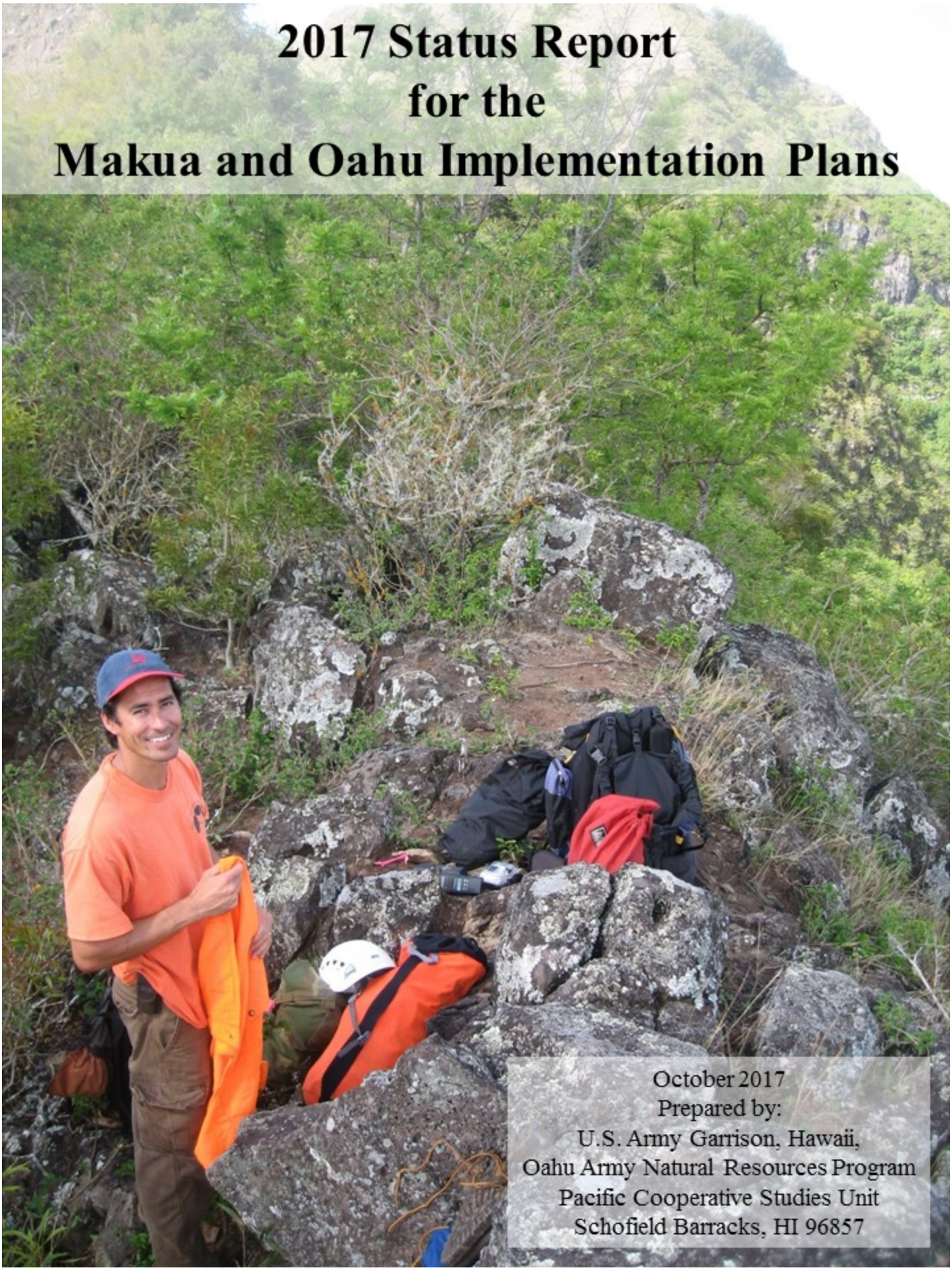
2017 Status Report for the Makua and Oahu Implementation Plans



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*Cover photo: Daniel Sailer, Senior Natural Resources Management Coordinator preparing for a rappel to monitor and collect endangered plants in Makaha.

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EXECUTIVE SUMMARY

The Oahu Army Natural Resources Program (OANRP) has nearly 60 personnel on staff, comprised of management and administrative support staff, an ecosystem restoration crew, an ungulate management crew, three resource management crews, and a nursery/seed bank crew. Most of these staff are employed via a Cooperative Agreement funded by the Army through the Pacific International Center for High Technology Research (PICHTR) and administered by the Research Corporation of the University of Hawaii - Pacific Cooperative Studies Unit (PCSU). Staff levels in Fiscal Year (FY) 2017 were slightly lower than those in FY 2016. For FY 2017, OANRP received a total of $5,746,173 to implement Makua Implementation Plan projects and Tier 1 projects from the Oahu Implementation Plan. This included funding for ongoing research initiatives, contracted snail predator fence construction projects, plant propagation services, ongoing rat control services and document preparation. As in FY 2016, for FY 2017, OANRP did not receive funding for OIP Tier 2 and Tier 3 projects as there was no training conducted that could impact the species at the Tier 2 and 3 levels, as specified in the 2003 Oahu Biological Opinion.

This status report (report) serves as the annual report for participating landowners, the U.S. Fish and Wildlife Service (USFWS), and the Implementation Team (IT) overseeing the Makua Implementation Plan (MIP) and Oahu Implementation Plan (OIP). The period covered in this report is July 1, 2016 to June 30, 2017. This report covers Year 13 of the MIP and Year 10 of the OIP.

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

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

OANRP is reporting on the thirteenth year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the tenth year of the OIP (finalized in 2008). The MIP Addendum emphasized management for stability of three Population Units (PUs) per plant taxon in the most intact habitat and 300 individuals of *Achatinella mustelina* in each Evolutionarily Significant Unit (ESU). The original Makua Biological Opinion (BO) in 2007 and amended BO in 2008, both issued by the USFWS, require that the Army provide threat control for all Oahu Elepaio (*Chasiempis ibidis*) pairs in the Makua Action Area, stabilize 28 plant taxa and *Achatinella mustelina*, and take significant precautions to control the threat and spread of fire as a result of the 2007 Waialua fire that destroyed individuals and habitat of *Hibiscus brackenridgei* subsp. *mokuleianus*. The OIP outlines stabilization measures for 23 additional plant taxa, the Oahu Elepaio, and six extant Koolau *Achatinella* species. Since the OIP was finalized, two additional species were added requiring stabilization, *Drosophila montgomeryi* and *Drosophila substenoptera*. Of the OIP plants, management activities are conducted with eleven taxa that are present in the Schofield Barracks West Range Action Area and in the Kahuku Training Area. In 2017, OANRP did not receive funding to support the remaining 12 OIP plant taxa and the six Koolau *Achatinella* species because of the lack of Army training impacts to these taxa in the Kawailoa Training Area. The MIP and OIP also requires surveys of Army Landing Zones for weeds and the prevention and control of weeds on training areas.

The Army contracted the Center for Environmental Management of Military lands based at Colorado State University to prepare an updated biological assessment for the Army to enter into formal consultation for Oahu training ranges (including Makua Military Reservation). This document will

include an analysis of the potential impacts from Army training (including weed spread) on the plant and animal taxa given federal status in August 2012 and September 2016. The decision was made to include Makua Military Reservation in this Biological Assesssment (BA), while in previous consultations, Oahu and Makua had been kept separate. This approach allows the Army to present a combined analysis of impacts to Oahu's endangered species. The draft BA is expected in October 2017 and a Biological Opinion from the USFWS is anticipated in the summer of 2018. Management requirements will be determined through the consultation process and outlined in the Biological Opinion to be issued upon completion of this process.

Infrastructure

During this reporting period there have been a handful of infrastructure projects supporting the natural resources program beyond ongoing routine maintenance. The program re-established a working shadehouse at our east range baseyard for growing common native plants, established a living collection and seed production site at a former landfill near the west range baseyard (Kahua) and completed a covered structure over gear storage units.

Landowner/Agency Cooperative Agreements and Partnerships

OANRP could not meet stabilization goals without the cooperation of public and private landowners and agencies. OANRP continues to operate under a 20-year license agreement with Kamehameha Schools (KS) (expiring November 2030). A three-year license agreement with Hawaii Reserves, Inc. expired in March 2017 and the four-year license agreement with the Honolulu Board of Water Supply expired in November 2014; however; the Army and BWS real estate staff are actively working on a renewal. The Army also continues to work cooperatively under an MOU with the U.S. Navy for work in Lualualei Naval Magazine. Lastly, the Army renewed its right of entry permit to protect Oahu Elepaio on Gill and Olson properties at Palehua.

In July 2011, an MOU was signed between the Army and the State of Hawaii (State), Department of Land and Natural Resources (DLNR). Currently, the Army holds six State of Hawaii permits, including a Natural Area Reserves Special Use Permit, a Threatened and Endangered Plant Species Permit, an Invertebrate Permit, a Forest Reserve Access Permit, a Conservation District Use Permit, and a Protected Wildlife Permit. The Army and the State are working on finalization of a rental agreement for OANRP's use of the NIKE site mid-elevation greenhouse and associated facilities. A signed lease is expected before the end of the 2017 calendar year.

OANRP continues to provide and receive support from partner agencies including the Oahu Invasive Species Committee, the Honolulu Board of Water Supply, Oahu Plant Extinction Prevention Program (OPEPP), Snail Extinction Prevention Program (SEPP), the Koolau and Waianae Mountains Watershed Partnerships and the Hawaii Department of Agriculture. The Army is also an official member of the Koolau Mountains Watershed Partnership, the Waianae Mountains Watershed Partnership, the Coordinating Group on Alien Pest Species, the Hawaii Rare Plant Restoration Group, the Pacific Island Climate Change Cooperative and the Hawaii Conservation Alliance. Highlights of our partnership work over the last fiscal year include fence gear sling loads using Army heavy lift helicopters for State watershed fences in the Kaluanui and Poamoho areas, staff exchanges for high priority incipient invasive weed control in the Koolau Mountains, aerial surveys for highly invasive species, rare snail enclosure construction and maintenance, and numerous habitat improvements for endangered plant and invertebrate OPEPP and SEPP species.

Management Unit (MU) Protection

Management Unit protection continued on several fronts during this reporting period through 1) ungulate control/fencing efforts, 2) aggressive weed control including control of incipient invasives, 3) an expanded effort at active habitat restoration through outplanting of common natives, and 4) rodent control technique development for MU application.

During this reporting period, OANRP worked to retrofit some existing MU fences with chicken wire mesh to prevent ingress of smaller ungulates into ungulate-free fences. In addition, management crews constructed water bars to prevent water driven erosion along steep sections. Maintenance and repair of fences is ongoing and includes replacing any fence fabric or posts that are rusting or rotten, repairing gulch crossings following flooding and controlling animals that breech the fence perimeter. Also, ungulate control efforts continue within the sizeable Makua Valley and Lihue fences.

