a predator proof fence (*A. mustelina* enclosure).
- Maintain enclosure to ensure no breeches occur.

- Reduce *E. rosea* outside the enclosure to reduce risk of incursion.

Monitoring Objectives:

- Annual or every other year census monitoring of *A. mustelina* populations to determine population trend (for more information please refer to the *A. mustelina*
- Weekly searches for predatory snails within *A. mustelina* enclosure immediately following construction. Include searching for *E. rosea* in trees where feasible. After snails have not been found for 40 days (length of time for eggs to hatch) proceed with quarterly sweeps. If snails or egg caches are found during a quarterly sweep, frequency should be increased to once a week until area has been clear of snails for at least 40 days.
- Quarterly searches for predatory snails within *A. mustelina* enclosure. If *E. rosea* detected commence with weekly searches as described above.
- Quarterly searches and removal of predatory snails within 50 m radius of the *A. mustelina* enclosure.

Oxychilus alliarus is an introduced omnivorous snail which threatens native treesnails. It has not been found at Puu Hapapa. It is imperative that proper sanitation methods are in effect so that they are not inadvertently introduced via predator proof fencing materials. This requires materials to be cleaned with a high pressure hose so that all debris is removed prior to transport to the site, in much the same way as greenhouse benches and pots are treated to remove snails. Although *O. alliarus* has not been found at either West or East Base (where materials are usually stored prior to transport onsite) a number of other alien snails are established at these locations including *Gonaxis kibweziensis;* a predatory snail. Care needs to be taken not in inadvertently transport any alien snails to the site.

1.2.1.6 Slug Control

Species: Deroceras leave, Limax maximus, Meghimatium striatum

Threat level: High

Control level: Localized

Seasonality: Wet season

Number of sites: Urera kaalae, Delissea waianaensis, Cyanea grimesiana ssp. obatae, Plantago princeps var. princeps, Phyllostegia mollis, P. hirsuta and Schiedea kaalae.

Acceptable Level of Activity: Slugs to be kept suppressed in proximity to rare plants.

Primary Objective: Reduce the threat of slugs to the germination and survivorship of rare plant taxa as well as those used by Drosophila mongomeryii as host plants.

Management Objective:

- Control slugs at sensitive plant populations via bi-weekly Sluggo® application during the wet season.

Monitoring Objectives:

Determine whether sites are appropriate for Sluggo® application. This requires an experienced malacologist to spend at least one day and one night at the site. If no rare species present, proceed with slug control.

- Annual monitoring of rare plant seedling recruitment (*Urera kaalae, Delissea waianaensis, Cyanea grimesiana* ssp. *obatae, Plantago princeps* var. *princeps, Phyllostegia mollis, P. hirsuta*

and *Schiedea kaalae*) with particular focus on detecting evidence of slug feeding (slime trails, leaf edges consumed, lower leaves consumed). If no slug feeding observed, then Sluggo® applications may be reduced or halted.
- Annual monitoring of slug densities during wet season using beer traps. If numbers are low, then Sluggo® application may be reduced or halted.

1.2.1.7 Ant Control

Species: *Anoplolepis gracilipes, Cardiocondyla wroughtoni,Pheidole megacephala, Plagiolepis alluaudi, Solenopsis papuana* and *Technomyrmex albipes*

Threat level: Unknown

Control level: Localized

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

Number of sites: Ants will be surveyed at four sites. These include two *Drosophila montgomeryi* sites (Kaluaa gulch and Puu Hapapa) and four human entry points: parking area at end of 4 wheel-drive road, at the entrance to Honouliuli preserve (gate along the fenceline), at the Puu Hapapa shelter and at the old TNC field nursery.

Acceptable Level of Ant Activity: Unknown

Primary Objective: Identify control methods for ants without adverse impacts to *D. montgomeryi*.

Management Objective: Investigate various toxicants and delivery systems for the purpose of ant control while preventing *D. montgomeryi* exposure.

Monitoring Objective:

- Continue to sample ants at human entry points using the standard survey protocol (Plentovich and Krushelnycky 2009) and *D. montgomeryi* sites a minimum of once a year. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.
- Track changes in *D. montgomeryi* numbers and see if these respond positively to decreased ant activity.
- Look for evidence of scale tending by ants on rare plants.
- Detect incursions of new ant species prior to establishment.

Ants have been documented to pose threats to a variety of resources, including native arthropods, plants (via farming of Hemipterian pests), and birds. In particular, they are believed to prey upon juvenile *Drosophila.* It is therefore important to know their distribution and density in areas with conservation value. This was accomplished in Kaluaa for the last two years using a survey methodology developed by Plentovich and Krushelnycky (2009). Among the species detected which are among the most aggressive are *Pheidole megacephala* and *Anoplolepis gracilipes*. Species present are widely established and control is not recommended at this time unless damage due to ants is confirmed and a safe control method is identified.

1.2.1.8 Black Twig Borer (BTB) Control

Species: *Xylosandrus compactus* (BTB)

Threat level: High

Control level: Localized

Seasonality: Population builds through the spring (March-May) with flight occurring between June and August.

Number of sites: *Alectryon macrococcus* var. *macrococcus* populations KAL-A,B,C, ELI-A,B and Reintro KAL-E

Acceptable Level of Activity: Unknown

Primary Objective: Reduce air layer failure due to BTB damage and promote health of *Alectryon macrococcus* var. *macrococcus* by depressing BTB populations.

Management Objective:

- Deploy BTB traps equipped with High Release Ethanol bait (Alpha Scents, Portland, OR) and Vaportape™ (Hercon Environmental, Aberdeen, PA) insecticidal strips if damage is observed. Service traps every three weeks until *A. micrococcus* air layers are established.
- Test efficacy of experimental repellents.

Monitoring Objective: Check *A. macrococcus* air layers for BTB damage.

OANRP has conducted extensive testing on the efficacy of trap deployment to reduce BTB damage (Joe 2009). Results have been mixed. Trees with traps sustained (on average) 25% less damage than those without, however, this difference was not statistically significant. As traps need maintenance every two to three weeks to be effective, the labor investment is considerable. Despite these drawbacks, trapping is the only option for managing BTB in a forest setting. Traps may be used, if needed, to protect air layers during establishment. There are no plans currently to install traps at wild *Alectryon macrococcus* var. *macrococcus* sites. OANRP is planning to test an experimental beetle repellent Verbenone® (ConTech Inc. Grand Rapids, MI). If proven effective, we will work with the manufacturer to get it registered for use in the State.

1.2.1.9 Vespula Control

Species: *Vespula pennsylvanica*

Threat level: Likely high

Control level: Localized

Seasonality: Year-Round

Number of sites: Two: *Drosophila montgomeryi* sites (Kaluaa gulch and Puu Hapapa)

Acceptable Level of Activity: Unknown

Primary Objective: Determine whether *V. pennsylvanica* populations come into contact with *D. montgomeryi*. If found, eradicate *V. pennsylvanica* from local area.

Management Objective:

- Locate nests by following workers. Destroy nests mechanically (by bagging nests and leaving in the sun, for example) if possible, as pesticides may impact *D. montgomeryi.*
- Cooperate with Big Island researchers in getting fipronil bait registered.

Monitoring Objective:

- Deploy traps baited with heptyl butyrate to monitor *V. pennsylvanica* presence. Reset and check traps quarterly. Leave baited traps in place for two weeks then collect and record catch.
- Determine whether *D. montgomeryi* populations respond favorably to lower numbers of wasps.

Vespula pennsylvanica is an important insect predator and flies have been recorded in its diet on the Big Island and Maui. It is likely a major predator of *D. montgomeryi* and should be monitored. No poison baits are currently approved for use in suppressing wasp numbers, however, USGS researchers at Hawaii Volcanoes National Park hope to get a finpronil bait registered. NRS will cooperate in this effort. Until better control methods are available, staff will monitor wasp numbers quarterly using traps. If populations increase substantially over time coinciding with a plunge in *D. montgomeryi* numbers NRS will locate and destroy nests.

Nests have been destroyed along and below the contour trail by State of Hawaii Dept. of Agriculture staff in 2001 at the request of TNC.

1.2.1.10 Jackson's Chameleon Control

Species: *Chamaeleo jacksonii* ssp. *Xantholophus* (Jackson's chameleon)

Threat level: High

Control level: Localized (Puu Hapapa)

Seasonality: Year-Round

Number of sites: One: *Achatinella mustelina* site at Puu Hapapa

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

Primary Objective: Reduce chameleons in proximity to snails to reduce predation risk. Eradicate within enclosure.

Management Objective:

- Keep sensitive snail populations safe from chameleons via construction of a predator proof fence (*A. mustelina* enclosure).
- Maintain enclosure to ensure no breaches from chameleons.
- Quarterly night-time sweeps of above and below the Puu Hapapa bench to capture and remove Jackson's chameleon as well as within and around the enclosure.

Monitoring Objectives:

- Annual or every other year census monitoring of *A. mustelina* populations to determine population trend.
- GPS locations of captured chameleons to track changes in their distribution and proximity to native snails. Follow numbers of captured animals over time to estimate density.
- Facilitate research by B. Holland (PhD) and Chiaverano (PhD) (UH Center for Conservation Research & Training University of Hawaii) to estimate chameleon population size, optimal foraging strategy, locality and range size on Oahu.

Chameleons are known to consume *Achatinella* where their ranges overlap. A single chameleon was *Achatinella* enclosure. Staff will continue to sweep the area for chameleons to ensure they do not threaten snails.

1.2.1.11 Fire Control

There is no recent history of fires burning near the Kaluaa and Waieli MU. The last significant fire was in 1996 in the Mauna Una area south of the MU near the old microwave reflection screen. The area is somewhat protected by weedy tree species. Forestry plantings of *Eucalyptus robusta* adjacent to the MU fence are susceptibility points. Ignition sources could be from military training although direction of fire

from South range is to the north, away from the Kaluaa and Waieli MU. There is currently limited public access to this unit and therefore the threat of arson is low, although campfires remain a constant threat and fire pits are observed on an irregular basis (e.g. Hapapa LZ, Contour trail, Kaluaa trailhead). This MU is easy to monitor from both OANRP baseyards and it is within close proximity to the Army Wildland Fire Baseyard. Now that Honouliuli is State land, DLNR, DOFAW staff could respond in the event of a fire within the MU.

Emergency landing zones were previously cleared and maintained by TNC on Mauna Una and the Hapapa Access Ridge but have since become overgrown. These could be cleared again as needed should fires break out in the MU.

1.2.2 Koloa

Ecosystem Restoration Management Unit Plan

OIP Year 5-9, Oct. 2011 – Sept. 2016

MU Koloa

Overall OIP Management Unit Goals:

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

1.2.2.1 Background Information

Location: Summit of Northern Koolau Mountains

Land Owner: Hawaii Reserves Inc.

Land Managers: OANRP

Acreage: 164 acres

Elevation Range: 1950 ft - 2400 ft

Description: The Koloa MU is bordered by the Koolau Summit Trail to the south, Kaipapau to the east, and Wailele to the west. The land to the north (makai) lies within the same Koloa gulch, but is separated by a series of waterfalls. The Koloa MU is a wet forest dominated by native vegetation. Perhaps due to its relatively flat topography, lacking the extremely steep walls and deep valleys like that of Kaipapau, the Koloa MU has a large number of IP taxa, including in situ populations of *Chamaesyce rockii, Cyanea koolauensis,* and *Viola oahuensis.* The Koloa MU can be accessed via the Kawailoa and Laie trails, however due the length of these trails, OANRP uses helicopters to access the MU to do management.

Native Vegetation Types

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

Wet Forest Vegetation types and views of Koloa

From Northern LZ looking NW towards Laie.

From the northern fenceline looking east

From the NW corner looking SE.

OIP Rare Resources

Organism Type	Species	Pop. Ref. Code	Population Units	Management Designation	Wild/ Reintroduction
Plant	*Chamaesyce rockii*	KOL-A,B, D,E,G,H,J,L	Kaipapau, Kawainui to Koloa and Kaipapau, and Kawainui	MFS/T2	Wild
Plant	*Cyanea acuminata**	KOL-L	None	MFS/T1	Wild
Plant	*Cyanea koolauensis*	KOL-B,C,D, E,H,L,N	Kaipapau, Koloa, and Kawainui	MFS/T1	Wild
Plant	*Cyrtandra viridiflora*	KOL-B,C,H,K	Kawainui and Koloa	MFS/T2	Wild
Plant	*Hesperomania arborescens*	KOL-A,D	Kamananui to Kaluanui	MFS/T1	Wild
Plant	*Huperzia nutans*	KOL-B	Koloa and Kaipapau	MFS/T1	Wild
Plant	*Myrsine judii*	KOL-B	Kaukonahua toKamananui-Koloa	MFS/T2	Wild
Plant	*Phyllostegia hirsuta*	KOL-A	Koloa	MFS/T1	Wild
Plant	*Viola oahuensis*	KOL-A,B,C, D,	Koloa	MFS/T2	Wild
Snail	*Achatinella livida*	KLO-B	Northern GU B	MFS/T2	Wild

MFS = Manage for Stability *= Population Dead T1 = Tier
MRS = Manage Reintroduction for Genetic Storage GU = Geographic Unit T2 = Tier 2

Other Rare Taxa at Koloa MU

Organism Type	**Species**	**Status**
Plant	*Cyanea humboldtiana*	Endangered
Plant	*Joinvillea ascendens ssp. ascendens*	Candidate
Plant	*Lobelia gaudichaudii ssp.gaudichaudii*	Species of Concern
Plant	*Cyanea calycina*	Species of Concern
Plant	*Cyanea lancelota*	Candidate
Plant	*Myrsine fosbergii*	Candidate
Plant	*Zanthoxylum oahuenses*	Endangered

Locations of rare resources at Koloa

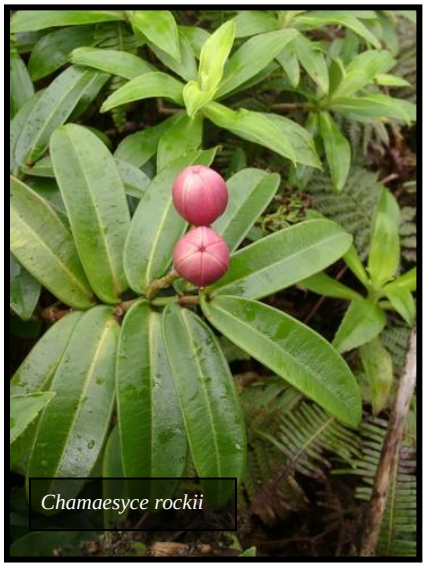
Rare Resources at Koloa


Viola oahuensis


Cyanea koolauensis


Zanthoxylum oahuense


Huperzia nutans


Chamaesyce rockii


Achatinella livida

MU Threats to OIP MFS Taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes, MU will be fenced
Euglandina rosea	*Achatinella livida*	Unknown	Unknown	Limited to hand removal and physical barriers
Oxychilus alliarus	*Achatinella livida*	Unknown	Unknown	Limited to hand removal and physical barriers
Slugs	*Chamaesyce rockii, Cyrtandra viridiflora, Cyanea acuminata, Hesperomania arborescens, Myrsine judii , Phyllostegia hirsuta, Viola oahuensis, C. koolauensis, C. humboldtiana* and *Lobelia gaudichaudii* ssp.*gaudichaudii*	Yes	No	Yes, Sluggo is available for local control if area has been surveyed by an experienced malacologist to determine whether rare snails are present
Ants	Unknown	Unknown	Unknown	Some available, depends on species
Weeds	All	No	Yes	Yes
Fire	None	N/A	N/A	Yes
Rats	All	Yes	No	Currently being developed

Management History

- 1993: HIHNP conducts rare resource surveys along Koolau Summit Trail through Koloa
- 1997: First OANRP record of an endangered plant in Koloa.
- 1998: First OANRP record of *A. livida.*
- 1998: Incipient weed taxa *Hedychium coronarium* and *H. gardnerianum* control begins.
- 2002: Predator control around *A. livida* begins.
- 2005: Last sighting of *H. coronarium* and *H. gardnerianum* in Koloa.
- 2009: MU Fenceline scoped. MU fence construction begins.
- Sept. 2011: MU fence construction begins and WCA boundaries are drawn. Container cabin flown to Puu Kainapuaa to serve as fence contractor campsite. When the eastern fenceline is completed, the container cabin will be flown to the site of the old Kahuku Cabin, and will be used to facilitate staff work trips.

1.2.2.2 Ungulate Control

Identified Ungulate Threats: Pigs

Threat Level: High

Primary Objective:

- Maintain MU as ungulate free.

Strategy:

- Maintain the fenced area as ungulate-free by maintaining fence and using transects to monitor for sign.

Monitoring Objectives:

- Conduct quarterly fence checks and fences across streams after storms.
- Note any pig sign while conducting day to day actions within fenced MU.

Management Responses:

- If any pig activity is detected in the fence area, implement snaring program. (Snares still remain within the MU, but not set. If ungulate sign is detected they will be reset.)

Fence Completions:

- Fence construction started September 2011 and is scheduled to be completed before the end of the calendar year or beginning of 2012.

Maintenance Issues:

The MU fence is 4.5 kilometers long and encompasses 164 acres. The major threats to the perimeter fence include fallen trees, vandalism, stream crossings, and flooding. Waterfalls in Koloa provide excellent natural barriers against ungulates and strategic areas for the fence to tie into to avoid the need to cross streams and create fence sections that are vulnerable to extreme weather events such as flooding. Special emphasis will be placed on checking the fence after extreme weather events. Monitoring for ungulate sign will occur during the course of other field activities. The fence will be kept clear of vegetation (especially grasses) to facilitate quarterly monitoring. This weed control is discussed in the Weed Control section.

Ungulate Management Locations at Koloa

1.2.2.3 Weed Control

Weed Control actions are divided into 4 subcategories:

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

These designations facilitate different aspects of MIP/OIP requirements.

Vegetation Monitoring

Vegetation monitoring protocols used in other MUs may not be feasible in Koloa MU. Due to the relatively intact condition of the Northern Koolau summit region, current monitoring practices would increase traffic through the MU and may negatively impact the area by introducing weedy species normally found in the fence corridors and trails. Possible alternatives to transect monitoring may be

aerial monitoring surveys, remote vegetation mapping, or a combination of both. Utilizing new technologies and methodologies to develop vegetation monitoring protocols is a priority for this MU.

Objectives:

- Develop vegetation monitoring protocol for Koloa MU.
- Conduct vegetation monitoring for Koloa MU every three years.
- Produce vegetation map every three years for comparative analysis of weeding efforts.

Surveys

Army Training: No. The Army conducts helicopter training in Kawailoa, immediately south and West of Koloa. Also, soliders may hike the summit trail, although this is uncommon.

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

Survey Locations: landing zones, summit trail, camp sites, high traffic areas (fencelines and cabin).

Management Objective:

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

Monitoring Objectives:

- Quarterly surveys of LZs (if used, LZ Norton once annually).
- Quarterly survey of Kahuku Cabin campsite (if used).
- Annual survey of the Koolau Summit Trail/fenceline.
- Note unusual, significant or incipient alien taxa during the course of regular field work.

Management Responses:

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

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Koloa currently remains unaffected by highly invasive weed species that infect surrounding areas, such as *Angiopteris evecta* in Kaipapau to the east, and *Falcataria moluccana* and *Leptospermum scoparium* in Wailele, Kaiwikoele, and Kawainui. OANRP currently control *F. moluccana* and *L. scoparium* in the surrounding areas to prevent their spread west into the Koloa MU.

Incipient Taxa Control (ICAs)

Management Objectives:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2014.
- Conduct seed dormancy trials for all high priority incipients by 2014.
- Identify potential paths of contamination and develop strategies to decontaminate gear when working in densely infested incipient areas.

Monitoring Objectives:

- Visit ICAs at stated revisitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.

Management Responses:

- If unsuccessful in preventing immature plants from maturing, increase ICA revisitation interval.

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

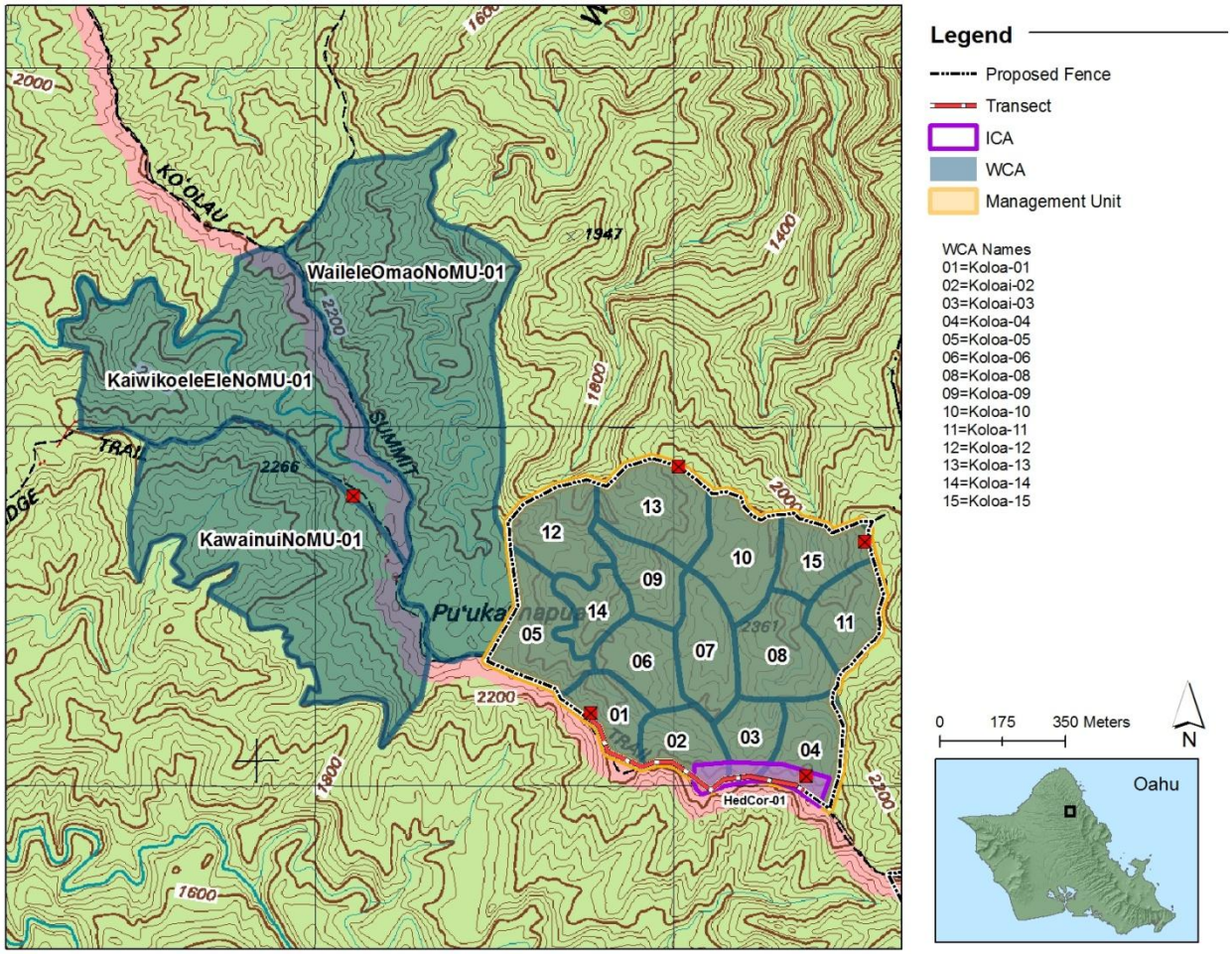
The table below summarizes invasive taxa at Koloa. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication in an MU. ICAs are not designated for every species in the table below; however, occurrences of all species in the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

Summary of Target Taxa

Taxa	Management Designation	Notes	No. of ICAs
Andropogon virginicus	Control locally	*A.virginicus* tends to show up along trails and cliffs. Target to keep off cliffs as difficult to control in steep areas.	0
Angiopteris evecta	Control locally	Incidental observations of *A. evecta* around the MU have been made. Plants seen should be GPSed and removed manually on discovery. The adjacent Kaipapa'u MU is infested with this taxa, which feeds spores into Koloa. Control is a high priority. Control any plants found during regular weed sweeps. Also control plants seen outside the MU, if near the fence.	0
Clidemia hirta	Widespread	*C. hirta* is a well established part of the Koolau vegetation type. OANRP do not currently target it for control, except in the vicinity of rare taxa	0
Erigeron karvinskianus	Control locally	Status of this species in the MU is unknown. Note locations of *E. karvinskianus* during regular control work. Evaluate whether species should be a target once have additional distribution information. This taxa is a threat to open cliff communities.	0
Falcataria moluccana	Control locally	Not known in Koloa at this time, but known from adjacent area in Kawainui. Target for control during regular weed sweeps.	0
Hedychium coronarium	Incipient	There is one site of this taxa in Koloa along the Summit trail. . No plants have been found for 5 years. The ICA will be checked annually, until staff determine that there is no seed bank present.	1
Leptospermum scoparium	Control locally	Not known in Koloa at this time, however control at surrounding areas Wailele, Kaiwikoele, and Kawainui, is ongoing to prevent the spread of *L. scoparium* into Koloa.	0
Melaleuca quinquenervia	Control locally	A few trees were treated in adjacent Wailele gulch by KMWP in 2010. If seen in the MU, this taxa will be targeted during regular weed sweeps.	0

Pterolepis glomerata	Widespread	This Melastome is ubiquitous across the Koolaus. It thrives in disturbed areas, particularly pig wallows. NRS do not currently target it for control.	0
Psidium cattleianum	Widespread	Patches scattered across Koloa. Primary target of WCA sweeps. The largest and thickest stands tend to be in gulches and draws. In areas with difficult terrain, staff will investigate alternative control techniques, such as Herbicide Ballistic Technology and aerial ball spraying.	0
Setaria palmifolia	Not present	None known from MU. If any *S. palmifolia* is found, it will be evaluated for control as an ICA	0
Sphaeropteris cooperii	Control locally	No plants known in MU, but individuals known from scattered locations across the Koolaus. *S. cooperi* will be targeted during regular weed sweeps.	0

Incipient and Weed Control Areas



Ecosystem Management Weed Control (WCAs)

OIP Goals:

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

Management Objectives:

- Maintain 50% or less alien vegetation cover in the understory across the MU.
- Reach 50% or less alien canopy cover across the MU in the next 5 years.
- In WCAs within 50m of rare taxa, work towards achieving 25% or less alien vegetation cover in understory and canopy.

Management Responses:

- Increase/expand weeding efforts if MU vegetation monitoring (conducted periodically, interval and technique to be determined) indicates that goals are not being met.

Koloa is dominated by native taxa, and may already meet the goal of 50% or less cover of alien vegetation across the MU. The major weed threat in the MU is *P. cattleianum*, which has the potential to form dense monotypic stands, and is a dominant presence in other areas of the Koolau Mountains. Weed control in Koloa will focus on conducting ground sweeps across all walkable portions of the MU, targeting *P. cattleianum* and other weeds (listed in the Summary Target Taxa table above). The entire MU has been divided into Weed Control Areas (WCAs) to assist in tracking and scheduling control efforts. WCAs will be weeded on a rotational basis given the difficulty of access, terrain, and limited staff resources. Staff will use aerial and ground surveys to guide control efforts

The WCAs that are most accessible, have the gentlest terrain, the most rare resources, and the fewest weeds will be prioritized for control.

In general, weed sweeps involve all staff lining up and walking in a phalanx across a WCA, treating every target weed seen. In the dense and often steep terrain of the Koolaus, this method is modified, with some staff acting as 'spotters' from ridges and other vantage points, directing other staff to the target weeds. Binoculars are critical for this spot-and-treat method. The goal of a sweep is to survey and achieve complete coverage of a WCA.

WCA: Koloa-01

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: Weed sweeps can be performed in this WCA from the Summit Trail north and down to the river. However the North side of the stream is too steep to do sweeps. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment (as described above).

WCA: Koloa-02

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is the most fragile in the MU, and contains large populations of *V. oahuensis, C. rockii, C. humboltiana, C. calycina,* and the *H. nutans,* among others. To minimize the impact to the area, sweeps will be done via Spot-and-treat method with extreme care taken to minimize disturbing native habitat.

WCA: Koloa-03

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is home to a large population of *C. rockii,* and consists of many small ridges and gulches. Weed sweeps can be performed across the entire WCA.

WCA: Koloa-04

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA surrounds the camp site, borders the Kaipapau MU, and consists of more Endangered species than any other WCA. Plants found in this WCA include *C. calycina, C. koolauensis, C. viridiflora, H.arbuscula sp., L. gaudichaudii* ssp. *gaudichaudii, V. oahuensis, Z. oahuenses*, and a large population of *C. rockii*. Half of this WCA is relatively open and weed sweeps in this area can be completed quickly with no damage to the Endangered taxa. In the other half, to minimize the impact to the area, weed sweeps will be done via Spot-and-treat method.

WCA: Koloa-05

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is the most southwest in the MU and consists of many small gulches and ridges. Weed sweeps can be performed in this entire WCA from the Summit Trail to the north, and from the west fence line to the East boundary, which is the river.

WCA: Koloa-06

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: Part of this WCA consists of extremely degraded pasture like habitat which makes weed sweeps quick. This WCA would benefit greatly from common plant reintroductions. The area likely will benefit from being pig-free, and native vegetation may recover on its own, otherwise sweeps for *P. cattleianum* and tree weed will be conducted. Photopoints should be installed to document any potential recovery.

WCA: Koloa-07

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: Part of this WCA consists of extremely degraded pasture like habitat which makes weed sweeps quick. This WCA would benefit greatly from common plant reintroductions. The area likely will benefit from being pig-free, and native vegetation may recover on its own, otherwise sweeps for *P. cattleianum* and tree weed will be conducted. Photopoints should be installed to document any potential recovery.

WCA: Koloa-08

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: To minimize impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment.

WCA: Koloa-09

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is steep. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method, and may be a candidate for remote/aerial control techniques.

WCA: Koloa-10

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA for the most part is relatively flat; full weed sweeps can be used.

WCA: Koloa-11

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: To minimize the impact to the rare plants in this area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment. This WCA borders the Kaipapau MU.

WCA: Koloa-12

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is the most northwest and is very steep. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment. Area has not been well surveyed yet.

WCA: Koloa-13

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is very steep. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment. Area has not been well surveyed yet.

WCA: Koloa-14

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: The West boundary of this MU is the river at the bottom of the west gulch. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment. Area has not been well surveyed yet.

WCA: Koloa-15

Veg Type: Wet Montane

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

Target: *P. cattleianum*, tree weeds

Notes: This WCA is the most North East and is very steep. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment. Area has not been well surveyed yet.

WCA: KawainuiNoMU-

Veg Type: Wet Montane

OIP Goal: None (not in MU)

Target: *L. scoparium, A. evecta*

Notes: This WCA is steep and comprised of many small ridges and gulches. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment.

WCA: KaiwikoeleEleNoMU-01

Veg Type: Wet Montane

OIP Goal: None (not in MU)

Target: *L. scoparium, A. evecta*

Notes: This WCA once held a large population of *L. scoparium* but has since been swept a few times. Remnant seedlings and immature plants continue to sprout and will require additional visits to maintain the low numbers left in this area. This WCA is relatively easy to work in as it is generally flat and not as heavily vegetated as the surrounding areas.

WCA: WaileleOmaoNoMU-01

Veg Type: Wet Montane

OIP Goal: None (not in MU)

Target: *L. scoparium, A. evecta*

Notes: This WCA has been swept in the past, but continues to produce *L. scoparium* plants. This WCA has extremely steep walls as well as has a relatively flat gulch bottom with a stream running through the center. To minimize the impact to the area, and for safety concerns of our staff, sweeps will be done via Spot-and-treat method: spotting from open ridges with binoculars and directing other staff to the plants for treatment

1.2.2.4 Rodent Control

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

Threat level: High

Current control method: Bait station & snap trap grids (localized control)

Seasonality: Year-round.

Number of control grids: 1

Acceptable Level of Activity: No MU-wide control program planned currently. Acceptable level of activity at localized sites is unknown.

Available tools: Rodenticide /Bait Stations, Aerial Broadcast, Hand Broadcast, Snap Traps, Tracking Tunnels, Chew Tabs

Primary Objective:

- To maintain rat/mouse populations to a level that facilitates stabilized or increasing snail and plant populations across the MU by the most effective means possible.

Management Objective:

- Continue to maintain bait station and snap trap grids (localized control) around individual *A. livida* populations in the short term. Try to implement self-resetting snaps for local control.
- Implement rodent control if determined necessary for protection of plant populations. Monitor susceptible species for evidence of rodent impacts.

Monitoring Objectives:

- Trap data and tunnels will be used to guide efforts to control rats.

Rodent Control:

- OANRP currently controls rodents around the *A. livida* population twice a quarter. Also, tracking tunnels are placed along the summit trail throughout the MU and are currently checked once a quarter to determine how effective a small bait grid around the population is. If new snail populations are found in the MU, we will evaluate the need for rat control and install additional grids if needed.

1.2.2.5 Slug Control

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

Threat level: High

Current control method: Localized

Seasonality: Wet season (September-May)

Number of species: *Cyrtandra viridiflora, Cyanea acuminata, Phyllostegia hirsuta, Viola oahuensis, C. koolauensis*

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

Primary Objective:

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

Monitoring Objective:

- Determine slug species present and estimate baseline densities using traps baited with beer.
- Determine monitoring methods for *C. humboldtiana* and *Lobelia gaudichaudii* ssp.*gaudichaudii*
- If Sluggo is deployed, monitor efficacy via beer traps.
- Annual census monitoring of slug densities during wet season.

Management Objectives:

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

1.2.2.6 Predatory Snail Control

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

Threat level: High

Control level: Unknown (need to do surveys)

Seasonality: Year-round

Number of sites: 1(*Achatinella livida*), but no control currently underway.

Acceptable Level of Activity: No activity tolerated in proximity to *A. livida*

Primary Objectives:

- Eradicate predatory snail populations to a level optimal for *A. livida* survival.
- Scope jail locations for *A. livida*

Monitoring Objective:

- Annual or every other year census monitoring of *A. livida* population(s) to determine population trend.
- Annual searches for predatory snails to confirm absence/presence in proximity to *A. livida.*

Management Objective:

- Continue to develop better methods to control predatory snails.
- Keep sensitive snail populations safe from predatory snails via currently accepted methods (such as hand removal of alien snails, construction of barriers which prevent incursion from alien snails).

1.2.2.7 Ant Control

Species: Unknown

Threat level: Unknown

Control level: Only for new incipient species

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

Number of sites: No ants have been observed at Koloa. Suggested sites to survey in the future are the Koloa cabin, and the Northern LZ which is adjacent to the *A. livida* population.

Acceptable Level of Activity: Unknown

Primary Objectives:

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

Monitoring Objective:

- Continue to sample ants at human entry points Koloa cabin, Northern LZ, and Koolau Summit Trail at a minimum of once a year. Use samples to track changes in existing ant densities and to alert OANRP to any new introductions.

Management Objective:

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

1.2.2.8 Fire Control

Threat Level: Low.

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

Management Objective:

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

Preventative Actions**:**

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

Action Table

Action Type	Actions	OIP Year 5 Oct 2011- Sept 2012				OIP Year 6 Oct 2012- Sept 2013				OIP Year 7 Oct 2013- Sept 2014				OIP Year 8 Oct 2014- Sept 2015				OIP Year 9 Oct 2015- Sept 2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Vegetation Monitoring	Conduct baseline vegetation monitoring across MU																				
	Conduct MU vegetation monitoring every 3 years																				
General Survey	Survey Koloa Cabin LZ whenever used, no more than once per quarter. If not used, do not need to survey.																				
	Survey Northern LZ whenever used, no more than once per quarter. If not used, do not need to survey.																				
	Survey Koloa/Kaiapapau LZ whenever used, no more than once per quarter. If not used, do not need to survey.																				
	Survey Koloa Midridge LZ whenever used, no more than once per quarter. If not used, do not need to survey.																				
	Survey the Kahuku Cabin campsite whenever used, no more than once per quarter. If not used, do not need to survey.																				
	Survey the transect along the fenceline/Koolau summit trail between Kahuku Cabin and Northern LZ annually.																				
	Survey LZ Norton/Kainapuaa annually																				
General WCA	GPS boundaries of all current WCAs																				
	Install photopoints at select locations in WCA 6 and 7. (Re-take annually, or every 3-5 years).																				

Action Type	Actions	OIP Year 5 Oct 2011-Sept 2012				OIP Year 6 Oct 2012-Sept 2013				OIP Year 7 Oct 2013-Sept 2014				OIP Year 8 Oct 2014-Sept 2015				OIP Year 9 Oct 2015-Sept 2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
ICA	KLOA-HedCor-01: Monitor/control Hedcor in Kahuku cabin vicinity annually.																				
	KLOA-HedCor-01: Survey area around known locations; check out mini gulches. Easiest to do with 4 people. Define ICA. GPS.																				
WCA'S Koloa-01 (Northern LZ)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-02 (Hupnut site)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-03 (Between Hupnut WCA and Camp WCA)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years..																				
Koloa-04 (Cabin WCA)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-05 (South West WCA, West of Northern LZ WCA)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-06 (Mid ridge to bottom of West gulch)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-07 (Mid ridge to Puu 2361)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-08 (Puu 2361 across East gulch)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				

Action Type	Actions	OIP Year 5 Oct 2011-Sept 2012				OIP Year 6 Oct 2012-Sept 2013				OIP Year 7 Oct 2013-Sept 2014				OIP Year 8 Oct 2014-Sept 2015				OIP Year 9 Oct 2015-Sept 2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Koloa-09 (Mid ridge to bottom of West gulch, North of 6)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-10 (Midridge to 2361 ridge)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-11 (Kaipapau side)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-12 (North West corner with huge waterfall)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-13 (Mid ridge to WCA 12)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-14 (West river towards Mid ridge)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
Koloa-15 (North East Corner)	Conduct canopy weed control across WCA. Focus effort around rare plant sites. Re-sweep every 3-5 years.																				
KawainuiNoMU-01	Monitor/control LepSco north of Koloa, west of summit trail. Coordinate efforts with KMWP, if possible. Focus on stopping southern spread of LepSco. Sweep LepSco areas every 3 years, but revisit hotspots annually (as needed).																				

Action Type	Actions	OIP Year 5 Oct 2011-Sept 2012				OIP Year 6 Oct 2012-Sept 2013				OIP Year 7 Oct 2013-Sept 2014				OIP Year 8 Oct 2014-Sept 2015				OIP Year 9 Oct 2015-Sept 2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
KaiwikoeleEleNoMU-01	Monitor/control LepSco at Kainapuaa, between summit trail and Kawailoa trail. Coordinate efforts with KMWP, if possible. Focus on stopping southern spread of LepSco. Sweep LepSco areas every 3 years, but revisit hotspots annually (as needed).																				
WaileleOmaoNoMU-01	Monitor/control LepSco north of Koloa, east of summit trail. Coordinate efforts with KMWP, if possible. Focus on stopping southern spread of LepSco. Sweep LepSco areas every 3 years, but revisit hotspots annually (as needed).																				
Ungulate Control	Fence and cabin construction																				
	Monitor fence integrity quarterly																				
	Set up and check snares until pig free																				
Rodent Control	Restock bait boxes and snap traps																				
	Implement localized rodent control if determined to be necessary for the protection of rare plants.																				
Ant Control	Conduct surveys for ants at 2 human entry points (Hunter's Cabin, Mokuleia Trailhead)																				
	Implement control if deemed necessary																				
Predatory Snail Control	Determine whether *O. allarius* is present in proximity to *A. livida*																				
	If predatory snails are found begin hand-removal or exclosure construction																				
Slug Control	Determine slug species present and estimate baseline densities to help guide future control if deemed necessary																				

Hatching=Quarter Scheduled

1.2.3 Manuwai

Ecosystem Restoration Management Plan

MIP Year 8-12, Oct. 2011 – Sept. 2016

MU: Manuwai

Overall MIP Management Goals:

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

1.2.3.1 Background Information

Location: Northern Waianae Mountains

Land Owner: State of Hawaii

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

Acreage: 300 Acres

Elevation Range: 1000ft-3000ft

Description: Manuwai Gulch is located in the northern Waianae Mountains. Manuwai Gulch and a series of adjacent, parallel gulches are drainages off the side of Kamaohanui Ridge, which extends eastward from Kaala. The Manuwai Management Unit (MU) consists of the fenced upper half of Manuwai Gulch, and a side gulch that drains into Alaiheihe Gulch, formed off the dividing ridge between Manuwai and Alaiheihe Gulch. The gulch drains to the Northeast. Most of the upper portion of the MU is within the Lower Kaala Natural Area Reserve (NAR); the rest is in the State Forest Reserve. Access to the MU is via a road through 'Flying R Ranch' that connects to a 4x4 contour dirt road managed by The State of Hawaii. There is no formal easement for use of the roads through 'Flying R Ranch'. The ranch owner allows use of the roads and access is requested as needed through him. Helicopter access to the MU is available.

Much of Manuwai Gulch is steep, and some of these steep areas are not accessible on foot without safety ropes. The elevation gradient of the MU is dramatic, and the vegetation types within the MU span from Wet Forest to Lowland Dry Shrubland/Grassland. There are also several *in situ* rare and endangered plant populations scattered throughout the MU, including some found on cliffs and steep areas. Overall the MU is dominated by canopy weeds; however, there are some pockets of forest with high levels of native canopy.

Native Vegetation Types

Waianae Vegetation Types
Lowland Dry Shrubland/ Grassland
Canopy includes: *Erythrina sandwicensis, Myoporum sandwicense, Dodonaea viscosa, Santalum ellipticum, Hibiscus brackenridgei* subsp. *mokuleianus.* Understory includes: *Heteropogon contortus, Sida fallax, Eragrostis variabilis, Abutilon incanum, Leptecophylla tameiameiae, Bidens* sp.