Last year, OANRP secured funding for two small fences at Makaleha West and Kaala MUs. The Makaleha West fence will be an expansion of our existing 3-Points enclosure to secure additional rare plant and snail habitat. The Kaala fence will also be an extension of an existing fenced area to better secure the plateau area from pig incursion via the headwaters of Waianae Kai Valley. Completion of those two small fences has been delayed due to contracting constraints, nonetheless, completion of these fences is anticipated before the summer of 2018. For more details about OANRP ungulate control see Chapter 1.

Native Habitat Restoration

As reported previously, OANRP transitioned ecosystem management efforts to more intensive MU weed control and restoration.

In this reporting period, OANRP spent 9,309 hours controlling weeds across 594 ha. Incipient Control Area (ICA) efforts accounted for 467 ha of this total which is 79% of the total area over which weeds were controlled. Staff spent 2,573 hours on ICA management and conducted 662 visits to 233 ICAs. There were 16 ICAs declared eradicated during this reporting period. The ICA totals represent an increase from previous reporting periods. Some of this increase is due to aerial treatment of *Chromolaena odoratum* using helicopters. Weed Control Area (WCA) efforts covered 127 ha which is a decrease from last year's effort. OANRP conducted control in WCAs for a total of 6,736 hours over 727 visits at 123 WCAs. Although the area covered in WCAs decreased, the number of hours spent increased. This is likely a result of the more intensive weed control and restoration being conducted by the Ecosystem Restoration Crew. See Chapter 3 for a comparison to last year's control figures.

OANRP conducted 105 road, landing zone, and weed transect surveys in order to detect and prevent the spread of any newly introduced invasive species. OANRP submitted 21 non-native plant samples to the Oahu Early Detection Program at Bishop Museum collected both during these surveys and during the course of regular work activities. Of these, two were new state records. Highlights are covered in Chapter 3.

OANRP has completed a total of 22 Ecosystem Restoration Management Unit Plans (ERMUPs) for the highest priority and largest MUs. Six ERMUPs updates are included in this year's report. These are Ekahanui, Kaena, Kaluakauila, Koloa, Ohikilolo (Lower Makua), Palikea and Pualii MUs.

Complementary to our other threat control programs, our additive restoration work expanded during this past reporting period. In six MUs, and across nearly three acres, 1,951 common native plants were planted to enhance recovery of native habitat, provide additional host plants for rare snails, and rare *Drosophila*

sp. flies, and to help stabilize the habitat for rare plants. Three MUs received the bulk of common outplants, Kaluaa and Waieli, Makaha, and Kahanahaiki. The area over which seeds sows, divisions and transplants occurred increased three fold from last year, as the use of these techniques expanded by the Program. See Chapter 3 for more information on habitat restoration efforts.

Rodent Control Program

OANRP directed rat and mice control in our MUs in small trap grids used for seasonal and year round localized rodent control around rare plant and snail populations and in large trap grids used for seasonal and year round rodent control across MUs for native habitat, rare plant, snail, and elepaio protection. In addition, OANRP continues to be on the leading edge of research and development for new rodent control tools to increase efficiency and effectivenss. We are partnering with the U.S. Department of Agriculture, National Wildlife Research Center to plan and vet the aerial application of rodenticide in the Lihue MU. If approved the application will occur in the Fall of 2017. This MU is inaccessible for much of the year due to intensive training utilization and creative tools to achieve rodent control are needed. In addition, planning has begun for a pilot study to deploy rat birth control and monitor the effectiveness. See Chapter 8 Rodent Control for details on these pilot projects.

OANRP continues to use Goodnature® automatic traps to reduce labor and increase trapping effectiveness. During this reporting period, citric acid was tested as an additive to the bait mixture in order to reduce secondary consumption by invasive slugs and it was highly successful. In addition, Goodnature released the auto pump lure which pushes out a small amount of fresh bait on a regular interval. These two developments combined have changed the effectiveness of the automatic traps and substantially reduced the labor required to effect quality control of rats at remote management sites. For more details about the OANRP rodent control program see Chapter 8 as well as Chapter 9 for a slug repellent/rat bait study using citric acid.

Monitoring Program

Our OANRP monitoring program consisted of a number of projects: baseline and follow-up vegetative community monitoring, weed control analysis, rare plant recruitment following *in situ* seed sowing, rare plant laboratory seed germination trials and bird gut passage treatments.

Near the end of this reporting period, OANRP monitored the Palikea MU, which will be reported on in the 2018 annual report.

Regarding remote sensing and weed control efforts, OANRP supported a University of Hawaii research project which compared satellite imagery, aerial imagery and gigapan robotic technology (Gigapan) for collecting vegetation monitoring data. This project was concluded during this reporting period the Master's Thesis for this project is included as Appendix ES-3. OANRP continues to use a Gigapan System in-house to guide management of target weed taxa at various sites, and is working towards in-house use of UAS in areas where ground based or Gigapan monitoring is impractical.

Regarding native habitat and rare plant stabilization monitoring efforts, staff:

- Completed analysis of ongoing vegetation changes at the Ohikilolo (monitored near the end of the last reporting year)(Appendix 3-9)
- Monitored vegetation change associated with a restoration project in Makaha (Appendix 3-11)
- Analyzed the effect of *Morella faya* control on surrounding vegetation at the Palikea MU, one year after control (Appendix 3-10).

- Conducted a laboratory trial to assess the effect of fruit senescence on *Cyanea grimesiana* subsp. *obatae* seed viability (Appendix 4-3).
- Conducted a laboratory investigation of seed germination from fresh versus senescing *Delissea waianaensis* fruit (Appendix 4-2).
- Established a field seed sow trial of *Cyanea superba* subsp. *superba* to examine environmental influences on germination at existing and potential manage for stability sites (Appendix 4-4).
- Installed and monitored a trial for establishing new populations of *Tetramolopium filiforme* var. *polyphyllum* using seed sowing and to test seed application techniques (Appendix 4-5).

Fire Management

During this reporting period, no fires occurred on Army training areas that impacted endangered species or critical habitat. One large fire occurred off Army training areas, caused by a vehicle fire, which threatened the Kapuna MU. Details regarding this fire are summarized in the Memorandum for Record included as Appendix ES-4. A total of ~500 acres burned and Army air support was critical in controlling and extinguishing the wildfire. The Army was mobilized under a mutual aid agreement between the State of Hawaii and the Army. Close coordination with State and City and County Partners was critical during the response.

In May of 2017, the Army conducted another successful prescribed burn at Schofield Barracks. The burn reduced fuel within the impact area as planned. No fires have occurred outside the Schofield Barracks firebreak road from training nor have any fires occurred at Makua Military Reservation.

Outreach Program

The OANRP outreach program is focused on training military members on environmental requirements and natural resource management issues, as well as community outreach through volunteer work trips, educational exhibits at community events, internships, and the production of publications and other media materials.

In 2017, 1,591 military members were trained during the Environmental Compliance for Officers course, were educated on Natural Resource Issues at Makua during 15-minute presentations and/or received a 20-minute brief on natural resource considerations on training lands.

During this reporting period, volunteers contributed 3,398 hours on 61 field work trips and 489 hours volunteering at our baseyard. In addition, the program hosted 8 interns in the spring and summer. Many former interns return to work for OANRP after college graduation. See Chapter 2 for more details on our Outreach Program.

Rare Plant Program

The Executive Summary tables on the following pages for the MIP and OIP plant taxa include current status (with totals not including seedlings), last year's population numbers, and the number of plants in the original IPs for comparison for each population unit. Genetic storage and ungulate protection status is also summarized for each PU. The number of PUs that have reached numeric stabilization goals are included.

As of the end of this reporting period, 46 of 101 MIP PUs (46%) and 14 of 31 (45%) PUs for OIP Tier 1 plant species are at or above the stabilization goal for minimum number of reproducing plants. All data tables are included on the CDs distributed to IT members. During this reporting period, OANRP

outplanted a grand total of 1,755 individuals of 11 species of MIP and OIP taxa. In the last year, OANRP made 469 observations at in situ and outplanting sites.

Genetic storage of at least 50 seeds each from 50 individuals, or at least three clones each in propagation from 50 individuals, is required for each PU. If there are fewer than 50 founders for a PU, genetic storage is required from all available founders. For example, if there are at least 50 seeds from five individuals, or at least three clones in propagation from five individuals, then the "% Completed of Genetic Storage Requirement" listed in the tables is 10%. Genetic storage for reintroduced populations is not required because those populations originate from other populations with their own genetic storage requirement. PUs with population sizes of zero and a genetic storage requirement of "n/a (reintroduction)" denote reintroductions that are planned but have yet to be conducted. The number of seeds in genetic storage approximates the number of viable seeds initially received for stored collections. Viability rates for most collections were estimated or calculated at the time of storage. For untested collections, seed viability was averaged from other collections within the same PU or taxon.

One rare plant research project is ongoing but still at the preliminary stages. It involves inoculating *Phyllostegia kaalaensis* with beneficial fungi. *Phyllostegia kaalaensis* is overwhelmed by a pathogenic leaf fungus, or powdery mildew. Beneficial fungal associates can provide plants with natural protection and thus improve survivorship. Thus far, there has been 100% mortality of planted *P. kaalensis* at reintroduction sites. Fungal inoculum has been isolated from field sites and clones have been grown for use in experiments. Planting of inoculated plants will occur during the winter season and OANRP is optimistic. For an update on the status of this research see Appendix ES-5.

A second study was concluded during this reporting period, An Assessment of the Short and Long-Term Stability Goals for Endangered Hawaiian Flora Managed by the Oahu Army Natural Resources Program: Orou Gaoue and Kasey Barton, Principal Investigators, Lalasia Bialic-Murphy, Graduate Assistant, Dept. of Botany, University of Hawaii at Manoa. Two papers regarding *Delissea waianaensis* population stability are under review for publication and are included as Appendix ES-6 and Appendix ES-7. In addition, an article published in the Journal of Applied Ecology regarding *Cyrtandra dentata* is also included in Appendix ES-8.

Table 1. MIP Plants Executive Summary

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 47 of 101

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Alectryon macrococcus var. macrococcus	50											
		Central Kaluaa to Central Waieli	4	3	1	0	8	53	0%	0%	No	
		Kahanahaiki to Keawapilau	2	1	1	0	2	8	0%	100%	No	
		Makaha	29	29	0	0	29	75	30%	100%	No	
		Makua	4	4	0	0	6	15	33%	100%	No	
		Alectryon macrococcus var. macrococcus Total:	39	37	2	0	45	151				0 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	302	184	118	54	319	20	60%	100%	Yes	
		Kahanahaiki and Pahole	276	200	76	20	292	276	28%	100%	Yes	
		Makaha and Waianae Kai	289	161	128	5	289	12	17%	97%	Yes	
		Cenchrus agrimonioides var. agrimonioides Total:	867	545	322	79	900	308				3 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	141	124	17	0	141	0	75%	100%	Yes	
		North branch of South Ekahanui	147	82	65	0	147	5	100%	100%	No	
		Pahole to West Makaleha	106	70	36	0	111	46	52%	100%	No	
		Palikea (South Palawai)	921	911	10	0	139	63	65%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	1315	1187	128	0	538	114				2 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	257	61	196	2	259	66	44%	100%	No	
		Makaha and Waianae Kai	246	116	130	0	306	4	33%	100%	Yes	
		Pahole	74	59	15	2	78	114	98%	100%	No	
		Cyanea longiflora Total:	577	236	341	4	643	184				1 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	226	48	178	1	226	152	100%	100%	No	
		Makaha	199	27	172	246	199	0	N/A	100%	No	
		Manuwai	79	0	79	0	108	0	N/A	100%	No	
		Pahole to Kapuna	166	95	71	4	166	170	N/A	100%	Yes	
		Cyanea superba subsp. superba Total:	670	170	500	251	699	322				1 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 47 of 101

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	175	33	142	9	175	97	32%	100%	No	
		Kawaiiki (Koolaus)	21	2	19	1	92	50	0%	0%	No	
		Opaeula (Koolaus)	196	35	161	2	196	26	4%	100%	No	
		Pahole to West Makaleha	814	330	484	97	1502	300	90%	100%	Yes	
		Cyrtandra dentata Total:	1206	400	806	109	1965	473				1 of 4
Delissea waianaeensis	100											
		Ekahanui	219	196	23	0	219	58	86%	100%	Yes	
		Kahanahaiki to Keawapilau	194	185	9	0	257	34	88%	100%	Yes	
		Kaluaa	538	499	39	0	661	44	80%	100%	Yes	
		Manuwai	168	132	36	0	132	0	N/A	100%	Yes	
		Delissea waianaeensis Total:	1119	1012	107	0	1269	136				4 of 4
Dubautia herbstobatae	50											
		Makaha	54	52	2	0	81	0	48%	0%	Yes	
		Ohikilolo Makai	137	133	4	0	91	700	0%	100%	Yes	
		Ohikilolo Mauka	400	373	27	0	424	1300	0%	100%	Yes	
		Dubautia herbstobatae Total:	591	558	33	0	596	2000				3 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	22	20	2	66	22	26	64%	0%	No	
		Kaena	1154	880	274	0	1154	300	90%	0%	Yes	
		Makua	85	85	0	0	85	40	90%	100%	Yes	
		Puaakanoa	150	135	15	0	131	157	56%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1411	1120	291	66	1392	523				3 of 4
Euphorbia herbstii	25											
		Kaluaa	20	0	20	0	0	0	N/A	100%	No	
		Kapuna to Pahole	97	54	43	1	98	170	36%	100%	Yes	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Euphorbia herbstii Total:	117	54	63	1	98	170				1 of 3

Makua Implementation Plan - Executive Summary - Plants

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Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Flueggea neowawraea	50											
		Kahanahaiki to Kapuna	143	5	138	0	136	32	29%	100%	No	
		Makaha	64	9	55	0	64	4	36%	44%	No	
		Manuwai	16	0	16	0	45	0	N/A	100%	No	
		Ohikilolo	1	1	0	0	1	3	50%	100%	No	
		Flueggea neowawraea Total:	224	15	209	0	246	39				0 of 4
Gouania vitifolia	50											
		Keaau	51	51	0	0	51	0	66%	0%	Yes	
		Makaha (Future Introduction)	0	0	0	0	0	0	N/A	100%	No	
		Manuwai (Future Introduction)	0	0	0	0	0	0	N/A	100%	No	
		Gouania vitifolia Total:	51	51	0	0	51	0				1 of 3
Hesperomannia oahuensis	75											
		Haleauau	5	1	4	0	1	0	0%	100%	No	
		Makaha	45	11	34	0	46	13	0%	100%	No	
		Pahole NAR	24	3	21	0	34	8	N/A	100%	No	
		Pualii	72	14	58	1	68	0	N/A	100%	No	
		Hesperomannia oahuensis Total:	146	29	117	1	149	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	122	117	5	0	66	4	43%	0%	Yes	
		Keaau	86	82	4	0	58	0	10%	100%	Yes	
		Makua	144	124	20	0	144	7	73%	100%	Yes	
		Manuwai	110	102	8	20	151	0	N/A	100%	Yes	
		Hibiscus brackenridgei subsp. mokuleianus Total:	462	425	37	20	419	11				4 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	161	77	84	4	145	60	60%	96%	Yes	
		Central Makaleha and West Branch of East Makaleha	32	22	10	22	32	47	62%	0%	No	
		Kahanahaiki to Pahole	202	102	100	150	202	161	100%	100%	Yes	
		Outplanting site to be determined	0	0	0	0	0	0	N/A		No	
		Kadua degeneri subsp. degeneri Total:	395	201	194	176	379	268				2 of 4

Makua Implementation Plan - Executive Summary - Plants

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Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Kadua parvula	50											
		Ekahanui	87	58	29	0	45	0	N/A	100%	Yes	
		Halona	35	31	4	0	35	64	40%	0%	No	
		Ohikilolo	230	129	101	0	215	66	74%	100%	Yes	
		Kadua parvula Total:	352	218	134	0	295	130				2 of 3
Melanthera tenuifolia	50											
		Kamaileunu and Waianae Kai	1061	815	246	274	1061	880	0%	0%	Yes	
		Mt. Kaala NAR	155	131	24	0	155	250	0%	100%	Yes	
		Ohikilolo	582	571	11	0	1099	2009	12%	100%	Yes	
		Melanthera tenuifolia Total:	1798	1517	281	274	2315	3139				3 of 3
Neraudia angulata	100											
		Kaluakauila	124	100	24	1	124	0	N/A	100%	Yes	
		Makua	78	67	11	0	75	29	46%	100%	No	
		Manuwai	161	97	64	10	207	12	67%	100%	No	
		Waianae Kai Mauka	13	11	2	0	13	46	56%	100%	No	
		Neraudia angulata Total:	376	275	101	11	419	87				1 of 4
Nototrichium humile	25											
		Kaluakauila	188	140	48	0	208	200	2%	100%	Yes	
		Makua (south side)	53	50	3	0	53	138	0%	100%	Yes	
		Manuwai	111	111	0	0	112	0	N/A	100%	Yes	
		Waianae Kai	305	204	101	0	290	200	0%	98%	Yes	
		Nototrichium humile Total:	657	505	152	0	663	538				4 of 4
Phyllostegia kaalaensis	50											
		Keawapilau to Kapuna	0	0	0	0	0	0	100%	100%	No	
		Makaha	0	0	0	0	0	0	N/A	100%	No	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Pahole	0	0	0	0	0	10	100%	100%	No	
		Phyllostegia kaalaensis Total:	0	0	0	0	0	10				0 of 4
Plantago princeps var. princeps	50											
		Ekahanui	57	5	52	0	83	33	84%	100%	No	
		Halona	15	6	9	0	15	50	49%	0%	No	
		North Mohiakea	51	39	12	0	51	30	38%	100%	No	
		Ohikilolo	50	28	22	0	8	14	82%	100%	No	
		Plantago princeps var. princeps Total:	173	78	95	0	157	127				0 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 47 of 101

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Pritchardia kaalae	25											
		Makaleha to Manuwai	134	123	11	0	134	141	0%	2%	Yes	
		Ohikilolo	1675	85	1590	0	1675	473	0%	100%	Yes	
		Ohikilolo East and West Makaleha	334	6	328	0	334	75	N/A	100%	No	
		Pritchardia kaalae Total:	2143	214	1929	0	2143	689				2 of 3
Sanicula mariversa	100											
		Kamaileunu	213	31	182	1	267	26	92%	100%	No	
		Keaau	28	0	28	34	13	141	8%	100%	No	
		Ohikilolo	229	0	229	0	160	162	32%	100%	No	
		Sanicula mariversa Total:	470	31	439	35	440	329				0 of 3
Schiedea kaalae	50											
		Kaluaa and Waieli	168	164	4	0	168	55	100%	100%	Yes	
		Maakua (Koolaus)	10	10	0	0	10	4	50%	0%	No	
		Pahole	84	45	39	3	125	3	100%	100%	No	
		South Ekahanui	268	172	96	1	297	85	79%	100%	Yes	
		Schiedea kaalae Total:	530	391	139	4	600	147				2 of 4
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	123	88	35	317	123	65	87%	100%	Yes	
		Kapuna-Keawapilau Ridge	57	55	2	0	57	4	100%	100%	Yes	
		Makaha	96	91	5	0	96	0	N/A	100%	Yes	
		Schiedea nuttallii Total:	276	234	42	317	276	69				3 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	351	229	122	23	448	90	100%	100%	Yes	
		Keawapilau to West Makaleha	405	42	363	16	494	36	100%	69%	No	
		Makaha	90	76	14	0	90	0	N/A	100%	No	
		Schiedea obovata Total:	846	347	499	39	1032	126				1 of 3
Tetramolopium filiforme	50											
		Kalena	117	24	93	0	117	0	16%	100%	No	
		Ohikilolo	3367	1903	1464	20	3366	2500	12%	100%	Yes	
		Puhawai	6	3	3	1	6	12	80%	0%	No	
		Waianae Kai	20	20	0	0	20	22	0%	0%	No	
		Tetramolopium filiforme Total:	3510	1950	1560	21	3509	2534				1 of 4

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 47 of 101

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Viola chamissoniana subsp. chamissoniana	50											
		Halona	21	16	5	0	20	3	7%	0%	No	
		Makaha	79	68	11	0	79	50	0%	100%	Yes	
		Ohikilolo	243	191	52	0	263	0	0%	100%	Yes	
		Puu Kumakalii	44	44	0	0	44	20	16%	0%	No	
Viola chamissoniana subsp. chamissoniana Total:			387	319	68	0	406	73				2 of 4