Dry forest
Canopy includes: *Diospyros* sp., *Myoporum sandwicense, Erythrina sandwicensis, Reynoldsia sandwicensis, Rauvolfia sandwicensis, Santalum ellipticum*, *Psydrax odoratum, Nestegis sandwicensis* and *Myrsine lanaiensis.* Understory includes: *Dodonaea viscosa, Sida fallax, Bidens* spp.
Mesic mixed forest
Canopy includes: *Acacia koa, Metrosideros polymorpha, Nestegis sandwicensis, Diospyros* spp., *Pouteria sandwicensis, Charpentiera* spp., *Pisonia* spp.,*Psychotria* spp., *Antidesma platyphylum*, *Bobea* spp. and *Santalum freycinetianum.* Understory includes: *Alyxia oliviformis, Bidens torta, Coprosma* sp., and *Microlepia strigosa*
Mesic-Wet forest
Canopy includes: *Metrosideros polymorpha polymorpha*. Typical to see *Cheirodendron trigynum*, *Cibotium* spp., *Melicope* spp., *Antidesma platyphyllum*, and *Ilex anomala*. Understory includes: *Cibotium chamissoi*, *Broussaisia arguta*, *Dianella sandwicensis*, *Dubautia* spp. Less common subcanopy components of this zone include *Clermontia* and *Cyanea* spp.
Wet forest
Canopy includes: *Metrosideros* spp., *Cheirodendron* spp., *Cibotium* spp., *Ilex anomala*, *Myrsine sandwicensis,* and *Perrottetia sandwicensis*. Understory includes: Typically covered by a variety of ferns and moss; may include *Melicope* spp., *Cibotium chamissoi, Machaerina angustifolia, Coprosma granadensis, Hedyotis centranthoides*, *Nothoperanema rubiginosa*, and *Broussaisia arguta*.
NOTE: For MU monitoring purposes vegetation type is mapped based on theoretical pre-disturbance vegetation. Alien species are not noted.

Views of Manuwai


Manuwai Gulch (looking South)

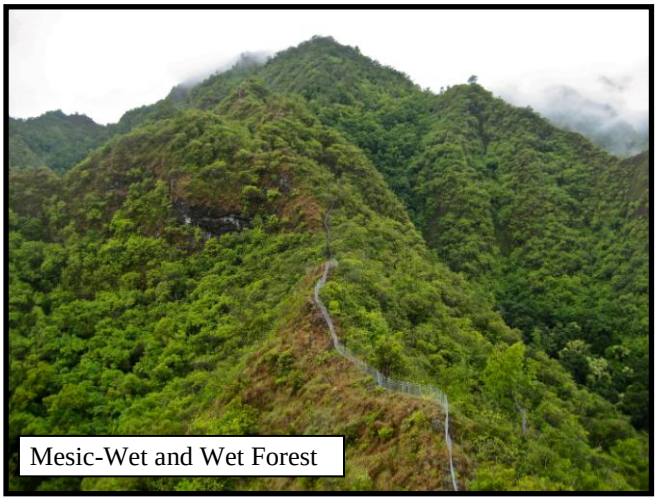

Manuwai Gulch (back of gulch)

Primary Vegetation Types at Manuwai


Lowland Dry Shrubland/Grassland


Dry Forest


Mesic Mixed


Mesic-Wet and Wet Forest

MIP/OIP Rare Resources

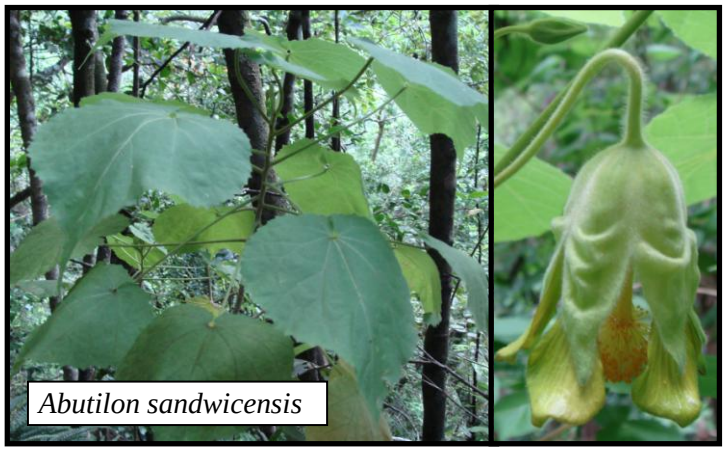
Organism Type	Species	Pop. Ref. Code	Population Unit	Management Designation	Wild/ Reintroduction
Plant	*Abutilon sandwicensis*	ANU-A, B, C, D, E, F, G, H, I †	Kaawa to Puulu	MFS	Both (reintroduction not yet done)
Plant	*Alectryon macrococcus* var. *macrococcus*	ANU-A, B*, C*	Manuwai	No Management	Wild
Plant	*Delissea waianaeensis*	ANU-A†	Manuwai	MFS	Reintroduction
Plant	*Flueggea neowawraea*	ANU-A*, B†	Manuwai	Manage Reintroduction for Stability	Both (reintroduction not yet done)
Plant	*Hedyotis degeneri* var. *degeneri*	ANU-A, B†	Alaiheihe and Manuwai	MFS	Both (reintroduction not yet done)
Plant	*Hibiscus brakenridgei* subsp. *mokuleianus*	ANU-A†	Kaimuhole and Palikea Gulch	MFS	Reintroduction (not yet done)
Plant	*Neraudia angulata* var. *dentata*	ANU-A*, ANU-B†, ANU-C†	Manuwai	MFS	Both (wild site extirpated, reintroduction not yet done
Plant	*Phyllostegia kaalaensis*	ANU-B†	Manuwai	MFS	Reintroduction (not yet done)
Snail	*Achatinella mustelina*	ANU-A	ESU-C	MFS	Wild

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

Other Rare Taxa at Manuwai MU

Organism Type	**Species**	**Status**
Plant	*Bobea sandwicensis*	Endangered
Plant	*Caesalpinia kavaiensis*	Endangered
Plant	*Colubrina oppositifolia*	Endangered
Plant	*Cyanea calycina*	Rare
Plant	*Dubautia sherffiana*	Vulnerable
Plant	*Exocarpos gaudichaudii*	Rare
Plant	*Lobelia niihauensis*	Endangered
Plant	*Pteralyxia macrocarpa*	Vulnerable; Candidate endangered species

MIP Rare Resources at Manuwai


Abutilon sandwicensis


Hedyotis degeneri var. *degeneri*


Alectryon macrococcus var. *macrococcus*


Achatinella mustelina

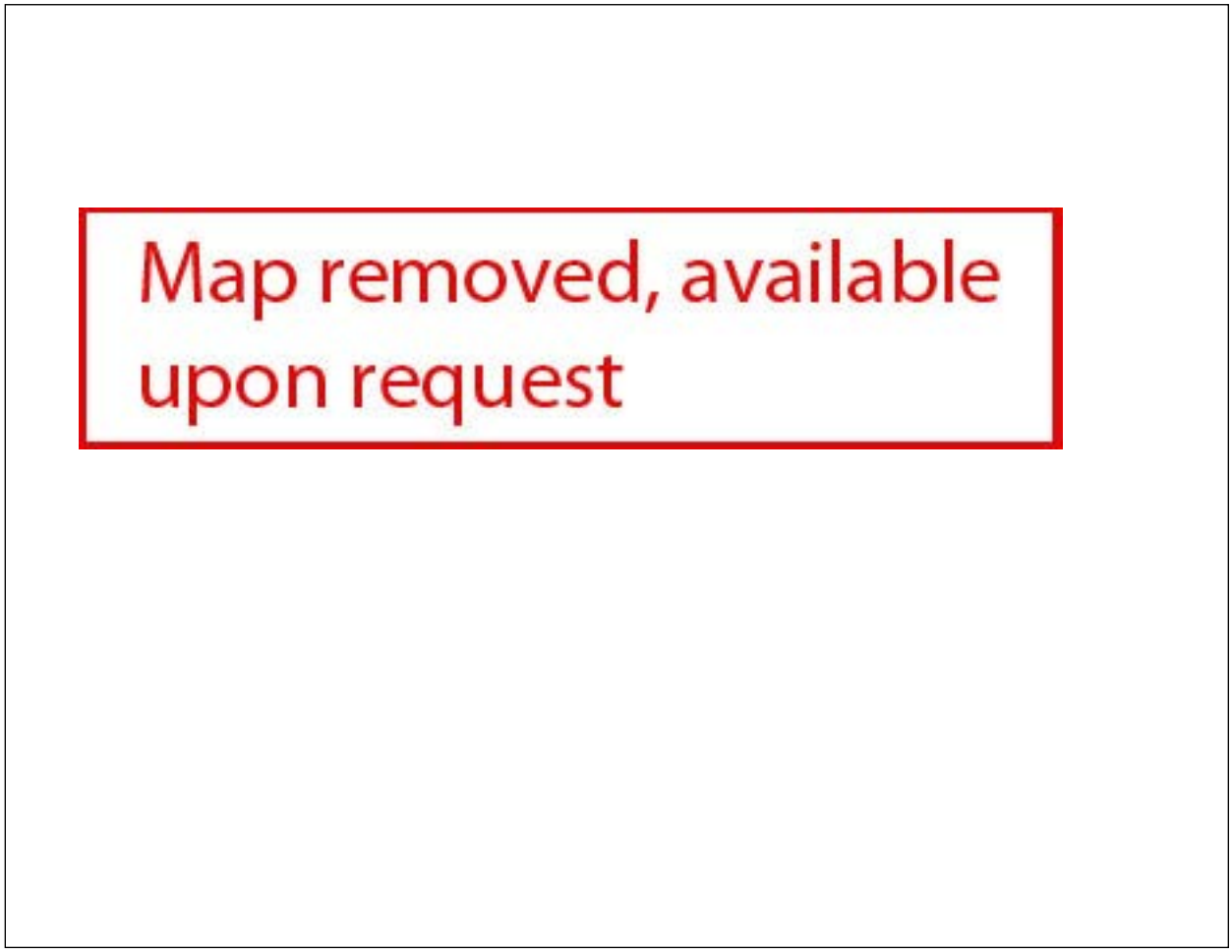

Flueggea neowawraea


Neraudia angulata


Delissea waianaeensis


Phyllostegia kaalaensis

Locations of Rare Resources at Manuwai



MU Threats to MIP/OIP MFS Taxa

Threat	Taxa Affected	Localized Control Sufficient?	MU scale Control required?	Control Method Available?
Pigs	All	No	Yes	Yes; MU fenced
Rats	*A. mustelina*, *A. macrococcus* var. *macrococcus*, *D. waianaeensis*, *F. neowawraea*	Yes	No	Yes; bait grids will be used around populations as needed
Predatory snails	*A. mustelina*	Unknown	No	Staff searches and removal
Slugs	*D. waianaeensis*, *N. angulata*, *H. degeneri* var. *degeneri*	TBD	No	Yes; Sluggo® applications around potential recruitment sites for rare plants
Black Twig	*A. macrococcus* var. *macrococcus*,	Unknown	No	No

Borer	*F. neowawraea,* *N. angulata* var. *dentata** *Abutilon sandwicensis**			
Ants	Unknown	Unknown	Unknown	Surveys yet to be conducted
Weeds	All	No	Yes	Yes; for steep cliff areas, herbicide ballistic technology being tested.
Fire	All	No	Yes	Yes; fuel pre-suppression, and rapid response and control of potentially threatening fires

*****Threat suspected. Field observation necessary.

Management History

Most OANRP management efforts in Manuwai have been to visit rare plant populations. The State NARS program conducted initial surveys in Manuwai and adjacent areas to document resources and to support the NAR designation for the area. With the completion of the fence in 2011, active management within the MU will begin (MIP Year 8). Ungulates will be removed, weeding will be conducted, and rare plant reintroductions will be established within those weeded areas.

- 1986: Botanist Steve Perlman conducts surveys in area. Manuwai is noted as having patches of the rare forest type, Oahu Diverse Mesic Forest.
- 1990: Mount Kaala Natural Area Reserve Management Plan is written by the Natural Area Reserves System Program.
- 1999-2010: OANRP visit historical rare plant populations, collect fruit from MIP species, and survey for new populations.
- 2000-2004: Snaring program in place for goat control along SBW border east of Kamaohanui.
- 2000-2006: Annual or semi-annual hunts for goats take place in the general Lower Kaala NAR region.
- 2007: In August, fire burns southern-most ridges of MU.
- 2010: Vegetation monitoring across MU conducted.
- 2011: MU fence completed. Pig eradication begins.

1.2.3.2 Ungulate Control

Identified Ungulate Threats: Pigs, Goats (low level threat, but goats are present in nearby gulches)

Threat Level: High

Primary Objectives:

- Eradicate pigs from MU.
- Maintain as pig free.
- Prevent goat ingress in exclosure

Strategy:

- Remove pigs from Subunit II with hunts and traps, and Subunit I with hunts, traps and snares as needed.

- Maintain as pig free by maintaining fence and using snares in Subunit II to reduce impacts and pressure.

Monitoring Objectives:

- Conduct fence checks and transects quarterly around entire MU, including strategic section along entire southern ridge. If absolutely sure that topography is excluding pigs, begin to check this section annually.
- GPS and mark the fence at ten meter intervals so that the fence will be one large transect.
- Monitor for pig sign while conducting other management actions in the fence.

Management Responses:

- If any pig activity is detected within the fenced unit, implement hunting and/or snaring program.

Maintenance Considerations:

There are several sections of the fence that are 'strategically' fenced, where natural barriers and geography (cliffs and pinnacle rocks) are used instead of actual fences to prevent pig ingress. There is a break in fencing around a large rock section on the western fenceline. Also, the entire southern edge of the MU is not fenced. The topography along this ridge is extremely steep, and pigs are not expected to be able to traverse. Additionally, Lihue (the forested gulches behind Schofield Barracks West Range) is undergoing fencing and pig removal. Eventually, pigs will be eradicated from this area and therefore the threat of ingress over this fenceless area is hoped to below. However, special attention will be given to the strategic fences during initial fence checks to ensure that the barriers are effective in keeping ungulates out of the MU.

1.2.3.3 Weed Control

Weed Control actions are divided into 4 subcategories:

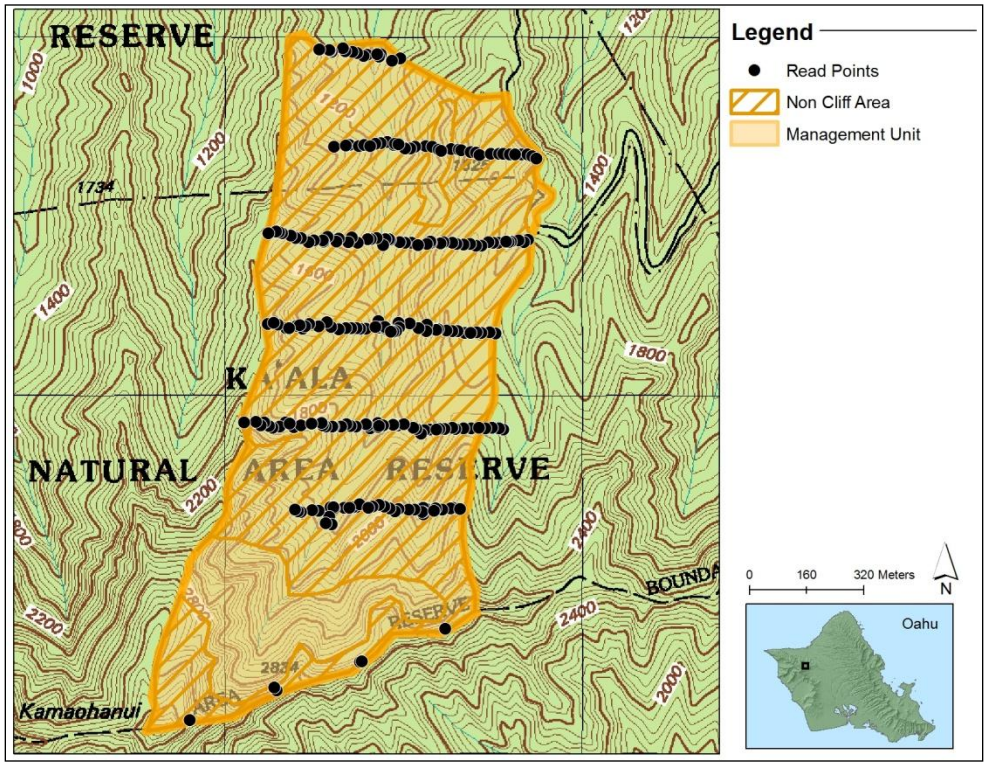
- Vegetation Monitoring
- Surveys
- Incipient Taxa Control (Incipient Control Area - ICAs)
- Ecosystem Management Weed Control (Weed Control Areas - WCAs)

These designations facilitate different aspects of MIP/OIP requirements.

MU Vegetation Monitoring

From October 2010 – April 2011 vegetation monitoring was conducted for the Manuwai management unit (MU). The total effort including commute time was 8 days for a crew of six. In the next few months the vegetation monitoring sub-committee will be meeting to set the monitoring interval for this MU. The vegetation monitoring data will provide NRP with trend analysis on the percent cover for alien vegetation in the understory and canopy, invasion and spatial distribution of priority weed species, and species richness. Since the MU vegetation monitoring protocol was designed in order to address two separate MIP management unit goals, the analysis is divided into two sections. The statistical thresholds used for both sections were copied directly from the Makua Implementation Plan.

Vegetation Monitoring Transects:



Section 1: Alien Percent Cover Management Objective

- Assess if the percent cover for alien understory and canopy is 50% or less across the entire management unit. For more discussion on this objective refer to Makua Impementation Plan, Chapter 10, Table 10.1.

Sampling Objective:

- Be 95% sure of detecting a 10% change in percent cover for both alien understory and canopy.
- The acceptable level of making a Type 1 error (detecting a change that did not occur) is 10% and a Type 11 error (not detecting a change that did occur) is 20%.

Vegetation Monitoring Protocol:

Refer to the monitoring section of the 2008 year-end report for a full description of the methods.

Vegetation Monitoring Analyses for Alien Percent Cover Goals:

Baseline data collected for the Manuwai MU in 2011 showed that the mean percent alien vegetation cover in the understory was 53% and in the canopy it was 64%. The mean alien percent cover did not meet the management goal of 50% or less alien vegetation cover in either the understory or canopy.

Management response:

If future vegetation monitoring analysis indicates that the alien percent in either the understory or canopy has not been met and are not getting closer to being reached, the weed control strategy will be re-evaluated by the IT.

Percent cover data analysis considerations:

To determine the sample size required to detect a minimum of 10% change in cover, a post-hoc power analysis was performed. With 80% power and standard deviation of 32 (the highest standard deviation in the 2010 dataset) the minimum sample size needed to meet the sampling objectives was 81 plots. Though only 81 plots were needed to detect a change in alien percent cover, more plots were monitored to ensure that there was a large enough sample size to detect change in occurrence of target species.

Section 2: Frequency of Occurrence Analysis

Frequency data was collected for all species that occurred within the Manuwai MU in 2010. This data will be used to tracking species richness, spatial distribution, and density of dominate species on an MU scale. This analysis was used by management to help determine if Manuwai is getting more or less native over time. For a complete list of species recorded during the 2010 monitoring period and the percent of plots they occurred in refer to appendix 1-8.

Species Richness and Vegetation Monitoring Checklist:

From the 2010 dataset a vegetation checklist of the vascular plant species was compiled. Within the canopy, a total of 67 plant species were recorded; 46 (69%) of these species were native and 21 (31%) were alien. In the understory, a total of 154 species were recorded; 85 (55%) of these species were native and 69 (45%) were alien.

Management Objective for priority alien species control:

- Assess the spatial distribution and frequency for priority 2 weed species.
- Provide an updated priority weed species list for the Palikea MU.
- Track species richness for alien species across the MU.

Sampling Objective:

- 95% confident of detecting 10% change in occurrence of priority 2 weed species (refer to the target weed species notes table in the weed control section).

Vegetation Monitoring Protocol:

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

Established Weed Species Discussion:

Priority weed species which are of particular interest to NRP due to their ecosystem altering potential are controlled on an MU or WCA scale. For notes on the control strategy for each of these species refer to the Summary of Target Taxa table in the ICA section of this report.

Several alien species which NRP plans to controlled on a WCA scale in the next five year are *Psidium cattleianum, Blechnum appendiculatum, Clidemia hirta, Syzygium cumini, Toona ciliata* and *Schinus terebinthifolius*. The weed management strategy for these species is to control them around rare plant locations and in native forest patches. Since these species will be controlled on a WCA scale, they will most likely be the species that vegetation monitoring will be detecting change due to weed control management. Given this, it will be important to analyze the change in spatial distribution of all priority weed species in order to determine if more weed control is needed.

Management Response:

If trend analysis indicates there has been no detectable change in any of the priority species, NRP will continue with the current management strategy. If future monitoring indicates that there has been a significant increase in any of the priority weed species, NRP will meet with the IT to evaluate the weed control strategy and decide if a species-specific weed control strategy should be implemented.

Management Objective for Native Species:

- Ensure the plant communities within the MUs are stable and native-dominated .

Sampling objectives:

- Be 95% certain of detecting a 10% change in occurrence of native species.

Native Species Frequency Analysis:

The most common native tree in both the canopy was *Diospyros sandwicensis*, occurring in 55% of the plots in the canopy and 48% of the plots in the understory. The next most common native species were *Psydrax odorata, Dodonaea viscosa* and *Diospyros hillebrandii*. For a complete species list refer to Appendix 1-8.

Vegetation Monitoring Protocol:

- Refer to the monitoring section in the 2008 year-end report.

Management response:

- If there has been significant decline in native species occurrence over time, assess the need for additional native species restoration.
- If the frequency of occurrence of native species does not significantly decrease, continue with the current management program.

Addition benefit on vegetation monitoring:

Incipient species detected:

A benefit of conducting vegetation monitoring was the detection of *Pterolepis glomerata* which was designated as an incipient population and will be controlled. In addition to this taxon, *Caesalpinia decapetala, Begonia vitifolia*, and *Montanoa hibiscifolia* were detected. NRP will continue to document occurrences of these species over the next year, and will evaluate whether they should be added to the incipient species list (Discussed in the Incipient Taxa Control section of this report).

Surveys

Army Training?: No

Other Potential Sources of Introduction: OANRP, State Biologists, pigs

Survey Locations: landing zones, fencelines, access road, high potential traffic areas.

Management Objective:

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

Monitoring Objectives:

- Quarterly surveys of LZs (if used).
- Annual survey of access road (Lower Kaala NAR access road)
- Quarterly surveys of campsites (if used)
- Note unusual, significant or incipient alien taxa during the course of regular field work, particularly when walking the fenceline.

Management Responses:

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

Surveys are designed to be the first line of defense in locating and identifying potential new weed species. Roads, landing zones, fencelines, and other highly trafficked areas are inventoried regularly. In Manuwai, LZs are surveyed as used, and the Lower Kaala NAR access Road is surveyed annually. The access trail from the parking spot on the road over the saddle and into the gulch bottom will also be surveyed annually (a trail for some of this will still need to be established). OANRP will consider installing additional surveys in other high traffic areas, however, incidental observations during regular field management may suffice.

Incipient Taxa Control (ICAs)

Management Objectives:

- As feasible, eradicate high priority species identified as incipient invasive aliens in the MU by 2016.
- Conduct seed dormancy trials for all high priority incipients by 2016.

Monitoring Objectives:

- Visit ICAs at stated re-visitation intervals. Control all mature plants at ICAs and prevent any immature or seedling plants from reaching maturity.

Management Responses:

- If unsuccessful in preventing immature plants from maturing, increase ICA re-visitation interval, or reassess feasibility of eradication.

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

The table below summarizes target weed taxa at Manuwai. Appendix 3.1 of the MIP lists significant alien species in the greater Lower Kaala NAR and ranks their potential invasiveness and distribution. Each species is given a weed management code: 0 = not reported from MU, 1 = incipient (goal:

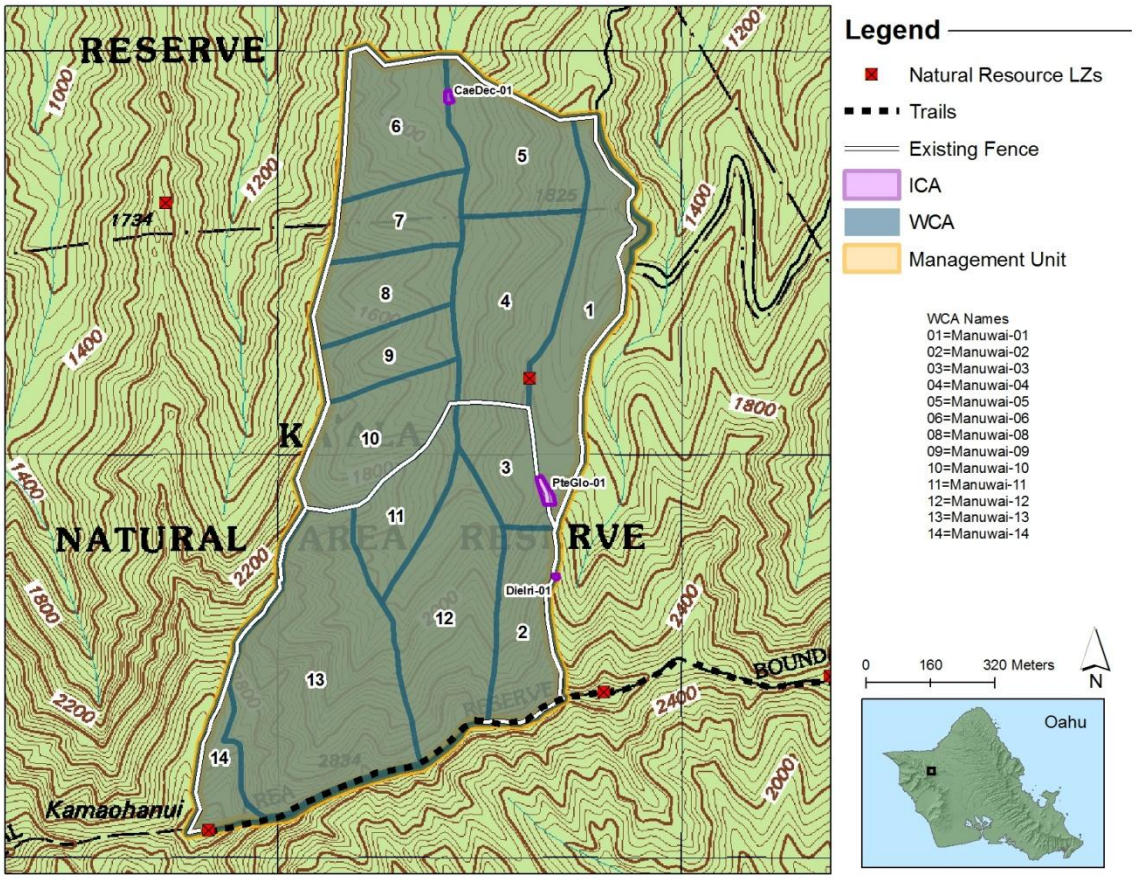
eradicate), 2 = control locally. OANRP supplemented and updated Appendix 3.1 with additional target species identified during field work. In many cases, the weed management code assigned by the MIP has been revised to reflect field observations. If no code is listed in the 'original' column, the species was not evaluated by the IP, but was added later by OANRP. While the list is by no means exhaustive, it provides a good starting point for discussing which taxa should be targeted for eradication, immediate control throughout the MU, or control within active WCAs. ICAs are not designated for every species in the table below; however, occurrences of all species in the table should be noted by field staff. All current ICAs are mapped.

Summary of Target Taxa

Taxa	MIP weed code		Notes	No. of ICAs
	Original	Revised		
Acacia confusa	1	2	Widespread on ridges. Target during weed control sweeps in priority WCAs.	0
Begonia vitifolia		1	Map all known locations of *B. vitifolia*. If widespread, treat during WCA control. If known from very limited locations, treat in ICAs.	0
Caesalpinia decapetala	1	1	One population known from bottom of gulch on north end. Will be targeted for control in an ICA. Any new sites will be treated the same way.	1
Clusia rosea	1	0	Noted from Lower Kaala NAR. Not detected during MU monitoring or initial surveys. If found, will treat as a WCA target.	0
Cupressus lusitanica		2	Treat as MU target. Not documented as being highly invasive in Hawaii, but staff have noted related species spreading in other areas.	0
Dietes iridioides		1	Known from east fenceline, just outside MU. Doesn't spread quickly. Target in ICA. Treat and initially recheck quarterly to establish control frequency.	1
Fraxinus uhdei	1	0	Noted from Lower Kaala NAR. Not detected during MU monitoring or initial surveys. If found, will treat as WCA target.	0
Juniperus bermudiana	1	2	Treat as MU target. Determine if present; easily confused with *Cupressus lusitanica*	0
Melaleuca quinquenervia	0	2	Treat as MU target. None found during vegetation monitoring, but known from MU. Has potential to spread quickly in appropriate habitat.	0
Melia azedarach	0	2	Target during weed control sweeps in priority WCAs.	0
Montanoa hibiscifolia	0	1	Map all known locations of *M. hibiscifolia*. If widespread, treat during WCA control. If known from very limited locations, treat in ICAs.	0
Panicum maximum	2	2	Important to strategically treat patches of *P. maximum* for fire suppression (see fire section). Target in WCAs as needed.	0
Pterolepis glomerata	0	1	Treat known population as an ICA. New populations found will be treated as ICAs.	1
Roystonia regia	0	2	Only a few individuals known. Treat as MU target.	0
Rubus argutus	2	2	Target in WCAs. Frequent retreatment is often required for control of this species. Use control measures such as digging out tubers and aggressive herbicides that will kill entire plant on first treatment.	0
Schefflera actinophylla	0	2	Immature plants are somewhat widespread through MU, and there are not many mature individuals. Treat as MU wide target (treat all known immature individuals throughout the MU at one time), and then control as needed in WCAs. Know to be ecosystem altering, fast growing, fruits prolifically, and disperses widely.	0
Setaria palmifolia	2	2	Target in WCAs around rare taxa.	0

Taxa	MIP weed code		Notes	No. of ICAs
	Original	Revised		
Spathodea campanulata	2	2	Several individuals throughout MU. High concentrations in Subunit II. Treat as MU target, then control as needed in WCAs.	0
Syzygium cumini	2	2	Target in WCAs.	0
Toona ciliata	2	2	Target in WCAs. There are high levels of this weed in the MU; it occurred in the overstory in 44% of vegetation survey plots, and 48% in the understory in survey plots. The tree is fast growing, and mature trees readily produce lots of offspring nearby. Where possible, target small stands entirely where possible in high priority WCAs.	0
Trema orientalis	2	2	Treat as MU target. Many large mature trees seen during vegetation surveys and visual surveys from ridges. Canopy is broad. Several trees are on slopes inaccessible on foot and will require remote control technologies.	0
Triumphetta semitrilobata	2	2	Target during weed sweeps in high priority WCAs, and target along trails, LZs, and campsites.	0

Incipient and Weed Control Areas at Manuwai



Ecosystem Management Weed Control (WCAs)

MIP Goals:

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

Management Objectives:

- Reach 50% or less alien canopy cover across the MU in the next 5 years.
- In WCAs within 50m of rare taxa, work towards achieving 25% or less alien vegetation cover in understory and canopy.

Management Responses:

Increase/expand weeding efforts if MU vegetation monitoring (conducted every 6 years) indicates that goals are not being met.

Weed Control Summary:

The entire Manuwai MU was broken up into WCAs to ease data tracking. Due to the high level of non-native cover in much of the MU and patchiness of native canopy pockets, large scale weed sweeps

targeting a wide variety of weeds will not take place in most WCAs. Instead, we plan to remove selected species across the entire MU (see 'MU wide species target list' table below). This list was selected based on distribution levels of taxa seen during vegetation monitoring, and also based on known characteristics of the taxa. For example, *Schefflera actinophylla* was chosen as a MU wide be target because it had a relatively low distribution throughout the MU making it feasible to control. Furthermore, most of the individuals seen were immature, and if the taxon can be treated across the MU before it becomes reproductive, there is a far greater chance to control it.

In addition to MU wide weed targets, OANRP will also conduct smaller scale, localized, intensive control around areas with high levels of native canopy, and around wild sites of rare taxa. Initially, this focused weed control will largely be conducted to prepare rare plant reintroduction sites, and then to maintain low levels of alien cover around those reintroductions. Canopy weed control should be cleared in advance of plant reintroductions so as not to disrupt rare plants after they are already in the ground. Understory weeds will be controlled continually as needed. Rare plant reintroductions will need to avoid large patches of *Blechnum appendiculatum*. It is however feasible to effectively remove smaller patches of this weed and it should be targeted in such cases. Additionally, if, ongoing *B. appendiculatum* herbicide trials find an effective herbicide to control larger patches of this weedy fern, it may be targeted prior to rare plant reintroductions as well.

The WCAs along Kamaohanui Ridge and some others in the MU are very steep. On the ground weed control will be difficult in these areas and in most cases control may be achieved via methods such as aerial ball spray or Herbicide Ballistic Technology (still in development). Aerial surveys of these areas is still needed to document distribution of weeds from the MU Wide Species Target List

MU Wide Species Target List

Cupressus lusitanica
Juniperus bermudiana
Melaleuca quinquenervia
Roystonia regia
Schefflera actinophylla
Spathodea campanulata
Trema orientalis

WCA: Manuwai-01

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA.

Notes: The terrain in this WCA is not as steep as most of the other WCAs in the MU and has slopes with large stands of native dominated forest including areas with *A. koa* canopy, stands of *D. sandwicensis* and a nice short stature shrub forest of *Styphelia tameiameiae, Metrosideros tremuloides,* and *Dodonea viscosa*. It encompasses a side gulch that drains into Alaiheihe Gulch. There are no known rare resources in this WCA, however the native dominated mixed-mesic forest in this gulch would be worthwhile to weed. It is easy to access as it is close to the road, and if given permission by NARS, would be a good site for volunteer weed control. MU wide target species will be controlled by MIP Year 11.

WCA: Manuwai-02

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA.

Notes: There are no known rare resources in this WCA and it is very steep. The WCA shares some of the native dominated forest aforementioned in WCA 1. However, unless rare plants, or suitable habitat for rare plant reintroductions is found, no regular WCA weed control will take place in this WCA. MU wide target species will be controlled by MIP Year 9.

WCA: Manuwai-03

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA.

Notes: There was a population of *A. macrococcus* var. *macrococcus* known from this WCA, however it is now thought to be gone. Unless rare plants, or suitable habitat for rare plant reintroductions is found, no regular WCA weed control will take place in this WCA. MU wide target species will be controlled by MIP Year 10.

WCA: Manuwai-04

Vegetation Type: Mesic Ridge

MIP Goal: 25% or less alien cover.

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, common weeds such as *S. terebinthifolius, S. cumini,* and *P. cattleianum,* will be treated in the overstory, and *C. arabica* in the understory.

Notes: This WCA has several current and historic rare plant populations. Some of these populations are managed by OANRP and others are managed by the Oahu Plant Extinction Prevention program. Most of these rare plants occur across a mostly native, *D. sandwicensis* dominated slope. Control efforts will be focused across this slope and around MIP rare plant species as needed to maintain low levels of alien cover directly around those populations. This WCA is also high priority for early removal of Target Weed Species. MU wide target species will be controlled by MIP Year 8.

WCA: Manuwai-05

Vegetation Type: Mesic Ridge

MIP Goal: 25% or less alien cover.

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, common weeds such as *S. terebinthifolius, S. cumini,* and *P. cattleianum,* will be treated in the overstory, and *C. arabica* in the understory. There are high levels of *P. maximum* throughout the WCA, that will be cleared directly around rare plants in any reintroduction established in this WCA. Aerial or on the ground *P. maximum* control along the northern edge of this WCA (fenceline) will also be evaluated to facilitate fence checks, and may serve as a potential fire break.

Notes: This WCA has several steep, grassy ridges and is largely degraded. There are a few rare plant populations in some of the shallow gulches. Weed control efforts will be focused around MIP rare plant species as needed to maintain low levels of alien cover directly around those populations. MU wide target species will be controlled by MIP Year 11.

WCA: Manuwai-06

Vegetation Type: Mesic Ridge

MIP Goal: 25% or less alien cover.

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA, as well as *P. maximum.*

Notes: There are high levels of *P. maximum* in the northern half of this WCA. The 2007 Waialua fire burned the northern half of this WCA and *P. maximum* has filled in all the burned area. The southern-most gulch of this WCA had a population of *Neraudia angulata* that has since died. There is also a sizeable stand of *Colubrina oppositifolia* on the ridge that divides WCAs 6 and 7. If no reintroductions take place in this WCA, only target weed species will be treated. MU wide target species will be controlled by MIP Year 9. Aerial or ground based *P. maximum* control along the northern edge of this WCA (fenceline) will also be evaluated to facilitate fence checks, and create a potential fire break.

WCA: Manuwai-07

Vegetation Type: Mesic Ridge

MIP Goal: 25% or less alien cover.

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, common weeds such as *S. terebinthifolius, S. cumini,* and *P. cattleianum,* will be treated in the overstory, and *C. arabica* in the understory.

Notes: The boundaries of this WCA run from the fenceline down 2 ridges, and surround 1 large gulch. There are rare plant populations in this WCA. Rare plant reintroductions may be conducted in this WCA. If so, weed control will be conducted to prepare sites before outplanting, and weed control thereafter will be conducted to keep alien canopy levels low. If no reintroductions take place in this WCA, only target weed species will be treated. MU wide target species will be controlled by MIP Year 9.

WCA: Manuwai-08

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, common weeds such as *S. terebinthifolius, S. cumini,* and *P. cattleianum,* will be treated in the overstory, and *C. arabica* in the understory.

Notes: The boundaries of this WCA run from the fenceline down 2 ridges, and surround 1 large gulch. These ridges are mostly native mid-slope, but are thick with coffee closer to the gulch. Rare plant reintroductions may be conducted in this WCA. If so, weed control will be conducted to prepare sites before outplanting, and weed control thereafter will be conducted to keep alien canopy levels low. If no reintroductions take place in this WCA, only target weed species will be treated. MU wide target species will be controlled by MIP Year 9.

WCA: Manuwai-09

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, common weeds such as *S. terebinthifolius, S. cumini,* and *P. cattleianum,* will be treated in the overstory, and *C. arabica* in the understory.

Notes: The boundaries of this WCA run from the fenceline down 2 ridges, and surround 1 large gulch. These ridges are mostly native mid-slope, but are thick with coffee closer to the gulch. Rare plant reintroductions may be conducted in this WCA. If so, weed control will be conducted to prepare sites before outplanting, and weed control thereafter will be conducted to keep alien canopy levels low. If no

reintroductions take place in this WCA, only target weed species will be treated. MU wide target species will be controlled by MIP Year 9.

WCA: Manuwai-10

Vegetation Type: Mesic Ridge

MIP Goal: 25% or less alien cover.

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, common weeds such as *S. terebinthifolius, S. cumini,* and *P. cattleianum,* will be treated in the overstory, and *C. arabica* in the understory.

Notes: This WCA has high levels of native cover and is of high priority for weeding. There are side gulches with *Pisonia sp.*, and *Cyanea angustifolia* scattered throughout the upper regions. There is also large population of *Melanthera tenuifolia* on and around the cliff that forms at the back of the gulch in the WCA. There are rare plant reintroductions slated for this gulch. Along the elevation gradient of the gulch there is suitable habitat for rare plants, and the terrain is not as steep as in other parts of the MU and is more manageable from that perspective. Weed control in this WCA will start as site preparation for reintroductions, and then be conducted to reduce non-native cover around these rare plant populations. This WCA is also high priority for early removal of Target Weed Species. MU wide target species will be controlled by MIP Year 8.

WCA: Manuwai-11

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA.

Notes: This WCA shares the native forest in WCA 10, and is also worthwhile to weed in order to extend the suitable habitat for the reintroductions slated for that WCA. Part of the WCA is quite steep and less management will take place in those areas. MU wide target species will be controlled by MIP Year 9.

WCA: Manuwai-12

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA. Additionally, understory and canopy weeds such as *Ageratina riparia, C. hirta, P. cattleianum* and *S. terebinthifolius* will be treated around rare plant populations.

Notes: The boundaries of this WCA run down two drainages, and encompass a ridge with a MFS population of *H. degeneri* var. *degeneri*. Weed control will be conducted mostly around these rare plants and in appropriate habitat up and down the ridge as needed. There are also other rare plants on the slopes of the ridge including: *A. macrococcus* var. *macrococcus, P. macrocarpa, D. sherffiana.* This is a large WCA, and the southern edge of this WCA is very steep and largely inaccessible. If remote weed control technologies are developed, such as Herbicide Ballistic Technology or aerial ball spraying, select weeds may be targeted for cliff side control. MU wide target species will be controlled by MIP Year 9.

WCA: Manuwai-13

Vegetation Type: Mesic Ridge

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA.

Notes: This WCA encompasses the cliffs abutting Kamaohanui ridge. The terrain is very steep, or vertical and is mostly inaccessible. Control in this area will be limited to accessible rare taxa and target weed species sites. If remote weed control technologies are developed, such as Herbicide Ballistic Technology or aerial ball spraying, select weeds may be targeted for cliff side control.

WCA: Manuwai-14

Vegetation Type: Wet Forest

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

Targets: Taxa from the MU Wide Species Target List will be treated in this WCA.