Table 2. OIP Executive Summary Plants

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 14 of 31

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Abutilon sandwicense	50											
		Ekahanui and Huliwai	175	57	118	0	175	44	12%	100%	Yes	
		Kaawa to Puulu	203	27	176	1	79	124	2%	52%	No	
		Kahanahaiki	74	69	5	0	78	0	100%	100%	Yes	
		Makaha Makai	225	92	133	0	225	100	100%	75%	Yes	
		Abutilon sandwicense Total:	677	245	432	1	557	268				3 of 4
Cyanea acuminata	50											
		Helemano-Punaluu Summit Ridge to North Kaukonahua	205	96	109	9	272	72	16%	0%	Yes	
		Kaluanui and Maakua	249	123	126	50	249	0	0%	0%	Yes	
		Makaleha to Mohiakea	284	195	89	0	279	118	18%	95%	Yes	
		Cyanea acuminata Total:	738	414	324	59	800	190				3 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	125	113	12	0	109	76	2%	85%	Yes	
		Opaeula to Helemano	28	21	7	0	24	13	0%	48%	No	
		Poamoho	39	20	19	0	39	12	3%	0%	No	
		Cyanea koolauensis Total:	192	154	38	0	172	101				1 of 3
Eugenia koolauensis	50											
		Kaunala	59	20	39	27	59	141	28%	95%	No	
		Oio	8	6	2	0	8	74	35%	83%	No	
		Pahipahialua	28	22	6	141	28	291	31%	100%	No	
		Eugenia koolauensis Total:	95	48	47	168	95	506				0 of 3
Gardenia mannii	50											
		Haleauau	74	74	0	0	77	2	33%	100%	Yes	
		Helemano and Poamoho	23	22	1	0	22	18	52%	5%	No	
		Lower Peahinaia	22	10	12	0	30	46	50%	60%	No	
		Gardenia mannii Total:	119	106	13	0	129	66				1 of 3
Hesperomannia swezeyi	25											
		Kamananui to Kaluanui	246	134	112	45	246	99	0%	4%	Yes	
		Kaukonahua	109	55	54	2	109	127	0%	0%	Yes	
		Lower Opaeula	26	11	15	6	38	24	0%	0%	No	
		Hesperomannia swezeyi Total:	381	200	181	53	393	250				2 of 3

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 14 of 31

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2016	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Labordia cyrtandrae	50											
		East Makaleha to North Mohiakea	343	294	49	0	349	100	22%	89%	Yes	
		Koloa	31	9	22	0	14	0	N/A	100%	No	
		Labordia cyrtandrae Total:	374	303	71	0	363	100				1 of 2
Phyllostegia hirsuta	100											
		Haleauau to Mohiakea	98	96	2	0	98	18	53%	100%	No	
		Koloa	149	111	38	1	153	0	117%	98%	Yes	
		Puu Palikea	142	87	55	0	142	0	N/A	100%	No	
		Phyllostegia hirsuta Total:	389	294	95	1	393	18				1 of 3
Phyllostegia mollis	100											
		Ekahanui	1	1	0	0	1	35	100%	100%	No	
		Kaluaa	97	72	25	0	137	49	100%	100%	No	
		Pualii	11	11	0	0	11	0	100%	100%	No	
		Phyllostegia mollis Total:	109	84	25	0	149	84				0 of 3
Schiedea trinervis	50											
		Kalena to East Makaleha	647	296	351	377	647	376	100%	89%	Yes	
		Schiedea trinervis Total:	647	296	351	377	647	376				1 of 1
Stenogyne kanehoana	100											
		Haleauau	230	230	0	0	281	1	100%	100%	Yes	
		Kaluaa	204	26	178	0	204	79	100%	100%	No	
		Makaha	60	0	60	0	60	0	N/A	100%	No	
		Stenogyne kanehoana Total:	494	256	238	0	545	80				1 of 3

Achatinella mustelina Management

During this reporting period, OANRP continued: 1) Monitoring wild snail populations; 2) Controlling rats around wild snail populations; 3) Improving rare snail habitat through weed control and host tree outplantings; 4) Maintaining existing snail enclosures; 5) Constructing one new snail enclosure; 6) Translocating snails into snail enclosures; and 7) Collecting Ekahanui *A. mustelina* to establish a lab population at the new SEPP facility in order to secure snails from *Euglandina rosea* predation. The table below presents the status summary for the Waianae *A. mustelina* in the MIP. There is no OIP snail table as all Koolau snail taxa are Tier 2 or 3. Populations of *A. mustelina* in the MIP have been genetically assigned to one of six evolutionarily significant units (ESU). The MIP goal is to achieve 300 total snails across all age classes in each of eight managed populations within the six ESUs. Consistent with last year, six of the eight managed field populations have over 300 snails. Ekahanui snails (ESU-E) were largely collected into the laboratory for safe keeping thus reducing the number of wild snails remaining. See summary table below.

Table 3. Summary of *A. mustelina* Management

ESU	Population	Number of Snails in MFS Pop. Reference Sites (PRS)	Number of Snails in No Mgmt. PRS	Number of Snails in PRS with Rat Control	Number of Snails in Enclosures (observed)	Planned Enclosure for Additional Snails Not Currently in Enclosures
A	Kahanahaiki	243	0	243	215 (Kahanahaiki) 28 (Pahole)	Kahanahaiki/Pahole
B1	Ohikilolo	330	7	330	0	West Makaleha
B2	East Makaleha	467	192	467	0	West Makaleha
C	Lower Kaala NAR & Schofield Barracks West Range	333	10	333	0	Kaala
D1	Central Kaluaa to Schofield Barraks South Range	805	10	805	805 (Hapapa)	Hapapa
D2	Makaha	313	0	131	0	None designated
D*	South Range to Lihue	0	335	0	0	Kaala and Hapapa
E	Ekahanui**	7	28	0	0	Palikea North
F	Puu Palikea	628	9	628	163 (Palikea)	Palikea

*Snails from this portion of the ESU are not managed for stability in the MIP
**100 additional snails protected in SEPP laboratory (from 71 collected snails)

During this reporting period, OANRP continued to maintain the Kahanahaiki and Puu Hapapa predator exclosures and cooperated with SEPP to maintain the Puu Palikea exclosure. OANRP nearly completed construction on the new Palikea North enclosure which will be the home for Ekahanui (ESU-E) *A. mustelina* in the future. OANRP and partners continued to monitor population trends for *A. mustelina* within the Kahanahaiki, Puu Hapapa, and Palikea predator exclosures using timed-count monitoring. Snails from fragmented subpopulations at Palikea ESU-F continued to be translocated into the existing Palikea exclosure. Also, the State continues to prepare for the replacement of the Pahole snail enclosure which should occur before the next annual report.

Sites for permanent snail enclosures were also selected at 3-Points Makaleha west and at Kaala for ESU-B2 and ESU-C respectively. Funding for these snail enclosures has been secured. Lessons learned during the construction of the Palikea North enclosure should make construction of these two additional enclosures more streamlined and efficient. For more information on rare snail management, see Chapter 5.

In addition, one OANRP-funded research project investigating the Adaptive Genetics of Hawaiian Tree Snails and Climate Change (Appendix ES-9). Results of this study helped to adjust management plans for *Achatinella mustelina* given the limited enclosure siting options.

Rare Vertebrate Management

Currently, OANRP manages three species of rare vertebrates, the Oahu Elepaio (*Chasiempis ibidis*), Nene geese (*Branta sandvicensis*), and the Opeapea, or Hawaiian Hoary Bat (*Lasiurus cinereus semotus*). Management consists of active predator control for the Elepaio, monitoring during Nene sightings at Schofield Barracks and Wheeler Army Airfield, and monitoring for Opeapea at Army installations across Oahu, as well as spot monitoring for bat roosting in trees requiring removal at Schofield Barracks during the bat pupping season.

In 2017, OANRP controlled rats to protect 89 pairs of Oahu Elepaio at four management sites. The BO requires the protection of 75 pairs, therefore, OANRP met this requirement. In addition, during annual monitoring, two male elepaio were observed at the Makua Military Reservation for the second year in a row.

The number of managed pairs and reproductive efforts in 2017 are summarized below.

Table 4. Summary of Elepaio Management

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings	Fledglings/ Managed Pair
2017	89	26	36	73	0.79

The number of documented fledgings from managed pairs this year was 73, which is up from last year's number. Four more pairs were managed in 2017 than 2016 which may account for the small increase in management statistics.

The total number of rats caught and the ratio of rats caught per trap decreased in 2016 across all four sites. Reasons for the lower catch rates might be attributed to higher rainfall (which washes off bait) or for other undetermined reasons. OANRP will continue to adapt rodent control approaches in order to maximize protection in a cost-effective manner. The total required access dates in Schofield Barracks West Range were met during the calendar year, but were not ideally distributed for Elepaio management. For more information, see the Rodent Management Chapter 8

Over the past year, Nene geese (*Branta sandvicensis*) were not observed at Army Installations on Oahu and therefore are not further covered in this report. OANRP will continue to track nene visitation via airfield operations staff and U.S. Department of Agriculture Staff conducting airstrike hazard management.

The U.S. Geological Survey acoustic monitoring project for the Hawaiian hoary bat concluded last year and results are pending, a report summarizing findings is expected before the end of the 2017 calendar year and will be published as a PCSU Technical Report and will be included in next year's report. A new bat study funded through windfarms is beginning and includes deployement of 100 total long term monitoring stations on Oahu. Army installations are included in their project and OANRP is working to secure access for detector installation and monitoring. In early September 2015, an official Garrison policy was signed that formalizes a tree cutting moratorium during the bat pupping season each year. OANRP was tasked to survey trees for roosting bats that required cutting, pruning or de-nutting because of safety issues. OANRP conducted eight bat survey to clear trees for removal or pruning, and ~14 hours

were spent by OANRP conducting the surveys (including travel time). Zero roosting bats were found. For more information, see the Rare Vertebrate Management Chapter 6.

Rare Insect Management

During this reporting period, OANRP continued to conduct regular monitoring of known *Drosophila* populations designated as 'manage for stability' and host tree outplanting efforts. This monitoring allows OANRP to track fluctuations and attempt to determine abundance patterns. *Drosophila* population numbers were reduced during this reporting period, likely due to extended dry weather conditions. Results of the surveys and management conducted during this reporting period are summarized in Chapter 7. An additional 48 *Urera glabra* were outplanted into the Palikea *Drosophila montgomeryi* site. Also, 122 *Cheirodendron trigynum* saplings were planted for habitat restoration and as host plants for *Drosophila substenoptera*. Many more *Drosophila* host plants are slated for outplanting in the upcoming planting season.

Surveys of suitable hosts continue at training ranges to obtain a thorough picture of endangered *Drosophila* distribution on Army training ranges for use in the upcoming Biological Assessment. Also, surveys for endangered *Hylaeus* bees are ongoing.

In addition, OANRP funded a study on the effect of the invasive ant, *Solenopsis papuana* on arthropods, including picture-wing *Drosophila*. An update on this study is included as Appendix ES-10. In summary, this ant taxon reduces successful *Drosophila* breeding. This result is relevant to the Army's ongoing stabilization efforts for two *Drosophila* species. The Researchers are planning to publish their results which will be included in next year's report.

Alien Invertebrate Control Program

The Alien Invertebrate Control Program continued to focus on slug control, Coconut Rhinoceros Beetle (CRB) detection and invasive ant detection during this past reporting period. OANRP has expanded its slug control program every year since 2010 for the protection of rare plants and rare plant habitat, and this year was no exception. We now protect 42 PU's from slugs (up from 32). In 2016-2017, OANRP controlled slugs within ten Management Units (MUs) across 11 acres, a 57% increase in area from the previous year (7 acres). OANRP is a cooperator in control and detection efforts for CRB and the little fire ant (LFA) on Oahu. There are no known breeding populations of CRB on Army controlled lands and the LFA has not been detected during OANRP surveillance of new plantings and Army plant holding facilities. The Army established an official Garrison policy for preventing the LFA from establishing at Army controlled lands in FY 2015. This policy requires that landscaping plants be sourced from LFA free nurseries and that the responsibility for eradication of LFA, if introduced, is with contractors. During this reporting period, OANRP conducted coconut palm surveys on Wheeler to complement CRB crew surveys.

Research Projects

During this reporting period, OANRP funded numerous outside research projects related to management of MIP and OIP taxa, these are referenced within related chapters or subject areas of this report. Direct funding available to support outside research has descreased with budget decrements. Nonetheless, our in-house research projects continue as management related questions arise which require attention. Current in-house research includes decreasing rat bait palatability to slugs, pollination biology, seed viability, germination, and storage. As mentioned above regarding our rodent control program, OANRP also partnered with the U.S. Dept. of Agriculture, Wildlife Services to hand broadcast rodenticide in one of our MUs as an experimental pilot project.

In addition, OANRP supported various research projects by providing access or guidance during study plan development. The following are ongoing projects supported by OANRP during this reporting period:

- Vertebrate Introductions and Novel Ecosystems (VINE) project which is investigating the role of non-native birds in dispersing native and non-native fruit at various forested locations on Oahu. This is a multi-year study funded by the Departement of Defense's Strategic Environmental Research and Development Program (SERDP).
- Seed Dispersal by non-native birds and potential application of con-specific attraction using playbacks to encourage dispersal of rare native plant taxa which was funded as a sub-project through the SERDP. Appendix ES-11 is a poster presented at the Hawaii Conservation Conference reporting on some of the research results.
- Pollination Biology of Hawaiian *Lysimachia.*
- Applying climate change modelling to select sites for reintroduction of *Hibiscus brackenridgei* subsp. *mokuleianus*.
- Investigation of Native Hawaiian Orchid fungal associations.

TABLE OF CONTENTS

Chapter 8: Rodent Management

Chapter 9: Alien Invertebrate Control Program

Appendices:

**Starred appendices are printed at the end of Chapter 9. All appendices are included in electronic format on a CD enclosed with this document. Also, they can be found online through the PCSU website at http://manoa.hawaii.edu/hpicesu/dpw_mit.htm.*

CHAPTER 1: UNGULATE MANAGEMENT

Notable projects from the 2016-2017 reporting year are discussed in the Project Highlights section of this chapter. This reporting year was from 1 July 2016 through 30 June 2017.

Threat control efforts are summarized for each Management Unit (MU) or non-MU land division. All totaled, about 200 meters of fencing was replaced during the reporting year due to environmental damages. No new fences were constructed and no large fence replacement projects were required. Ungulate control data is presented with minimal discussion.

UNGULATE CONTROL PROGRAM

The Oahu Army Natural Resources Program (OANRP) ended the large scale fence construction phase of its management program in 2012 and has since focused more on ecosystem management. OANRP transferred management of some Manage for Stability (MFS) plant populations in the MIP into the completed fences rather than building additional enclosures. Since Army training has not been shown to directly impact the Tier 2 or 3 species on Dillingham Military Reservation, Kahuku Training Area, Kawailoa Training Area or Schofield Barracks Military Reservation, the program focused work on the OIP Tier 1 species that are impacted by training. This significantly reduces the number of fences required for management from the 2003 Oahu Biological Opinion. The adjustment to the fence building schedule from the original MIP/OIP is in the table below.

Table 1: Ungulate fences no longer scheduled for OANRP construction

Makua Implementation Plan MU fences	Oahu Implementation Plan MU fences
East Makaleha	Kawaiiki I/II
Kamaileunu/ Waianae Kai	Kawailoa
Alaiheihe and Kaimuhole	Poamoho Lower
	Poamoho Lower II
	Poamoho Pond (*)
	Poamoho Upper (*)
	Opaeula Lower II
	South Kaukonahua II
	Kaipapau
	Manana
	North Kaukonahua (*)
	Waiawa I (!)
	Waiawa II (!)
	Kahana
	Kaukonahua-Punaluu (*)

Since 2012, OANRP has focused on working within partnerships to contract some of the above fence construction projects jointly [i.e. Native Ecosystem Protection and Management (NEPM) Program Partnerships]; these are marked with a (*). These opportunistic partnerships will allow all parties to share the costs rather than one program absorbing all of it. Some of these fence projects may also be completed by other programs through other funding means (!).

In regards to staffing and funding, OANRP budgeted for two ungulate management technician positions for fence monitoring/maintenance and ungulate control work. One position was filled, but we continue to look for a qualified interested person to fill the second. Funding was also secured to construct three small fences at Kaala, West Makaleha, and Palikea. The Kaala fence will better secure the summit area. The West Makaleha fence will provide more ungulate-free rare plant habitat at West Makaleha. At Palikea, an extension to the existing fence is planned to protect a new snail enclosure. These actions are scheduled for the 2018 report year.

Summary of Fencing Efforts

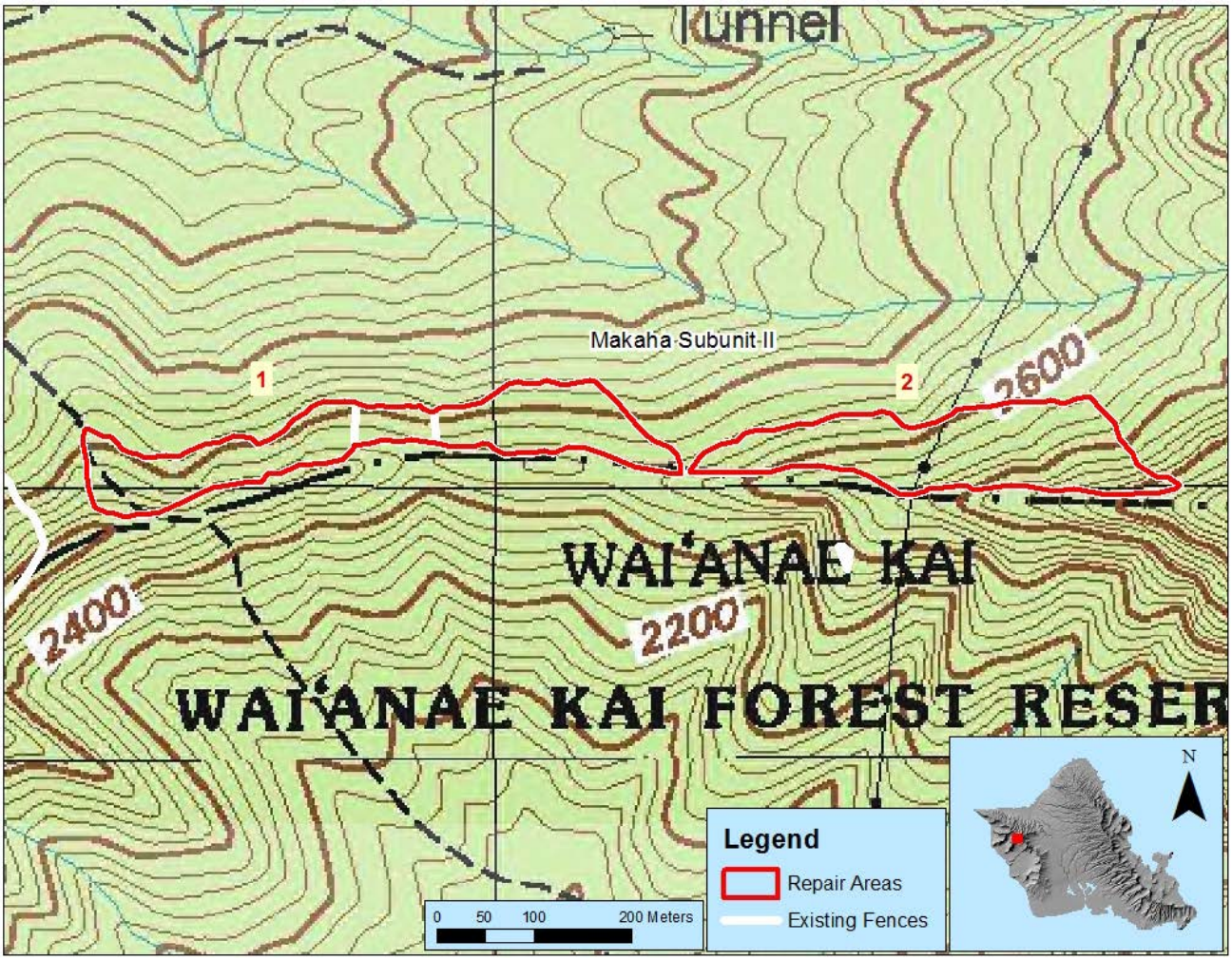


Figure 1: Map of fickle fence application and repair work at Makaha Subunit 2

- **Makaha II**: In 2015, two small pigs were able to squeeze through the fences into both the upper (2) and lower (1) units of Makaha Subunit 2 (Figure 1). Due to the enormous amount of ungulate pressure on the outside of the fence, OANRP decided it was best to attach a chicken wire mesh (fickle) onto the fence to prevent further ingress. The crew completed this project. OANRP has observed over the past several years that the water flow coming down the Kumaipo trail along the southeastern line of the Upper unit was beginning to undercut the fence and destroy the trail in certain areas. Staff constructed nine water bars to direct water flow away from the fence and reinforce the sections of fence affected by heavy water flow during the reporting period.