Notes: This WCA is the highest in elevation in the MU and is mostly Wet Forest. Unless there is a need to weed around the one population of rare plants in this WCA, or suitable habitat for rare plant reintroductions is found, no regular WCA weed control will take place in this WCA. Similar to WCA 14, remote weed control technologies will be required for control of MU wide target species.

1.2.3.4 Other Threat Control:

As listed in the Threat Summary Table, the following are identified as current or potential threats to MIP species. These threats still need further evaluation. Management approaches will be developed over the next few years as more is learned about how these threats impact the rare resources in the MU.

- Rodents: *Rattus rattus* (black rat, roof rat), *Rattus exulans* (polynesian rat, kiore), *Mus musculus* (house mouse); monitor resources for damage caused by rats and mice.
- Slugs: Take samples opportunistically while conducting management. Species likely include: *Deroceras leave, Limax maximus, Meghimatium striatum*
- Predatory Snails: *Euglandina rosea* (rosy wolf snail); not yet documented from MU, but likely present.
- Ants: Surveys yet to be conducted at areas with high levels of human activity: Parking area, DZs, campsites and rare plant reintroductions.
- Black Twig Borer: *Xylosandrus compactus*; impacts to *F. neowawraea* reintroduction will be monitored when this reintroduction is planted.

Primary Objective:

- Identify presence of threats mentioned above
- Maintain populations of identified threats to a level that facilitates stabilized or increasing plant and snail populations across the MU by the most effective means possible.

Management Objective: Ensure MIP/OIP rare plant resources within the MU are not impacted by identified threats.

Monitoring Objectives:
- Monitor rare plant and snail resources to help guide localized threat control.
- Sample ant populations at sites with high levels of management to identify species present.

1.2.3.5 Fire Control

Threat Level: Medium

Available Tools: Fuelbreaks, Helicopter water drops, Army Wildland Fire, staff expertise at fire incident command.

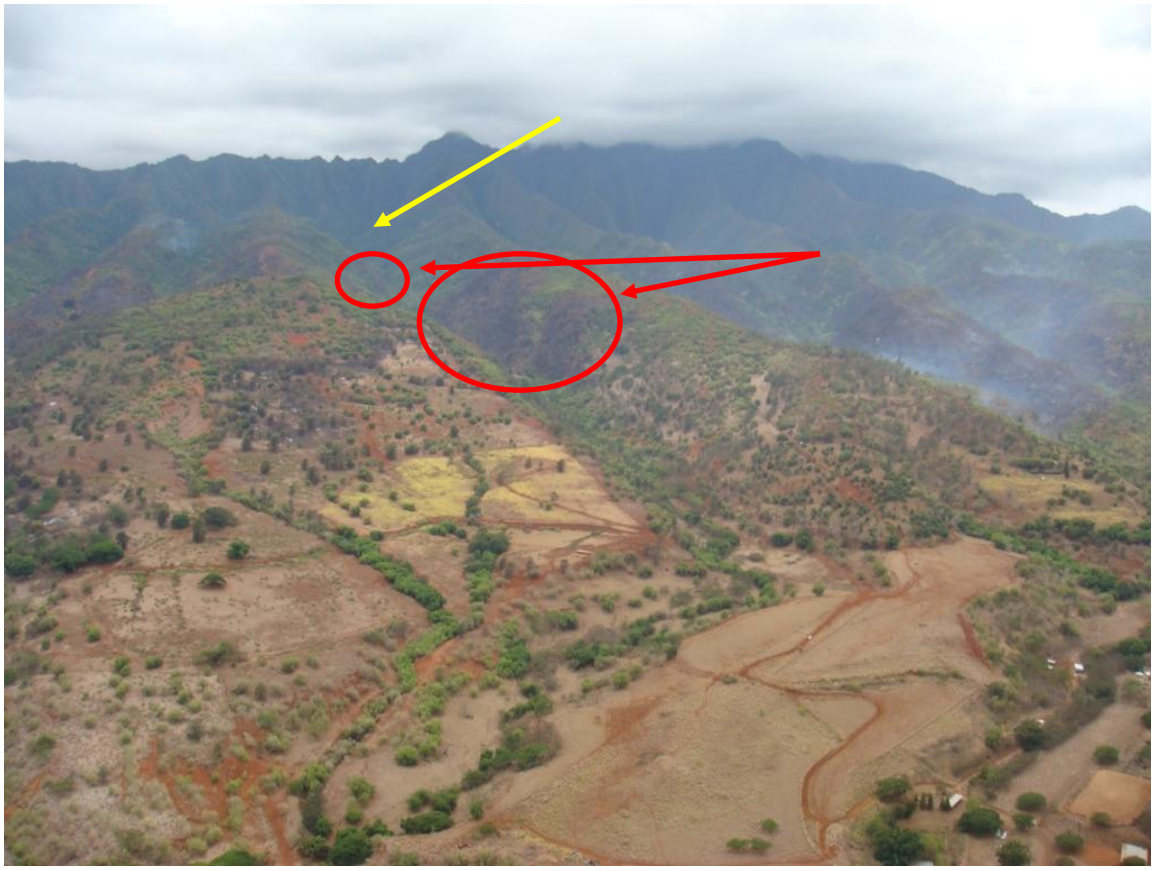
Management Objective:

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

Fire History

In 2007, a fire burned in Waialua, crossed Kaukonahua Rd. and burned up through ranch land, to State Forest Reserve and Natural Area Reserve Land. OANRP staff and other knowledgeable resource managers guided helicopter water drops to priority areas around natural resources for 8 days as the fire burned. Prior to 2007, no fires had burned through this area in at least 50 years. The southernmost portion of Manuwai MU was burned, and while no rare plants were affected in Manuwai, the fire reached as close as 100 meters to known rare plant populations. The burned area quickly filled back in with *P. maximum*, and serves as a large fuel load at the bottom of the MU.

Photo of area burned in Manuwai Gulch in 2007 fire



Preventative Actions

Since the 2007 fire, OANRP began to contract discing of grass growing in fallow fields along Kaukonahua Road. This creates a wider and continuous fire break at the site where the fire jumped the road in 2007. Efficient grass spraying techniques such as using helicopters with spray booms and ball

sprayers will be investigated. This technique could be useful to create a fuelbreak at the bottom of the MU or in other strategic locations. It is also important to maintain roads and LZs for fire access and as fire escape routes. The help of OANRP staff and other knowledgeable resource managers to direct helicopter water drops to priority areas around natural resources is key in dealing with fires across the area. Additionally, it will be important to work with The State to develop a fire management plan for the entire Mokuleia Forest Reserve and Lower Kaala NAR.

Action Table

Action Type	Actions	MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Monitoring																					
General Survey	Survey LZ 149 (East Ridge) LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Survey LZ 55 (Kamaohanui) LZ whenever used, not to exceed once per quarter. If not used, do not need to survey.																				
	Quarterly surveys of campsites (if used)																				
	Survey road from gate at top of Bob Cherry's ranch to contour road, past Puulu gulch, to where road ends in west range (RS-KLN-01).																				
	Survey most frequently used access trail annually: from parking spot over ridge saddle, into gulch (trail yet to be created)																				
ICA	Control *Caesalpinia decapetala* in the bottom of the gulch in Subunit I every 6 months.																				
	Map all found locations of *B. vitifolia* at the end of MIP Year 8. Evaluate level of control needed.																				
	Control known *Dietes iridioides* patch on eastern fenceline. Monitor quarterly to evaluate re-treatement frequency needed.																				

Action Type	Actions	MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Map all known locations of *Montanoa hibiscifolia* at the end of MIP Year 8. Evaluate level of control needed.																				
	Control *Pterolepis glomerata* on the eastern fenceline quarterly. Use OUST herbicide to exhaust seedbank.																				
WCA 1	Conduct target species weed control across WCA by MIP Year 11; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
WCA 2	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
WCA 3	Conduct target species weed control across WCA by MIP Year 10; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
WCA 4	Conduct target species weed control across WCA by MIP Year 8; cover entire WCA once every 5 years. Species include but not																				

Action Type	Actions	MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
	Control weeds across rare plant zone, and high quality lama-band annually.																				
WCA 5	Conduct target species weed control across WCA by MIP Year 11; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
	Control weeds around isolated rare plant populations as needed.																				
WCA 6	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
WCA 7	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla,*																				

Action Type	Actions	MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Spathodea campanulata, Trema orientalis.																				
WCA 8	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
WCA 9	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
WCA 10	Conduct target species weed control across WCA by MIP Year 8; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
	Conduct weed control around rare plant reintroductions; prepare and maintain sites.																				
WCA 11	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla,*																				

Action Type	Actions	MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	Spathodea campanulata, Trema orientalis.																				
	Conduct sweeps across lama dominated slopes and ridge shared with WCA 10.																				
WCA 12	Conduct target species weed control across WCA by MIP Year 9; cover entire WCA once every 5 years. Species include but not limited to: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*.																				
	Weed throughout *H. degeneri* var. *degeneri* population and suitable habitat along ridge annually.																				
WCA 13	Evaluate feasibility of controlling target species on the ground (area is very steep). Species include: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera actinophylla, Spathodea campanulata, Trema orientalis*. Where not possible, aerially identify locations of targets. Control with remote control technologies if determined appropriate control for those targets. Complete control by MIP Year 11.																				
WCA 14	Evaluate feasibility of controlling target species on the ground (area is very steep). Species include: *Cupressus lusitanica, Juniperus bermudiana, Melaleuca quinquenervia, Roystonia regia, Schefflera*																				

Action Type	Actions	MIP Year 8 Oct 2011-Sept 2012				MIP Year 9 Oct 2012-Sept2013				MIP Year 10 Oct 2013-Sept2014				MIP Year 11 Oct 2014-Sept2015				MIP Year 12 Oct 2015-Sept2016			
		4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
	actinophylla, Spathodea campanulata, Trema orientalis. Where not possible, aerially identify locations of targets. Control with remote control technologies if determined appropriate control for those targets. Complete control by MIP Year 11.																				
Ungulate Control	Continue hunts to remove pigs from Subunit I and II. Use snares as needed to remove pigs from Subunit II.																				
	Conduct quarterly fence checks.																				
Other Threat Control	Conduct annual ant surveys at camp site most frequently used.																				
	Conduct annual ant survey along access trail from the road.																				
Hatched=Quarter Planned																					

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 new staff. In many cases, data or information is still being gathered and these plans will continue to be updated. A brief description of each slide is given here:

- **Species Description:** The first few slides provide an overview of each taxon. The IP stability requirements are given along with a taxon description, biology, distribution, population trends, habitat and taxonomic history. The species descriptions for 2011 rare plant stabilization five year plans are largely taken from the Monograph of *Schiedea* (Wagner et al. 2005).
- **Historic Collections Table:** This information was summarized from Bishop Museum specimens and collections listed in published research, the Hawaii Biodiversity and Mapping Program and other collectors notes.
- **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 and pollinator syndromes as reported in the MIP and OIP. The information on seeds is from data collected at the Army seed lab and from collaborative research with the Harold L. Lyon Arboretum.
- **Pictures:** These photos document habitat, habit, floral morphology and variation; all stage/age classes and many stages of maturing fruit and seed. This will serve as a reference for field staff making collections and searching for seedlings.
- **Habitat Characteristics and Associated Species:** These tables summarize habitat data taken using the Hawaii Rare Plant Restoration Group's Rare Plant Monitoring Form. The data is meant to provide an assessment of the current habitat for the *in situ* and outplanting sites. Temperature and rainfall estimates are also included for each site.
- **Species Occurrence Maps:** These maps display historic and current locations, MUs, landmarks and any other useful geographic data for each taxon. Other features may be used on public documents to obscure locations of rare elements.
- **Population Units:** A summary of the PUs for each taxon is provided with current management designations, action areas and management units.
- **Population Structure:** Data from monitoring the population structure for each species is presented with a plan to establish or maintain population structure at levels that will sustain stability goals.
- **Monitoring Plan:** Current techniques and plans are discussed in this section. Monitoring of the *in situ* and reintroduction populations will be conducted to determine progress toward attaining taxon stability. Data to be collected may include number, vigor, and phenological phase of all plants or samples of the individuals by size class. This information may be evaluated using an appropriate statistical analysis to assess current and projected status of the monitored PUs. Adaptive modifications to the *in situ* management, augmentation, or reintroduction strategies for the PUs for each taxon and

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

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

Schiedea kaalae

- **Scientific name :** *Schiedea kaalae* Wawra
- **Hawaiian name:** ma`oli`oli
- **Family:** Caryophyllaceae (Pink family)
- **Federal status:** Listed Endangered October 29, 1991
- **Requirements for MIP Stability**
  - 4 Population Units (PU)
  - 50 reproducing individuals in each PU
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology:**

– **Habit**- Coarse herb from a woody caudex; stems, 0.2-1.2 (-5) dm long, thick and somewhat fleshy, purple, ± ascending, unbranched, tortuous, internodes greatly compressed, leaves tufted at apex, glabrous.

– **Leaves**- Leaves opposite; blades (8-) 14-24 cm long, (1.5-) 2-5 (-6) cm wide, thick and coriaceous, usually somewhat irregular, either curved or concave, elliptic-oblanceolate to nearly spatulate, with only the midvein evident, the midvein ± excentric, glabrous, margin entire, apex acuminate, acute, or obtuse with a mucronate tip, base long-attenuate; petioles 0-3 cm long, purple, at least near the stem.

Modified from Wagner et al. 2005

Schiedea kaalae

- **Description and biology continued:**

– **Flowers**-Inflorescence terminal, with 20-300 flowers, 20-40 (-60) cm long, diffuse, erect, the tertiary and higher order internodes ascending or appressed; bracts subulate, purple, ciliate at least toward base, those of central axis 2-4 mm long, those of branches and flowers 1.5-3 mm long; pedicels 7-10 mm long, elongating to 15 mm long in fruit, conspicuously asymmetrically flattened. Flowers hermaphroditic. Sepals 3.5-4.1 mm long, lanceolate, purple, opaque, completely reflexed, the proximal 1/2 convex, producing an elongate low bulge, the distal part concave to shallowly navicular, usually slightly twisted, abaxial side glabrous, margin scarious, sparsely ciliate, especially toward the apex, apex attenuate. Nectary base 1-1.2 mm long, whitish purple to pale yellow, the nectary shaft 2.3-3.2 mm long, straight to gently recurved, at 90° angle to the axis, apex bifid to slit on the abaxial side. Stamens 10; filaments dimorphic, the antisepalous whorl 4.3-4.5 mm long, the alternate whorl 3.7-4 mm long; anthers 0.7-0.95 mm long, subequal, yellow. Styles 3 (-4).

– **Fruit**- Capsules ca. 3.5-5 mm long, ca. 1.6-2.2 mm in diameter, narrowly ovoid.

– **Seeds**-Seeds 1.0-1.1 mm long, orbicular-reniform, slightly compressed, transversely rugose.

Modified from Wagner et al. 2005

Schiedea kaalae

Taxonomic background: *Schiedea* is one of the largest adaptive radiations of vascular plants in the Hawaiian Islands; comprised of 34 species that evolved from a single hermaphroditic ancestor. *Schiedea kaalae* is in the section *Mononueura* and likely sister to *S. nuttallii* (Wagner et al. 2005).

- **Distribution-** O`ahu, Punaluu and Kaipapau, Koolau Mountains, and Makaleha, Pahole Gulch, Mokuleia, Puu Hapapa, Ekahanui and Huliwai, Waianae Mountains; diverse mesic forest to perhaps wet forest on steep slopes in shaded sites; 410-730m. *Schiedea kaalae* is distinctive in its habit, a perennial herb with greatly compressed internodes. Sherff recognized two varieties: var. *kaalae*, the leaves 3-6.5 cm wide, the apex rounded and with a mucronate tip, and sepals ca. 4 mm long; and var. *acutifolia*, the leaves narrower, with an acute apex, and sepals ca. 3 mm long. Several populations are now known where both variants are represented, and thus they are not given formal recognition here (also in Wagner et al. 1990). Fewer than 100 individuals are now known of *S. kaalae*, which appears to be especially susceptible to habitat degradation by feral goats and pigs. The specific epithet refers to Wawra's type locality, Mt. Kaala.

Modified from Wagner et al. 2005

Historic Collections of *Schiedea kaalae* on O`ahu

Area	Year	Collector	Pop. Reference Code/Notes
Ekahanui	1980	Takeuchi 3438	
Ekahanui	1987	Perlman obata 6107	
Hauula	1943	Degener Bush 5931	
Huliwai	1933	Russ	
Kaala	1871	Hillebrand	
Kaala	1873	Wawra 2220	
Kaipapau	1932	Degener 4153	makai of PAP-A
Kaipapau	1922-1988	Degener 5925	makai of PAP-A
Kaluaa	1977	Warshauer 1056	
Kaluaa	1987	Perlman & obata 5812	
Kaluaa	unknown	Hutchison 7368	more mauka than KAL-A
Koolau	1929	Degener 5966	
Makaleha	1869-1920	Lydgate	West Makaleha
Makaua	1983	Lau 850	
Makaua	1987	Perlman & obata 5149	main fork under Kukui tree
Makaua	1980s	Perlman & obata 5421	
Pahole	1978	Obata 344	PAH-A
Pahole	1922-1988	Degener Degener 27924	
Pualii	1980s	Takeuchi 3417	
Punaluu	1933	Swezey	
Puumaialau	1987	Takeuchi 3587	

Information compiled from Wagner et al. 2005, and Bishop Museum herbarium

Population Units

Manage For Stability Population Units	PU Type	Which Action Area is the PU inside?	Population Reference Codes	Management Units for Threat Control
Kaluaa and Waieli	Reintroduction	None	KAL-A,C	Kaluaa and Waieli
Maakua (Koolaus)	in situ and augmentation*	None	MAA-A,B	Maakua
Pahole	in situ and augmentation	MIP	PAH-A,B,C, KAP-A	Pahole & Upper Kapuna
South Ekahanui	in situ and augmentation	None	EKA-A,B,C,D	Ekahanui
Genetic Storage Population Units				
Kahana (Koolaus)	in situ and augmentation	None	KNA-A,B	PEPP fence and weed control
Makaua (Koolaus)	in situ	None	AKA-A,B,C	PEPP fence and weed control
North Palawai	Extirpated. Stock in storage and outplanted.	None	PAL-A	None
No Management (extirpated)				
Huliwai	Extirpated. Stock in storage and outplanted.	None	HUL-A	None
Kaipapau (Koolaus)	Extirpated. Stock in storage and outplanted.	None	PAP-A	None
Mohiakea	Extirpated. Stock in storage and outplanted.	SBW	SBW-A	Lihue

*= outplanting not started yet

Comments: No new sites have been discovered since the Kaipapau and Kahana plants

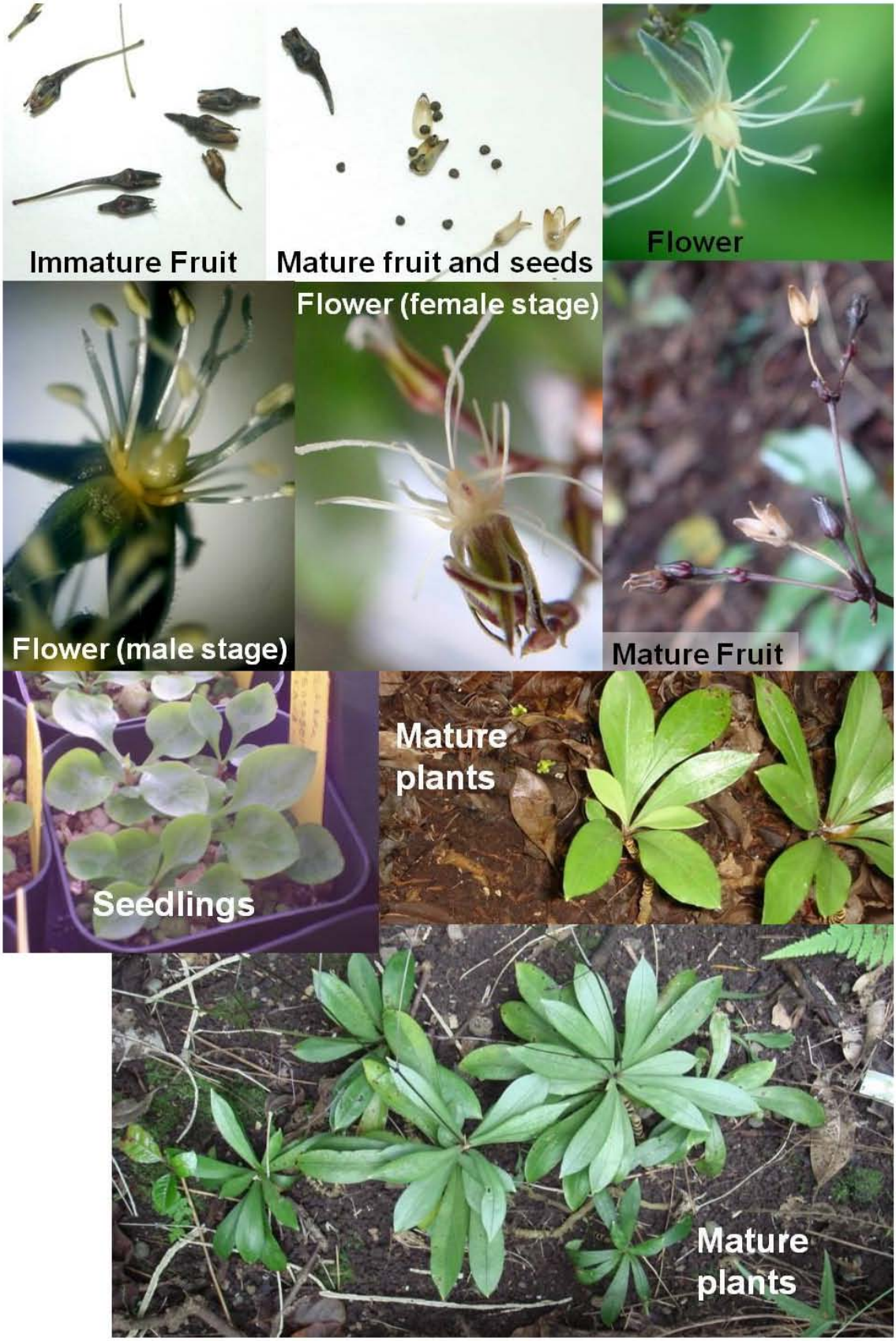
Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
ALL	Year-round[a]	Year-round[a]	Year-round[a]	Hermaphroditic[b]	Pyralid Moth[c]	4.67 ± .14	None

[a] Largest concentrations of flowering have been during winter months, and fruit production during late winter/spring months. Peak collection time is in the spring (April-May).

[b] Isolated plants are capable of self-fertilization, though pollen: ovule ratios suggest the species has a facultatively xenogamous (outcrossing) mating system (Weller et al. 1998). Historically small populations, however, suggests that the species likely has high levels of selfing.

[c] Pyralid moths have been observed visiting this species in Ekahanui (Weisenberger 2012). These moths have also been observed visiting *S. lydgatei* on Maui (Norman et al. 1997). Several reintroduction sites have been monitored for floral visitors, and only one, at Ekahanui, had any visitation by a suspected pollinator (Pyralid moth). This site was the research site of 700+ outplants of mixed founders, and is the only site with a high density of plants. This may have provided an attractive resource for the moths. Without a biotic pollinator (presumed pollination vector; Weller et al. 1998), it is likely that high levels of selfing are ongoing at all populations sites.


Immature Fruit
Mature fruit and seeds
Flower
Flower (female stage)
Flower (male stage)
Mature Fruit
Seedlings
Mature plants
Mature plants


Pahole & Kapuna reintroductions
Ekahanui *in situ* site
Waianae Mountain PUs
Koolau Mountain PUs
Makaua and Kahana

Habitat Characteristics of the Waianae PUs

PU	PRC	Elevation (ft.)	Slope	Canopy Cover	Topography	Aspect	Annual Average Max.Temp. (F)*	Average Annual Rainfall (mm)*	Average Annual Rainfall (mm)**
Huliwai	HUL-A	2140	Unknown	Unknown	Unknown	Unknown	75.20	1073	1198.2
Kaluaa & Waieli	KAL-A	2400	Steep	Closed	Mid-slope	Northeast	75.20	1256	1191.8
Kaluaa & Waieli	KAL-C	2300	Unknown	Unknown	Unknown	Unknown	75.20	1256	1196
Mohiakea	SBW-A	2220	Steep	Closed	Lower-slope	North	75.20	1395	1435.8
North Palawai	PAL-A	2410	Moderate	Closed	Mid-slope	Northeast	75.20	1073	1171.3
Pahole	PAH-A	1645	Unknown	Unknown	Unknown	Unknown	77.00	1588	1375.2
Pahole	PAH-B	1800	Moderate	Closed	Mid-slope	Unknown	77.00	1567	1329
Pahole	PAH-C	1645	Unknown	Unknown	Unknown	Unknown	77.00	1588	1381.5
Pahole	KAP-A	1800	Moderate & Steep	Intermediate	Lower Slope	Northeast Southeast	75.20	1784	1477.1
South Ekahanui	EKA-A,B,C,D	2480	Moderate	Closed	Mid-slope	Various	73.40	1178	1221.1
Summary for all Waianae sites		1645-2480	Moderate -Steep	Intermediate -Closed	Mid-lower Slope	Various	73.40-77.00	1073-1784	1171-1477.10

Information was compiled from OANRP observation forms and GIS data unless otherwise noted. Where 'unknown' is used, these characteristics have not yet been documented at those sites or are from sites where the plants are now extirpated.
*(PRISM 2004)
**(Giambelluca et al 2011)

Habitat Characteristics for the Koolau PUs

PU	*in situ* PRC	Elevation (ft.)	Slope	Canopy Cover	Topography	Aspect	Annual Average Max.Temp. (F)*	Average Annual Rainfall (mm)*	Average Annual Rainfall (mm)**
Kahana	KNA-A	1245	Flat to Moderate	Closed	Lower-slope & Gulch bottom	Northwest	75.20	2056	1724
Kaipapau	PAP-A	1150	Moderate	unknown	Mid-slope	Northwest	77.00	5122	4560.4
Maakua	MAA-A	670	Flat to Moderate	Intermediate	Lower-slope & Gulch bottom	N/A	78.80	4088	3789.2
Makaua	AKA-A	1430	Moderate	Intermediate	Gulch bottom	East	77.00	2084	1655.2
Summary for all Koolau sites		670-1430	Flat to Moderate	Intermediate to Closed	Mid-Lower Slope & Gulch bottom	East – Northwest	75.20-78.80	2056-5122	1655.2-4560.4
Summary for all Waianae sites		1645-2480	Moderate-Steep	Intermediate -Closed	Mid-lower Slope	Various	73.40-77.00	1073-1588	1171-1477.10

Information was compiled from OANRP observation forms and GIS data unless otherwise noted. Where 'unknown' is used, these characteristics have not yet been documented at those sites or are from sites where the plants are now extirpated.
*(PRISM 2004)
**(Giambelluca et al 2011)


Map removed, available
upon request

Population Structure

•The MIP assumed *S. kaalae* live less than 10 years, although a few plants have been observed to live longer. Of the thirteen *in situ* sites known since 1995, 6 were continually observed as having a single mature plant and only 3 sites, EKA-A (South Ekahanui PU), Maakua and Kahana have ever had more than 5 mature plants. Seedlings have not been observed in any of the *in situ* sites monitored since 1999. Small juvenile plants have been observed in the past at the *in situ* sites in the South Ekahanui and Kahana PUs. No *in situ* individual has ever been observed from seedling through senescence. Due to senescing mature plants and no recruitment, most PUs have been declining for many years. The plants in the Makaua PU were known to have declined from 30 individuals to a single plant within ~20 years (Joel Lau pers. comm.) due primarily to ungulate impacts. Of the 6 known population sites with only one individual in the last decade, only 3 remain. The population in Kahana has been reduced by flooding and ungulate disturbance. The largest population, in Ekahanui, has remained at a size of approximately ten plants for over the last 30 years.

•A dozen seedlings have been observed at the Kapuna reintroduction. The seedlings at Kapuna were observed within three years of the first planting and have survived to be immature plants. Two seedlings were also briefly observed at a reintroduction in Pahole (PAH-C) and have also been observed at both outplanting sites in Kaluaa. Seedlings were observed to transition to immature plants only at the Kapuna site.

•A large outplanting (700+ plants) was established in Ekahanui in 2010 as part of an outcrossing study (Weisenberger 2012). Recruitment was observed within 4 months of planting and at least one seedling was observed to transition into a mature plant 12 months later. Slugs (*Derocerus laeve)* were observed on most plants, and despite their presence and leaf damage on recruits, many seedlings and immature plants persisted.

Population structure for *S. kaalae* has been non-existent and cannot currently be used to guide outplanting strategies. Outplanting strategies are discussed in detail in the Reintroduction Plan section below.

Population Estimate History of *in situ* sites

Population Monitoring History							
YEAR	2000	2004	2005	2006	2007	2008	2011
Manage For Stability Population Units							
Maakua (Koolaus)			16/0/0			10/0/0	10/0/0
Pahole	2/0/0				2/0/0		2/0/0
South Ekahanui			17/0/0				12/0/0
YEAR	2003	2004	2005	2006	2008	2009	2011
Genetic Storage Population Units							
Kahana (Koolaus)		11/0/0			6/2/0	6/1/0	6/1/0
Makaua (Koolaus)	1/1/0	1/1/0	1/1/0	1/0/0		1/0/0	1/0/0
North Palawai	1/0/0				0/0/0		0/0/0
No Management Population Units							
Huliwai	2/0/0	1/0/0	0/0/0				0/0/0
Kaipapau (Koolaus)	2/0/0		0/0/0				0/0/0
Mohiakea	1/0/0	1/0/0	1/0/0	1/0/0	0/0/0		0/0/0

Blank boxes indicate that no changes were observed or no monitoring was done.

Monitoring Plan

- The remaining *in situ* sites: PAH-A, EKA-A, B will be monitored annually using the HRPRG Rare Plant Monitoring Form (RPMF) to record population structure and the age class, reproductive status and vigor of all known plants. The Maakua (MAA-A) site will be monitored every two years considering the difficulty of access and the relative stability of the habitat. Each site will be searched for new seedlings and all new juvenile plants will be tagged. If there is any threat to the health and safety of plants from tagging, adjustments to the method and/or number of tagged individuals will be made.
- OANRP will work with Plant Extinction Prevention Program to get monitoring data for *in situ* sites: AKA-A, KNA-A; and NARS to get data for the PAH-B site. This monitoring data will serve to document the populations at the remaining sites to guide *in situ* threat management and genetic storage needs.
- The managed reintroduction sites in all MFS PUs will be monitored annually in the winter (January-March) using the RPMF to record population structure, age class, reproductive status and vigor. All outplants will be accounted for along with a total population census (including recruits). This data will be used to guide future outplanting. The total number of mature recruits per total number of plants outplanted will be used to guide the number of outplants needed to establish 50 mature recruits. The large outplanting in Ekahanui (over 700 plants), will be monitored for replacement (ratio of cumulative mature recruits to cumulative outplants) by annual census of survival of outplants and population structure of recruits.
- Beginning in November 2011, Sluggo® will be applied to the existing EKA-D reintroduction in Ekahanui. Recruitment will be monitored and the effect of Sluggo® on recruitment will be determined (there has been no known recruitment at this site in the past). If Sluggo® increases recruitment, in may be applied at other outplanting sites if native snails are not present.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Seed + Divisions	Seed = Reintroductions; Divisions = *in situ*	Seed = -18C / 20% RH Divisions = nursery	10 years	Yes	Re-collect seed from mixed-source reintroductions. Maintain clones in the nursery.

Genetic Storage Plan Comments: A clone of every available *in situ* individual will be kept in the nursery. These plants will serve as genetic storage for these founders and be used for controlled breeding. Seeds will be collected and stored from mixed-source reintroductions to represent all genetic combinations of this species *ex situ*. OANRP will also attempt to establish explants in the micro-propagation lab from the clones in the nursery.

Reintroduction Plan for MFS PUs

Manage for Stability Population Units	Reintroduction Site(s)	Number of Plants to be Planted	Propagule Type	Propagule Population(s) Source	Total Number of Founders from Source Population (s)	Plant Size	Pot Size
Kaluaa and Waieli	KAL-C #	230 (130)	Immature Plants	KAL-A-1 EKA-A,B,C HUL-A-1 PAL-A-1 SBW-A-1	23	10-30cm	4" or 6" bulb pot
Maakua	MAA-B*	230 (0)	Immature plants	MAA,AKA, PAP,KNA‡	14	10-30cm	4" or 6" bulb pot
Pahole	PAH-C+ KAP-A #	80(77) 150(46)	Immature Plants	PAH-A-1 PAH-A-1 &PAH-B-1	1 2	10-30cm	4" or 6" bulb pot
Pahole	PAH-D*	230 (0)	Immature Plants	All (see EKA-D)	39	10-30cm	4" or 6" bulb pot
South Ekahanui	EKA-D §	TBD	Immature Plants	KAL-A-1 EKA-A,B,C HUL-A-1 PAL-A-1 SBW-A-1 PAH-A-1 PAH-B-1^	39	10-30cm	4" or 6" bulb pot

The total number to be planted at each site is given followed by the number already planted in ().
#= will be completed by February 2013; += planting complete;
*= outplanting not started yet (success of existing outplantings & Sluggo® will be monitored & analyses will benefit these reintroduction designs)
§ = will be completed by February 2013; the number to be planted with the addition of Koolau stock will be determined
‡ = plants will result from hand-pollinating Koolau stock with pollen from both Koolau and Waianae paternal populations
^= plants will result from hand-pollinating Waianae stock with pollen from both Koolau and Waianae paternal populations

Reintroduction Plan Comments

The number to plant is based on the current survival of three previous OANRP outplantings that have been in the ground for at least one year as of October 2011. Survival of individuals at OANRP outplantings in the Pahole PU differs between the two planting sites (PAH-C= 29% [12/42], KAP-A=60%[15/25]) and planting at the PAH-C site has been suspended in favor of KAP-A. Survival for individuals in the OANRP outplanting in the Kaluaa and Waieli PU (KAL-C) is 29%(60/208). Survival for plants in these three sites overall is 32% (87/275). Given this low survival, minimal or no observed recruitment at all sites and that some immature outplants fail to become reproductive before dying, the initial number to plant has been set at 230, which is more than 4x the stability goal of 50 reproducing plants for this long-lived species.

- The MAA-B site will be planned once threat control is established in this area. The results of previous outplantings, and the success of slug control may be used to redesign the proposed founder mix and number to plant.
- Planting at the PAH-C site will be suspended and the remaining plants grown from that founder will be added to the KAP-A site. This planting will be complete in the next two years and the results will determine the need for additional planting in this MFS PU.
- The PAH-D site will be planned and planted only if the outplantings at PAH-C and KAP-A fail to meet stability goals for this MFS PU. The founder mix for this sites may be changed to include all the other founders based on the results and management recommendations described below.
- The EKA-D site was initially established by TNCH and those plants are still being accounted for. Once all plants have been accounted for and the founder mix for the new plants has been finalized, the number to plant will be determined.

Reintroduction Plan Comments

•The founder mix for several outplantings has been changed due to results of a recent study that was undertaken to determine the fitness of outplants grown from seed produced by outcrossing and self-fertilization of the available stocks of *S. kaalae* (Weisenberger 2012). Results and management recommendations from this study are now being used to guide the founder mix at each outplanting. These recommendations are changes from the plan in the MIP and the following is an excerpt from the MIP 2003 to provide background for the new research and results presented below:

"Low levels of genetic diversity in *S. kaalae* populations may not be detrimental to the species, as plants from populations that appear to have undergone repeated self-fertilization are vigorous in cultivation, and are among the most vigorously growing of *Schiedea*s under greenhouse conditions (Weller pers. comm. 2000). However, if there are indications that the species' naturally-occurring or reintroduced populations are being affected by inbreeding depression, controlled experiments on the ramifications of mixing different stocks should be conducted. Plants from the Koolau and Waianae Mountain Ranges should not be mixed in reintroductions. Since many miles of unsuitable habitat separate the Waianae Range and Koolau Range populations, it is presumed that genetic communication between the two populations was rare under natural conditions. Additionally, since the Waianae and Koolau *S. kaalae* habitats are rather different, it may be especially important when reintroducing this species to utilize stock originating from the same mountain range where the reintroduction is attempted. Such stock is likely to be better adapted to the environmental conditions of the reintroduction site than stock from the other mountain range. There is a large gap between the recorded locations for *S. kaalae* in the northern Waianaes and recorded locations in the southern Waianaes. As it is possible that the northern and southern plants are genetically distinct because of the gap, the northern and southern stocks should be preserved separately. Outplanting lines have been drawn limiting the outplanting of the northern and southern stocks to their respective ends of the mountain range."

Reintroduction Plan Comments

Due to a continued decline in the plants at the *in situ* sites and very little recruitment at reintroduction sites despite years of outplanting, it became worthwhile to investigate these assumptions and re-assess the restrictions on founder stock in reintroductions. The recommendations to keep stock from each mountain range separate and to favor the use of local stock had been strictly followed in the outplantings established since the MIP in 2003. The northern Waianaes are represented by the Pahole PU and only that stock has been used there. The two available founders in the Pahole PU have also been kept separate. Since the PAH-C outplanting occurs near the PAH-A plant, only that stock has been used there. The PAH-B stock is all planted at Kapuna (KAP-A). The southern Waianaes are represented by everything south of Mt Kaala and to date, these founders have all been mixed in the same way at the South Ekahanui and Kaluaa and Waieli PUs. Also, the OPEP plantings in the Koolau Mts have used only Koolau stock.

•Results

Results indicate that there was no outbreeding depression, and offspring fitness increased with increasing distance between parent populations. This trend of increasing heterosis with increasing parental distance indicates there is likely little concern for the expression of outbreeding depression in future generations. The only hesitation towards mixing mountain ranges is the wetter habitats of the the Koolau Mt. populations, though little local adaptation was detected at the study sites. This concern can largely be avoided by planting only maternal founders from their respective mountain range, but allowing their paternal sources to be from all founders, regardless of mountain range. Offspring are relatively least fit when they are from selfed seed, and they are relatively most fit when parent populations are the furthest apart as possible (different mountain ranges). For example, selfed plants produced 6.5 times less seeds than plants with parent sources from different ranges (435 : 2840 seeds). Plants with Waianae Mt. maternal populations, however, had a lower chance of surviving at the Koolau Mt. outplanting site (Hakipuu gulch) than at a Waianae Mt. outplanting site (Ekahanui). Koolau Mt. habitats may be too wet for Waianae Mt. plants. It is, therefore, not recommended to plant a large amount of pure Waianae stock into the Koolau Mts (Weisenberger 2012).

Reintroduction Plan Comments

•Management Recommendations:

Based on these results, the reintroduction strategy should be adapted to focus on balancing among three regions: Southern Waianaes (Palawai, Ekahanui, Huliwai, Kaluaa, Mohiakea), Northern Waianaes (Pahole), and the Koolaus (Kahana, Kaipapau, Maakua, Makaua). Each region will be represented and balanced in the Waianae Mt. reintroductions and one of the Koolau Mt. reintroductions. Offspring from *ex situ* hand-pollinations crossing the 3 regions will initially be added to the existing site in Ekahanui as well as the Maakua PU. Koolau Mt. reintroductions may be most successful if the maternal source of the outplants are from the Koolaus, while the paternal source of these outplants should have all 3 regions represented equally. Producing seeds by controlled breeding of nursery stock is also a more efficient way to meet genetic storage goals and produce propagules for outplanting. Especially considering the effort to access these remote PU multiple times during fruiting season to collect the seeds as they mature. Since few seeds are available in each fruit, this effort is substantial. A large number of plants should be planted close together to potentially attract floral visitors.

–Kaluaa and Waieli: This reintroduction will be completed using stock from the southern Waianae Mt. region. This will serve to preserve the 'pure' stock from these plants and may be used to compare with the mixed stock outplantings in the South Ekahanui PU.

–Maakua: This reintroduction will begin after threat control and management options are better assessed. All of the founders from the Koolau region will be balanced in this augmentation from plants propagated from *ex situ* hand-pollinations. Every Koolau founder will receive mixed pollen loads (multiple donors) from both the Waianae and Koolau Mts. This site will serve as a source for storing seed from a mixed source planting.

–South Ekahanui: New additions to this reintroduction will be made with outplants grown from *ex situ* hand-pollinations crossing the 3 regions. Clones of the *in situ* plants will be secured *ex situ*. Every Waianae founder will receive mixed pollen loads (multiple donors) from both the Waianae and Koolau Mts. This site will also serve as a source for storing seed from a mixed source planting.