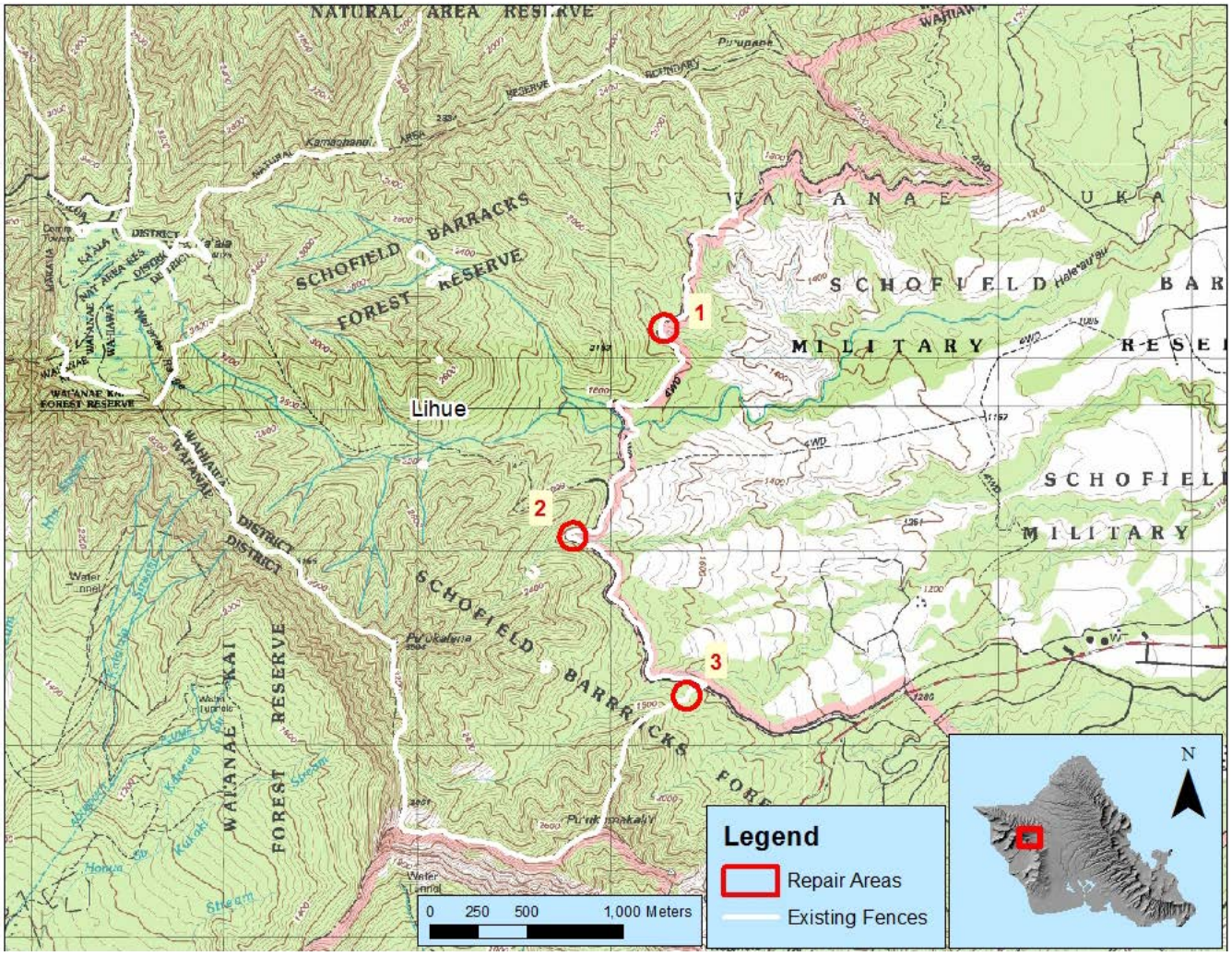


Figure 2: Map of fence repair/redirection at Lihue MU

- **Lihue**: Throughout the reporting period, OANRP had to conduct repairs at three sites on the fenceline along the Firebreak road in the Lihue MU (Figure 2). Point 1 is located at "Dry Gulch" and has a small culvert that runs under the road. The culvert has a tendency to become blocked after heavy rainfalls so OANRP had to dig out the culvert on two occasions and installed new baffles to decrease the amount of debris building up on the culvert. Point 2 is located at "Banana Gulch" where the water flows over the road. Since construction of the fence, there has been a build-up of debris along the fence that has changed the natural flow of water crossing the road. This change in the flow has caused erosion problems in different areas along that section of fence. OANRP redirected the fence down into the gulch off the road to allow natural water flow again. At Point 3, the fence was cut and propped open by hunters to allow animal access. OANRP repaired the sabotage.

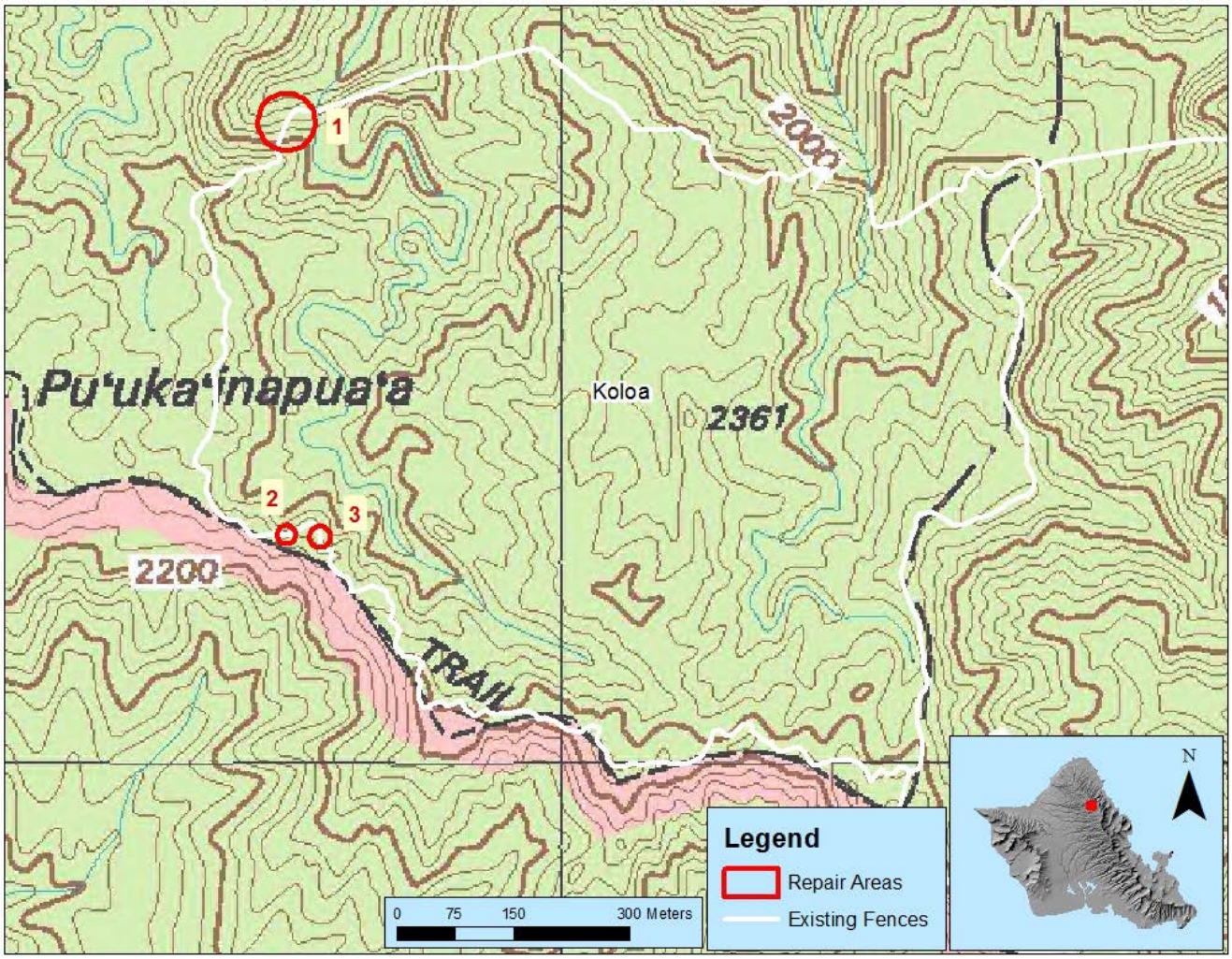


Figure 3: Map of fence repairs at Koloa MU

- **Koloa:** Heavy rains caused mud-slides that damaged the fence in three locations at the Koloa MU (Figure 3). OANRP did the necessary repairs and it appears no animals entered through the breaches. No sign has been found.

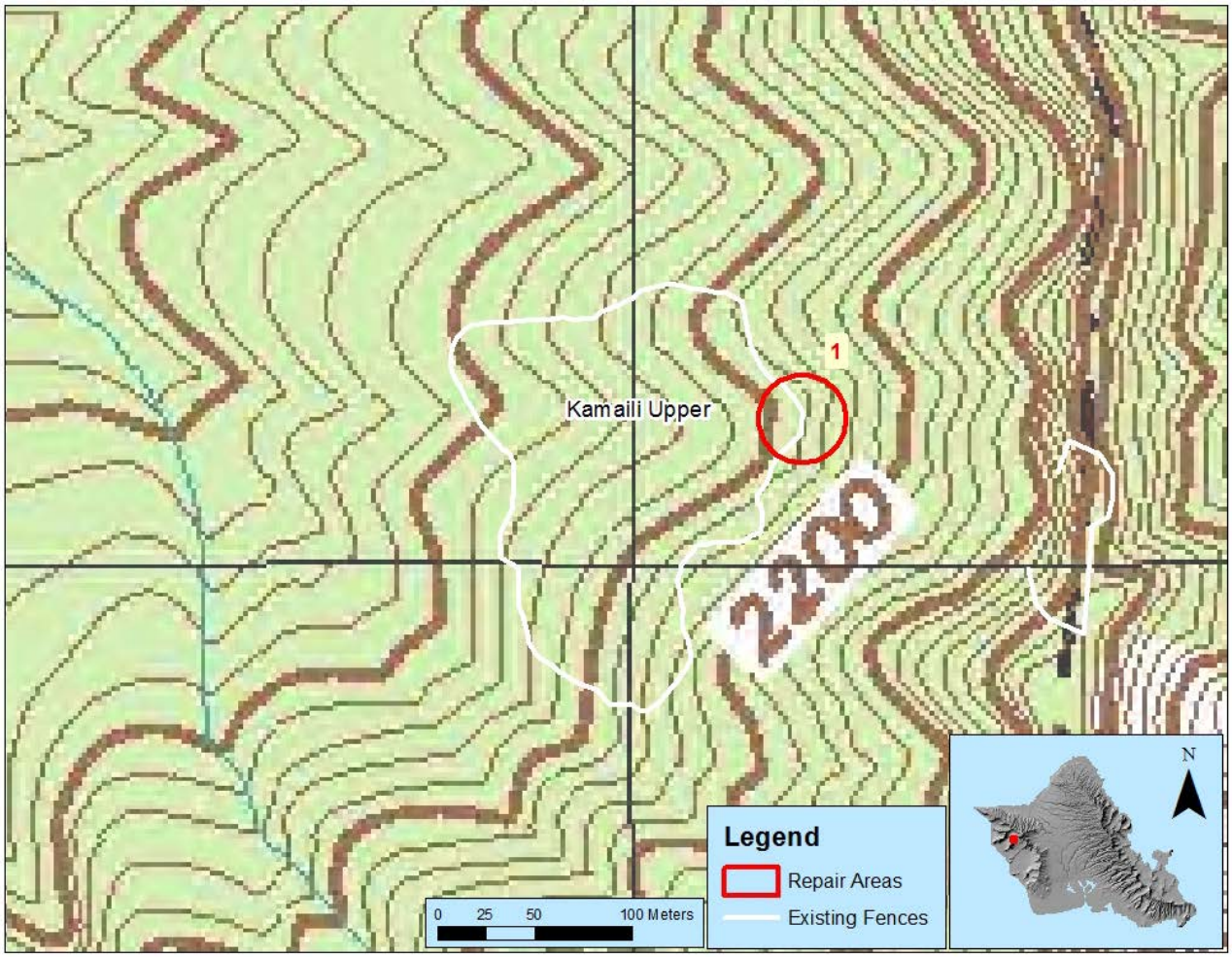


Figure 4: Map of fence repairs at Kamaili MU

- **Kamaili:** Rock falls continue to plague the Upper unit of the Kamaili MU fence (Figure 4). OANRP repaired the broken sections of fence and also installed several baffles to reduce the amount of damage. This section of fence is very prone to rock falls and will continuously need extra diligence.