–Pahole: The PAH-A and PAH-B stock will be used to complete the KAP-A planting. The status relative to the stability goals and available management options will be assessed in 2013. If stability cannot be achieved with current founder representation within a couple years, the PAH-D reintroduction will be initiated with the propagules from *ex situ* hand-pollinations crossing all three regions.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are there enough propagules in Genetic Storage?
Kaluaa	Yes	No	Yes	Yes	No	Partial	No	n/a	Yes
Maakua	No	No	No	No	No	No	No	n/a	No
Pahole	Yes	No	Yes	Yes	No	Partial	No	n/a	Yes
South Ekahanui	Yes	No	Yes	Yes	Yes	Partial	Partial	n/a	No
Genetic Storage Population Units									
Kahana	No	No	Yes	No	No	No	No	n/a	Yes
Makaua	No	No	Yes	No	No	No	No	n/a	Yes
North Palawai	No	No	Yes	No	No	No	No	n/a	Yes
No Management Population Units									
Huliwai	n/a								Yes
Kaipapau	n/a								Yes
Mohiakea	n/a								Yes

5 Year Action Plan

	Proposed Actions for the following years:				
Population Unit	**MIP YEAR 8 October 1 2011 – September 31 2012**	**MIP YEAR 9 October 1 2012 – September 31 2013**	**MIP YEAR 10 October 1 2013 – September 31 2014**	**MIP YEAR 11 October 1 2014 – September 31 2015**	**MIP YEAR 12 October 1 2015 – September 31 2016**
Kaluaa and Waieli	•Monitor Annually (KAL-B, KAL-C) •Collect seed for storage	•Monitor Annually (KAL-B, KAL-C) •Complete Reintroduction •Sluggo® Treatment	•Monitor Annually (KAL-B, KAL-C) •Sluggo® Treatment	•Monitor Annually (KAL-B, KAL-C) •Sluggo® Treatment •Review and adapt management	•Monitor Annually (KAL-B, KAL-C) •Sluggo® Treatment
Maakua (Koolaus)	•Monitor and assess threat control and augmentation options •Controlled breeding of cloned stock	•Monitor •Select and prepare outplanting site	•Establish reintroduction (MAA-B)	•Monitor •Complete Reintroduction	
Pahole	•Monitor Annually •Collect seed for storage	•Monitor Annually •Complete Reintroduction	•Monitor Annually •Collect seed for storage •Review and adapt management	•Monitor Annually	•Monitor Annually
South Ekahanui	•Continue Reintroduction •Monitor Annually •Sluggo® Treatment •Controlled breeding of cloned stock	•Complete Reintroduction •Monitor Annually •Sluggo® Treatment •Collect seed for storage	•Monitor Annually •Sluggo® Treatment	•Monitor Annually •Sluggo® Treatment •Review and adapt management	•Monitor Annually •Sluggo® Treatment
Kahana (Koolaus)	•PEPP Monitor Annually and Collect seed for storage				
Makaua (Koolaus)	•PEPP Monitor Annually and Collect seed for storage				

COMMENTS: The reintroductions at the Kaluaa and Waieli, Pahole and the South Ekahanui PUs will all be complete by 2013. Management reviews are planned within two years of completing the plantings to evaluate the success of the sites relative to stability goals. Additional management actions such as more threat control and planting, will be prioritized as needed.

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Schiedea nuttallii

- **Scientific name:** *Schiedea nuttallii* Hooker.
- **Hawaiian name:** None known
- **Family:** Caryophyllaceae (Pink family)
- **Federal status:** Listed endangered October 10, 1996
- **Requirements for Makua Implementation Plan Stability**
  - 3 Population Units (PUs)
  - 50 reproducing individuals
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology*:**

– **Habit-** Erect to strongly ascending subshrubs 10-15 (-19) dm tall; stems many-branched, glabrous throughout, except bracts and sepals, internodes purple-tinged.

– **Leaves**- Leaves opposite; blades 5-13 cm long, 1.4-3.5 cm wide, narrowly ovate or lanceolate to narrowly or broadly elliptic, dull green, sometimes purple-tinged, slightly thickened and rubbery, chartaceous when dry, with only the midvein evident, the midvein ± slightly excentric, margin entire, slightly thickened becoming revolute toward the base, apex acute to acuminate; petioles 0.3-1 cm long, weakly ± grooved.

*Description and biology modified from *Wagner et al. 2005*

Schiedea nuttallii

Description and biology continued:

– **Flowers**- Inflorescence terminal, with 50-240 flowers, 20-25 (-32) cm long, diffuse, erect, the tertiary and higher level internodes or pedicels usually ascending or appressed, but pedicels usually spreading at anthesis, sometimes with a few hairs toward the base of the internodes; bracts subulate, the lowermost of central axis elliptic, green and purple-tinged or purple, margins ciliate, the lower ones 2-60 mm long, those of branches and flowers 1.5-2 mm long; pedicels 6-12 mm long at anthesis, elongating to 10-20 mm long in fruit, conspicuously asymmetrically flattened and weakly quadrangular, sometimes with a few hairs toward the base on the angles. Flowers hermaphroditic. Sepals 3.5-4.5 mm long, lanceolate, green, sometimes purple-tinged or nearly purple throughout, opaque, strongly reflexed and convex in the proximal 1/4, producing a small transverse bulge, the distal part concave or shallowly navicular, oriented at 5° to 30° angle to the pedicel, abaxial side glabrous, margins conspicuously scarious, ciliate, apex attenuate, often slightly twisted. Nectary base 0.7-1 mm long, yellow, the nectary shaft 2.8-3.7 mm long, gently recurved, at 90° angle to the axis, apex deeply bifid to ca. 1/2 their length. Stamens 10; filaments dimorphic, the antisepalous whorl 5.8-7.1 mm long, the alternate whorl 4.8-5.5 mm long; anthers 0.7-1.1 mm long, subequal, pale yellow. Styles 3.

– **Fruit**-Capsules 2.5-3.5 mm long. narrowly ovoid.

– **Seeds**- Seeds 0.9-1 mm long, orbicular-reniform, compressed, the surface rugose.

Modified from Wagner et al. 2005

Schiedea nuttallii

Description and biology continued:

–Distribution- In the Hawaiian Islands, endemic to O`ahu, Moloka`i, Maui. O`ahu(in Waianae from Ekahanui Gulch to Mokuleia and Koolau ranges; also formerly from Nuuanu pali, and Manoa and Niu Valleys, but not collected since 1922), Molokai (Kalae and Kamalo, not collected since 1910), and Maui (probably West Maui, not collected since 1792 [1793]); in diverse mesic forest; 350-760 m. *Schiedea nuttallii* formerly had one of the widest geographical ranges in the genus, but it is now restricted to a few populations in the northern Waianae Mountains.

–Pollination and dispersal- *Schiedea nuttallii* belongs to a subgroup of *Schiedea* species that are probably either insect-pollinated, wind –pollinated, bird-pollinated, or autogamous (Wagner *et al.* 2005). Dispersal agents for the subspecies of *S. nuttallii* that includes the Waianae Range plants are unknown.

Taxonomic background: *Schiedea nuttallii* is morphologically similar to *S. kauaiensis*, *S. laui*, *S. jacobii*, and *S. implexa*. These four species share an erect habit, but differ primarily in the size of the inflorescence and flower. *Schiedea kauaiensis* differs from *S. nuttallii* in its fewer-flowered, open, sparsely to moderately puberulent inflorescences, and larger flowers and leaves, whereas *S. implexa* is characterized by numerous small flowers, a glabrous or puberulent inflorescence, and narrow leaves. *Schiedea jacobii* has smaller, facultatively autogamous flowers; the seeds are retained in capsules. *Schiedea laui* differs primarily in having cleistogamous flowers.
Modified from Wagner et al. 2005

Historic Collections of *Schiedea nuttallii* on O`ahu Information compiled from Wagner et al. 2005, and Bishop Museum herbarium

Area	Year	Collector	Pop. Reference Code
Ekahanui	1946	St. John 21536	
Ekahanui	1978	Obata 402	
Ekahanui	1922-1988	Degener 17493	
Haleauau	1934	Bryan 851	
Huliwai	1933	Russ	
Kaala	1908	Forbes 1781	
Kaala	1933	Swezey 12770	
Kaala	1922-1988	Degener 17694	
Kahanahaiki	1982	Lau 830	MMR-B
Kahanahaiki	1922-1988	Degener 5918	
Kalena	1938	Selling 3608	
Kanehoa	1932	Webster 1644	
Keawapilau	1991	Welton Haus 632	PIL-A
Makaleha	1870	Lydgate	
Makaleha	1918	Rock 17004	
Makaleha	1947	Sakimura	
Manoa		Skottsberg 251	
Niu	1867	Hillebrand & Lydgate	
Nuuanu	1834	Nuttall	
Nuuanu	1909	Faurie 1091	
Ohikilolo	1922-1988	Degener 5921	
Pahole	1962	Degener 27959	
Pahole	1973	Herbst 3083	
Pahole	1982	Obata 442	PAH-A
Pahole	1987	Perlman & Obata 5279	PAH-A
Pahole	1991	Welton 768	PAH-A
Pauoa	1864	Brigham 370	
Puu Kanehoa	1940	Degener 12799	
Puu Kanehoa	1948	Cowan 1038	
Puu Kumakalii	1937	Fosberg 13644	
Puu Kumakalii	1922-1988	Degener 17494	
Waianae	1909	Faurie 1083	

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Area	Year	Collector	Pop. Reference Code
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Kaala	1933	Swezey 12770	
Kaala	1922-1988	Degener 17694	
Kahanahaiki	1982	Lau 830	MMR-B
Kahanahaiki	1922-1988	Degener 5918	
Kalena	1938	Selling 3608	
Kanehoa	1932	Webster 1644	
Keawapilau	1991	Welton Haus 632	PIL-A
Makaleha	1870	Lydgate	
Makaleha	1918	Rock 17004	
Makaleha	1947	Sakimura	
Manoa		Skottsberg 251	
Niu	1867	Hillebrand & Lydgate	
Nuuanu	1834	Nuttall	
Nuuanu	1909	Faurie 1091	
Ohikilolo	1922-1988	Degener 5921	
Pahole	1962	Degener 27959	
Pahole	1973	Herbst 3083	
Pahole	1982	Obata 442	PAH-A
Pahole	1987	Perlman & Obata 5279	PAH-A
Pahole	1991	Welton 768	PAH-A
Pauoa	1864	Brigham 370	
Puu Kanehoa	1940	Degener 12799	
Puu Kanehoa	1948	Cowan 1038	
Puu Kumakalii	1937	Fosberg 13644	
Puu Kumakalii	1922-1988	Degener 17494	
Waianae	1909	Faurie 1083	

Schiedea nuttallii Population Units

Manage For Stability Population Units	PU Type	Army Action Area	Population Reference Codes	Management Units for Threat Control
Kahanahaiki to Pahole	in situ and augmentation	MMR	MMR-B,C,D, PAH-A, PAH-B, PAH-D, PAH-E	Kahanahaiki & Pahole
Kapuna-Keawapilau Ridge	Reintroduction	MMR	PIL-A, PIL-B	Upper Kapuna
Makaha	Introduction	None	MAK-A, MAK-B	Makaha I & II

The three remaining *in situ* sites in the Kahanahaiki to Pahole PU (MMR-B, PAH-A, PAH-B), and the extirpated site in the Kapuna-Keawapilau Ridge PU (PIL-A) have been known since at least the early 1990's. No other locations have been found since then.

Schiedea nuttallii Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
ALL	Jan-Aug	Mar-Aug	Mar-Sep	Hermaphroditic	Insect-pollinated	4 ± 1	None

- Suspected pollinator: *S. nuttallii* plants were determined not to be wind-pollinated after using wind tunnel experiments to quantify pollen dispersal (Weller et al. 1998), and are presumed to be pollinated by insects or birds. Non-native Syrphid flies were the only floral visitors observed during 30 hours of monitoring plants in the largest reintroduction site in 2010. Pyralid moths (seen on *S. kaalae* and *S. lydgatei* flowers) are proposed as potential native pollinators (Norman et al. 1997, Weisenberger unpubl. data). This species can easily self-fertilize when isolated and may currently have high levels of selfing at all remaining sites.
- Peak collection time =spring (April-May). First check for mature fruit should be April 1.

Mature Plant

Outplants and recruitment at the PAH-D reintroduction site

Schiedea nuttallii Habitat Characteristics

PU	PRC	Elevation (feet)	Slope	Canopy Cover	Topography	Aspect	Annual Average Maximum Temp. (F)*	Average Annual Rainfall (mm)*	Average Annual Rainfall (mm)**
Kahanahaiki to Pahole	MMR-B *in situ*	2000	Moderate	Intermediate	Upper slope	North	75.20	1561 (least)	1367.3 (least)
Kahanahaiki to Pahole	PAH-A *in situ*	2360	Steep & Moderate	Intermediate	Upper slope	Northeast	75.20	1766	1505.5
Kahanahaiki to Pahole	PAH-B *in situ*	1680	Moderate	Closed	Lower slope	Northeast	77.00	1588	1375.2
Kahanahaiki to Pahole	PAH-D Reintro	2120	Moderate	Intermediate	Upper slope	North	75.20	1619	1383.6
Kahanahaiki to Pahole	PAH-E Reintro	2160	Moderate	Intermediate	Upper slope	North	75.20	1619	1383.6
Kapuna-Keawapilau Ridge	PIL-A *in situ*	2160	Moderate	Closed	Upper slope	North	75.20	1781	1565.5
Makaha	MAK-A Reintro	2600	Steep	Open	Crest	West	73.40	1946	1768.5
Makaha	MAK-B Reintro	2560	Steep & Moderate	Intermediate	Upper Slope	Northwest	73.40	1946 (most)	1857.3 (most)
Summary for all sites		1680-2600	Steep-Moderate	Open-Closed	Lower-Upper Slope & Crest	Northwest-Northeast	73.40-77.00	1561-1946	1367.3-1857.3

Information was compiled from OANRP observation forms and GIS data unless otherwise noted.
*(PRISM 2004)
**(Giambelluca et al 2011)


Map removed, available
upon request


Map removed, available
upon request

Population Structure and Planning for Outplanting

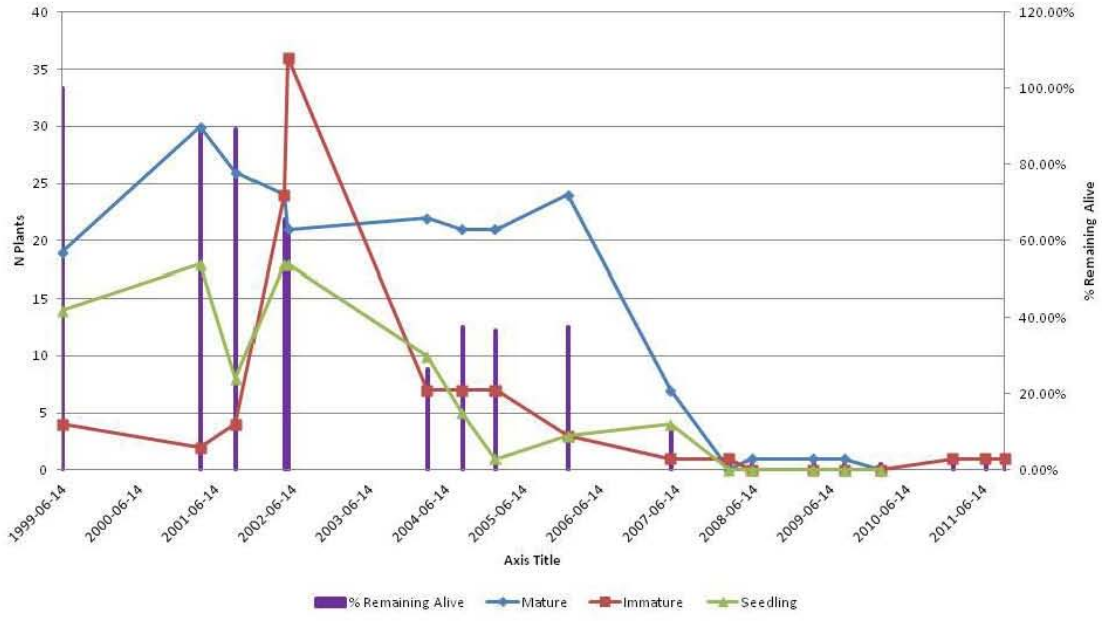
The population structure of the remaining *in situ* sites of *S. nuttalii* (and many other IP taxa) are unable to serve as examples of stable or increasing populations that support ≥50 mature plants. Therefore, measures taken from monitoring data of the population structure in established outplantings are used to guide future numbers to outplant for all taxa in this situation. Initially, before recruitment has begun in a reintroduction, the survival of mature outplants is used to guide how many plants above the stability goal (50 plants for *S. nuttalii*) should be planted to maintain the goal. This first measure is the 'survival ratio' of alive, mature outplants over the cumulative number of outplants (Fig. 4). This will help plan for the survival of ≥50 mature outplants. At first, the stability goal is met by having ≥50 mature outplants. However, as the outplants begin to decline, the resulting recruitment must produce enough mature plants to maintain a stable population or additional outplanting may be needed.

As recruitment begins to occur at an outplanting site, and as recruits mature and reproduce, population structure data from annual census monitoring can be used to guide how many outplants are needed to reach, and maintain, the stability goal of ≥50 reproducing plants without additional outplanting (Fig. 4). This second measure is the 'replacement ratio' of mature recruits over the cumulative number of outplants.

Once mature recruits are established and reproducing at an outplanting site, a third measure can be incorporated into outplanting planning. Age and/or size-class transition data (vital rates) and a population matrix projection model can be used to predict population growth and anticipate declines below stability goals over a longer period that could be mitigated with additional outplanting and/or threat control.

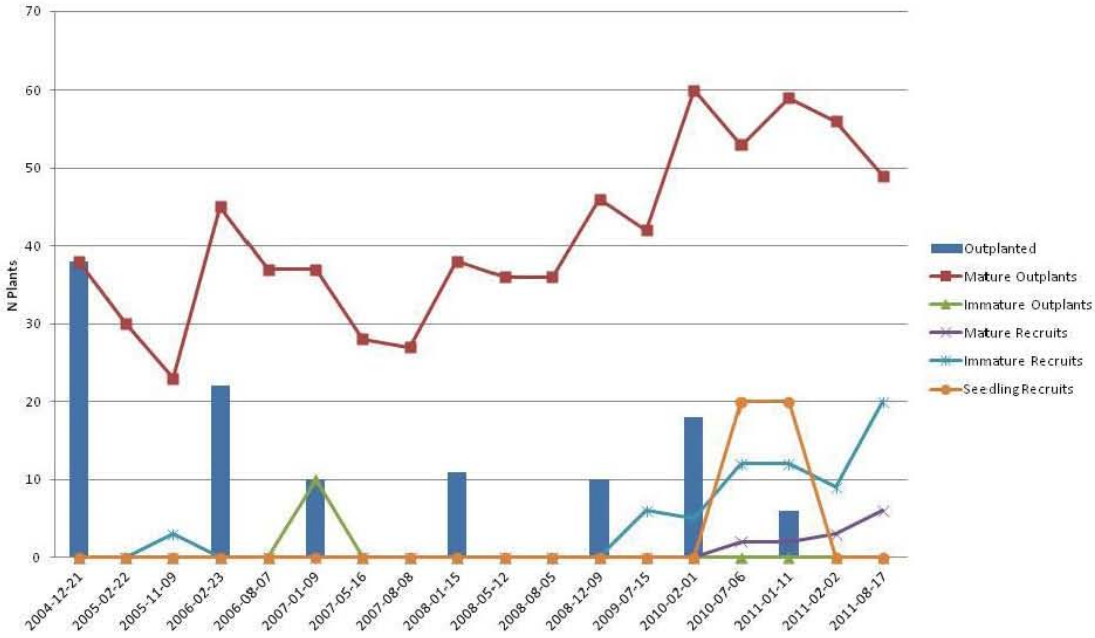
The monitoring data needed to obtain these three measures is described in the Monitoring Plan. Details on how these population structure measures are incorporated into future reintroduction planning for *S. nuttalii* is discussed further in the Reintroduction Plan Comments.

Fig. 1: Population Structure of *S. nuttallii* MMR-B, wild site



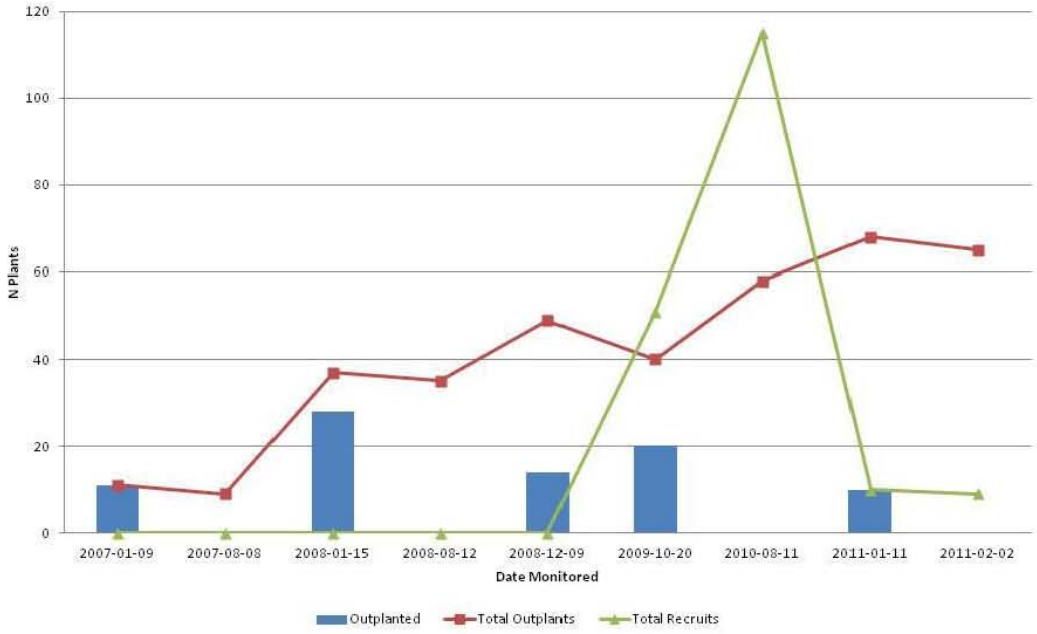
The blue line shows the total number of mature plants observed. The number of immature plants is depicted by the orange line and seedlings by the green line. The purple bars show the percentage of all the tagged, mature plants that are alive at each successive observation date. While the purple bars show that the tagged plants were dying, they were being replaced with new mature plants keeping the total number of matures were moderately constant from 1999-2006.

Fig. 2: Population Structure *S. nuttallii* PAH-D



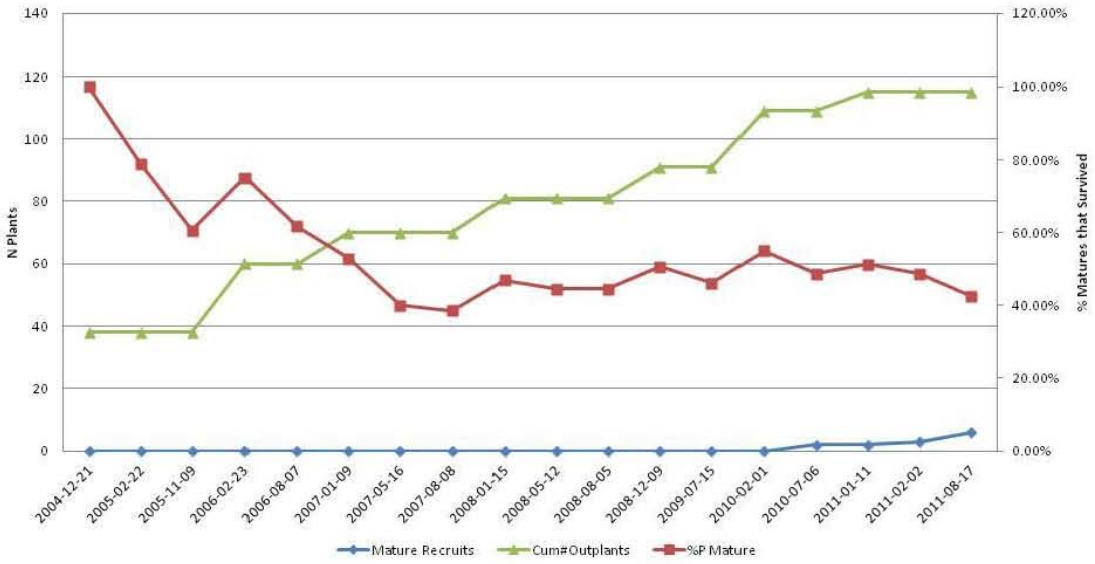
This graph depicts the population structure observed at this reintroduction since 2004. The blue bars represent the total number of plants outplanted on a given day. The lines correspond to different size classes of both outplants and recruits. Recruitment was initially observed in 2005 but those plants did not survive. Recruitment was observed again in 2008 and those plants have matured and the number is currently increasing.

Fig. 3: Population Structure *S. nuttallii* PAH-E



This graph depicts population structure at this reintroduction since 2007. The blue bars represent the total number of plants outplanted on a given day and the red line shows the total number of alive outplants over time. The green line depicts recruitment of immature plants beginning in 2009.

Fig. 4: Survivorship & Replacement: *S. nuttallii* PAH-D



This graph displays the population structure data that are used to guide how many outplants are needed to create a stable population with ≥50 reproducing plants. These measures are discussed in the 'Population Structure and Planning for Outplanting' and 'Reintroduction Plan' sections. The red line shows the percentage of outplants that matured and are alive. This is Measure 1, the 'survival ratio'. The cumulative number of plants ever planted are shown in green, and the cumulative number of mature recruits in blue. These are used to obtain Measure 2, the 'replacement ratio'.

Monitoring Plan

- All *in situ* sites (PAH-A, MMR-B) will be monitored annually using the HRPRG Rare Plant Monitoring Form (RPMF) to record population structure and the age class, reproductive status and vigor of all known plants. The site will be searched for new seedlings and all new juvenile plants will be tagged. If there is any threat to the health and safety of plants from tagging, adjustments to the method and/or number of tagged individuals will be made. This monitoring data will serve to document the populations at the remaining sites to guide *in situ* threat management and genetic storage needs.

- The reintroduction sites in all PUs will be monitored annually in the winter (January-March) using the 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 obtain the survival and replacements ratios that will guide future outplanting.

- New juvenile F1 plants at PAH-D, PAH-E and MAK-A will be tagged until a total of 50 have been tagged at each of these three sites. The annual survival (RPMF- Vigor) of these tagged F1 plants will be recorded along with the rest of the plants using the RPMF. This data will be used to document life-history data and measure vital rates. These rates may be later used in conjunction with population census data to obtain a population growth rate, compare the importance of each vital rate (i.e. seedling-juvenile vs. juvenile-mature) and explore results of differing management such as slug control. The results of this analyses are the third measure used to adjust the number of outplants planned for future nearby reintroductions (PIL-C, MAK-B) and to augment or replace underperforming sites if a decline is anticipated.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.
Seed	Reintroductions	Seed Storage: -18C / 20% RH	≥ 10	Yes	Single and Mixed-Source Reintroductions

Genetic Storage Plan Comments: The re-collection interval to replace *S. nuttallii* seeds in storage will be extended until a decline in viability is detected, at which time the re-collection interval will be set and testing will cease. No decline has been detected after 10 years of storage. Seed will be collected for storage from the largest outplanting sites (PAH-D and PAH-E). Collections are ongoing and re-collections will be necessary starting in 2012. Once the new reintroductions are established, seeds will be stored from those mixed-founder reintroductions as well. A living collection of clones collected from the PAH-A, PAH-B, and MMR-B sites will be maintained in the nursery to produce outplants and may be used for controlled breeding. Seeds collected from the PIL-A stock at UC Irvine will be obtained, stored and propagated and kept in the nursery as well.

Reintroduction Plan

Manage for Stability Population Units	Reintroduction Site(s)	Number of Plants to be planted	Propagule Type	Propagule Population(s) Source	Number of Founders in	Plant Size	Pot Size
Kahanahaiki to Pahole	PAH-D §	125 (115)	Plants from cuttings	MMR-B	30	20-50cm, multi-branched	4-6-inch
Kahanahaiki to Pahole	PAH-E +	100 (84)	Plants from cuttings	PAH-A & B	18	20-50cm, multi-branched	4-6-inch
Kapuna-Keawapilau Ridge	PIL-B *	200 (0)	Plants from cuttings	MMR-B, PAH-A & B, PIL-A	50	20-50cm, multi-branched	4-6-inch
Makaha	MAK-A +	100 (34)	Plants from cuttings	MMR-B, PAH-A & B, PIL-A	50	20-50cm, multi-branched	4-6-inch
Makaha	MAK-B #	100 (0)	Plants from cuttings	MMR-B, PAH-A & B, PIL-A	50	20-50cm, multi-branched	4-6-inch

§ = to be completed in 2011 += to be completed in 2012 *=will begin in 2012 #= will begin in 2014

The total number to be planted at each site is given followed by the number already planted in (). The number to be planted at each site is currently determined by factoring in the survival of previous plantings at Pahole and Makaha (Measure 1) and the number of mature recruits produced by the surviving outplants at Pahole (Measure 2).

Measure 1 Survival Ratio: A survival of 48% for *S. nuttallii* was determined by averaging survival for cohorts planted prior to 2010 at: PAH-D, PAH-E, and MAK-A. **Measure 2 Replacement Ratio**: The ratio of the cumulative sum of mature recruits at PAH-D and PAH-E to the total outplanted gives a replacement value of 1:20 or one mature recruit for every 20 outplants. Since recruitment just recently began to increase at these sites (<3 years), the survival ratio was used as a 2x multiplier of the goal for each PU and the replacement ratio was used as a guide (also 2x) instead of a direct multiplier. Incorporating these values, the target number to plant in order to reach to goal of ≥50 reproducing plants in each PU has been quadrupled to 200 at least outplants. The data from survival and replacement will continue to be updated and used to guide the number of outplants used to supplement those sites and in planning future efforts in the Kapuna-Keawapilau Ridge and Makaha PUs.

Reintroduction Plan Comments

A recent study (Weisenberger 2012) was undertaken to determine the fitness of outplants grown from seed produced by outcrossing and selfing the MMR-B and PAH-A founders of *S. nuttallii*. The PAH-B plant was not used due to unique morhphology and the possibility of hybridzation with another species of *Schiedea*. The Keawapilau stock was not included because there were no known sources until 2011, when it was realized that there are two founders represented in an *ex situ* greenhouse collection at UC Irvine. Seed from these Keawapilau founders should be available in 2012. Results and management recommendations from this study are being used to guide the founder mix at each outplanting and are summarized here for each wild site:

The Kahanahaiki (MMR-B) stock does not show inbreeding depression, outbreeding depression, or heterosis and is relatively less fit than stock from Pahole (PAH-A). The recommended reintroduction strategy for the Kahanahaiki stock is to complete the planting of all Kahanahaiki stock into the PAH-D site. Also, the Kahanahaiki stock should be included in a multi-source reintroduction of the Pahole, Kahanahaiki, and Keawapilau stock that will be used for outplantings in the Kapuna-Keawapilau Ridge and Makaha PUs. If outplantings do not achieve stability goals for each PU within five years of establishment, more plants should be planted and the switch to plants grown from controlled breeding of all available founders should be considered.

Pahole plants (PAH-A) do not suffer from inbreeding depression and do not express heterosis upon outcrossing with Kahanahaiki (MMR-B). Possible weak outbreeding depression was detected in outcrossed plants (PAH-A x MMR-B) in Kahanahaiki (Weisenberger 2012). The second filial generation (F2) may be observed in the common garden study site to determine if outbreeding depression is detected in that generation, where continued outcrossing may cause more outbreeding depression to be expressed. The Pahole reintroduction (PAH-E) should (and currently does) only include Pahole stock. Also, the Pahole stock, despite potential outbreeding depression, should be included in a multi-source reintroduction with Kahanahaiki, and Keawapilau stock in the Kapuna-Keawapilau Ridge and Makaha PUs. This is recommended because the Pahole stock is relatively more fit in comparison to the Kahanahaiki stock, and its addition to the reintroduction may provide the best chance for representing Kahanahaiki (and potentially Keawapilau) stock in a successful reintroduction. If these outplantings do not achieve stability goals for each PU within five years of establishment, more plants should be planted and the switch to plants grown from controlled breeding of all available founders should be considered.

Reintroduction Plan Comments

The PAH-B site consists of one plant further down gulch from the PAH-A site. It is in a slightly different habitat and has a slightly different habit (Longer leaves, more vine-like, longer internodes along stem and inflorescences). When the plant is cloned or seedlings propagated, the resulting plants are much more similar to other populations, suggesting phenotypic plasticity as opposed to genetic variation as the source for morphological differences. Molecular variation will be quantified for this species. If there is a similar or lower amount of variation between PAH-B and PAH-A as compared to the intrapopulation variation of PAH-A, PAH-B stock can be mixed with PAH-A stock in Pahole.

Stock from the extirpated *in situ* site at Keawapilau (PIL-A) has been maintained in cultivation at UC Irvine by Drs. Stephen Weller and Ann Sakai. Propagules from these plants will be used in the outplantings in the Kapuna-Keawapilau Ridge and Makaha PUs and in future controlled breeding of nursery stock.

Very little pollinator activity was observed at the PAH-D site in 2010 (Weisenberger 2012) and it is possible the current populations are too small and fragmented to attract effective pollinators (Groom 1998, Kolb 2008). Also, outplants are short-lived (average 5-10 years [PAH-D]), and produce seeds for a few years yielding only a few cohorts. The density and total number of outplants may need to be increased to attract pollinators and produce a large quantity of seeds within the first few years of planting.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are there enough propagules in Genetic Storage?
Kahanahaiki to Pahole	YES	NO	YES	YES	YES	N/A	N/A	N/A	PARTIAL
Kapuna-Keawapilau Ridge	YES	NO	YES	NO	No	N/A	N/A	N/A	NO
Makaha	NO	NO	YES	YES	No	N/A	N/A	N/A	N/A

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

	Proposed Actions for the following years:				
Population Unit	**MIP YEAR 8 October 1 2011 – September 31 2012**	**MIP YEAR 9 October 1 2012 – September 31 2013**	**MIP YEAR 10 October 1 2013 – September 31 2014**	**MIP YEAR 11 October 1 2014 – September 31 2015**	**MIP YEAR 12 October 1 2015 – September 31 2016**
Kahanahaiki to Pahole	•Monitor Annually (MMR-B, PAH-D, PAH-E) •Collect seeds for storage (PAH-D, PAH-E)	•Monitor Annually (MMR-B, PAH-D, PAH-E) •Complete Reintroduction •Collect seeds for storage (PAH-D, PAH-E)	•Monitor Annually (MMR-B, PAH-D, PAH-E) •Review and adapt management	•Monitor Annually (MMR-B, PAH-D, PAH-E)	•Monitor Annually (MMR-B, PAH-D, PAH-E)
Kapuna-Keawapilau Ridge	•Prepare planting sites	•Begin reintroduction	•Monitor Annually •Complete reintroduction	•Monitor Annually	•Monitor Annually •Review and adapt management
Makaha	•Monitor reintroduction at MAK-A Annually	•Monitor Annually •Complete reintroduction at MAK-A	•Monitor Annually •Review and adapt management	•Monitor Annually •Begin reintroduction at MAK-B	•Monitor Annually

Review and adapt management: The status of each PU in relation to the IP stabilization goals, population structure trends from monitoring data, and threats to each site will be assessed. This will be done within a couple of years of the planting being complete. If PUs are not meeting stability goals, management may be adapted to control threats to plants in affected age classes, the number of outplants may be increased and the founder sources may be changed.

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Schiedea obovata

- **Scientific name:** *Schiedea obovata* Sherff
- **Hawaiian name:** None
- **Family:** Caryophyllaceae
- **Federal status:** Listed Endangered October 29, 1991
- **Requirements for MIP Stability**
  - 3 Population Units (PU)
  - 100 reproducing individuals in each PU
  - Stable population structure
  - Threats controlled
  - Complete genetic representation of all PUs in storage
- **Description and biology*:**

– **Habit-** Suberect or ascending, branched shrubs 3-10 dm tall, glabrous throughout except for the leaf margins.

– **Leaves**- Leaves opposite; blades 4-11 cm long, (1.5-) 2.5-5 (-6.8) cm wide, thick and somewhat fleshy, light green becoming yellowish white toward the base and at the apex (youngest yellowish white, sometimes purple tinged), elliptic to broadly elliptic, sometimes obovate or oblanceolate, with 3 principal veins, sometimes also with an inconspicuous looping pair of veins near the margins, margins serrulate, the teeth with antrorsely hooked hairs ca. 0.1-0.2 mm long, apex mucronate; petioles 1-3 (-3.8) cm long, yellowish white.

*Description and biology modified from *Wagner et al. 2005*

Schiedea obovata

- **Description and biology continued*:**

– **Flowers**- Inflorescence pseudoaxillary, with 22-33 flowers, somewhat congested; bracts much smaller than uppermost leaves, usually curled and twisted, lowest pair to 1.4 cm long; peduncles (2-) 5-25 mm long, not elongating much in fruit, the internodes of the lateral inflorescence branches 2-10 mm long; pedicels thinner, 15-30 mm long, elongating mostly just prior to anthesis. Flowers apparently adapted for bird pollination, pendent. Sepals (4-) 5 (-6), often variable on the same plant, 7-8.4 mm long, 5.5-6 mm wide, enlarging to 9-12 mm long and 8-9 mm wide in fruit, white adaxially, the outer ones oblong-elliptic, pale green abaxially, inner ones elliptic to obovate, greenish white with a green midrib, the apex broadly obtuse and usually retuse, the outer ones sometimes with a subapical minute mucro, becoming dark purple and fleshy as fruit matures. Stamens (8-) 10 (-12); filaments 4.4-5 mm long, subequal; anthers 1.9-2.65 mm long, pale reddish purple at anthesis, changing to a darker reddish purple, the pollen gray. Nectary ring bright green, the flap-like extensions weakly connate at the base, thin, translucent, 2.2-2.5 mm long, irregularly 2-toothed to subentire. Styles (4-) 6-7 (-8), often variable in number on the same plant.

– **Fruit**- Capsules 9-12 mm long, ovoid to subglobose.

– **Seeds**- Seeds 1.2-1.5 mm long.

*Modified from *Wagner et al. 2005*

Schiedea obovata

- **Description and biology continued*:**
- **Distribution-** O`ahu, formerly nearly throughout the Waianae Mountains, now restricted to the north end of the Waianae Mountains; rare and scattered on ridges and slopes in diverse mesic forest; 550-800 m.

- **Pollination and dispersal-** Passerine birds have been suspected pollinators due to nectar concentration and amount (Weller et al. 1998), but no birds have been observed visiting this species (Weisenberger 2012). The fleshy dark purple sepals surrounding the mature capsules of the this species (along with *S. trinervis*) are unique in the Caryophyllaceae and may have attracted birds as dispersal agents.

- **Taxonomic background*:** There are 34 species in the endemic genus *Schiedea*. All species have been shown to have arrived from one single colonization. The name *Schiedea obovata* was changed from *Alsinidendron obovatum* after molecular and morphological data from Wagner *et al.* (2005), concluded that *Alsinidendron* formed a monophyletic group within *Schiedea*. *Alsinidendron* has since been subsumed into the Hawaiian endemic genus *Schiedea*. *Schiedea obovata* is differentiated from the closely related *S. trinervis* by its more congested inflorescence, flowers that open fully during anthesis and have greater nectar production, and thicker leaves, the young ones whitish green. It grows in mesic forests at lower elevations than *S. trinervis*. The congestion in the inflorescence of *S. obovata* appears to be primarily due to the reduction of the internodes of the lateral inflorescence branches and to the delayed elongation of the pedicels until just prior to anthesis.

*Modified from *Wagner et al. 2005*

Historic Collections of *Schiedea obovata*

Information compiled from Wagner et al. 2005, and Bishop Museum herbarium

Area	Year	Collector	Pop. Reference Code
Kaluaa	1978	Takeuchi	
Keawapilau	1980s	Welton	PIL-A
Makaleha	1978	Gagne & Gagne	LEH-B
Mokuleia	1908-1920	Forbes 1833	
Pahole	1932	Degener et al 5945	PAH-A
Pahole	1934	Onouye	PAH-A
Pahole	1934	St John 14803	
Pahole	1973	Nagata & Obata 1167	PAH-C
Pahole	1975	Herbst & Obata 5360	
Pahole	1987	Perlman & Obata 5800	PAH-A
Pahole	1987	Perlman 6472	PAH-A
Palehua	1911	Forbes 1680	
Palehua	1927	Degener Horner 5930	
Palehua	1929	Russ	
Palehua	1929	St John 9888	
Palehua	1931	Degener Park 5928	
Palehua	1933	Judd	
Palehua	1933	Russ	
Palehua	1934	Wilder	
Palehua	1937	Fosberg 13807	
Palehua	1938	Skottsberg 335	
Palehua	1946	Kerr 37-1	
Palehua	1950	Hatheway et al 87	

Population Units

Manage For Stability Population Units	PU Type	Army Action Area	Population Reference Codes	Management Units for Threat Control
Kahanahaiki to Pahole	Reintroduction	MIP	MMR-A,G; PAH-A,C,D,E	Kahanahaiki Pahole
Keawapilau to West Makaleha	in situ and augmentation	MIP	PIL-A,B,C; LEH-A,B,C	Upper Kapuna West Makaleha
Makaha	Introduction	None	MAK-A,B	Makaha Sub Unit II

There are no remaining *in situ* sites in the Kahanahaiki to Pahole PU. All have been extirpated since the late 1990's (MMR-A, PAH-A, PAH-C). Since then, several hundred outplants have gone into this PU using seeds from those last plants. There are three *in situ* sites remaining in the Keawapilau to West Makaleha PU (PIL-B, LEH-A, LEH-B). These plants have been known and monitored for many years. No other locations have been found since 2006. Reintroductions of the PIL stock have been completed at the PIL-C site. The Makaha PU will be established using outplants grown from the other PUs. There is no historic record of *S. obovata* in Makaha, but was determined to be appropriate habitat in the MIP.

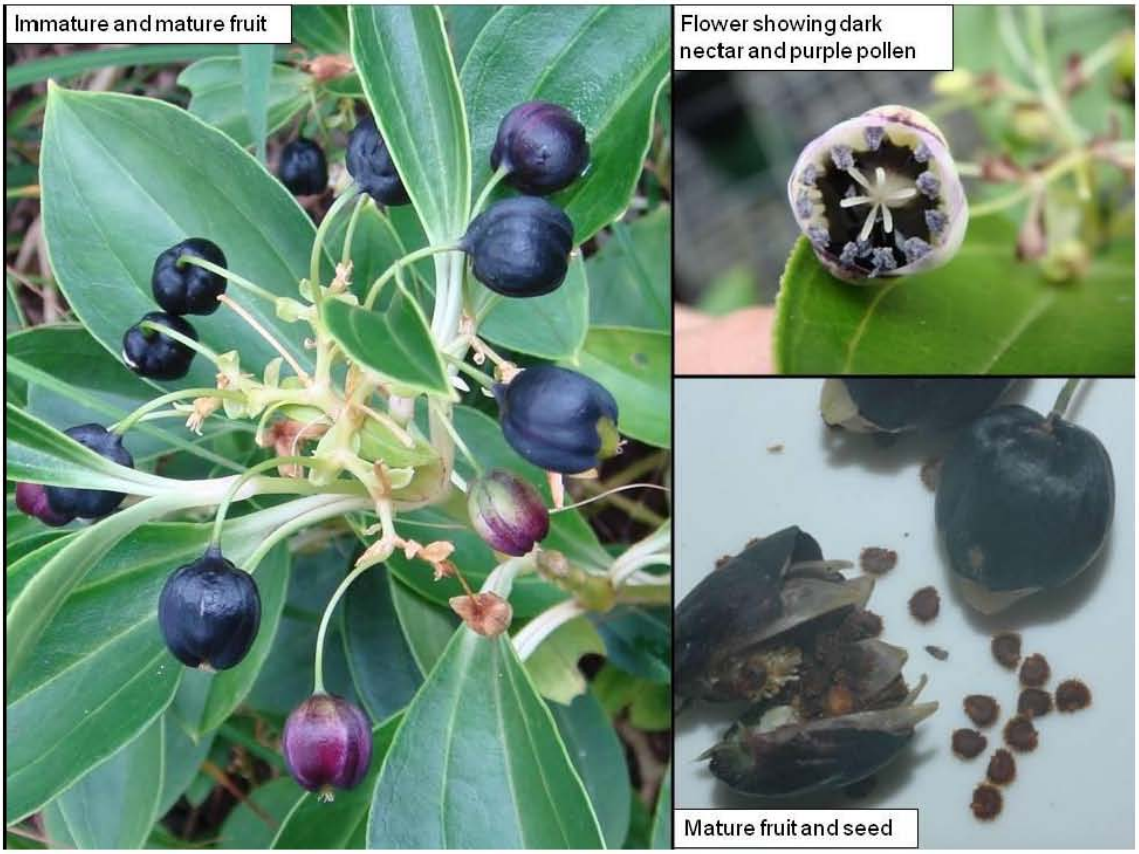
Reproductive Biology Table

	Observed Phenology			Reproductive Biology		Seeds	
Population Unit	Flower	Immature Fruit	Mature Fruit	Breeding System	Suspected Pollinator	Average # Per Fruit (viable)	Dormancy
Kahanahaiki to Pahole	Jan-June	Jan-July	Jan-Sep	Hermaphroditic	Bird or None	~100¥	None*
Keawapilau to West Makaleha	Same	Same	Same	Same	Same	LEH-B: 48 ± 3	Same

- Peak collection time for mature fruit is spring (April-May)
- Breeding System: Hermaphroditic (facultative autogamy) (Weller et al. 1998) with high selfing rates and very little pollinator visitation (Weisenberger unpubl. data). Passerine birds have been suspected pollinators due to nectar concentration and amount (Weller et al. 1998), but no birds have been observed visiting this species (Weisenberger 2012). As the fruit matures, the calyx lobes persist and become purple and fleshy, while the interior capsule of the fruit is dry. This 'false berry' is very likely to attract fruit-eating birds that may disperse the species' seeds (Carlquist 1970).

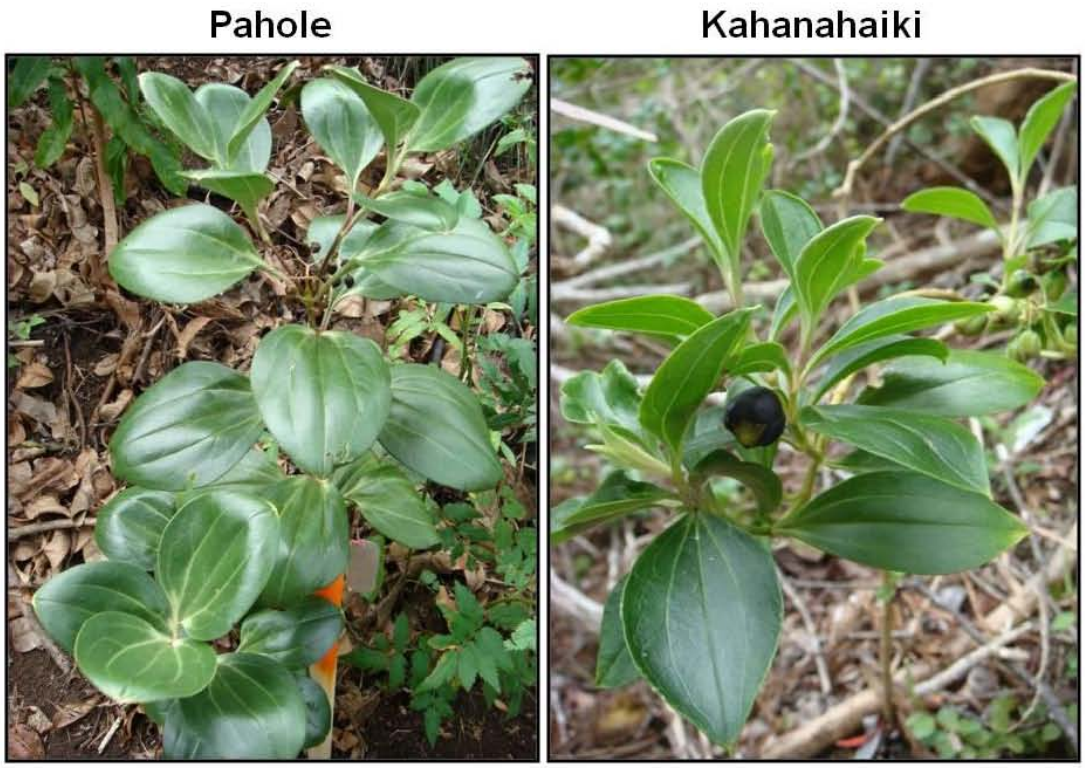
¥ Some collections of mature fruit have a lower number of seeds per fruit; likely because fruit are picked after some seeds have dispersed. Fruit from the *in situ* NW Makaleha population (LEH-B) typically produce less seeds per fruit than all other population sites.

* Some collections have delayed initial germination for approximately six months. A physiological mechanism to prevent germination until cooler, wetter winter months may be present. This delay has been documented occasionally across all populations and collections. There is substantial variation in length of time until initial germination between individual plants within the same collection and between different collections of the same plant. Delayed germination may be a mechanism for preventing germination during the hottest months immediately following dispersal.



Immature & Mature Fruit

Early slug control attempts



Examples of variation in leaf morphology at each PU


Habitat of wild site at Keawapilau
Wild S. obovata


Habitat at the Keawapilau reintroduction site

Reintroduction Recruits at Pahole

Reintroduction Recruits at Kahanahaiki

Habitat Characteristics

PU	PRC	Elev. (ft.)	Slope	Canopy Cover	Topography	Aspect	Mean Annual Max.Temp. (F)*	Mean Annual Rainfall (mm)*	Mean Annual Rainfall (mm)**
Kahanahaikito Pahole	MMR-A *in situ*	1880	Vertical	Intermediate	Upper Slope	North	77.00	1561	1334.7
Kahanahaikito Pahole	MMR-G reintro	2000	Moderate	Intermediate	Upper Slope	North	77.00	1531	1347
Kahanahaikito Pahole	PAH-A *in situ*	2297	Steep	Closed	Upper Slope	North	75.20	1766	1505.5
Kahanahaikito Pahole	PAH-C *in situ*	2100	Steep	Intermediate	Upper Slope	North	75.20	1667	1425.9
Kahanahaikito Pahole	PAH-D reintro	2250	Moderate	Intermediate	Upper Slope	North	75.20	1667	1406.8
Keawapilauto West Makaleha	PIL-A *in situ*	2149	Moderate	Intermediate	Upper Slope	North	75.20	1781	1565.5
Keawapilauto West Makaleha	PIL-B *in situ*	2240	Moderate	Intermediate	Upper Slope	NE	75.20	1880	1612.2
Keawapilauto West Makaleha	PIL-C reintro	2500	Moderate & Steep	Intermediate & Open	Upper Slope & Crest	North	75.20	1880	1612.2
Keawapilauto West Makaleha	LEH-A *in situ*	2598	Steep & Vertical	Intermediate	Upper Slope	North	73.40	2022	1764.8
Keawapilauto West Makaleha	LEH-B *in situ*	2500	Moderate & Steep	Intermediate	Upper Slope	East	75.20	1962	1651.3
Keawapilauto West Makaleha	LEH-C reintro	2760	Steep	Intermediate	Upper Slope & Crest	NE	73.40	2023	1764.8
Makaha	MAK-A reintro	2600	Moderate & Steep	Intermediate	Upper Slope	North	75.20	1921	1857.3
ALL	ALL	1880-2760	Moderate -Vertical	Open-Closed	Upper Slope – Crest	N-E	73.40-77.00	1531-2023	1334-1857

Information was compiled from OANRP observation forms and GIS data unless otherwise noted. *(PRISM 2004) **(Giambelluca et al 2011)

Associated Species Table

PU	PRC	Canopy	Understory
Kahanahaikito Pahole	MMR-A *in situ*	MetPol, AntPla, PsiCat, SchTer, PsyOdo	BleApp, DooKun, GahGah, AlyOli, CibCha
Kahanahaikito Pahole	MMR-G reintro	AcaKoa, PsyOdo, MetPol, SchTer, PsiCat, SanFre, AntPla, DioHil	AlyOli, MicStr, MepExa, DiaSan, CarWah, VioCha, OplHir, DooKun, HedTer, ConBon, MelMin, AspKau, PhlAur, AspNid, CocTri, RauSan, ChaMul, ReySan, DieFal, LanCam, PepTet, AspHor, BleApp
Kahanahaikito Pahole	PAH-A *in situ*	AcaKoa, MetPol, AntPul, GreRob, PsiGua	PasCon, StaDic, BidTor, SchNut, CyaLon
Kahanahaikito Pahole	PAH-D Reintro	Not Yet Recorded	Not Yet Recorded
Kahanahaikito Pahole	PAH-Ereintro	SchTer, MetPol, LepTam, PsiCat, DodVis, PsyOdo	DiaSan, CliHir, MelMin, LanCam, MicStr, AlyOli, CocTri
Keawapilauto West Makaleha	PIL-A *in situ*	MetPol, MelPed, GreRob, AntPla, WikOah, PsyMar, PsiCat	NepExa, AlyOli, PasCon, OplHir, DiaSan, BidTor, DryGla, BleApp, HedTer, AspHor, PleAur, CliHir, SchNut, CyaLon
Keawapilauto West Makaleha	PIL-B *in situ*	MetPol, AcaKoa, AntPla, SchTer, GreRob, PsiCat	CarWah, MicStr, RubRos, CliHir, BleApp, DooKun
Keawapilauto West Makaleha	PIL-Creintro	MetPol, AcaKoa, PsiCat, SchTer, PsyOdo, NesSan, SyzCum, GreRob	DodVis, BleApp, DooKun, MelMin, LepTam, DicLin, StaDic, MicStr, RubRos, CarWah, BidTor, AlyOli, CopFol, NepCor, NepExaHaw, OxaCor, PsiCat, ElaPal, PsiNud, CreCre, PanNep, CliHir, CocTri, HedTer, WikOah, LanCam, ConBon
Keawapilauto West Makaleha	LEH-A *in situ*	AntPla, PsiCat, MetPol, GreRob	DipPin, AlyOli, CliHir, OdoChi, RubRos, DooKun
Keawapilauto West Makaleha	LEH-B *in situ*	MetPol, PsiCat, AcaKoa, SchTer	MelMin, BidTor, AlyOli, AgeAde, DodVis, PanNep, CarWah
Keawapilauto West Makaleha	LEH-Creintro	PsiCat, MetPol, CopFol, MelClu, ScaGau, AntPla, DodVis	RubArg, BleApp, MelMin, StaDic, RubRos, CliHir, ChrPar, MetPol, PriKaa, PitGla, DicLin, PsiCat, NepMul, MelClu, AntPla, DipSan, PepMem, WikOah, FreArb

Native species and introduced species are listed in order of abundance as observed by OANRP


Map removed, available
upon request

Population Structure at outplanting sites

OANRP began to outplant *S. obovata* into the Kahanahaiki to Pahole PU in 1999 and the Keawapilau to West Makaleha PU in 2007. The outplantings consisted of immature plants grown from seeds. The seeds were collected from the last remaining *in situ* plants (MMR-A, PAH-C, LEH-A, PIL-B) and from seed collected by Dr. Stephen Weller and Dr. Ann Sakai from plants in a greenhouse living collection at UC Irvine. The UC Irvine living collection was grown from *in situ* collections of seed from PAH-A and PIL-A. There are now three reintroduction sites that are monitored regularly and have had seedlings and immature recruits: Kahanahaiki (MMR-G), Pahole (PAH-D) and Keawapilau (PIL-C). Each year, each outplant was monitored and assigned to the appropriate age class. Also, all new, recruiting (F1) plants were identified, monitored and assigned to an age class. The recruitment and population structure observed at the main outplanting sites are described below:

- Planting at the Kahanahaiki site (MMR-G) began in 1999 and mature plants in the first and second filial generations (F1s and F2s) were observed within a few years (Fig. 2&3). There was an increase in recruitment observed at the Kahanahaiki reintroduction in February 2010. The increase of recruits may be attributed to increased annual rainfall, increasing number of outplants (Fig. 4), or other undetermined factors. Since then, many seedlings transitioned to immatures and the total number of recruits declined (Fig. 2&3). Recruitment is currently increasing. From 2003 to 2011, there were 61 F1's that matured from a total of 210 plants outplanted (Fig. 4).

- Planting at the Pahole (PAH-D) site began in 2003 and outplants yielded mature F1s and F2s within a few years (Fig. 5&6). There was an increase in recruitment following the initial reintroduction. However, despite the large number of seedlings, they did not transition into >100 matures for the PU (Fig. 7). A new cohort of many seedlings was observed in 2010.

- Planting at the Keawapilau (PIL-C) site began in 2007 and recruitment was documented three years later (Fig. 8). There are over 500 seedlings and immature plants currently at the outplanting site. No additional plants will be outplanted at this site in the next couple years, but the recruits will be closely monitored.

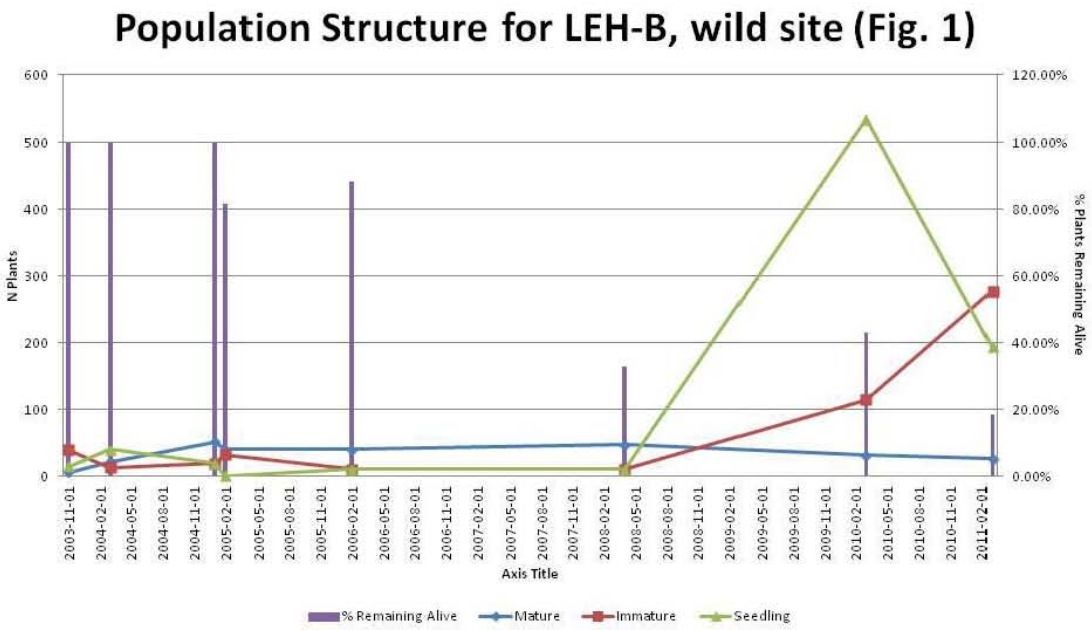
Population Structure and Planning for Outplanting

The population structure of the remaining *in situ* sites of *S. obovata* (and many other IP taxa) are unable to serve as examples of stable or increasing populations that support ≥100 mature plants. Therefore, measures taken from monitoring data of the population structure in established outplantings are used to guide future numbers to outplant for all taxa in this situation. Initially, before recruitment has begun in a reintroduction, the survival of mature outplants is used to guide how many plants above the stability goal (100 reproducing plants for *S. obovata*) should be planted to maintain the goal. This first measure is the 'survival ratio' of alive, mature outplants over the cumulative number of outplants. This will help plan for the survival of ≥100 mature outplants. At first, the stability goal is met by having ≥100 mature outplants. However, as the outplants begin to decline, the resulting recruitment must produce enough mature plants to maintain a stable population or additional outplanting may be needed.

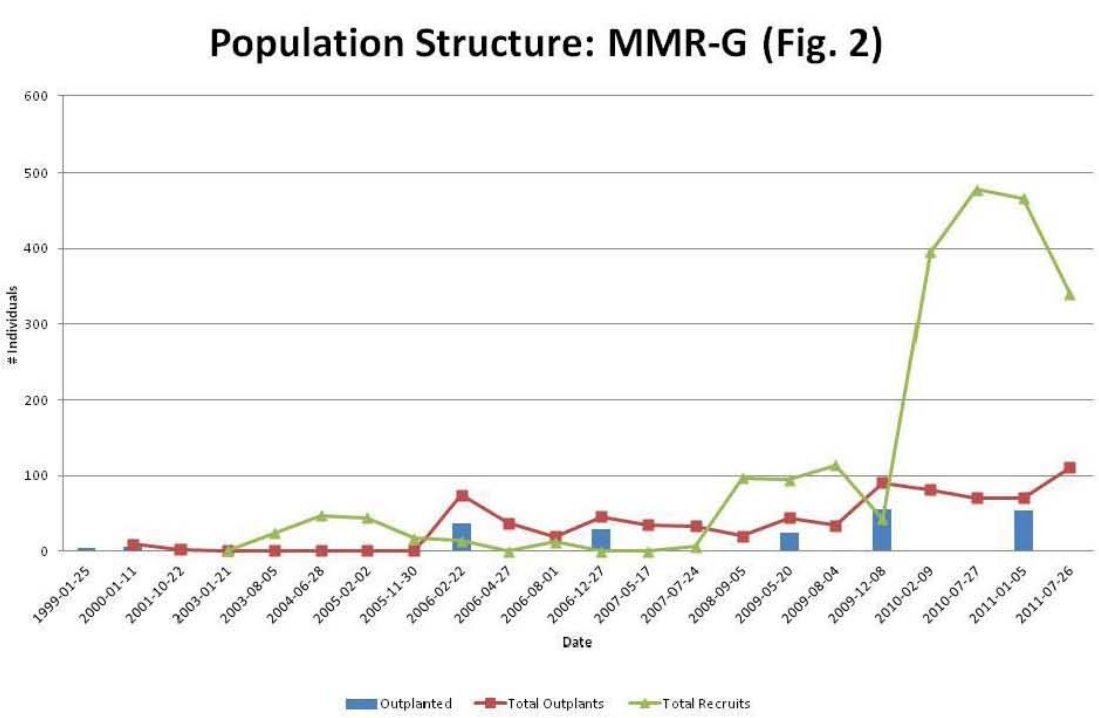
As recruitment begins to occur at an outplanting site, and as recruits mature and reproduce, population structure data from annual census monitoring can be used to guide how many outplants are needed to reach, and maintain, the stability goal of ≥100 reproducing plants without additional outplanting. This second measure is the 'replacement ratio' of mature recruits over the cumulative number of outplants.

Once mature recruits are established and reproducing at an outplanting site, a third measure can be incorporated into outplanting planning. Age and/or size-class transition data (vital rates) and a population matrix projection model can be used to predict population growth and anticipate declines below stability goals that could be mitigated with additional outplanting and/or threat control.

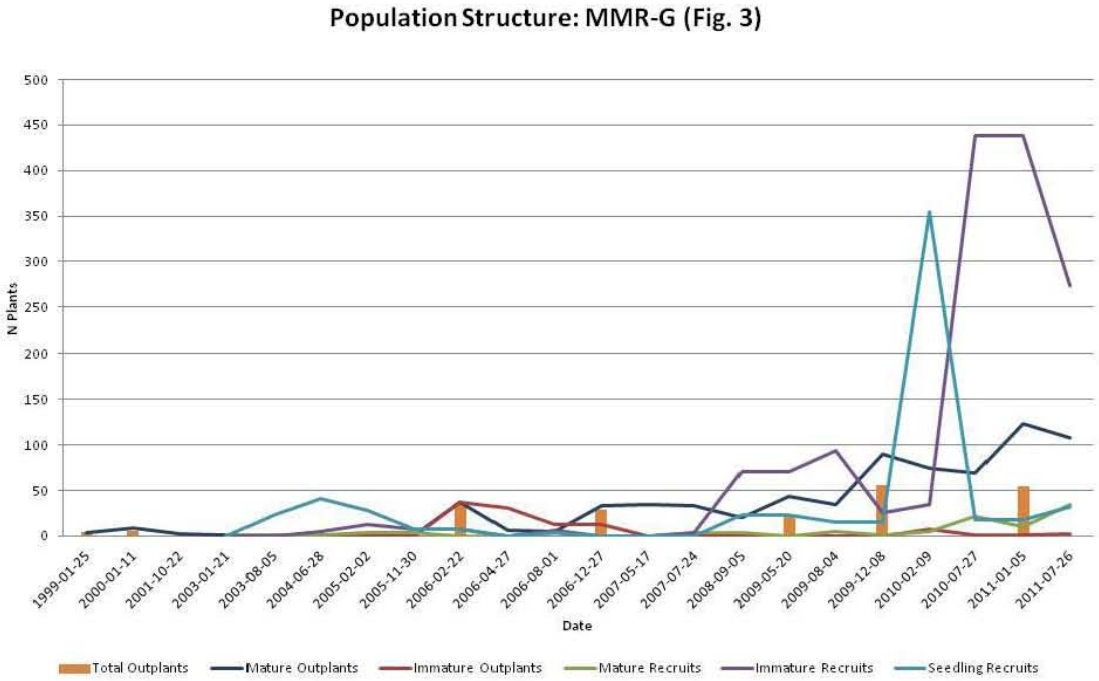
The monitoring data needed to obtain these three measures is described in the Monitoring Plan. Details on how these population structure measures are incorporated into future reintroduction planning for *S. obovata* are discussed further in the Reintroduction Plan Comments.



The blue line shows the total number of mature plants observed. The number of immature plants is depicted by the orange line and seedlings by the green line. The purple bars show the percentage of all the tagged, mature plants that are alive at each successive observation date. While the purple bars show that the tagged plants were dying, they were being replaced with new mature plants keeping the total number of matures were moderately constant.

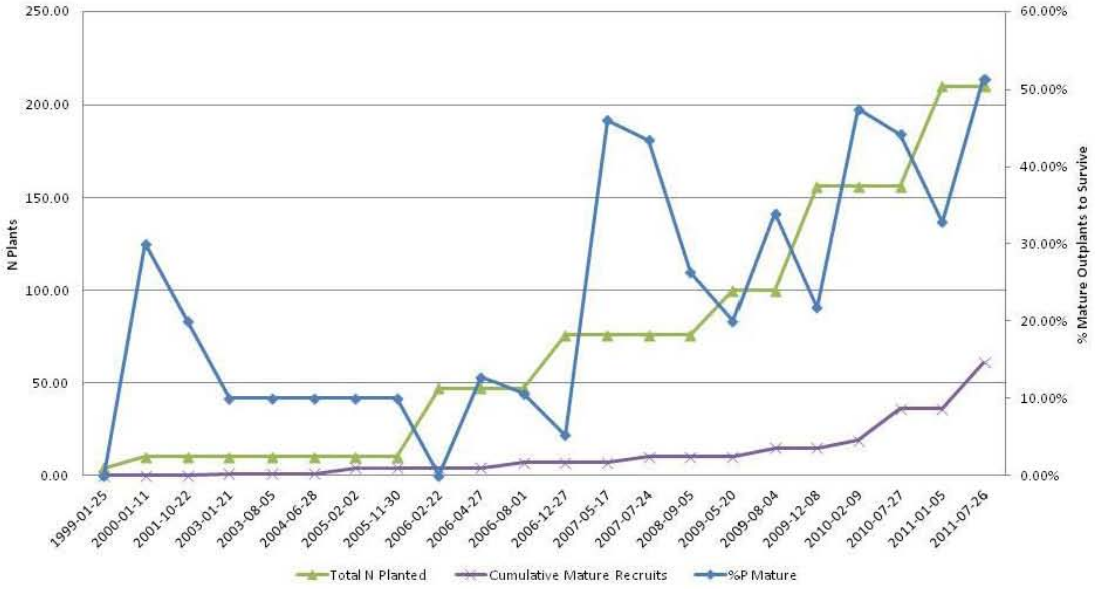


This graph depicts population structure at this reintroduction since 1999. Blue bars represent the total number of plants outplanted on a given day. The orange line shows the total number of live outplants over time; while the green line depicts recruitment with the total number of live recruits (seedling, immature and mature). Both F1 and F2s have been observed at this site.



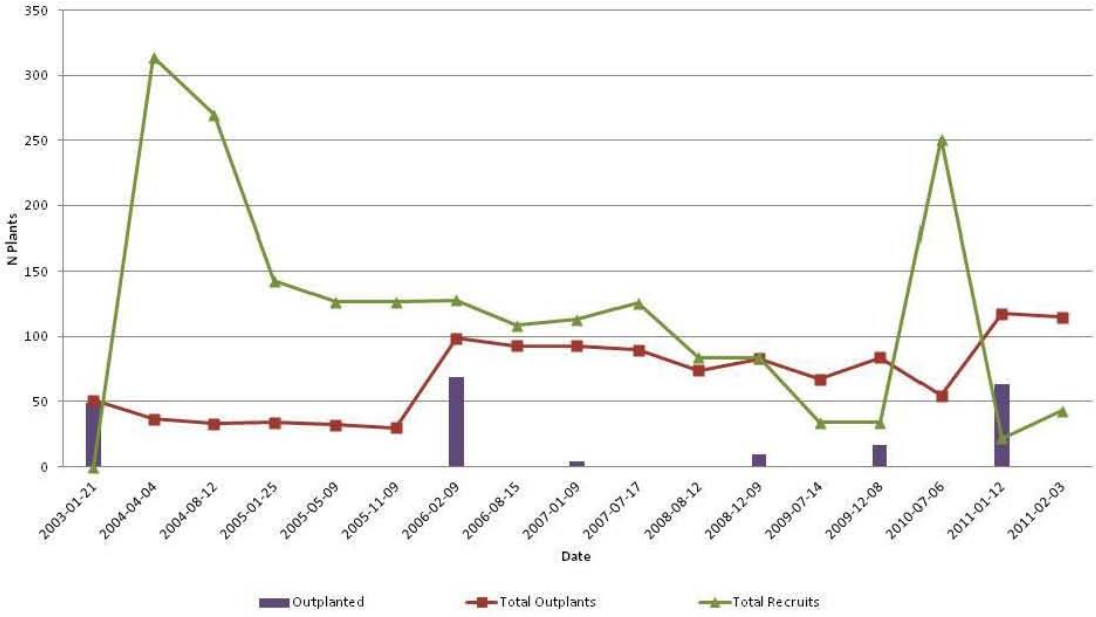
This graph depicts population structure at this reintroduction. Orange bars represent the total number of plants outplanted on a given day. The lines correspond to different size classes of both outplants and recruits. A few mature F1s and F2s resulted from initial outplantings but subsequent plantings have greatly increased the numbers of recruits. Planting will be completed in the coming year.

Survival & Replacement *S. obovata* MMR-G (Fig. 4)



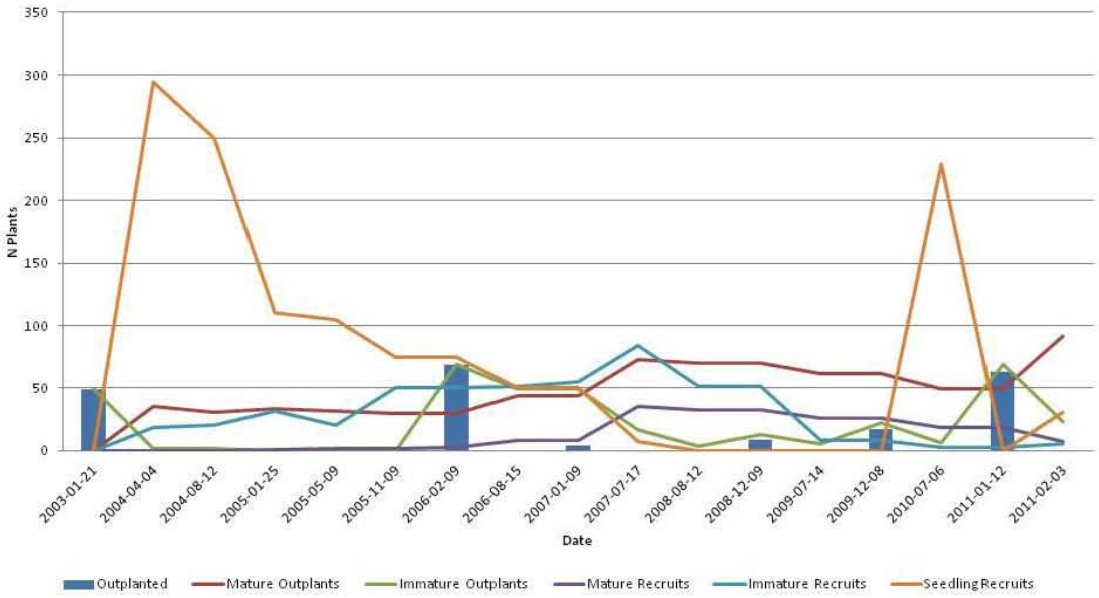
This graph displays the population structure data that are used to guide how many outplants are needed to create a stable population with ≥100 reproducing plants. These measures are discussed in the 'Population Structure and Planning for Outplanting' and 'Reintroduction Plan' sections. The blue line shows the percentage of outplants that matured and are alive. This is Measure 1, the 'survival ratio' and is currently ~50%. The cumulative number of plants ever planted are shown in green, and the cumulative number of mature recruits in purple. These are used to obtain Measure 2, the 'replacement ratio'.

Population Structure: PAH-D (Fig. 5)



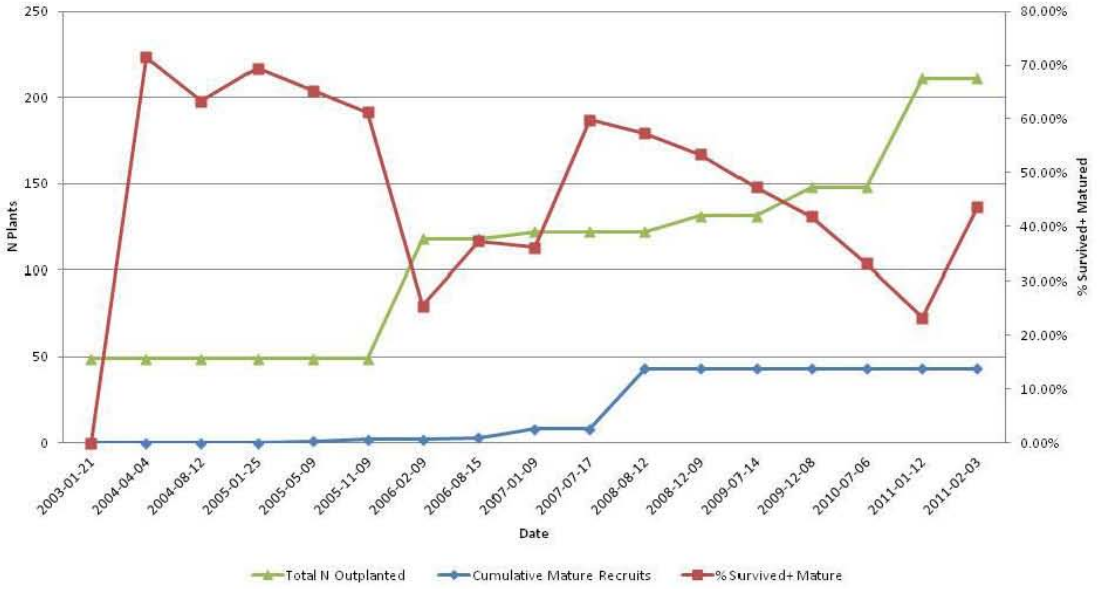
This graph depicts the population structure recorded at this reintroduction each observation date. Purple bars represent the total number of plants outplanted on a given day. The red line shows the total number of live outplants over time and the green line depicts recruitment with the total number of live recruits (seedling, immature and mature). Both F1 and F2s have been observed at this site.

Population Structure: PAH-D (Fig. 6)



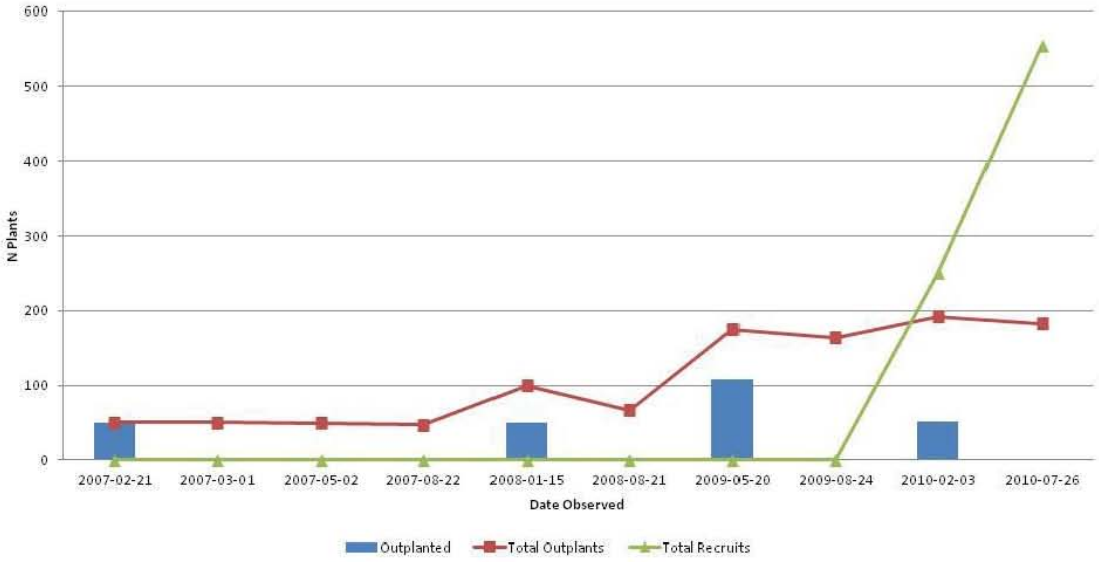
This graph depicts population structure at this reintroduction. Blue bars represent the total number of plants outplanted on a given day. The lines correspond to different size classes of both outplants and recruits. Planting at this site was completed in 2011.

Survival & Replacement *S. obovata* PAH-D (Fig. 7)



This graph displays the population structure data that are used to guide how many outplants are needed to create a stable population with ≥100 reproducing plants. These measures are discussed in the 'Population Structure and Planning for Outplanting' and 'Reintroduction Plan' sections. The orange line shows the percentage of outplants that matured and are alive. This is Measure 1, the 'survival ratio' and is currently ~45%. The cumulative number of plants ever planted are shown in green, and the cumulative number of mature recruits in blue. These are used to obtain Measure 2, the 'replacement ratio'.

Population Structure PIL-C (Fig. 8)



This graph depicts population structure at this reintroduction. Blue bars represent the total number of plants outplanted on a given day. The orange line shows the total number of live outplants over time; while the green line depicts recruitment with the total number of live recruits. Planting was completed at this site in 2010.

Monitoring Plan

- All extant *in situ* sites (LEH-A, LEH-B, PIL-B) will be monitored annually using the HRPRG Rare Plant Monitoring Form (RPMF) to record population structure, age class, reproductive status and vigor of all known plants. The site will be searched for new seedlings and all new juvenile plants will be tagged as long as the health and safety of the plants and the site are not jeopardized. This monitoring data will help guide *in situ* threat management and genetic storage needs.
- The managed reintroduction sites in all PUs will be monitored annually in the winter (January-March) using the RPMF to record population structure, age class, reproductive status and vigor. All outplants will be accounted for, and a total population census will be conducted. This data will be used to obtain the survival and replacements ratios that will guide future outplanting.
- New juvenile F1 plants at PAH-D, PAH-E and MMR-G will be tagged until a total of 50 have been tagged at each of these three sites. The annual survival (RPMF-Vigor) of these tagged plants will be recorded annually along with the rest of the plants using the RPMF. This data may be used to document life-history data and measure vital rates. These rates may be later used in conjunction with population census data to obtain a population growth rate, compare the importance of each vital rate (i.e. seedling-immature vs. immature-mature) and explore results of differing management such as slug control. The results of this analyses are the third measure used to adjust the number of outplants planned for future nearby reintroductions and to augment or replace underperforming sites if a decline is anticipated.
- Sluggo® applications have recently commenced at the West Makaleha (LEH-C) & Kahanahaiki (MMR-G) reintroductions. Recruitment will be monitored and compared to previous years to determine if the application of Sluggo® affects the amount of recruitment at these two reintroductions.

Genetic Storage Plan

What propagule type is used for meeting genetic storage goal?	What is the source for the propagules?	What is the Genetic Storage Method used to meet the goal?	What is the proposed re-collection interval for seed storage?	Is seed storage testing ongoing?	Plan for maintaining genetic storage.*
Seeds	Reintroductions	Seed Storage: -18C / 20% RH	≥15 years†	Yes	Single-source and Mixed Reintroductions*

†Seeds in storage of this species have not shown a decline in viability. The next viability tests are scheduled in 2015. Re-collection intervals will continually be extended until a decline in viability is detected. In 2015 there is one plant that will need to be re-collected. OANRP can collect from the reintroduction site in West Makaleha to accomplish this goal. Additional re-collections from other reintroductions will be necessary starting in 2021.

*Plants in the nursery will be pollinated with a mixed pollen load from all sources. Pollinated flowers will be tagged. These fruit will serve as a propagule source for mixed reintroductions in the Makaha PU.

*Seeds will be collected from reintroductions.

Reintroduction Plan

Manage for Stability Population Units	Reintroduction Site(s)	Number of Plants to be planted	Propagule Type	Propagule Population(s) Source	Number of Founders in Source Population	Plant Size	Pot Size
Kahanahaiki to Pahole	MMR-G §	250 (210)	Immature plants	MMR-A	1	>10cm	4"-1gallon
Kahanahaiki to Pahole	PAH-D¤	200	Immature plants	PAH-C	3	>10cm	4"-1gallon
Kahanahaiki to Pahole	PAH-E §	180 (166)	Immature plants	PAH-A	1	>10cm	4"-1gallon
Keawapilau to West Makaleha	PIL-C¤	310	Immature plants	PIL-A, B	4	>10cm	4"-1gallon
Keawapilau to West Makaleha	LEH-C¤	133	Immature plants	LEH-A	6	>10cm	4"-1gallon
Makaha	MAK-A*	400 (0)	Immature plants	Mixed source from hand-pollinating all plants	N/A	>10cm	4"

The total number to be planted at each site is given followed by the number already planted in ().
*= outplanting not started yet
¤= planting complete
§ =will be completed by February 2012.

Reintroduction Plan Comments

Since recruitment has begun at the MMR-G site, **the survival ratio**, (**Measure 1**) is no longer used to guide the number to plant. Instead, the number to be planted at each site is currently determined by factoring in the number of mature recruits produced by the surviving mature outplants at the MMR-G site in the Kahanahaiki to Pahole PU (Measure 2 Replacement Ratio). This site was selected because it is the longest established outplanting and has had F1 and F2 recruits observed for many years. The **replacement ratio, (Measure 2)** is the cumulative sum of mature recruits at MMR-G to the total outplanted and this gives a value of one mature recruit for every 3.46 outplants (1:3.46). Incorporating this value, the target number to plant in each PU has been increased to 400 outplants for a goal of establishing 100 mature recruits within 5 years. The data from survival and replacement will continue to be updated and used to guide the number of outplants used to supplement those sites and in planning future efforts in the Makaha PU. Planting at the MAK-A site will be phased in over a few years to ensure that the initial survival rates are comparable to Kahanahaiki (MMR-G).

Reintroduction Plan Comments

A recent study was undertaken to determine the fitness of outplants grown from seed produced by outcrossing and self-fertilization of the available stocks of *S. obovata* (Weisenberger 2012). Results and management recommendations from this study are being used to guide the founder mix at each outplanting and are summarized below:

A common garden study in Kahanahaiki was carried out to compare relative fitness of progeny from the outcrossing and self-fertilizing treatments. Relative fitness of plants increases when parents are from different populations. When the maternal parent was from the furthest populations from Kahanahaiki (and consequently cooler and wetter), relative fitness was reduced, regardless of the paternal parent.

-Mixed source reintroductions will be implemented at the Makaha PU. The completed single-source founder reintroductions at the Kahanahaiki to Pahole and Keawapilau to West Makaleha PUs will be maintained as is for now.