Summary of Ungulate Removal Efforts

- Pig eradication efforts continued in Lihue MU. To date, a total of 544 pigs have been removed. Pig sign in all portions of the unit has been dramatically reduced but sign is still visible in a few areas. It seems that the few remaining animals have become snare shy, making them difficult to capture. Efforts are focused on increasing coverage in areas with few snares, and making sure all snares strategically set. OANRP is also running live traps along the firebreak road as an alternative to snaring exclusively. Access is limited so OANRP can only run those traps during the range maintenance week available each month.

- Occasionally, goats breach the ridge fence on Ohikilolo and OANRP is unclear as to where this is happening. Snaring occurs along the fence line to catch any of these wayward invaders. One goat was removed from the Ohikilolo MU fence area over the past reporting period.

- OANRP initiated an eradication effort for the Makua Military Reservation since the last section of fence was completed, enclosing the entire Valley. At this time, only snares are employed since there is no hunting with dogs allowed due to UXO risks. OANRP would like to install live traps and baiting/shooting stations to try some alternative methods at removal; however, RCUH currently does not have an approved firearm policy. To date, 129 pigs have been removed. OANRP continues to expand the snaring area into newer sites.

OIP/MIP Management Unit Fence Status

The MU status tables below (Table 1 and Table 2) shows the current status of all proposed and completed fence units, organized by MU. Shaded boxes identify where ungulate management or compliance documentations and authorizations are needed. The table identifies whether or not the fence is complete, whether it is ungulate free, identifies how many acres are actually protected versus acreage proposed in the IP, and lists the year the fence was completed or is expected to be completed. Fences which required a Conservation District Use Permit (CDUP), Cultural 106, MOU, ROE or RA, or a License agreement are checked in the appropriate box. The number of Manage for Stability Population Units (MFS) protected is also identified for each fence. For the sake of simplicity, this number also contains the number of Manage Reintroduction for Stability PUs. The MFS PUs are divided by taxa: P (Plants), I (Invertebrates) and V (Vertebrates). The table also contains notes giving the highlights and status of each fence and lists the current threats to each fence unit.

Table 1. MIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete or Proposed	CDUP	106	MOU/ ROE/ RA	Lic. Agr.	# MFS PUs					Notes	Current Threats
										MIP		OIP				
										P	I	P	I	V		
ARMY LEASED AND OWNED LANDS																
Kahanahaiki	Kahanahaiki I	Yes	Yes	64/64	1996					9	1	1			Complete and ungulate free.	None
	Kahanahaiki II	Yes	Yes	30/30	2013		X								Fence is complete and ungulate free.	None
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002					5					Complete. Fence is in need of some repair but still pig-free.	None
Opaeula Lower	Opaeula Lower	Yes	Yes	26/26	2011	X	X		X	1		1	1		Fence is complete and ungulate free.	None
Ohikilolo	Ohikilolo	Yes	No	4000/574	2002 2016		X			14	1				The Makua valley is complete, ungulate eradication has been initiated. There are six PU fences within the larger unit which are ungulate free. Since July 2006, 24 goats have been able to breach the fence. Snaring is being conducted all over the valley and along the fence line to remove them. One goat removed in past reporting year.	Pig/Goat
Ohikilolo Lower	Ohikilolo Lower	Yes	No	70/70	2000					3					This strategic fence is complete.	None
Puu Kumakalii	Puu Kumakalii	No	-	-	-	-	-	-	-	3					None needed but is partially included within the Lihue fence. Any potential goat issues will be dealt with as they arise.	None
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES																
Ekahanui	Ekahanui I	Yes	Yes	44/44	2001	X				6	1	2		1	Completed by TNCH.	Pigs
	Ekahanui II	Yes	Yes	165/159	2009	X	X								Complete and ungulate free. The completed fence is 3% larger than the original proposed MU fence.	None
Haili to Kealia	Haili to Kealia	No	-	-	-	X	-	-	-	1					As per DOFAW staff ‘no fence needed’.	None

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete or Proposed	CDUP	106	MOU/ ROE/ RA	Lic. Agr.	# MFS PUs					Notes	Current Threats
										MIP		OIP				
										P	I	P	I	V		
Kaena	Kaena	Partial	-	-	-	X	-	-	-	1					There is a predator proof fence installed by State but it only protects a few *Euphorbia celastroides* var. *kaenana* plants.	None
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999	X		X		6	1	2	1		Completed by TNCH. The completed fence is 9% larger than the original proposed MU fence.	None
	Kaluaa/Waieli II	Yes	Yes	25/17	2006	X		X							Completed by TNCH. The completed fence is 7% larger than the original proposed MU fence.	None
	Kaluaa/Waieli III	Yes	Yes	43/11	2010	X	X	X							Complete and ungulate free. The completed fence is 3% larger than the original proposed MU fence	None
Keaau	Keaau Hibiscus	Yes	Yes	8/33	2014	X	X	X		2					Complete and ungulate free. DLNR requested OANRP reduce the size of original proposed MU fence.	None
	Keaau III	Yes	Yes	4/33	2015	X	X	X							Fence was built by OPEP with assistance from WMWP and OANRP.	None
Keaau/Makaha	Keaau/Makaha	Yes	Yes	1/3	2009	X	X			1					Complete and ungulate free. The completed fence is smaller than the original proposed due to the terrain limitations.	None
Manuwai	Manuwai I	Yes	Yes	166/166	2011	X	X	X		3	1		1		Complete and ungulate free. Closed strategic section out of concern for possible ungulate breach.	None
Napepeiaoolelo	Napepeiaoolelo	Yes	Yes	1/1	2009	X	X	X		0					Complete and ungulate free.	None
Pahole	Pahole	Yes	Yes	215/215	1998	X				14	1				Complete and ungulate free.	None
Palikea	Palikea I	Yes	Yes	23/21	2008	X		X		1	1	1	2		Complete and ungulate free. Extension to fence is planned to protect the new snail enclosure.	None
Kapuna Upper	Kapuna I/II	Yes	Yes	32/182	2007	X		X		13	1				Complete and ungulate free.	None
	Kapuna III	Yes	Yes	56/182	2007	X		X							Complete and ungulate free.	None
	Kapuna IV	Yes	Yes	342/224	2007	X		X							Complete and ungulate free.	None

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete or Proposed	CDUP	106	MOU/ ROE/ RA	Lic. Agr.	# MFS PUs					Notes	Current Threats
										MIP		OIP				
										P	I	P	I	V		
Waianae Kai	Slot Gulch	Yes	Yes	9/9	2010	X	X	X		1					Complete and ungulate free.	None
	Gouvit	Yes	Yes	1/1	2008	X		X		1					Complete and ungulate free.	None
	NerAng Mauka	No	No	1/1	2011	X	X	X							Complete. All management actions have been transferred to Kamaili unit due to the continuous rock fall damage and threat to personnel.	Pigs/Goats
West Makaleha	West Makaleha	Yes	Yes	7/11	2001 2016	X	X	X		5					The *Schiedea obovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free. OANRP will expand the existing *C. grimesiana* fence to include more *Cyrtandra dentata* MFS plants in FY 2018.	None
BOARD OF WATER SUPPLY																
Kamaileunu	Kamaileunu	Yes	Yes	5/2	2008	X	X		X	1			1		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					8	1				Complete and ungulate free. Pigs breached the fence and were removed.	None
	Makaha II	Yes	Yes	66/66	2013	X	X		X	5		1			Complete and ungulate free. Pigs breached the fence and were removed.	None

Table 2. OIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete or Propose	CDUP	106	MOU/ ROE/ RA	Lic. Agr.	# MFS PUs					Notes	Current Threats
										MIP		OIP				
										P	I	P	I	V		
ARMY LEASED AND MANAGED LANDS																
Kaala-Army	Kaala	Partial	No	183/183	2008		X					4	1		Strategic fences complete. Three pigs were caught in 2014, the first since 2010 and no sign since but there is a chance a pig can still come up from the Waianae Kai side. A line has been scoped for this section to close it up. OANRP is pursuing construction of this fence in FY 2018.	Pig
Kaunala	Kaunala	Yes	Yes	5/5	2006		X					1			Complete and ungulate free.	None
Lihue	Lihue	Yes	No	1800/980	2012		X			3	1	6			Completed. Encompasses six PU fences and the original three proposed units. A total of 544 pigs have been removed. There are very few pigs left in unit.	Pig
Oio	Oio	Yes	Yes	4/4	2006	X						1			Complete and ungulate free.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	273/273	2001/ 2007							1			Complete and ungulate free.	None
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006	X						1			Complete and ungulate free.	None
South Kaukonahua	South Kaukonahua I	No	No	0/95	TBD		X					1			Postponed pending completion of Section 7 consultation in 2018. The Tier 1 taxa *Hesperomannia swezeyi* occurs within this MU.	Pig
STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES																
Huliwai	Huliwai	Yes	Yes	.3/1	2014	X		X				1			Complete and ungulate free.	None
Ekahanui	Ekahanui III	Yes	Yes	8/8	2010	X	X					1			Complete and ungulate free.	None
Manuwai	Manuwai II	Yes	Yes	138/138	2011	X	X			10	1	1	1		Complete and ungulate free. The Lihue and Manuwai II unit share a strategic boundary and the ungulate free status is subject to pig traffic from Lihue which is unlikely but possible.	Pig
North Kaukonahua	North Kaukonahua	Yes	No	0/31	Cancelled	X	X	X				1			Is included within the larger Poamoho NAR fence. Fence is completed.	Pig

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete or Propose	CDUP	106	MOU/ ROE/ RA	Lic. Agr.	# MFS PUs					Notes	Current Threats
										MIP		OIP				
										P	I	P	I	V		
Poamoho	Poamoho Lower II	Yes	Yes	5/5	2014	X	X	X				1			Included within the larger Poamoho NAR fence.	Pig
North Pualii	North Pualii	Yes	Yes	20/20	2006	X				1		1	1		Completed by TNCH and ungulate free.	None
	BOARD OF WATER SUPPLY															
Kamaili	Kamaili	Yes	Yes	9/7	2014	X	X		X	1		1			Complete and ungulate free.	None
	HAWAII RESERVES INC.															
Koloa	Koloa	Yes	Yes	177/160	2012	X	X		X			4			Complete and ungulate free.	None

CHAPTER 2: ENVIRONMENTAL OUTREACH

The OANRP Outreach Program is tasked with:

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

The following text highlights outreach activities from the 2017 reporting year.