-Due to a lower elevation, higher annual maximum temperature, and lower annual rainfall at Kahanahaiki gulch, only Kahanahaiki stock should be planted into this gulch (see Habitat Characteristics Table). Some caution should be exercised when outplanting Kahanahaiki stock into substantially wetter habitats, as these plants may be adapted to drier conditions. If initial outplanting attempts fail, effort to balance representation of this stock should cease.

-Stock from Makaleha (particularly LEH-A) should not be planted into habitat much drier and warmer than current conditions. The site where the LEH-A stock is planted (LEH-C) has similar temperature and rainfall patterns as the wild site.

-In Makaha, an introduction into wetter and cooler conditions is being planned. If stock from the drier end of environmental extremes (MMR-A) fails at this site, efforts to balance representation should cease. The stock to be used for controlled breeding for these outplantings will come from seeds collected from the single-source reintroductions at MMR-G, PAH-D, PAH-E, PIL-C and *in situ*-collected seed from LEH-B and PIL-B. These plants will be maintained *ex situ* in the nursery and hand-pollinated to mixed-source pollen loads. The resulting outcrossed plants will be used for the Makaha introductions.

2010-2011 Stabilization Goals Update

MFS Population Units	PU Stability Target		MU Threat Control						Genetic Storage
	Has the Stability Target for mature plants been met?	Does the PU have observed structure to support the stability target in the long-term?	Ungulates	Weeds	Rodents	Fire	Slug	Black Twig Borer	Are there enough propagules in Genetic Storage?
Kahanahaiki to Pahole	YES	TBD	YES	YES	PARTIAL	NO	PARTIAL	N/A	YES
Keawapilau to West Makaleha	YES	TBD	YES	YES	NO	NO	PARTIAL	N/A	YES
Makaha*	NO	NO	NO	NO	NO	NO	NO	N/A	N/A

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.
*Not Planted yet

5 Year Action Plan

	Proposed Actions for the following years:				
Population Unit	**MIP YEAR 8 October 1 2011 – September 31 2012**	**MIP YEAR 9 October 1 2012 – September 31 2013**	**MIP YEAR 10 October 1 2013 – September 31 2014**	**MIP YEAR 11 October 1 2014 – September 31 2015**	**MIP YEAR 12 October 1 2015 – September 31 2016**
Kahanahaiki to Pahole	•Monitor Annually in Qtr.1 (MMR-G, PAH-D, PAH-E) •Complete reintroductions •Collect seed for storage and propagation •Slug control at MMR-G	•Monitor Annually in Qtr.1 (MMR-G, PAH-D, PAH-E) •Slug control at MMR-G	•Monitor Annually in Qtr.1 (MMR-G, PAH-D, PAH-E) •Review and adapt management •Slug control at MMR-G	•Monitor Annually in Qtr.1 (MMR-G, PAH-D, PAH-E) •Slug control at MMR-G	•Monitor Annually in Qtr.1 (MMR-G, PAH-D, PAH-E) •Slug control at MMR-G
Keawapilau to West Makaleha	•Monitor Annually in Qtr.1 (LEH-A-C, PIL-B-C) •Collect seed for storage and propagation •Slug control at LEH-C	•Monitor Annually in Qtr.1 (LEH-A-C, PIL-B-C) •Slug control at LEH-C	•Monitor Annually in Qtr.1 (LEH-A-C, PIL-B-C) •Review and adapt management •Slug control at LEH-C	•Monitor Annually in Qtr.1 (LEH-A-C, PIL-B-C) •Slug control at LEH-C	•Monitor Annually in Qtr.1 (LEH-A-C, PIL-B-C) •Slug control at LEH-C
Makaha	•Prepare planting sites at MAK-A •Complete Makaha II fence	•Begin introduction at MAK-A	•Monitor Annually •Determine the need for slug control	•Monitor Annually •Complete introduction at MAK-A	•Monitor Annually •Review and adapt management

Review and adapt management: The status of each PU in relation to the IP stabilization goals, population structure trends from monitoring data, and threats to each site will be assessed. If PUs are not meeting stability goals, management may be adapted to control threats to plants in affected age classes, the number of outplants may be increased and the founder sources may be changed.

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Weisenberger, L. 2012. Inbreeding Depression, Outbreeding Depression and Heterosis in Rare Species of *Schiedea* (Caryophyllaceae) on O'ahu. PhD Dissertation. University of Hawai'i, Honolulu.

Weller, S. G., A. K. Sakai, A. E. Rankin, A. Golonka, B. Kutcher, and K. E. Ashby. 1998. Dioecy and the evolution of pollination systems in *Schiedea* and *Alsinidendron* (Caryophyllaceae: Alsinoideae) in the Hawaiian Islands. American journal of botany **85**:1377-1388.

CHAPTER 3: *ACHATINELLA* SPECIES MANAGEMENT

3.1 INTRODUCTION

OANRP changed the annual reporting format, therefore, this year's rare snail chapter is very different from previous year-end reports. All the tabular data and ESU updates are achieved this year through a distributed copy of the OANRP database. Please refer to Appendix ES-2 for a tutorial on how to access this data. The annual report from the UH snail lab can also be found in this Appendix (ES-3). That report summarizes captive propagation and Jackson's chameleon study results. This chapter will update OANRP efforts to construct three new rare snail and predator proof enclosures.

3.2 PREDATOR RESISTANT FENCING

OANRP embarked on a long awaited project this year, the construction of predator proof fences at three sites; Puu Hapapa and Palikea in the southern Waianae Mountains and Poamoho in the northern Koolau Mountains. The goal for these exclosures is to exclude all predators and provide an area where *Achatinella* and other rare Hawaiian snails can exist free from rats, mice, *Euglandina rosea* and Jackson's chameleons. Sites were chosen after careful consideration and site selection criteria included relatively flat terrain, accessibility, and high quality snail habitat. Flat terrain is necessary due to design and budget limitations.

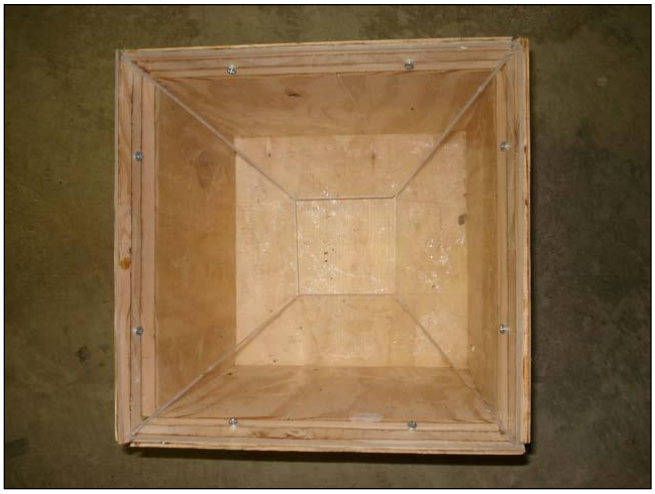
3.3 PREDATOR RESISTANT EXCLOSURE SITES

To begin this project, OANRP requested that interested and qualified companies submit proposals. Only two companies expressed interest in the project; Pest Proof Fencing and Excluder. Both of these companies are based in New Zealand and have a proven track record of constructing this type of fencing. Proposals for the project were accepted in August 2010 and OANRP selected Excluder to build the exclosures given their lower cost.

The overall design was based on a rat/mouse proof mesh fence with added barriers for predatory snails. The rat/mouse proof fence needed to be a tested and proven design consisting of a buried ground barrier, a hood, tight-mesh construction, and engineered fasteners and junctions. All fence materials must be stainless steel or heavily galvanized to ensure longevity under harsh conditions. In addition to the typical mouse/rat exclusion features, additional barriers against *Euglandina rosea* will be mounted to include an angle obstacle barrier, an electric wire barrier, and a cut wire mesh barrier.

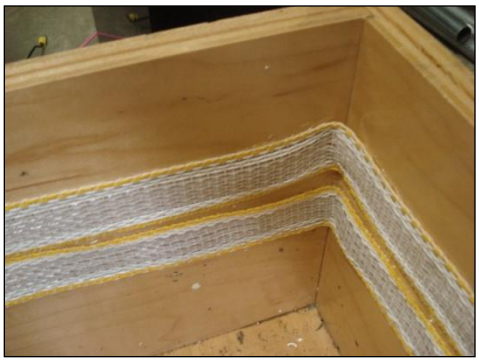
3.3.1 Angle Obstacle Barrier:

This is the simplest of the barriers to be installed. A smooth piece of copper or stainless flashing will be attached to the vertical wall of the fence such that it extends down at an angle of 15°-20° and at its terminal edge is at least 7 cm from the wall of the fence. The picture below shows the trial box for tests of this barrier.



3.3.2 Electric Barrier:

Two 16-wire livestock tapes are fastened in parallel to the vertical surface. These tapes are attached to an electric fence unit and will deliver a shock to snails that attempt to cross the wires. The photo below shows the trial box with wire tape in its proposed configuration. So far this configuration has worked fine o a small scale but has proven unsuccessful when expanded into a larger scale. More experimentation will be required before the electrical barrier is finished.



3.3.3 Cut Wire Mesh Barrier:

This is the most effective physical barrier and has no electric components. The barrier works by presenting a surface that does not provide adequate adhesion to snails. *E. rosea* would need to cross the barrier upside-down and the snails are unable to do this. The points must be spaced close enough to force *E. rosea* of all sizes to pass over the wire and not through it. There are no strict parameters and Excluder is currently looking into various options for the production of this barrier. Below is a close up of the barrier constructed with copper screen mesh mounted no more than 4-5 mm apart for a total width of no less than 8 cm.

3.4 REMOTE SITE MONITORING

OANRP want to maintain these sites with only a minimum number of visits. There will be occasional site visits to conduct necessary resource management activities and record biological data but they will be relatively infrequent. With so much invested in the development and construction of these fences, a remote monitoring system will be included to ensure continuous barrier integrity. This system must be remotely accessible and provide the following information:

- The system will indicate if anything has fallen across the barrier and a breach has occurred. This can be accomplished by using a grounding ring system or something comparable.
- It will report the integrity of the photovoltaic system including the condition of the batteries.
- It will collect weather data including temperature, wind speed, direction and gust velocity, humidity and rain fall. These can be measured by many types of commercially available weather stations.

- It may use remote-access cameras as a useful monitoring device.

3.5 CONSTRUCTION STATUS

In the summer of 2011, Excluder crews began construction on the Puu Hapapa and Poamoho fences. The rodent resistant barriers were mostly completed and the Excluder crew is expected to return in November 2011 to build the Palikea exclosure and install the *E. rosea* barriers and hoods on all three fences. This will take approximately one month to complete. Discussions are continuing about the final configuration of the three barriers presented above. Below are details about each site.

3.5.1 Puu Hapapa, Waianae Mountains.

Near the summit of Puu Hapapa at 2,600 feet, the site is a mix of native and introduced vegetation and is protected from ungulates by large scale fencing. Puu Hapapa is an area of intensive management, with ongoing weed control, outplanting and rare species management. Puu Hapapa has been an area of recent focus by OANRP as the predatory snail *E. rosea* reached previously undocumented numbers and greatly reduced the large number of *A. mustelina* in the area in just 6 years. OANRP has been removing *E. rosea* from the area and moving *A. mustelina* to the University of Hawaii snail laboratory for safe keeping. See Appendix ES-3 for status of these snails. The pest resistant fence is 170 m long and encompasses approximately one half acre. The terrain is relatively flat and the substrate is mostly soil.

Location of the Hapapa Exclosure

Completed Section of the Hapapa Exclosure with Common Native Outplantings

Aerial View of Hapapa Snail Exclosure

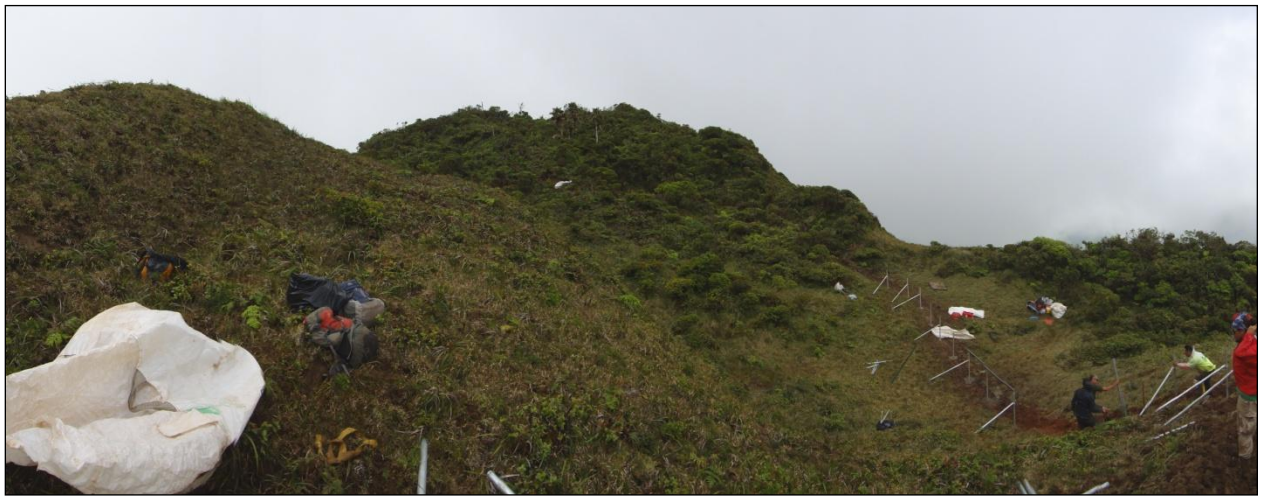
3.5.2 Poamoho, Koolau Mountains.

Near the source of the Helemano stream drainage, at 2,600 ft, a site has been chosen for the reintroduction and translocation of multiple species of endangered Hawaiian tree snails. OANRP will work with four species of *Achatinella* that occur sympatricly nearby: *A. sowerbyana*, *A. bulimoides*, *A. lila*, and *A. byronii/decipiens*. The site is not surrounded by ungulate-proof fencing; however it will be enclosed within a larger ungulate fence after construction is complete. This will help to provide a wind screen as well, hopefully increasing its longevity. The area is a mix of short wind-swept native trees and introduced and native understory vegetation. Of special note is the winds often blow in access of 40 mph and not uncommonly reach speeds in excess of 70 mph. The proposed fence line is 175 m long and approximately one half acre in size. The terrain is relatively flat and the substrate is soft, muddy soil. The land here is owned by Kamehameha Schools Bishop Estate and there are no *Achatinella* snails here at the present time, although they were at this site in 1995.

Location of the Poamoho Exclosure

Map removed, available upon request

Pictures of the Construction at Poamoho



The above photo shows wind damage to the wall of the exclosure incurred because the wall was left incomplete and in a weaker state than if construction had been completed

3.5.3 Puu Palikea, Waianae Mountains.

This site is located at the 3,000 ft level in the Honouliuli Forest Reserve and is a mixture of mesic-wet native and non-native forest (see map below). It is home to *A. mustelina* as well as the rare *Laminella sanguinea* snail species and the endangered *Drosophila substenoptera* fly species. The construction component for the exclosure is being funded by the U.S. Fish and Wildlife Service and OANRP will supply monitoring and management. The area is protected from ungulates by large scale fencing. The proposed fence line is 150 m in length and approximately one fifth acre in size. The terrain is relatively flat and the substrate is mostly soil. Construction of the Palikea exclosure should begin in November 2011. Vegetation restoration plans are being developed for each exclosure to encourage maximum native plant cover which maintains a moist environment and supports an appropriate microclimate for *Achatinella*.

Location of the Poamoho Exclosure

CHAPTER 4: OAHU ELEPAIO

4.1 OIP ELEPAIO MANAGEMENT

4.1.1 Background

In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the Oahu Elepaio (*Chasiempis ibidis*) endangered species status under the federal Endangered Species Act and designated critical habitat on Oahu for the Elepaio in 2001. Under the terms of the Biological Opinion for Routine Military Training and Transformation dated 2003, Oahu Army Natural Resources Program (OANRP) is required to manage and monitor a minimum of 75 Oahu Elepaio pairs. The OANRP is required to conduct on-site management at Schofield Barracks West Range (SBW) for as many of the 75 pairs as possible, with the remaining number managed at off-site locations with cooperating landowners. The OANRP has conducted rat control and Elepaio monitoring at Schofield Barracks Military Reservation (SBMR) (1998-present), Ekahanui Gulch in the Honouliuli Forest Reserve (2005-present), Moanalua Valley (2005-present), Palehua (2007-present), Makaha Valley (2005-2009), and Waikane Valley (2007-2008). This chapter will summarize rodent control efforts and Elepaio reproduction results at each of these management sites, and to provide recommendations for improving the Elepaio program. This section also lists and discusses the terms and conditions for the implementation of reasonable and prudent measures outlined in the 2003 Biological Opinion.

4.1.2 Methods

4.1.2.1 Monitoring

Throughout the nesting season, from early January to late June, each Elepaio territory was visited at one or two-week intervals. The location and age of all birds observed and color band combination, if any, was noted on each visit. Nests were counted as successful if they fledged at least one chick, and nest success was calculated as the successful proportion of total active nests. Nest success was based only on nests known to have had eggs laid in them, as determined by observations of incubation. Some nests were abandoned for unknown reasons before eggs were laid. Reproduction was measured as the average number of fledglings produced per protected pair.

To facilitate demographic monitoring, Elepaio have been captured with mist-nets and marked with a standard aluminum bird band and a unique combination of three colored plastic bands. This is useful because it allows individual birds to be distinguished through binoculars and provides important information about the demography of the population, such as survival and movement of birds within and between years. It also makes it easier to distinguish birds from neighboring territories, yielding a more accurate population estimate. In most cases, Elepaio recordings were used to lure birds into a mist-net. Each bird was weighed, measured, inspected for molt, fat, and health, then released unharmed at the site of capture within one hour.

4.1.2.2 Rodent Control

Rodents were controlled with a combination of Victor® rat traps baited with peanut butter and molasses/peanut-butter flavored Ramik® mini-bars (0.005% diphacinone) placed in tamper-resistant plastic Protecta® rodent bait stations to shield it from rain and reduce the risk of poisoning to non-target species. Bait stations were secured in trees at least one meter off the ground and wired shut to restrict access by dogs (*Canis familiaris*) and feral pigs (*Sus scrofa*). Snap traps baited with peanut butter were used to augment the control. Traps were tied to trees or rocks to prevent scavengers from removing them.

Traps were counted as having caught a rodent if hair or tissue was stuck to the trap, and traps were cleaned with a wire brush after each capture so previous captures were not counted again.

Rodent control was conducted for the duration of the Elepaio nesting season. The number of bait stations and snap traps deployed varied among sites. At Ekahanui, bait stations were not used and a new rat trapping grid was established for management of all Elepaio territories at this site (see Rodent Control Chapter: Ekahanui: Large Scale Trapping Grid). Two bait stations and four snap traps were deployed in each Elepaio territory at Palehua. Three bait stations and six snap traps were deployed at SBW and Moanalua where access is more restricted and where territories are scattered over greater distances. Traps and bait stations were checked and rebaited once a week for the first month when rodent capture rate and take of bait were high, then about once every two weeks for the rest of the breeding season. Traps and bait stations were deliberately concentrated in sections of each territory known to have been used habitually for nesting, thereby increasing the efficiency of the control program. Application of diphacinone bait was conducted in compliance with U.S. Environmental Protection Agency registration numbers 61282-26 and special local need registrations HI-980005.

4.1.3 Results

The OANRP exceeded the prescribed target of managing 75 Elepaio pairs for the 2011 breeding season. In general, rodents were controlled only in territories that contained a breeding pair. Rodents were also controlled in a few territories that contained a single male or were vacant in order to create a larger continuous control area, or because there was some turnover of territory occupancy and it was not clear at the beginning of a season which territories contained a pair.

In 2011, Pono Pacific was contracted to conduct rat control and monitoring of Elepaio at Ekahanui, Moanalua, and Palehua. At SBW, they were contracted to only conduct rat control. OANRP conducted monitoring of birds at SBW, while assisting Pono Pacific with rat control. OANRP also assisted in monitoring of Elepaio at Ekahanui, Moanalua and Palehua. The results of management conducted for each area during the 2011 breeding season are compiled below. The results from each area are presented in two ways. First, a map presents a compilation of all the known Elepaio territories within each Elepaio management unit. SBW is a combination of the separate gulches. The map denotes all of the territories that were baited. Second, the data is presented in tabular form with the number of territories that were single or contained pairs. The table also presents the number of pairs territories in which rodent control was conducted, the number of active nests observed, total successful and failed nests, how many fledglings were observed, and the ratio of fledglings per pair.

Oahu Elepaio feeding nestlings at a nest in Ekahanui.

4.1.3.1 Schofield Barracks West Range

Schofield Barracks West Range Territory Occupancy Status and Rat Control 2011

Map removed, available upon request

Schofield Barracks West Range Site Demographic Data

SBW (BAN, BAW, COF, GUA, MOH, NWA, SWA)	*2011*	*2010*	*2009*	*2008*	*2007*	*2006*	*2005*
Singles	3	5	9	6	11	5	12
Pairs	56	25	19	12	13	14	16
Pairs with Rat Control	31	22	14	11	6	14	16
Active Nests[1]	36	22	10	7	2	3	6
Successful Active Nests[2]	24/36=67%	11/22=50%	6/10=60%	2/7=29%	0	0	3/6=50%
Unknown Nest Outcome[3]	0	5	2	4	2	3	3
Failed Active Nests	12	6	2	1	0	0	0
Family Groups Found[4]	11	9	9	3	3	3	2
Fledglings Observed[5]	46	25	16	7	3	3	6
Fledglings/Managed Pair[6]	1.48	1.14	1.14	0.64	0.50	0.21	0.38

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

Reproductive Results

Of the active nests monitored in SBW, 67% (24/36) were successful in producing 32 fledglings, while 33% (12/36) of the active nests failed. Fourteen fledglings were found in 11 managed pairs where no nesting had been observed (family groups). A total of 46 fledglings were observed in territories benefiting from rodent control management. Another two fledglings were observed in territories not protected from rats.

Seventeen year old Oahu Elepaio captured in Banana gulch in SBW.

Schofield Barracks West Range Rodent Control

Rodent control was initiated from 26 January 2011 and continued through 23 June 2011 in four gulches at SBW: Banana (BAN), Baby Water (BAW), Mohiakea (MOH), North Haleauau (NWA). A total of 31

pairs were managed in these gulches during the 2011 breeding season. Three gulches that include Guava (GUA), Coffee (COF) and South Haleauau (SWA) were not managed this season.

Schofield Barracks West Range Rat Control Data

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

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

Schofield Barracks West Range Summary

During the 2011 breeding season, OANRP managed 55% (31/56) of all the known pairs at SBW.

The 2011 breeding season proved to be another exceptional season with 1.48 fledglings/managed pair produced. There was a 17% increase in successful active nests over the 2010 breeding season, with 21 more fledglings observed. OANRP have been able to access SBW with greater frequency in the 2008-2011 breeding seasons. The increase in active nests, successful nests, fledglings found, and the fledglings/managed pair ratio is presumably related to this improved access, allowing for more monitoring time and an increased frequency of rat baiting. With the data collected it is difficult to determine whether this is due directly to better breeding conditions or just increased management/monitoring. OANRP surmise that it is a combination of the two.

This improved access will continue through the 2012 breeding season and possibly the next year due to construction on the range. Once the construction is complete access to the range will be reduced due to increased usage for training.

OANRP was able to exceed the requirement of managing 75 pairs by combining management in both on and off site locations. At the present time, if OANRP was to initiate management for all Elepaio pairs in SWA it is likely that management at one of the off site locations would have to be dropped because of personnel and time constraints. If at some time in the future the use of targeted aerial application of rodenticide is permissible, then OANRP would utilize this management technique to manage all of the territories (pair and single male) at SBW.

4.1.3.2 Honouliuli Forest Reserve - Ekahanui

Ekahanui Territory Occupancy Status and Rat Control 2011

Ekahanui Site Demographic Data

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

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

Ekahanui Reproductive Results

Of the active nests monitored, 53% (8/15) were successful in producing 10 fledglings, 40% (6/15) failed, and 7% (1/15) had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Sixteen fledglings were found in 14 managed

pairs where no nesting had been observed (family groups). A total of 26 fledglings were observed in territories benefiting from rodent control management.

Ekahanui Rodent Control

OANRP took a new rodent control approach at Ekahanui for the 2011 breeding season with the implementation of a large scale rat trapping grid. This large scale trapping grid is based on the New Zealand Department of Conservation current best practice for killing rats and is similar to the grid being run currently at Kahanahaiki and Palikea in the Waianae mountains.

Ekahanui Summary

Overall, it was a good breeding season and a vast improvement over previous seasons at Ekahanui, despite a late start in monitoring due to the construction of the new rat trapping grid. Successful active nests increased 31% over the previous season and there were more fledglings observed this season than any other in the past. Fledglings/managed pair increased to 0.87. A significant increase in monitoring hours, a new rodent control grid and favorable weather conditions throughout the year are all possible factors contributing to this year's breeding success in Ekahanui.


Oahu Elepaio captured at Ekahanui.

4.1.3.3 Palehua

Palehua Territory Occupancy Status and Rat Control 2011

Palehua Site Demographic Data

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

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

[6]The ratio of fledglings per managed pair.

Palehua Reproductive Results

Of the active nests monitored, 76% (10/13) were successful in producing 10 fledglings, while only 1 nest failed. 15% (2/13) 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). Six fledglings were found in 5 managed pairs where no nesting had been observed (family groups). A total of 16 fledglings were observed in territories benefiting from rodent control management.

Palehua Rodent Control

Rodent control was initiated from 27 December 2010 and continued through 20 June 2011 at Palehua. A total of 17 pairs were managed during the 2010-2011 breeding season.

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

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

Palehua Summary

Overall, it was a good breeding season at Palehua. There were more successful active nests and fledglings observed this season than in any previous year. Increased monitoring time and favorable weather conditions throughout the year are possible factors contributing to this years' breeding success in Palehua.

Oahu Elepaio with Bromeliad mosquito (*Wyeomyia mitchellii*) at Palehua.

4.1.3.4 Moanalua Valley

Moanalua Territory Occupancy Status and Rat Control 2011

Moanalua Site Demographic Data

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

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

[6]The ratio of fledglings per managed pair.

Moanalua Reproductive Results

Of the active nests monitored, 38% (5/13) were successful in producing 6 fledglings, 24% (3/13) failed, and 38% (5/13) had unknown outcomes (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). Three fledglings were found in 3 managed pairs where no nesting had been observed (family groups). A total of 9 fledglings were observed in territories benefiting from rodent control management.

Moanalua Rodent Control

Rodent control was initiated from 22 December 2010 and continued through 29 June 2011 at Moanalua. A total of 16 pairs were managed during the 2011 breeding season.

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

Moanalua Summary

Overall, it was a below average breeding season at Moanalua. The .56 fledglings/managed pair produced was below the average of .66 fledglings/managed pair observed over the previous five years. The poor reproductive output is likely due to inadequate/insufficient monitoring during the breeding season.

4.1.4 OIP Summary

4.1.4.1 Management Actions 2011

- The new position of Avian Conservation Specialist was added to the OANRP in early 2011 to improve monitoring results and to oversee Elepaio management efforts by Pono Pacific at all four management sites.
- Conducted rodent control in a total of 94 territories with pairs at four management sites.
- Following the breeding season, during the months of August-October, OANRP conducted a large scale banding effort where 67 Elepaio were captured, processed and banded. This will result in increased accuracy of monitoring and tracking of an Elepaio population and individual throughout its lifetime.
- The table below summaries the number of managed pairs and reproductive output since 2005.

4.1.4.2 Summary of Elepaio Management Table

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings
2011[1]	94	47	34	97
2010[1]	87	18	15	39
2009[2]	81	29	24	60
2008[3]	74	25	20	56
2007[3]	78	18	26	46

2006[4]	69	11	17	33
2005[5]	44	7	16	25

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

Management Actions 2012

- Conduct rodent control and Elepaio monitoring at SBW, Ekahanui, Palehua, Moanalua to meet required 75 managed pairs.

4.1.5 Terms and Conditions for Implementation

4.1.5.1 Minimize direct impacts of military activities on survival and reproduction of Oahu Elepaio within the action area at Schofield Barracks Military Reserve (SBMR).

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 2010-2011]

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. In February 2011, an elepaio territory was lost as the result of over-spray of an herbicide being used to clear vegetation along the firebreak road. This incident was reported to the Service and a copy of the letter is included as appendix 4-1 to this report.]

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]

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

[No specimens were collected by OANRP staff]

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

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]

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]

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

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]

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 2011

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.

Banded Oahu Elepaio being released.

4.2.2.1 Makua Territory Occupancy Status and Rat Control 2011

Makua Site Demographic Data

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

[1] Nest containing eggs or nestlings.
[2]Total number of successful active nests observed.
[3]Total number of active nests with unknown outcome (time gap between visits).

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

Makua Reproductive Results

During one site visit in the 2011 breeding season, no pairs were observed (only single males). No nests or fledglings were observed.

Makua Rodent Control

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

Makua Rat Control Data

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

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

4.2.3 MIP Summary

4.2.3.1 Management Actions 2011

- The limited number of site visits (1) during the 2011 breeding season to Lower Makua may have been inadequate to detect females in previous pair territories.

4.2.3.2 Management Actions 2012

- Conduct yearly territory occupancy surveys at all territories within the Makua AA, monitoring and banding, and data entry and organization.
- Conduct rat control in all pair territories and monitoring of Elepaio at Makua to meet the BO requirements

CHAPTER 5: RESEARCH PROGRAM

5.1 SUMMARY

This chapter describes the status and outcome of actions carried out under the direction of the program's Research Specialist. This section does not include all research projects supported by the program. Please refer to the appendices to view research carried out by Brendan Holland, Ph.D, (University of Hawaii Manoa, Center for Conservation Research & Training) on *Euglandina rosea, Chameleo jacksonii,* and *Achatinella sp.* Research by Paul Krushelnycky, Ph.D, (University of Hawaii Manoa, Dept. of Plant & Environmental Protection Sciences) on the impacts of rats on arthropod communities also appears in the appendices.

Statistical analyses in this section were performed with Minitab Release 14 software of Minitab Inc. (Ryan et al. 2005). Significance during hypothesis testing was characterized by p-values less than 0.05. With the exception of a single two-sample T test, nonparametric statistical tests (Mann–Whitney U Test) were used in analyses as most datasets were non-normally distributed.

5.2 MOLLUSCICIDE SPECIAL LOCAL NEEDS LABELING (SLN) STATUS

Since 2006 OANRP has been working with the manufacturer of Sluggo® (Neudorff Co., Fresno), to complete research in support of a label expansion which would allow it to be used for the protection of native plants. The final Special Local Needs (SLN) label was approved in October 2010 and is valid within the state of Hawaii through October 2015. Below is the final label as it appears on the Hawaii Department of Agriculture (HDOA) website (http://hawaii.gov/hdoa/labels/sln/1004_2015.pdf).

SECTION 24(c) REGISTRATION

FIRST CHOICE® SLUGGO®
SLUG AND SNAIL BAIT

FOR CONTROL OF SLUGS AND NON-NATIVE SNAILS IN FORESTED AREAS FOR CONSERVATION PURPOSES

EPA Reg. No. 67702-3-34704
EPA SLN No. HI–100004
Issue Date: 10/27/2010
Expiration Date: 10/26/2015

SUPPLEMENTAL LABELING INFORMATION FOR DISTRIBUTION AND USE ONLY IN FORESTED AREAS WITHIN THE STATE OF HAWAII

This label is valid until October 26, 2015 or until otherwise amended, withdrawn, cancelled or suspended.

DIRECTIONS FOR USE

This label and the federal label for this product must be in the possession of the user at the time of pesticide application.

Follow all application directions, restrictions, and precautions on this Supplemental label and the main EPA-registered label. It is a violation of federal law to use this product in a manner inconsistent with its labeling.

PURPOSE: For the control of slugs and non-native snails in forested areas to protect native, threatened and endangered Hawaiian plants.

HOW AND WHERE TO APPLY: Scatter the slug and snail bait granules on the soil around the base of the plants to be protected. Scatter granules by hand or with a granular or broadcast spreader. Use 20 to 44 lbs. per acre (0.5 to 1 lbs per 1,000 square feet). Apply the 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. Do not place in piles. If the ground is dry, wet it before applying bait. The soil should be moist but with little or no standing water.

WHEN TO APPLY: Apply bait in the evening, as slugs travel and feed mostly by night or early morning.

ACCEPTED
October 27, 2010
Under Hawaii Pesticides Law
as Supplement to Product No.
8378.115

USE RESTRICTIONS:

- Bait must not be applied within 6.1 m (20 feet) of any body of water, including lakes, ponds or rivers.
- Area must be thoroughly searched by experienced malacologists during the day and at least one night prior to application of NEU1165M Slug and Snail Bait granules to ensure that non-target endemic Hawaiian snail species are not impacted. Do not apply in areas where it may come into contact with known populations of endemic Hawaiian snail species from the following rare families or subfamilies: *Amastridae*, *Achatinellinae* and *Endodontidae*). Bait must not be applied within 20 m of any tree known to harbor endangered Hawaiian tree snails (*Achatinella* spp.). Report any evidence of suspected poisoning of Hawaiian snails to the Pesticides Branch of the Hawaii Department of Agriculture, phone: (808) 973-9401.

24(c) Registrant:

Loveland Products, Inc.
P. O. Box 1286
Greeley, CO 80632

The information contained in this label was presented by OANRP staff at the 19th Annual Hawai‘i Conservation Conference. The abstract and title of our presentation follows:

Joe, S. Oral Presentation. Registration of Sluggo® for rare plant restoration: an effective new tool for slug control.

Introduced slugs are seedling predators of several endangered plant species. Since 2006, OANRP has worked with state and federal agencies to investigate the safety and efficacy of the molluscicidal bait Sluggo® (active ingredient, iron phosphate) to control slugs in forestry settings without harming native snails. In late 2010, OANRP successfully petitioned HDOA to pass SLN labelling for Sluggo®. This label amendment means that, for the first time, eradication of slugs in a natural area is possible. Prior to Sluggo®, available slug control methods (*e.g.* traps baited with beer or copper barriers) were highly labor-intensive and of limited efficacy. Here we describe the SLN registration process. We review label restrictions intended to reduce risk to native snails. Finally, we describe Sluggo® application techniques to maximize protection of vulnerable plants.

5.3 Seedling Response to High and Low dose Application of Sluggo® in a Forested Area

5.3.1 Introduction

The purpose of this experiment was to determine whether Sluggo® applied once a month is equal to application at the same rate (44 lbs. per acre) twice a month as indicated by the survival of naturally occurring *Cyanea superba* subsp. *superba* (hereafter referred to as *C. superba*) seedlings over 16 months

(March 2010-July 2011). This experiment directly relates to how Sluggo® would be applied to maximize native plant recruitment while taking into account labor costs.

5.3.2 Methods

Thirty six *C. superba* in the Kahanahaiki Management Unit produced fruit in the 2009-2010 season. This unprecedented fruiting event allowed us to compare, for the first time, the efficacy of Sluggo® application at intervals less frequent than the label rate (two week intervals) thereby minimizing labor associated with slug control. This experiment began prior to the SLN label expansion passed in October 2011, thereby necessitating that we acquire an Experimental Use Permit from HDOA to apply Sluggo® in a forest setting.

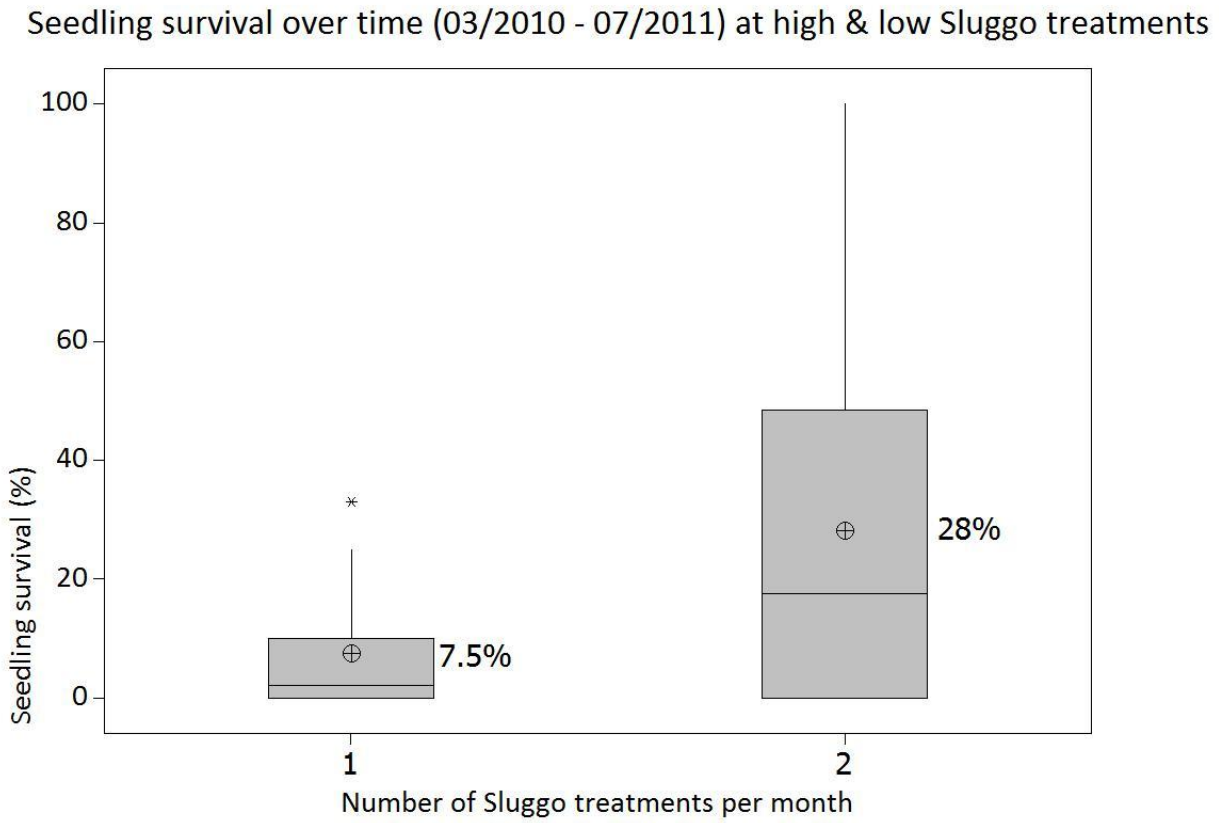
Twenty-nine plants had offspring at the start of the experiment in March 2010. We randomly divided these plants into two groups (see table below), one of which received Sluggo® every two weeks (n=14), the other which received it once month (n=15). Note that the replicate unit was the plant with its associated seedlings, not the individual seedlings. The proportion of seedlings extant after 16 months at each adult was subsequently compared between treatments.

Number of seedlings per plant in the low (Sluggo® given once a month) treatment group	Number of seedlings per plant in the high (Sluggo® given twice a month) treatment group
1	1
1	1
2	2
4	2
5	2
5	3
14	3
16	10
21	13
24	21
26	30
44	46
52	58
63	131
72	

Table showing number of seedlings per adult *C. superba* by treatment at the start of the experiment (March 2010). Note that each group included at least six plants with five or fewer seedlings. Under ideal conditions, these would have been excluded from the study. The small sample size, however, necessitated their inclusion.

5.3.3 Results & Discussion

At 16 months, no significant difference in seedling survival was evident between the two groups (Mann-Whitney U two-sided test: W = 191.5, P=0.14). Despite this result, it is notable that the high treatment group had a mean (and median) survival rate that was over three times that of the low dose group (see graph below).



The lack of significance may be due to the low number of seedlings per adult. Approximately half of adults produced five or fewer seedlings at the outset (see table above). These low numbers led to many adults with 0% surviving seedlings after 16 months. Another problem with the study design was the close proximity of the plants to one another. This meant that adults with offspring receiving the high dose treatment were sometimes less than four meters away from adults from the low dose group. It is likely, therefore, that although the bait at the low dose treatment was inert after two weeks, fresh bait at neighbor plants ensured slugs were being controlled at all times. It would be tempting, given the lack of a significant difference between groups, to conclude that application of Sluggo® should proceed at a low dose rate. However, given the limitations of the study design and the generally high survival of seedlings in the high treatment group, such a management decision would be premature.

5.3.4 Finding an optimal slug control strategy

OANRP is concerned with providing plants maximum protection from slugs. Given the unclear outcome of the study above, it seems safest to apply Sluggo® at a high rate until a lower dose can be proven equally effective.

Slug control is planned at four sites. Each was chosen to include endangered plant species known to be vulnerable to slugs and treatments are scheduled to take place throughout the wet season (when slugs are abundant). Treatment is timed to coincide with the production of fruit and seedlings. Treatments will become less frequent as the wet season transitions to the dry season, or earlier if slugs are found to be considerably less abundant. Maps of each of the four sites as well as plants receiving treatment appear below:

Sluggo® application site in Ekahanui

Sluggo® application site in Kahanahaiki

Sluggo® application site at Three Points

Sluggo® application site at Palikea

The new Sluggo® label specifies that the bait cannot be applied if certain rare snails are present (see USE RESTRICTIONS section 7.1, this document). Snails found during both daytime and nighttime surveys conducted by an experienced malacologist (V. Costello) appear below.

Location	Plant species present that are vulnerable to slugs	Day survey date followed by night survey date	Snails found?	Action
Ekahanui (MAP 1)	*Delissea waianaensis, Schiedea kaalae, Cyanea grimesiana* subsp. *obatae*	3/22/2011, 3/22/2011	Yes, *Achatinella mustellina*	Closest trees with snails are >30 m from application site, therefore not at risk. First Sluggo® treatment occurred on 10/17/2011.
Kahanahaiki (MAP 2)	*C. superba* subsp. *superba, S. obovata*	12/28/2010, 3/16/2011	Yes, three areas had *Leptachatina sp.*	Sluggo® will not be applied in proximity to any of the three *Leptachatina* sites.

Three points (MAP 3)	*C. longiflora, C. grimesiana* subsp. *obatae, S. obovata*	4/12/2011, 10/25/2011	No	Sluggo® was deployed on 11/21/2011
Palikea (MAP 4)	*C. grimesiana* subsp. *obatae, C. superba* subsp. *superba*	1/3/2011, 1/3/2011	Yes, *Achatinella mustellina*	Closest trees with snails are >50 m from application site. Sluggo® was deployed on 10/19/2011

Slugs are to be monitored both within and outside (control group) of the treatment area to ensure bait efficacy, as well as to alert OANRP to seasonal reductions in slugs to trigger reduced or halted Sluggo® application. For example, slug populations in some areas (Kahanahaiki) have previously crashed during dry summer months. Sluggo® applications would cease during intervals of low slug activity. Beer traps centrally placed within the treatment area and another set placed in a similar habitat, but at a distance of at least 20 meters (from the treatment edge), will be used to track changes in slug numbers.

Sampling inside and outside the treatment area in both Palikea and Ekahanui prior to Sluggo® application indicated no pre-existing difference in slug numbers within individual management units (n=8, Two-sample t-test P>0.05). Differences in slug densities between management units, however, are emerging. A single trap in Ekahanui yielded an average of 17.25 slugs (±0.84), compared to 5.25 slugs (±0.59) found in Palikea traps over the same time interval. Such disparities in slug numbers between sites suggest that no single method of Sluggo® application will be appropriate for all areas.

Sluggo® will be applied at two-week intervals within the treatment areas for no less than three months. At that time, numbers of slugs within and outside of the treatment area will be compared. If no significant differences are found, then the buffer area around the treatment area will be expanded, as it will be assumed that incursion from slugs there is high. Should numbers of slugs remain unchanged within the treatment area, despite a large buffer, it will be considered a failure. Treatment will be considered effective if it results in a substantial and statistically significant decrease in slugs when compared against the control group. For areas where the two-week treatment is proven effective, treatment will be reduced in frequency with the goal of determining whether the low application rate results in the same decrease in slug numbers.

5.4 SURVEY OF INVASIVE ANT SPECIES

Ants are most likely to become established around disturbed areas frequented by humans such as bathrooms, campgrounds, fence lines, helipads, and roads (Plentovich 2010). Areas undergoing construction of fences or other structures should be carefully monitored for new introductions. Activities including the transfer of soil, such as out-planting, should also be carefully monitored. Careful monitoring will increase chances of early detection, and early detection is key to successful eradication or control.

OANRP conducts annual surveys of invasive ants in high-risk areas using a standard protocol developed by Sheldon Plentovich, PhD, (University of Hawaii at Manoa Zoology) and Paul Krushelnycky, PhD, (University of Hawaii at Manoa Plant Environmental Pest Program) (Plentovich and Krushelnycky 2009).

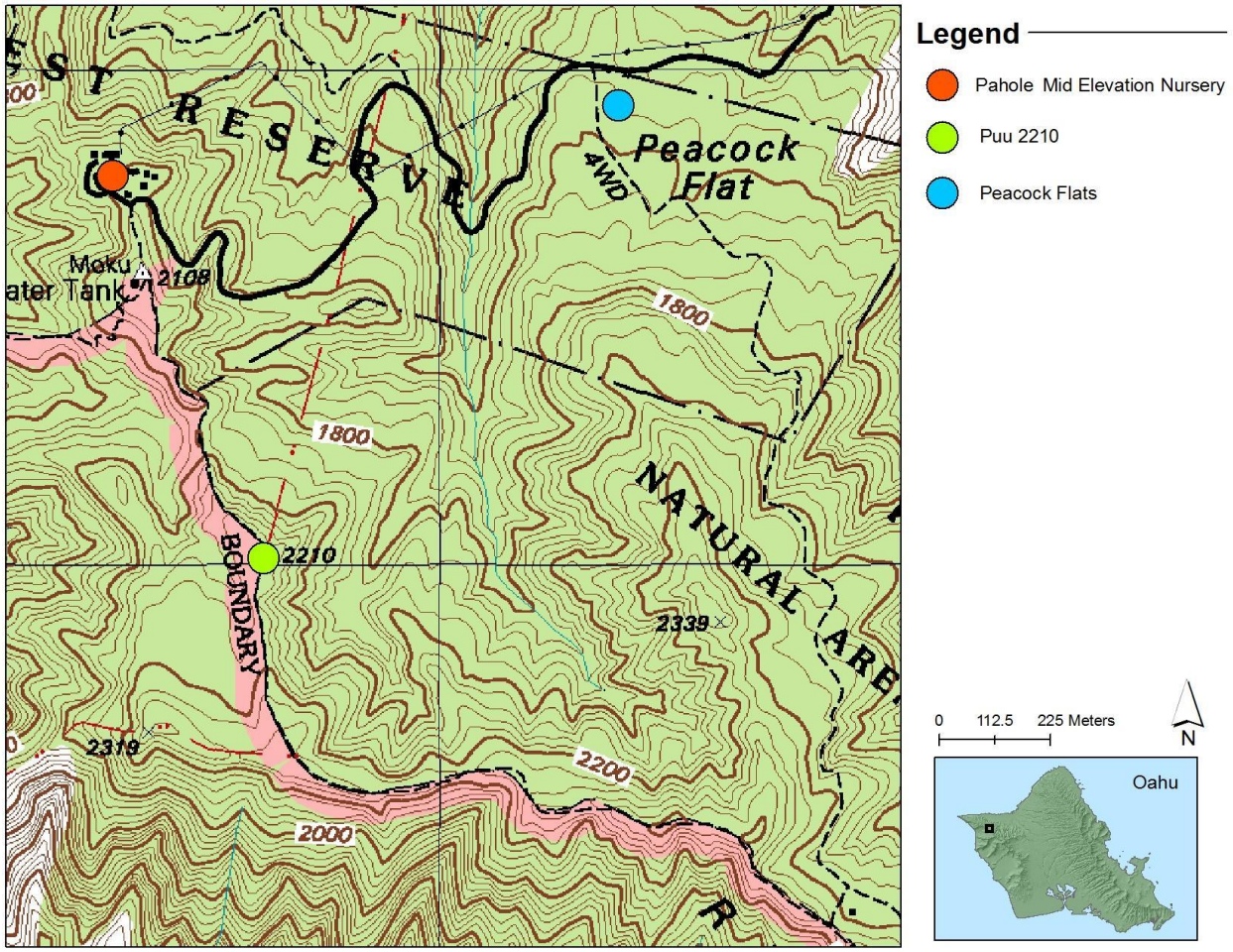
Below is a table listing ant species found in each Management Unit. New records for 2011 are indicated with an asterisk (*).

Management Unit	Ants recorded from site before 2011	Action needed?

Pahole	*Solenopsis geminata*, S. papuana, Paratrechina bourbonica, Leptogenys falcigera*	Treatment of *S. geminata* has begun. More information is provided in the Ant Control section (below).
Kaluakauila	*Anoplolepis gracilipes, Cardiocondyla emeryi*, Ochetellus glaber, Paratrechina bourbonica*, Plagiolepis alludi, S. papuana*,*	*Anoplolepis gracilipes* is an aggressive species; however, it is too widespread for control.
Kaala	*Solenopsis papuana, Ochetellus glaber, Tetramorium simillimum, Cardiocondyla venustula, C. wroughtoni, C. minutior*	Species present are at low numbers and are not considered a threat.
Kahanahaiki	*Cardiocondyla emeryi, C. wroughtoni, C. venustula, Leptogenys falcigera, Ochetellus glaber, Plagiolepis alludi,S. geminate*, S. papuana, Technomyrmex albipes, Tetramorium simillimum*	Treatment of *S. geminata* and *A. gracilipes* has begun. More information provided in the Ant Control section (below).
Kahuku Training Area	*Leptogenys falcigera, Pheidole megacephala*	*Pheidole megacephala* is an aggressive species, but too widespread for control.
Ekahanui	*Solenopsis papuana, Plagiolepis allude*	Species present are not considered a threat.
Palikea	*Cardiocondyla venustula, Pheidole megacephala*, Solenopsis papuana*	*Pheidole megacephala* is only known from a single winged male. If workers are found, control will commence.

5.4.1 Ant Control Actions

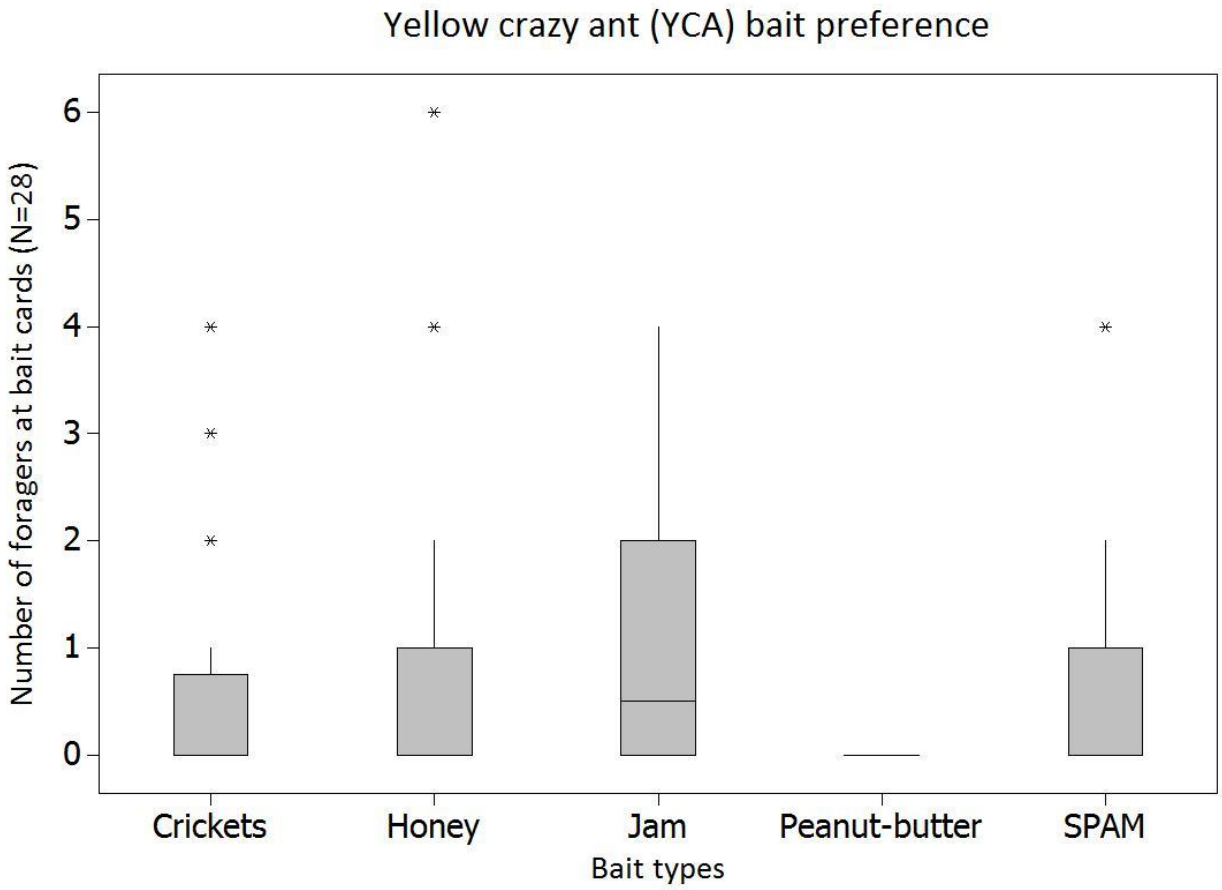
OANRP identified three sites for ant control. Although ants are present in all Management Units, priority is given to those with the following characteristics 1. The infestation is <3 acres, 2. The ant species present is not widespread in adjacent locations and 3. The ant species present is known to have harmful impacts on native species. Given these criteria, we carried out control of *S. geminata* (tropical fire ant) at the Peacock Flats Campground and Puu 2210 in Pahole and control of both *S. geminata* and *A. gracilipes* (yellow crazy ant) at the Pahole Mid Elevation Nursery (see map below).



MAP 5. Location of the Pahole Mid Elevation Nursery where *S. geminata* and *A. gracilipes* control took place. Also shown is Puu 2210 and Peacock Flats, both part of the Pahole Natural Area Reserve where *S. geminata* control occurred.

5.4.1.1 Yellow Crazy Ant Control

Anoplolepis gracilipes was first recorded at the Pahole Mid Elevation Nursery in 2008. Using bait cards with no toxin and visual searches for foragers and nests, we determined the infestation covered an area of approx. 1 acre. Treatment of the infestation began in March 2009 using Amdro® (BASF Australia, Ltd.) a granular pesticide containing hydramethylnon suspended in a corn-grit matrix. This is a popular product, as it is easy to deploy, breaks down in sunlight and is registered for use in "forested areas." It is therefore one of the very few pesticides used when treating ant infestations in natural areas (Maxforce® a product by Bayer Environmental Science is also used). It should be noted that a range of products are registered for use at nurseries, so we are not limited to Amdro® and Maxforce®. Densities of foragers at nontoxic bait cards containing SPAM, peanut butter, and honey left for 1 hour (10-11 am) remained unchanged before and after treatment. Pre-treatment numbers averaged 6.85 ants ± 0.91 per bait card vs. 5.39 ants ± 0.88 per bait card, two weeks after the treatment. In order to better understand *A. gracilipes* (yellow crazy ant) bait preference, we offered foragers five different bait types: 1. peanut butter, 2. honey, 3. SPAM®, 4. cricket mash (composed of crickets put in a blender with water), and 5. jam. Twenty-eight cards of each bait type were deployed and the number of foragers frequenting the bait counted after one hour.



Peanut butter was the least preferred bait, with no visitations (see figure above). All other bait types were significantly more attractive (Mann-Whitney U $P<0.05$), but ants showed no significant preference for baits within this group. These results may help explain why Amdro® was such a poor choice for control of *A. gracilipes*. The corn-grit carrier is oily and attracts ants that prefer fats. Based on *A. gracilipes* recruitment to sweet baits, we attempted control using Terro® (Nisus Co., TN), a liquid sugar bait containing boric acid. Fifty traps were deployed containing a 2% boric acid solution in May 2009. The number of *A. gracilipes* foragers visiting bait dropped to zero post-treatment. Traps were refilled monthly for one year, during which time *A. gracilipes* was undetectable at nontoxic bait, but still noticeable foraging around buildings. We are now looking at increasing the number of stations, as well as testing other baits to achieve eradication. Maxforce® makes use of the same active ingredient as Amdro®, but incorporates it into powdered silkworm larvae to attract species which prefer to feed on other insects. This bait has been ordered and future tests are planned.

5.4.1.2 Tropical Fire Ant Control

Solenopsis geminata was documented at Peacock Flats campground in late 2008. In September 2011, the State Department of Land and Natural Resources cooperated with OANRP to close the campground for several days so that the infestation could be treated using Amdro®. It is unknown at this time whether the treatment was effective, however, cooperative follow-up surveys are planned later this year.

Two small pockets of *S. geminata* were found in August 2011. One measures 120m^2 and is located on a road cut within the Pahole Mid Elevation Nursery, the other encompasses an area of 800m^2 along the trail at Puu 2210 (see MAP 5.). Both were treated with AMDRO at the label rate. One month later, no *S.*

geminata were found at the Pahole Mid Elevation Nursery. Some foragers were found at Puu 2210, but they were showing abnormal behavior (trembling). The latter site was re-treated on September 26, 2011. A follow-up survey of the Pahole Mid Elevation Nursery in October confirmed *S. geminata* were absent and perhaps eradicated. Puu 2210 has not yet been resurveyed since the second treatment in September 2011. OANRP plans to resurvey all sites with *S. geminata* for one year. If the ants are not found over a two-year period (surveys to be conducted quarterly), the infestation will be considered eradicated.

5.5 SMALL VERTEBRATE PEST CONTROL– LARGE SCALE TRAPPING GRIDS

5.5.1 Introduction

OANRP has installed large scale trapping grids in three of our management units (MUs). 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.

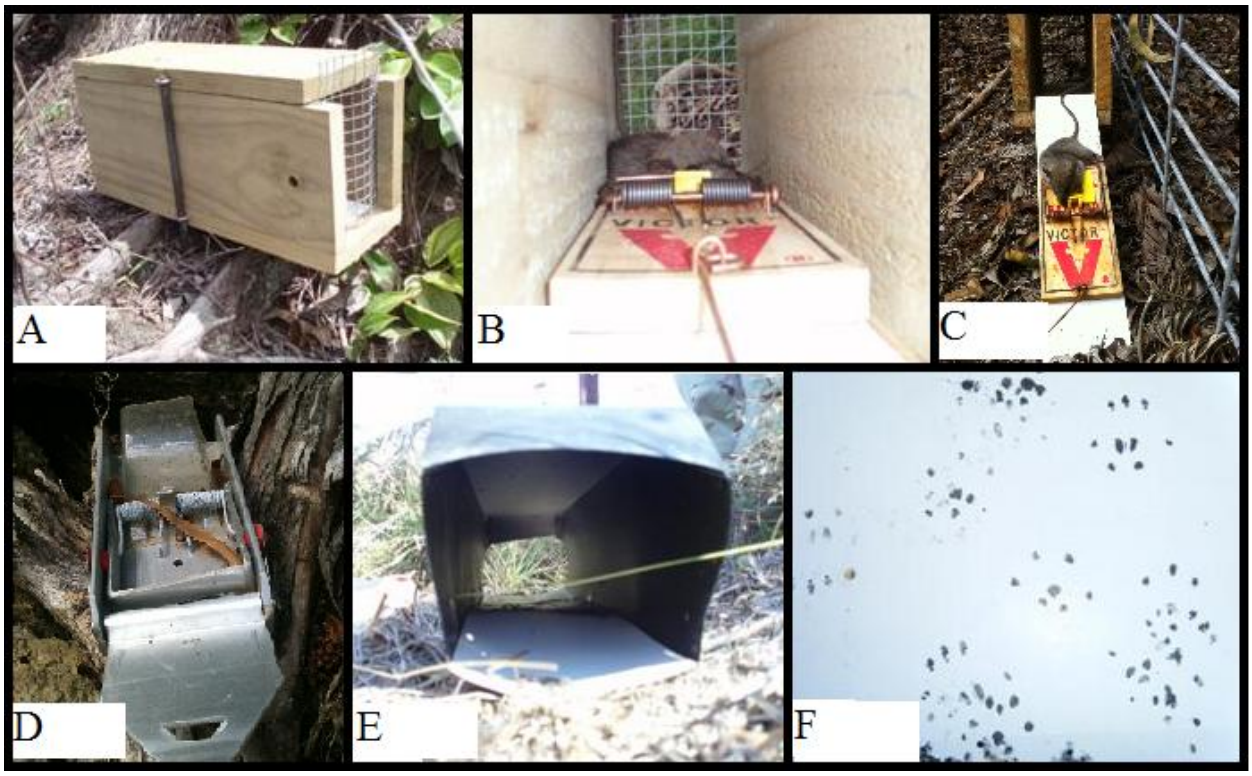
These grids are designed for large-scale lethal trapping for Black, Norwegian and Pacific rats (*Rattus* sp.) across MUs. The overall goal is to reduce rat activity within an MU to a level that benefits the endangered plants, *Achatinella mustelina* (Oahu tree snail), *Chasiempis ibidis* (Oahu Elepaio), 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. Prior to these grids, rat control in these areas consisted of using small-scale diphacinone bait station grids and snap traps surrounding an individual plant, small groupings of plants, individual snail trees or nesting locations of Elepaio. The large-scale trapping grids follow the New Zealand Department of Conservation's current best practices for kill trapping rats (NZ DOC 2005). Wooden rat trap boxes and tracking tunnel monitoring equipment were purchased from New Zealand in 2009. The box is designed to exclude non-target species, guide target species, prevent accidental triggering, and maintain the integrity of the trap from weather. Equipped with Victor® snap traps (Woodstream Corp., USA), the wooden boxes are deployed at Kahanahaiki and Ekahanui. Metal Ka Mate™ snap traps (Ka Mate™ Traps Ltd., New Zealand) were deployed at Palikea directly on the ground without wooden boxes because they have less risk of being accidentally triggered (see section **5.5.6.** for more details about traps and efficacy trial of Ka Mate™ versus Victor® traps).

Footprint tracking tunnels at each trapping grid are used to index rat activity levels; tracking tunnels rely on ink-pads and paper to record target species' tracks, and by extrapolation, their abundance. Tracks are analyzed by rodent type counted as either present or absent; no inference on the number of rodents of each species is made. They are used to compare relative abundances of rodents within similar habitat types, and are best when coupled with another sampling method, e.g. trapping grids (Blackwell 2002). Tracking tunnels baited with peanut butter are set out for one night and collected the next day (see photos below).

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. These include: increased native invertebrate abundances (Appendix ES-5, P. Krushelnycky), reduced fruit predation on *Cyanea superba* subsp. *superba* (OANRP 2010), increased native seed rain (*Diospyros hillebrandii*) and common native seedlings (A. Shiels, unpublished data), and the 2010 Ekahanui Elepaio nesting season had more successful nests recorded than any previous years (Chapter 7). However, strawberry guava *(Psidium*

cattleianum) seedlings may also be increasing due to less rat predation on seeds (A. Shiels, unpublished data).

In the sections below, data for each grid is discussed separately as well as any changes in management practices for the coming year.



(A) Wooden rat trap box (B) Inside wooden rat trap box with Victor® rat trap

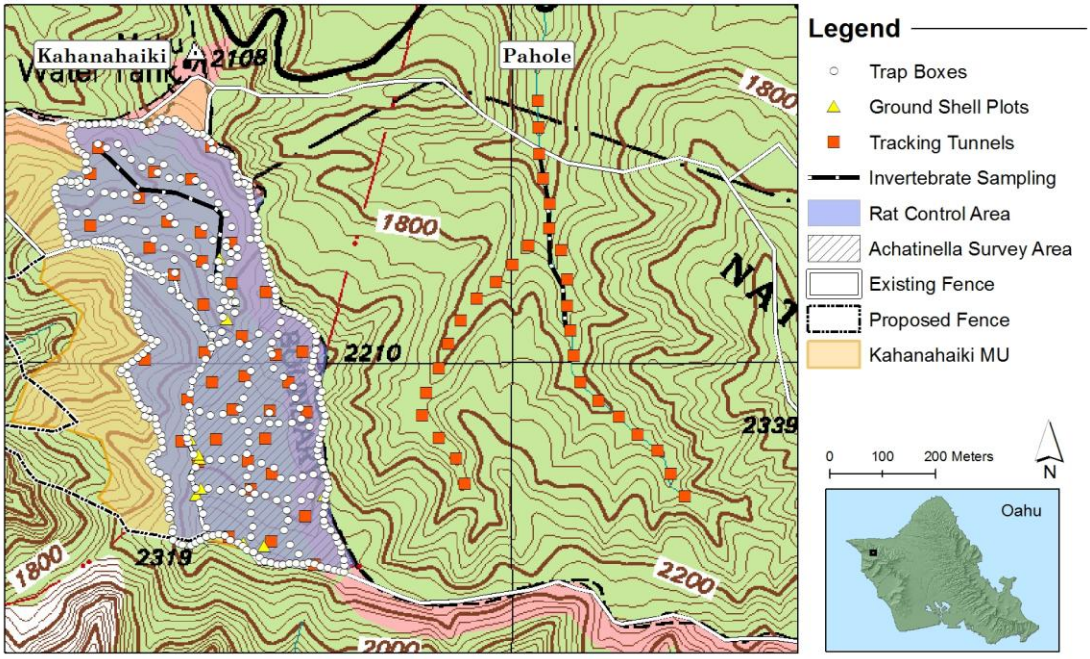
(C) Victor® trap easily accessed within wooden box (D) Metal Ka Mate™ trap (not set) (E) Plastic tracking tunnel with inked tracking card (F) Tracking card with rat tracks

5.5.2 Kahanahaiki

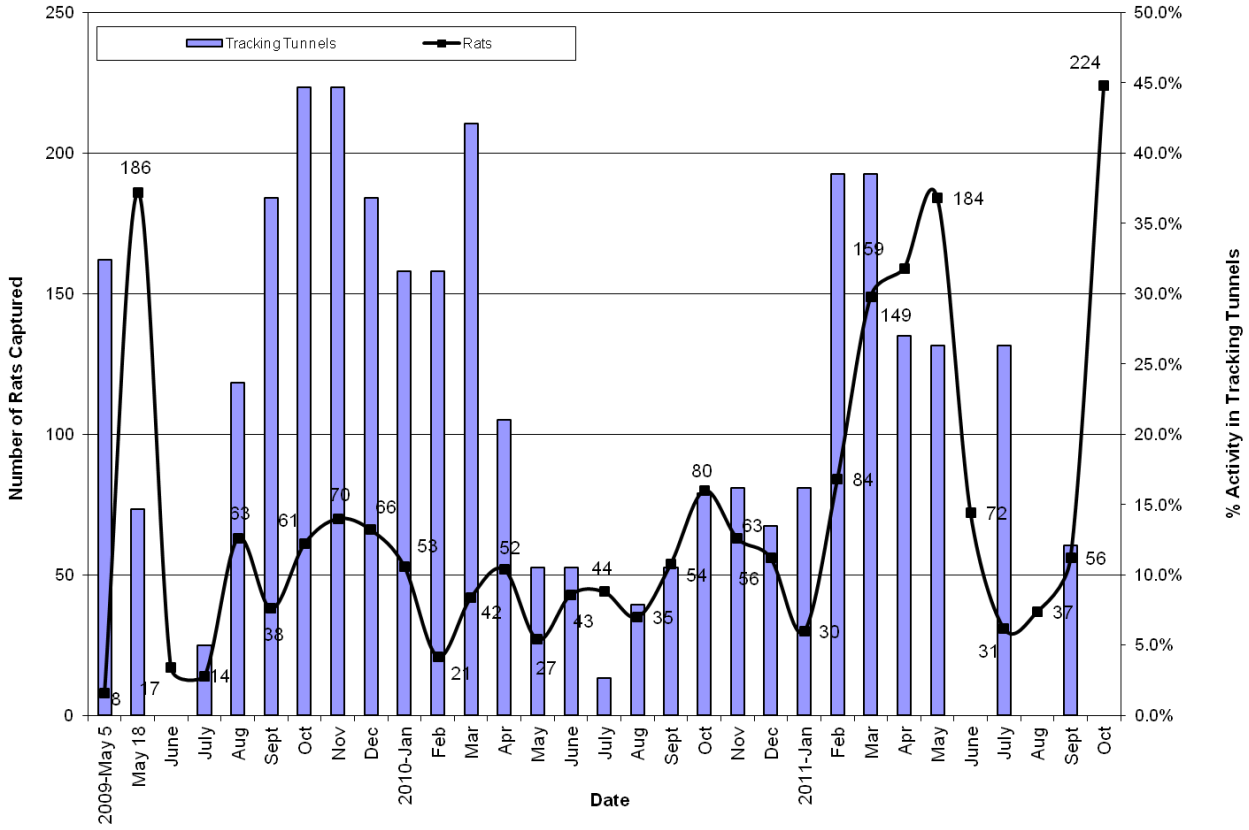
The Kahanahaiki grid covers an area of 65 acres (26 ha) of the Kahanahaiki MU (see map below). The grid encompasses 11 endangered plant species, including both wild and reintroduced populations, and a population of endangered *A. mustelina*. Seedlings, seed rain, arthropod composition and abundance, and slug and *Euglandina rosea* populations are monitored at Kahanahaiki. The adjacent Pahole Natural Area Reserve (NAR) has continued to serve as a comparison site (outside the trapping grid) where rats remain uncontrolled. Pahole NAR contains similar habitat to that in Kahanahaiki and has many of the same resources, yet lacks a large-scale trapping grid. Because of this difference, it is useful to compare rat activity (using tracking tunnels) in the two MUs (see graph "Kahanahaiki Monthly Rat Kills and Percent Tunnel Activity"). The Kahanahaiki grid is composed of 480 Victor® snap traps in boxes. The perimeter consists of 234 traps spaced 12.5 meters apart. The interior contains 246 traps on transects and trails at a spacing of 25 meters apart. The home range of *R. rattus* in the Waianae Mountains is 9.4 acres or 3.8 ha (Shiels 2010); therefore, migration from neighboring rat populations can quickly repopulate the relatively small and narrow MU in a day or two. Traps are checked once every two weeks unless more than 30 rats are caught on a single check. This 'threshold' number was selected by noticing that the number of rats

killed in a single bi-monthly check was often 30 or fewer, but when spikes in rat kills occurred, more than 30 rats per bi-monthly check were killed. In that case, traps are baited and checked weekly until two consecutive weekly checks are completed with fewer than 30 rats caught, then the bi-monthly baiting resumes. This threshold number is used as a rough guideline for current management strategies and will be refined as more data on how this level of rat activity is correlated with predation on plants, snails and birds is collected.

Map of Trapping Grid, Tracking Tunnel Locations, and Sampling Locations at Kahanahaiki and Tunnel Locations Pahole NAR



Kahanahaiki Monthly Rat Kills and Percent Tunnel Activity



The graph above shows number of rats killed and percent rat activity in the tracking tunnels each month since the grid was established. Data shown for the number of rats killed each month represents the summary of the rats found at all checks that month; this varies from two to four checks depending on fluctuations in rats caught (as discussed above). Tracking tunnel data represents rat activity in the 38 tracking tunnels randomly placed at Kahanahaiki. Months that do not show tracking tunnel activity were skipped (as opposed to zero activity).

The grid has been checked a total of 99 times and has killed 2,161 rats and 841 mice (from May 2009 to October 31). On average, 22 rats are caught (killed) per check. The data show interesting trends; early to mid summer catch rates (May- July) have lower numbers of catches and less rat activity in the tracking tunnels, however, fall catch rates (September-November) show increased numbers of rats killed. One possible explanation for this trend is that in the summer, rats may not have to scavenge as much due to an abundant food source from strawberry guava fruits and therefore do not enter tracking tunnels and snaps as frequently. In the fall, when the fruiting season ends, there is a boom in rat activity (possibly due to higher birth rates following increased food consumption) and increased scavenging for food, including tracking tunnel bait and snap trap bait. Consequently, catch rates show an increase. This increase was especially noticeable in October 2011 with 224 rats killed (traps baited/checked weekly).

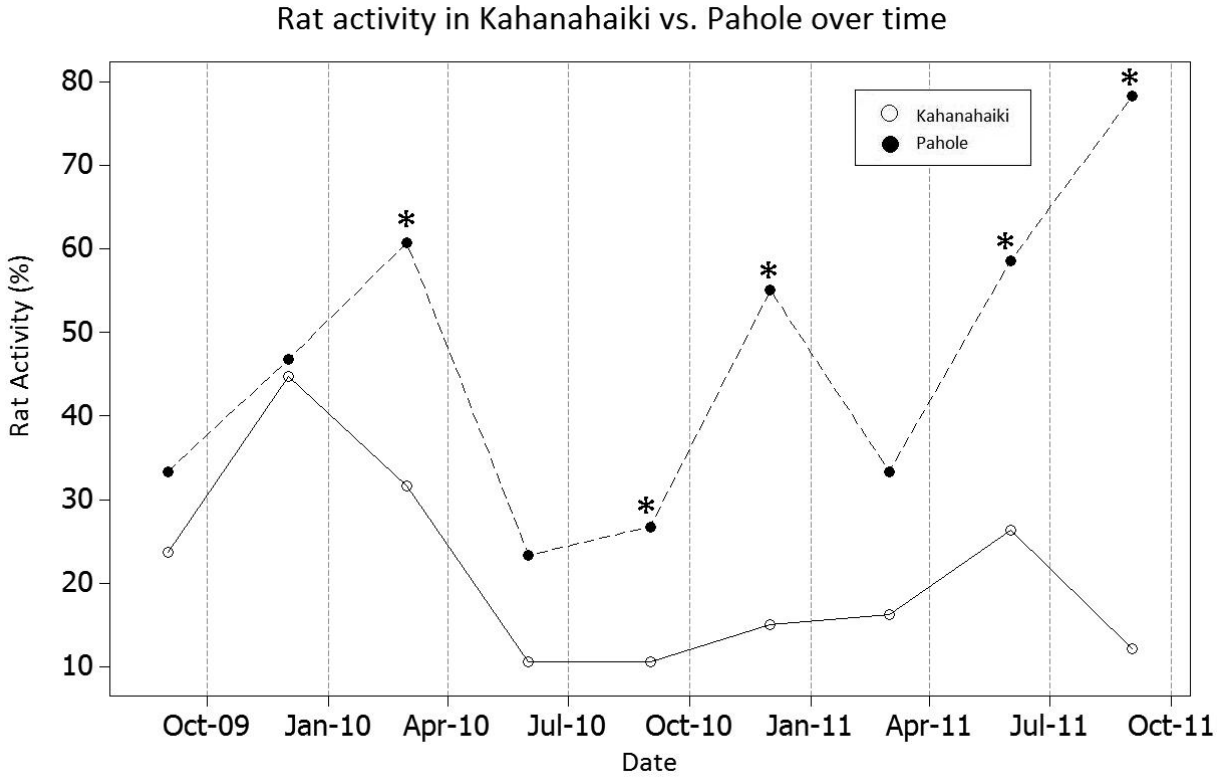
In February 2011, there was a high spike in rat kills. OANRP began baiting more frequently (weekly), and in May 2011 a high of 184 rats killed. This number is second only to May 2009 when the grid was first established. By July 2011, the number of rats caught in two trapping events had fallen to 31 and OANRP resumed the normal twice a month baiting schedule. This large spike cannot be explained with the current monitoring at Kahanahaiki and the cause is unknown.

Discussion of Kahanahaiki MU rat control methods for 2012:

Further analysis of individual trap catch data is needed to determine which areas of the MU are more likely to be re-colonized in order to optimize our grid design. OANRP is investigating new baits to use on snap traps that will minimize slug and ant consumption and render traps more effective. After critical review of grid layout and analysis highest rat kill areas, reduction of the number of boxes may also occur to optimize labor efficiency (for comparison 619 traps are used over a 177 acre area in Ekahanui whereas 480 traps are used for just a 65 acre area in Kahanahaiki). An Access database for recording trapping data will assist with these analyses. A subcontractor will also likely perform the trapping work instead of OANRP staff. Food resources for rats will also continue to be reduced through ongoing guava control across the MU. More frequent trap checks may also take place in the late summer period in anticipation of seasonal spikes in populations. Pono Pacific, a local resource contractor, will begin baiting the grid in January 2012. OANRP will provide supplies, clear trails and conduct quality control.

5.5.2.1 Tracking Tunnel Monitoring – Kahanahaiki vs. Pahole

Starting in August 2009, tracking tunnels were checked quarterly at both the Kahanahaiki MU (38 tracking tunnels) and the Pahole NAR (30 tracking tunnels) to test the effect of the rat grid on rat densities during its establishment and determine if it was effective as designed (see graph below).



* = significant difference between MUs in a given month P<0.05 (Chi-Square analysis).

Rat activity was significantly higher in Pahole five out of the nine time periods sampled and Pahole showed more rat activity than Kahanahiki every month. OANRP will discontinue sampling in Pahole NAR after November 2011, as there is enough evidence to show that Kahanahaiki consistently has lower numbers of rats.

5.5.2.2 Slug & Euglandina Monitoring (Kahanahaiki MU & Pahole NAR)

The purpose of this research was to determine whether rats are an important predator of other pest species (slugs and *Euglandina rosea*). When the rat trapping grid was installed in 2009, there was concern that removal of rats might result in a release of invertebrate prey such as slugs and *Euglandina.* If this were the case, then the full conservation benefits of rat removal on both rare plant populations (which are impacted by slugs) and *Achatinella* tree snails (which are consumed by *Euglandina*) would not be realized (Meyer & Shiels 2009)[1]. Fortunately, data collected on rat activity as it pertains to slug and *Euglandina* densities over a two year period does not support this hypothesis. There is no apparent increase in populations of slugs and *Euglandina* with decreased rat activity.

Study design

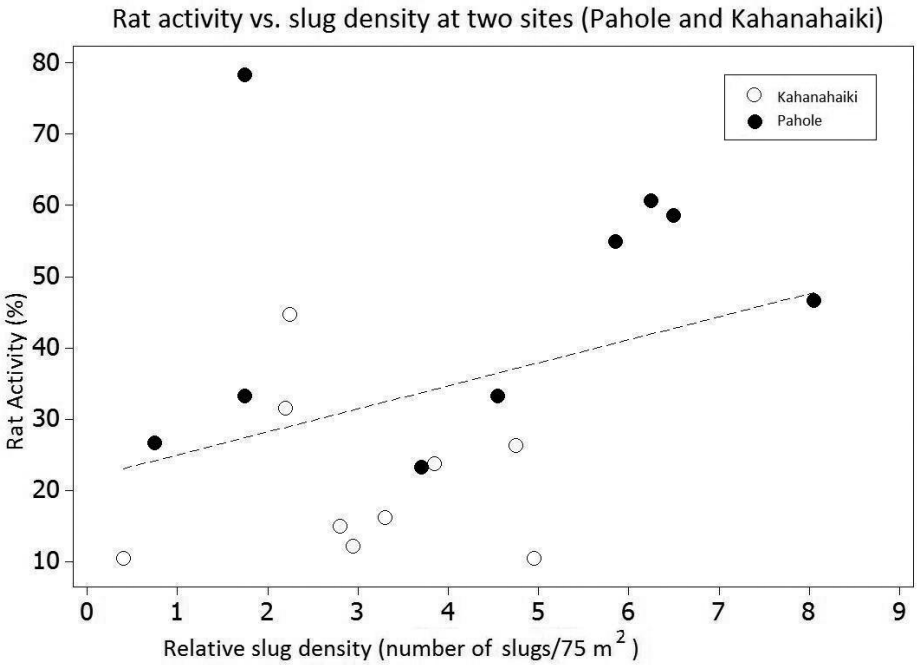
Slugs found in beer baits left out for one week were used to estimate slug numbers. Forty eight-ounce jars were deployed at 25 meter intervals along a 400 meter transect in the Kahanahaiki gulch bottom and in the main drainage of the Pahole NAR (Gulch 2). Once a quarter (in March, June, September and December) traps were baited with five ounces of Guinness® beer and the number and species of slugs caught within one week was recorded.

Euglandina were sampled using timed searches (one person hour) at 10 discrete points along the 400 meter transect established for slug sampling. Each of the points marked the center of a 75 m^2 plot along which three people searched for *Euglandina* over 20 minutes (total time equal to one person hour per plot). Live *Euglandina* were counted, shell length recorded (mm) and left in place so as to not artificially control populations via manual removal. *Euglandina* shells were scored for damage (either potentially rat damaged or whole) and destroyed so as to not be re-counted at a later time.

Results & discussion

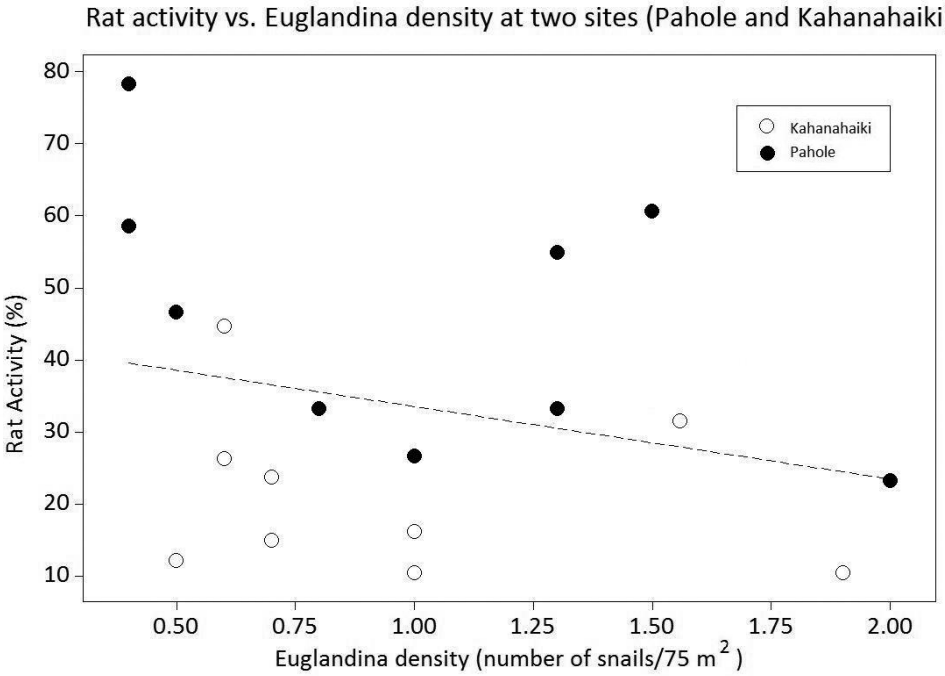
Data from September 2009 through September 2011 show no evidence that decreased rat activity (as indicated by tracking tunnels) results in an increase in slug density (see figure below).

[1] Meyer, W. and A. Shiels. 2009. Black rat (*Rattus rattus*) predation on nonindigenous snails in Hawaii: complex management implications. *Pacific Science* 63(3): 339-347.



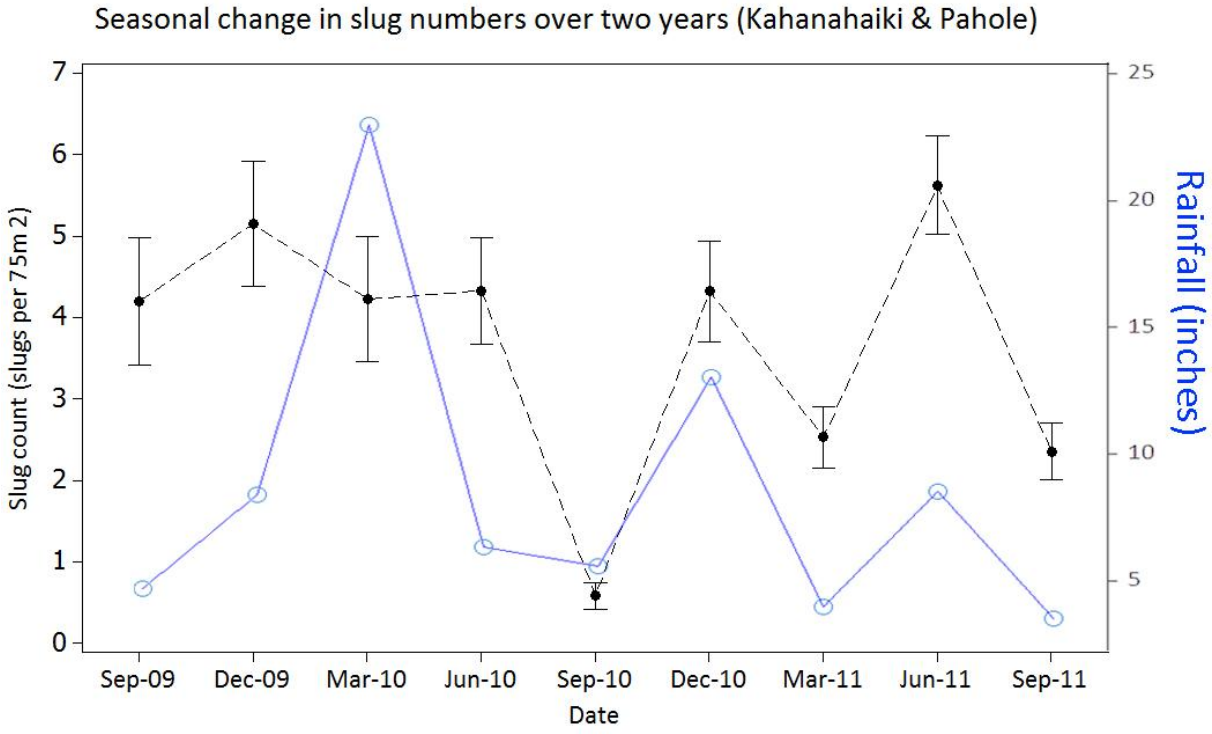
No association between rat activity and slug density is evident in the above graph. The calculated line showing a weak positive relationship is not significant (Pearson's correlation r^2=7%; P=0.169).

As with slugs, there was no clear relationship between rat activity and *Euglandina* density (see figure below).

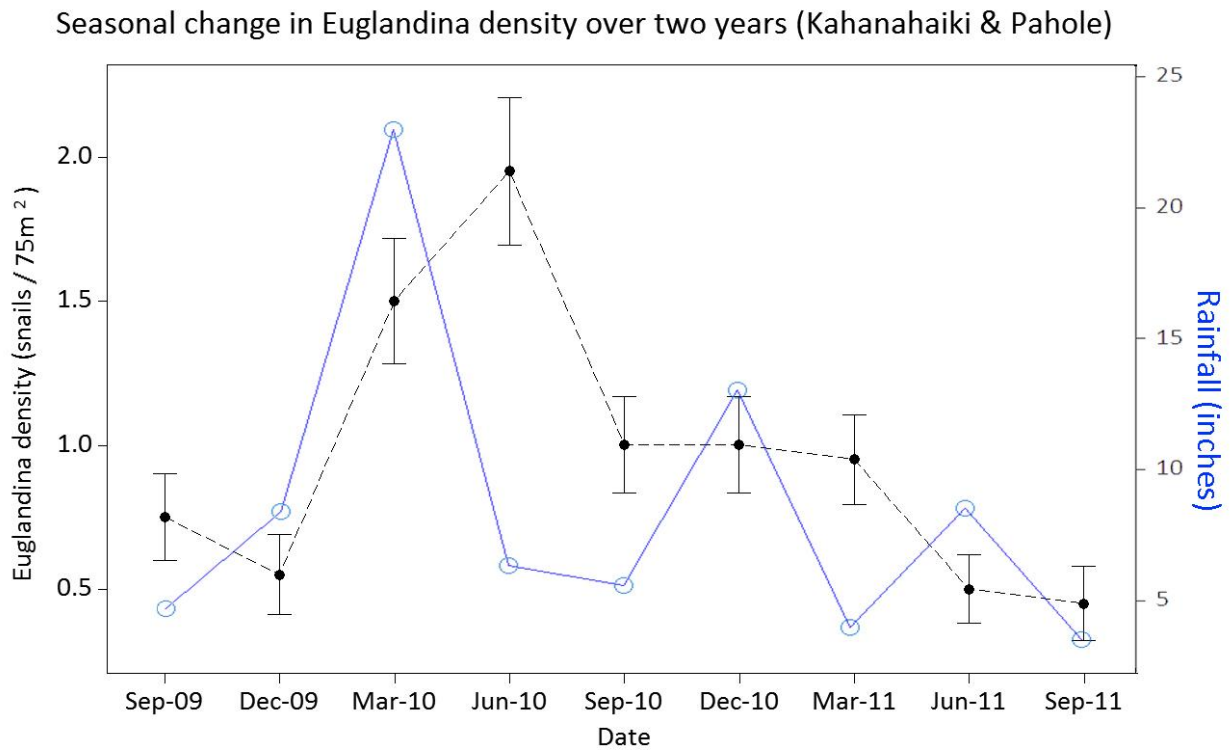


No association between rat activity and *Euglandina* density is evident in the above graph. The calculated line showing a weak negative relationship is not significant (Pearson's correlation; r^2 = 6.5%; P = 0.307).

Over a two year period, there was no difference in slug numbers between sites (Two-Sample T-Test; t = -1.35, P = 0.202). *Euglandina* numbers were log transformed prior to analysis to fit a normal distribution. Like slugs, there was no difference in *Euglandina* density between sites (Two-Sample T-Test; t = 0.21, P = 0.838). Though *Euglandina* are known to consume slugs, there was no relationship between slugs and *Euglandina* (Pearson's correlation r^2=0.5%; P=0.196). As there was no difference between sites, data was lumped to review seasonal patterns. Below are two graphs showing change in slug and *Euglandina* numbers over two years (error bars in both graphs = ± 1 SEM) with rainfall data from the Nike greenhouse site.



For slugs, numbers remained fairly constant from Sept. 2009-June 2010. The noticeable crash in slug numbers in Sept. 2010 might be the result of a dry summer. Despite this crash, slugs had recovered to previous levels by Dec. 2010. Slug numbers were higher this June than in 2010. This is perhaps due to a wetter summer; however there was no significant correlation between rainfall and slug numbers over two years. It is interesting to note that rainfall and slug numbers appeared to synchronize between Sept. 2010 and Sept. 2011.

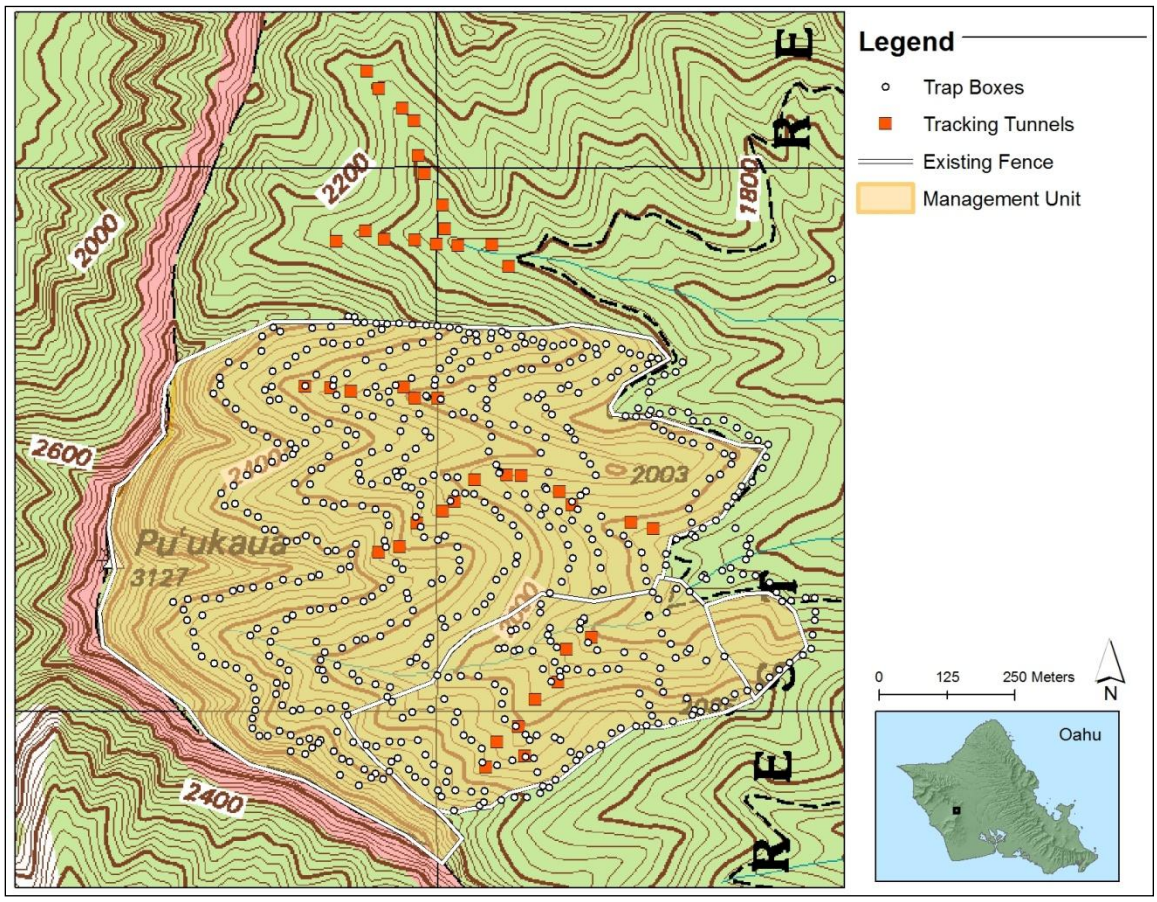


Euglandina numbers peaked in June 2010 perhaps in response to heavy rain the previous quarter. Like slugs, there was no significant correlation between rainfall and *Euglandina* density but the slight synchronicity between the two factors suggests a relationship. Based on the patterns shown in the above graphs, we expect an increase in numbers of terrestrial mollusks following heavy rain and the reverse following a dry period.

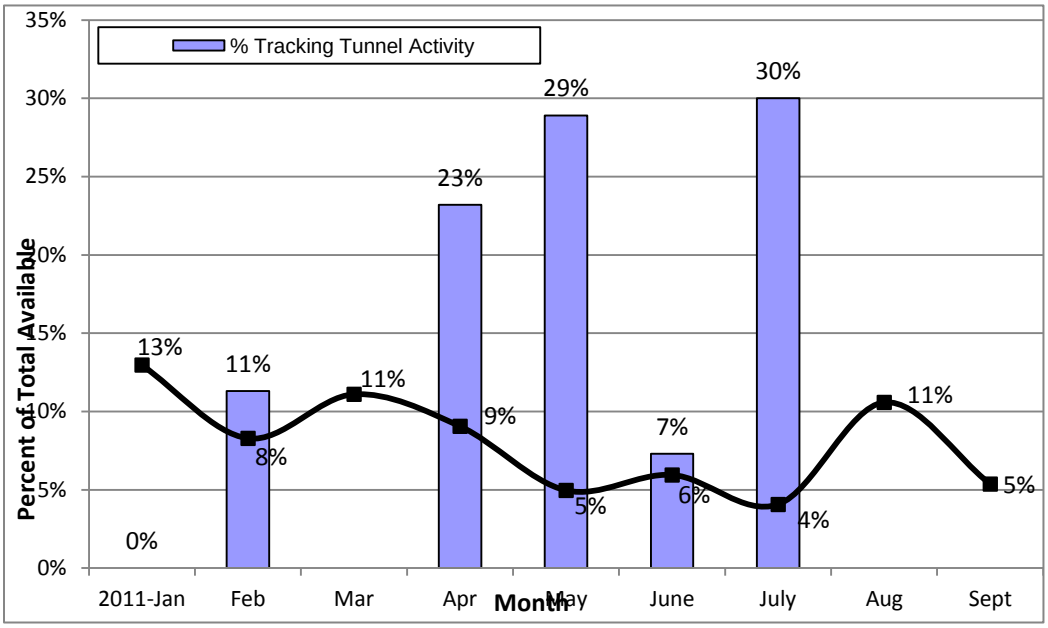
5.5.3 Ekahanui

The Ekahanui grid covers an area of 177 acres (72 ha) (see map below). The grid encompasses 15 endangered plant species, including both wild and reintroduced populations, *A. mustelina*, and one of the largest populations of Oahu Elepaio *(Chasiempis ibidis)*. North Ekahanui is the comparison site (outside the trapping grid) where rats remain uncontrolled. The grid consists of 619 traps; there are 225 on the perimeter of the MU and 394 in the interior of the MU, all spaced 25 meters apart. All traps are checked once a week during the first month of Elepaio nesting season (December) and then twice per month until the end of the nesting season (June). From July to November, the whole grid is checked once a month and additionally two weeks later a subset (143) of the traps are baited to protect the tree snails. The grid is run by Pono Pacific, a local resource contractor. OANRP provides supplies, clears trails and conducts quality control.

Map of Trapping Grid, Tracking Tunnel Locations, and Sampling Locations at Ekahanui and Tunnel Locations in North Ekahanui



Proportion of Rats Killed/Traps Baited Each Month and Percent Tunnel Activity at Ekahanui



The graph above shows the percentage of traps that had rat kills and rat activity in the tracking tunnels each month since the grid has been established. For example, in September 2011, 5% of the total checked snaps had rats. Data regarding rat catch is presented in this manner because of the variation in number of traps baited or checked monthly; therefore, it is more valuable to look at the data as a percentage rather than raw numbers of rats killed. Tracking tunnel data represents rat activity percentages in the 59 tracking tunnels installed in the main drainages of Ekahanui. Months after January that do not show tracking tunnel data were skipped (as opposed to zero activity).

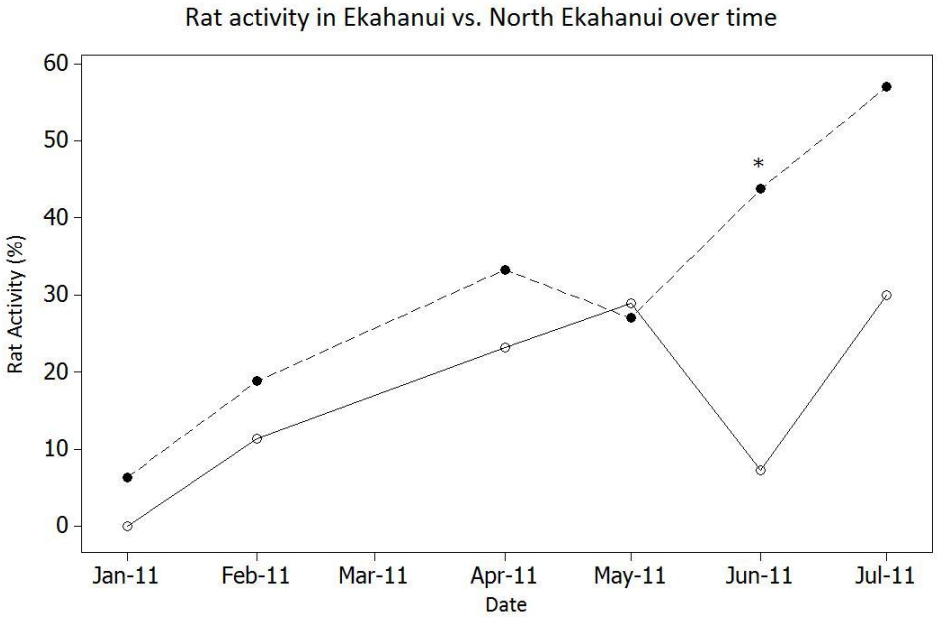
The trapping grid has been checked 25 times since January of 2011, with a total of 511 rats and 9 mice killed. On average, 20 rats were captured per trip. There does not appear to be any significant correlation between tunnel activity and catch rates; inferences on seasonal patterns will be made as more data is collected.

Discussion of Ekahanui MU rat control methods for 2012

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. Grid layout will also be mapped against recently monitored Elepaio territories to determine if lines need to be moved closer to paired territories. If grid lines are moved, OANRP will pre-bait to increase initial kill rates. Pre-baiting is the practice of baiting traps with peanut butter but not setting them to encourage rat familiarity with traps; when traps are later set, a larger knock-down in the population occurs. Reduction of the number of boxes may also occur in an area where Elepaio pairs are not present to optimize labor efficiency (e.g. in the *Abutilon* sp. subunit fence area). OANRP is investigating new baits to use on snap traps that will minimize slug and ant consumption and render traps more effective. OANRP has plans to stimulate *Acacia koa* regeneration through aggressive guava control along certain ridges formerly dominated by koa for long-term habitat improvements for Elepaio. Trail and snap maintenance across the grid is also needed. Pono Pacific will continue to run the grid through 2012.

5.5.3.1 Tracking Tunnel Monitoring – Ekahanui vs. North Ekahanui

Tracking tunnels were checked six times from January to July at both the Ekahanui MU (59 tracking tunnels) and in North Ekahanui (16 tracking tunnels) to compare the trapping area with an adjacent control area to determine if the grid was effective as designed (see graph below). In both locations, tunnels are set out at 50 meter intervals, but because North Ekahanui is a much smaller area than Ekahanui MU, it has fewer tunnels.



***** = significant difference between areas in a given month P<0.05 (Chi-Square analysis)

- • = North Ekahanui
- ○ = Ekahanui

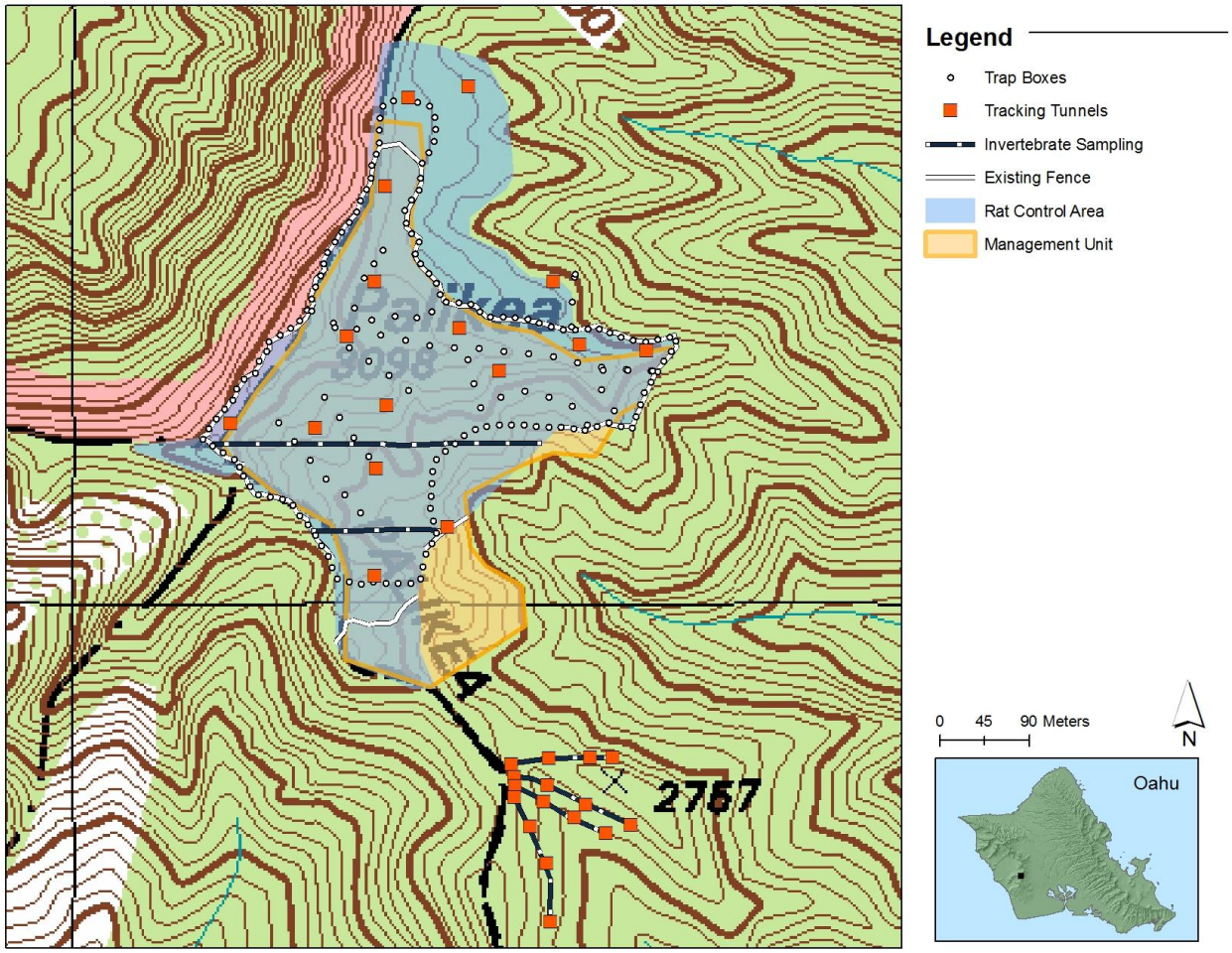
Rat activity did not differ significantly between sites five out of the six time periods sampled, though it was on average higher outside of the trapping grid in North Ekahanui. There was a significant difference in rat activity between sites in June 2011, with North Ekahanui having more rat activity than Ekahanui. Another year of tracking tunnel data will help solidify any trends. Additionally, increasing the number of tracking cards in the control area may also boost data and cause a solid trend to emerge. OANRP is considering other locations to use as a control area for monitoring rat activity that may be better matched to the habitat inside the Ekahanui trapping grid area. In particular, there is less strawberry guava in North Ekahanui and the canopy consists of *Araucaria* sp. and *Schinus terebinthifolius*.

5.5.4 Palikea

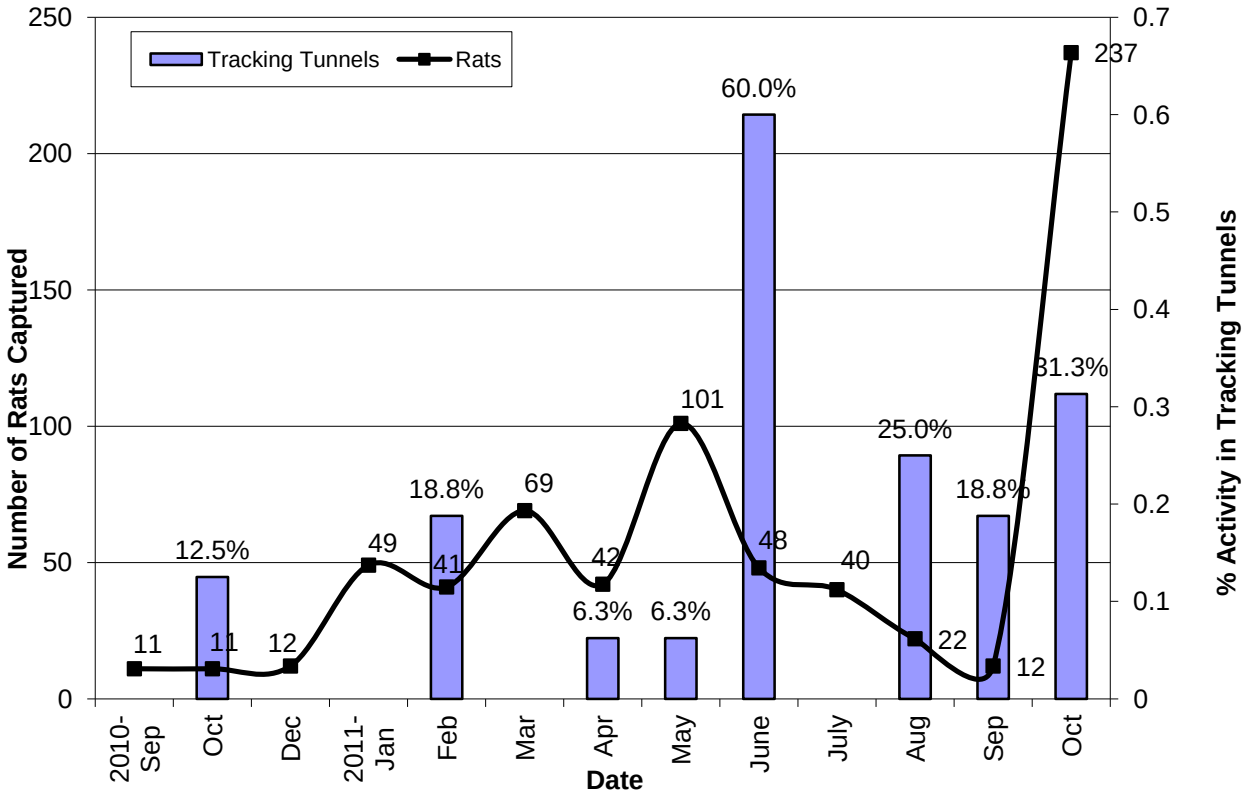
The Palikea grid covers an area of 21 acres (9 ha) (Fig. 11). The grid encompasses six endangered plant species, including both wild and reintroduced populations, and populations of endangered *A. mustelina*, Oahu Elepaio and *Drosophila sp*. Kaaikukai Gulch is the comparison site (outside the trapping grid) where rats remain uncontrolled. The grid consists of 180 traps; there are 98 on the perimeter of the MU spaced 12.5 meters apart and 82 in the interior of the MU spaced 25 meters apart along newly installed trails. Unlike the Ekahanui and Kahanahaiki grids, OANRP used Ka Mate ™ traps without boxes instead of Victor® traps in boxes (see photos). 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 grid was designed this way to evaluate the effectiveness of Ka Mate™ traps, as this is the first time these traps have been used in Hawaii as part of a large-scale grid. The baiting interval varied between monthly and weekly because of a trial (see section discussing efficacy of Ka Mate™ versus Victor® traps) or because of high numbers of rats caught in a single check. OANRP has not determined a "threshold" number of rats caught in a single check that triggers more frequent baiting intervals. A protocol similar to Kahanahaiki during times of high rat numbers (30 or more rats in one check triggers weekly baiting) will be finalized for Palikea in the coming months by reviewing catch data per visit and looking for rough seasonal trends in data. For example, what is the average number of catches per visit when rat numbers are low versus high?

Map of Trapping Grid, Tracking Tunnel Locations, and Sampling Locations at Palikea and Tunnel Locations Kaaikukai



Palikea Monthly Captures and Percent Rat Activity



The graph above shows the number of rats killed and percent rat activity in the tracking tunnels each month since the grid has been established. Data shown for the number of rats killed each month represents the summary of the rats found at all checks that month; this varies from one to four checks depending on trials being conducted (see section **5.5.6.**) and fluctuations in rat densities that may warrant more frequent baiting. Tracking tunnel data represents rat activity percentages in the 16 tracking tunnels randomly placed at Palikea. Months that do not have tracking tunnel data were skipped (as opposed to zero activity).

Since inception of the trapping grid in September 2010, the entire grid has been checked 16 times and a subset of the grid was checked 6 additional times as part of a trial (see section **5.5.6.**). A total of 654 rats and 163 mice have been caught, with an average of 36 rats caught when the whole grid was checked.

Prior to the establishment of the trapping grid, OANRP conducted baiting and trapping every six weeks around tree snail populations at a number of small sites nearly across the MU. When the grid was established, checks occurred at the six week intervals to keep the work effort the same. Very few rats were caught in the first three months; the cause of such low catch rates is unknown. When numbers started to rise in March 2011, OANRP responded in April 2011 by deploying diphacinone bait to existing stations around *A. mustelina* populations throughout the MU and checking traps on a monthly basis. In addition, during April and May OANRP ran weekly trials on a portion of the grid to compare catch rates of Victor® traps and Ka Mate™ traps (see section **5.5.6.**). 101 rat catches in May reflects both the high rat catches at the time but also our increased effort (OANRP checked traps three times that month). After May, numbers steadily declined to a low of 12 rats in September. In early October, numbers increased; in the first week alone 80 rats were caught. As a result, OANRP moved to weekly checks of the entire grid.

By the end of the month, 237 rats were killed in four weekly checks. The last check of the month showed that catch numbers declined to 24.

A similar seasonal trend seems to be occurring in Kahanahaiki: in the summer catch rates are lower and in the fall rat activity and rat kills increase. This could be due to rats feeding on abundant strawberry guava fruit in the summer and avoiding the bait; then in the fall, when fruiting season ends, the robust rat population must scavenge more for food and thus rat kills increase. This increase is especially noticeable in October of this year with 237 rats killed (traps baited and checked weekly).

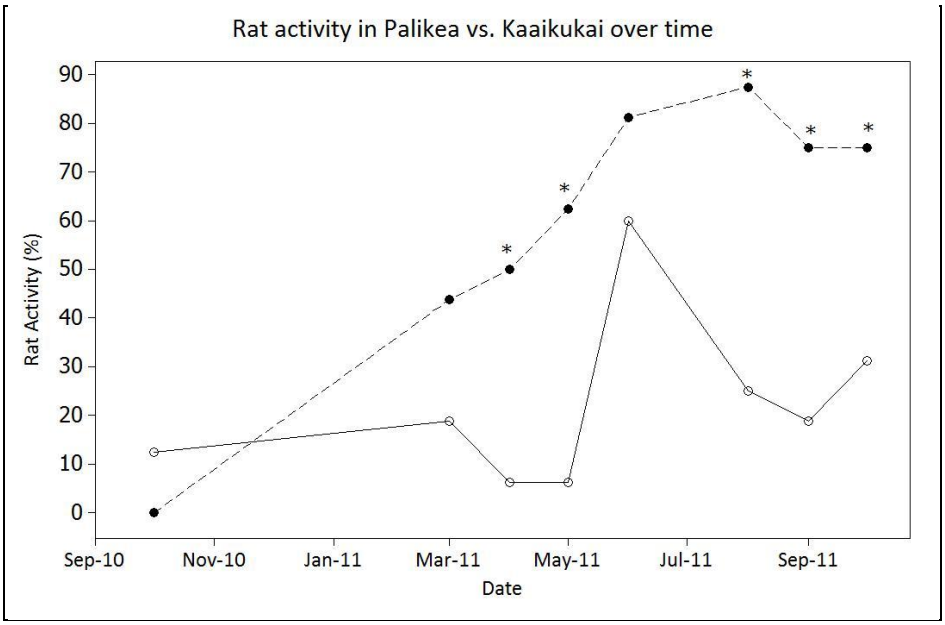
It is also remarkable that this grid catches more rats on average per check than the Kahanahaiki grid and Ekahanui grid (22 rats and 20 rats, respectively), although it is the smallest grid with the fewest traps. There are several factors that may be influencing this number. First, there might not be enough data collected yet to calculate an accurate average as the grid is relatively new compared to the Kahanahaiki grid. 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 section **5.5.6.**). Additionally, the baiting interval varied from six weeks to weekly whereas in Kahanahaiki, the baiting interval was at least every two weeks; baiting intervals likely affect how many rats are caught per check. Finally, there may simply be a higher density of rats at Palikea than at the other MUs.

Discussion of Palikea MU rat control methods for 2012

As with the other grids previously discussed, further analysis of individual 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, though some modifications may be made by placing them in some kind of tunnel or using a new type of bait (see section **5.5.6.**). Ka Mate™ traps are currently baited with coconut or macadamia nuts, but baits are prone to being quickly eaten and the traps thereby rendered useless. OANRP is investigating new baits that will minimize slug and ant consumption and render traps more effective. Food resources for rats will also continue to be reduced through ongoing guava control. A management trigger for increasing the frequency of trap checks during times of high rat numbers (e.g. 30 or more rats in one check) will be selected in the coming months by reviewing catch data per visit and looking for rough seasonal trends in data. More frequent trap checks and diaphacinone baiting may also take place in the late summer period in anticipation of seasonal spikes in populations. Pono Pacific, a local resource contractor, will begin baiting the grid in January 2012. OANRP will provide supplies, clear trails and conduct quality control.

5.5.4.1 Tracking Tunnel Monitoring – Palikea vs. Kaaikukai

Since October 2010, tracking tunnels were checked run every six weeks at both Palikea MU (16 tracking tunnels) and Kaaikukai (16 tracking tunnels) to compare the trapping area with an adjacent control area to determine if the grid was effective as designed (see graph below).



* = significant difference between areas in a given month P <0.05 (Chi-Square analysis)

- • = Kaaikukai
- ○ = Palikea

Rat activity was significantly higher in Kaaikukai 5 out of the 8 dates sampled. Another year of tracking tunnel data will help solidify any trends. Additionally, increasing the number of tracking tunnels in both sites may increase the statistical power of the design and trends may emerge. OANRP may continue to collect tracking tunnel data in the two areas for a minimum of two years total to monitor rat activity levels in the trapping grid and outside the grid where rats remain at uncontrolled levels.

5.5.5 Bait Preference Trial – Nutella® vs. Peanut Butter

Starting August 2011 OANRP ran a trial in Kahanahaiki to compare the efficacy of Nutella® and peanut butter as different baits on Victor® snap traps. Switching baits every few months is useful to keep rats interested in entering snap devices (Peters, pers. comm.).

Study Design

One hundred and three snap traps in Kahanahaiki gulch were used for the trial, as the gulch has the highest catch rate out of all areas in the MU and all snaps can be set and checked by a single person in one day. The traps involved in this trial are part of the existing trapping grid. At every trapping event, 50 traps were randomly selected to be baited with Nutella® and the remaining (53) receive peanut butter (the standard bait; brands of peanut butter varied). Baiting intervals for the trial followed same baiting interval as the whole grid (varied between weekly and every other week).

Results and Discussion

Date	Rat Kills: Nutella®	Rat Kills: PB	Mouse Kills: Nutella®	Mouse Kills: PB
2011-08-01	n/a	n/a	n/a	n/a
2011-08-16	7	0	0	0
2011-08-29	5	7	0	3
2011-09-12	9	3	1	0
2011-09-26	5	2	4	5
2011-10-10	10	12	0	0
2011-10-18	7	7	0	3
2011-10-24	7	5	6	5
2011-10-31	4	5	2	1
2011-11-08	7	2	2	3
2011-11-15	4	5	5	2
Totals:	65	48	20	22

Since the trial was set up, 113 rats were killed; 65 kills (57.5%) were from traps baited with Nutella® and 48 kills (42.5%) were from traps baited with peanut butter. Although on average more rats were killed with Nutella® bait, there was no significant difference detected between rat kills with Nutella® and rat kills with peanut butter (P=0.195, Two Sample T Test). The data show that at the very least, Nutella® is just as good as peanut butter at attracting rats to Victor® traps, demonstrating its utility as rat bait. Additionally, OANRP will analyze data to test for differences between bait durability. Peanut butter in the field is often devoured in days by ants and slugs and therefore is not available to attract rats to the snap trap. Anecdotal observations suggest both ants and slugs avoid Nutella®, which could make it a better bait choice for OANRP.

5.5.6 Snap Trap Type Efficacy Trial – Victor® vs. Ka Mate™

OANRP conducted trials testing the efficacy of Victor® traps and Ka Mate™ traps as part of the trapping grids in Palikea MU and Kahanahaiki MU. However, in this section only the results of the Palikea trial will be discussed as data for Kahanahaiki trial are not reliable due to bait inconsistencies during the trial. Victor® traps are wood-based wire snap traps that are set by placing bait on a plastic trip pedal (the pedal itself is an additional rat attractant). The trap is triggered when the rat steps on the pedal. Victor® traps are placed in wooden boxes designed to prevent accidental triggering, exclude non-target species, guide target species, and maintain the integrity of the trap. Ka Mate™ traps are reverse-bait trigger traps; they 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. Victor® traps remain set when no bait is present whereas Ka Mate™ traps will spring and thus be ineffective if the bait is completely eaten by non-target taxa (such as ants).

In New Zealand, Ka Mate™ traps were found to be most effective at killing larger rodents such as the black rat (mean mass 116 grams), and a wooden "pedal trigger" trap (similar to Victor® trap) was most effective at killing smaller rodents such as the Pacific rat (mean mass 81 grams). Both trap types were baited with coconut (Theuerkauf 2011). In OANRP's trapping grid areas, black rats are the most abundant species of rodent and their average mass ranges from 102-116 grams, depending on the site (Shiels 2010). A similar yet less extensive study in New Zealand found that when Ka Mate™ and Victor® traps are both baited with coconut, 114 rats were killed by Ka Mate™ traps and 51 rats were killed by Victor® traps. Moreover, Ka Mate™ traps killed more rats and mice than Victor® traps throughout the duration of the trial with all bait combinations, except when Ka Mate™ traps were baited with a "coil" bait (L. Wilson, unpublished data). However, when Ka Mate™ traps baited with coil bait were compared to metal "pedal trigger" traps (DOC-150 traps, baits varied), the metal pedal trigger traps caught four times as many rats (Cleddau Restor. Proj. 2010). These studies indicate that Ka Mate™ traps

with coconut bait may be superior to Victor® traps at killing OANRP's target rodent (black rats) as well as other rodent species. OANRP wanted to test these results in Hawaii.

Study Design

At Palikea, 50 Victor® traps in boxes were installed as part of the existing Ka Mate™ trapping grid. The layout of the trial incorporated perimeter and interior trap lines. Each Victor® was installed approximately one meter from an existing Ka Mate™ trap. The traps were baited with either coconut or macadamia nut and each pair of traps received the same bait at each baiting interval. The trial also looked weekly versus monthly baiting intervals to test for differences in trap efficacy when baiting intervals are varied.

Results

The rat and mice kills were sorted into two categories: confirmed kills and unconfirmed kills. Confirmed kills are when an actual rodent carcass was present in the trap; unconfirmed kills are when only hair or a body part was present. Sorting the data this way minimizes human error in identifying rodent types and ensures that the animal caught in the trap was actually killed. Data were non-normal for both sites and were therefore analyzed using Mann-Whitney U Tests. Kills categorized by each type of trap are presented in the charts as percentages of total kills.

Percentage of all kills (confirmed and unconfirmed combined) by trap type

	Victor Median	Kamate Median	P Value
Rats Only	39.13%	60.87%	0.0250*
Mice Only	20.00%	80.00%	0.0073*
Rats and Mice Combined	31.82%	68.18%	0.0000*

* = *significance (P<.05)*

The percentage of rodents caught by Ka Mate™ traps at Palikea was significantly higher when looking at confirmed and unconfirmed kills combined, for all categories (rats only, mice only, rats and mice combined).

Percentage of confirmed kills only by trap type

	Victor Median	Kamate Median	P Value
Rats Only	33.33%	66.67%	0.0131*
Mice Only	10.00%	90.00%	0.0179*
Rats and Mice Combined	30.77%	69.23%	0.0000*

* = *significance (P<.05)*

The percentage of rodents caught by Ka Mate™ traps at Palikea was significantly higher when looking at confirmed kills for all rodent categories (rats only, mice only, rats and mice combined).

Baiting Interval Trial

	# Times Checked	Total Rats	% Victor	% Kamate
Weekly	10	146	32.88%	67.12%
Monthly	5	91	36.26%	63.74%

For both the weekly baiting interval and the monthly baiting interval, more rats were killed by Ka Mate™ traps. There does not appear to be a significant difference between the two baiting intervals. Data sets were too small to do statistical analysis, but it is notable that in both baiting intervals, Ka Mate™ traps killed more rats on average.

Discussion

Ka Mate™ traps killed more rats and mice in every analysis; however, the difference in performance between the two traps was not extreme enough to warrant immediate change in OANRP's protocols; the cost of Ka Mate™ traps may be a limiting factor as they are more expensive than the Victor® traps. OANRP will conduct a more thorough analysis of total cost of each trap type including calculating cost of helicopter time (for deploying wooden boxes), durability of traps, wood box construction costs, cost of staff time (if one trap type needs to be set less often), shipping costs, etc., before drawing conclusions on which trap is best for the Program in the future. Placing Ka Mate™ traps in an inexpensive tunnel device such as a large diameter flex pipe may further increase rat kills and make them the better overall trap for the Program.

The percentages of confirmed kills only do not differ significantly from confirmed and unconfirmed kill results. This may support the presumption that trained OANRP staff can identify rodent types when only hair remains. Additionally, the results indicate that mice and rat carcasses decompose or otherwise disappear at the same rates because the results did not differ when whole bodies were analyzed or when only hair was analyzed. This is interesting because OANRP can assume that outside factors such as predation on the carcasses are not influencing the abundance of which type of rodent are found in the trap. OANRP can trust that the data collected regularly are accurate.

Although no significant differences were seen when looking at the different baiting intervals, anecdotal evidence suggests that Ka Mate™ traps are most effective when baited more frequently as they are rendered inoperable after the bait is eaten by non-target taxa. Finding more persistent (but still attractive) baits for both the Ka Mate™ and Victor® traps will increase trap efficiency and will affect overall choice of trap type (see section 5.5.5.). Research is ongoing and trials will be set up once more prospective baits are found. For now, OANRP will continue to use both types of traps in the trapping grids and make future decisions on a case by case basis.

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