Volunteer Program

The outreach program coordinated and led an average of five volunteer trips each month during this reporting period and met volunteer weeding goals at field sites. Three volunteers regularly supported volunteer activities at the OANRP baseyards, including seed lab and nursery work and maintenance of the native Hawaiian interpretive garden. In addition, outreach staff maintained a volunteer database of 2,067 individuals and communicated regularly with active volunteers.

The table below (Table 1) compares volunteer participation at OANRP for this year with that of previous years, distinguishing between volunteer efforts spent in the field and around the OANRP baseyards.

Table 1. Volunteer participation at OANRP from 2010 to 2017

Report Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Work Site**	Total Volunteer Trips	Total Baseyard Volunteer Hours***
2017	**3397.5**	**905.75**	**61**	**489**
2016	3,575.5	974.5	68	537.75
2015+	3,013.5	824	52	333.25
2014	4,421.5	1,133.75	78	490.75
2013	3,767.5	957	69	569.5
2012	4,302.5	1,261.5	78	602.5
2011	4,194	1,231	76	618
2010	3,415	1,299	58	885

***Includes driving time to and from trailhead, safety briefing, hiking time to and from work site, and gear cleaning time at end of day*
***Includes actual time spent weeding, planting or monitoring*
****Includes propagule processing, nursery maintenance, gear preparation, outreach support and maintenance of interpretive native gardens*
+Shorter reporting year, spanning nine (9) months

Volunteers use small hand tools to clear along the fenceline at West Makaleha.

The primary participants in the volunteer program are from the general public, which includes members of the community with no affiliation, along with special interest groups such as hiking groups and hula halau.

School groups make up a large portion of the volunteer program audience, with students as the primary participants. This reporting year, numerous K-12 volunteer trips were scheduled for teaching staff seeking to expand their knowledge of environmental and cultural issues for staff development purposes.

This year the outreach program experienced an increase in volunteer participation from both the higher education and the conservation community audiences. New conservation community participants included staff from Kokua Hawaii Foundation, Malama Loko Ea Foundation, and the Hawaii VINE Project. Outreach staff also supported the U.S. Department of Agriculture's Hawaii AgDiscovery Program with a volunteer outing for the second year in a row.

Outreach staff also facilitated an Eagle Scout Project with Troop 24 (Schofield Barracks), which focused on trail improvement at the Kahanahaiki MU. Project activities included placing trail markers, vegetation removal, and tying of webbing in steep sections to facilitiate easier hiking on the trails. The Scouts completed the project on April 29 and volunteered a collective total of 130 hours.

The figure below depicts the variety of audiences that participated in OANRP volunteer trips during this reporting year.

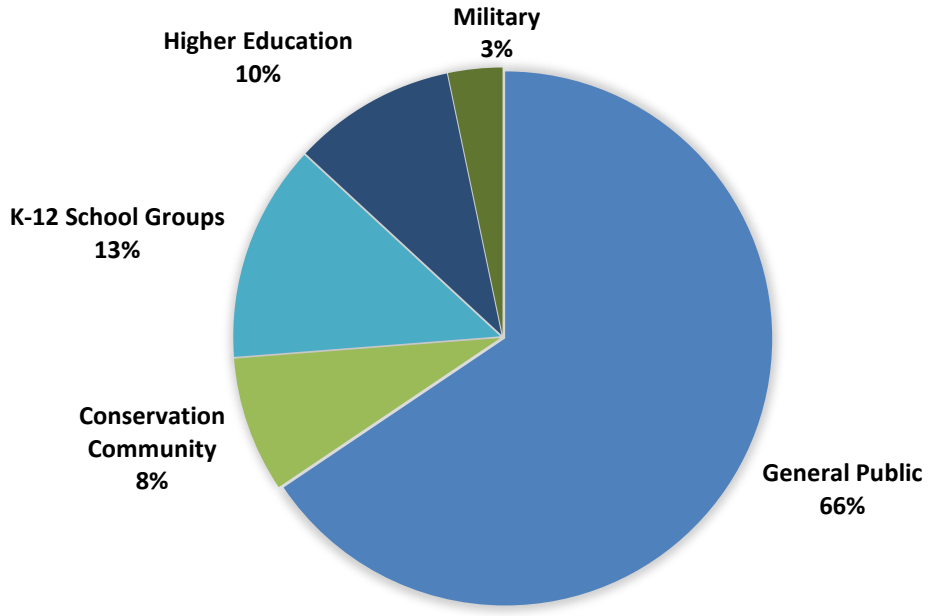


Figure 1. Volunteer service trip audience for 2017

Weed control within the Kaala and Kahanahaiki MUs were the primary focus for volunteer efforts this reporting year, which is consistent with the focus in years past. There is a greater number of volunteer-appropriate weeding tasks at Kaala and Kahanahaiki due to terrain and hiking distance. The decline in the number or volunteer trips aimed at controlling *Sphagnum palustre* at Kaala is due, in large part, to the effectiveness of past years volunteer efforts for this target weed species. In addition to weeding, outreach staff coordinated revegetation projects in consultation with the ecosystem restoration program. These efforts included fruit collection, seed sows and outplanting activities to enhance native plant diversity within previously weeded areas. Several of these collection and planting activities are reflected as half-day visits in the table below, as there were occassions when volunteer time was divided between weeding and revegetation efforts.

The table below summarizes volunteer service trips by location.

Table 2. Volunteer service for reporting period 2017

Management Unit	Projects	Number of Visits
Kahanahaiki	Habitat weed control in WCAs	13
	Trail scoping and maintenance	3
Kaala	Incipient weed control in *Sphagnum palustre* ICAs	4
	Incipient weed control in other ICAs	10
	Habitat weed control in WCAs	8.5
	Revegetation projects	2.5
Makaha I	Habitat weed control in WCAs	5
Palikea	Incipient weed control	2
	Habitat weed control in WCAs	3
West Makaleha	Habitat weed control in WCAs	2.5
	Revegetation projects	1.5
Kaluaa	Habitat weed control in WCAs	3
Pualii	Habitat weed control in WCAs	3

Internships and Mentor Programs

Outreach staff engaged youth and young adults interested in the field of natural resource management through internship and mentoring programs, which included hands on conservation field work.

- Spring and Summer Internships

  Outreach staff scored 53 applicants, interviewed 12 applicants, and awarded eight individuals with paid spring and summer internships with natural resource field and horticultural crews. The spring internships spanned four months (February-May) while the summer internships lasted three months (June-August). Outreach staff and field crews planned and implemented three-day orientation sessions for both spring and summer interns, consisting of new hire training modules and hands on field activities.

  Two interns from the 2016 summer cohort, Kaia Kong and Jonah Dedrick, have since joined the OANRP staff as full-time natural resource management technicians.

- Hawaii Youth Conservation Corps (HYCC)

Hosted two teams of seven HYCC members during this reporting year, one team in July 2016 and one team in June 2017. Each HYCC team spent one week working with natural resource program field crews.

- 2017 Hawaii State Science Fair

  Natural resource management technician Jessica Hawkins judged student science fair projects at the 60th Hawaii State Science and Engineering Fair on April 10-12, 2017 at the Hawaii Convention Center.

Educational Materials

Outreach staff developed new educational materials in various media focused on natural resource issues specific to MIP and OIP species and their habitats. Many of these materials were developed for the International Union for the Conservation of Nature (IUCN) World Conservation Congress held at the Hawaii Convention Center in September 2016. An estimated 10,000 people attended this 10-day conference. The IUCN materials and all other educational contributions for this reporting year are summarized by category in the bulleted list below.

OANRP staff hosted a booth at the IUCN World Conservation Congress in Honolulu, which drew in over 10,000 people from all over the world. Natural resource management technician Kelly Cloward (left) and outreach specialists (from right) Celeste Hanley and Kim Welch posed for a photo with former OANRP staff visiting the exhibit at the convention.

Outreach Exhibits and Activities:

- IUCN Multimedia Exhibit
  Provides overview of OANRP's management efforts in ungulate control, rare plant propagation and reintroductions, and predator control.

  1. Ungulate Control Display
     - 8' x 10' banner serves as a backdrop and features an Army Chinook helicopter sling-loading fencing material into the forest
     - 22" x 30" aluminum fence sign is displayed on section of fencing with information on threats posed by pigs and goats
     - 6" x 30" aluminum fence sign contains caption to explain the Chinook sling-loading operation depicted on banner
     - Video clip shows OANRP staff building fences in the mountains; video monitor is encased within a native forest display

2. Predator Control Display
   - 8’ x 3’ chalk board wall features a three-dimensional “murder-mystery” display highlighting rat impacts on endangered tree snails, forest birds and rare plants

3. Rare Plant Program Display
   - Samsung Galaxy tablet displays a slideshow story of the *Cyanea superba* subsp. *superba* (haha) at kiosk at exhibit entrance
   - Digital Media Photo Oppportunity
     - 6.5’ x 4’ banner features endangered haha as a backdrop
     - 4.5’ x 2.5’ foam-core cutout of OANRP staff person monitoring the haha (visitors pose behind cutout to have photo taken)

- Signs
  - Damselfly Sign
    - Discourages car washing in parking area at Tripler that is in close proximity to Orangeblack damselfly habitat

- Presentations
  - Environmental Compliance Officer (ECO) training presentation
    - Updated exisiting presentation to streamline time frame and to incorporate video footage

- Other
  - OANRP Video
    - Completed production of an eight-minute informational video on OANRP highlighting MIP/OIP species status, threats, and protection measures. Video is currently being shown at monthly ECO presentations and will be incorporated into future public outreach presentations.

  - Notices on Melastomaceae Seed Contamination of Cinder
    - Prepared and distributed two notices to conservation community, publicizing the discovery of invasive weed seeds found in locally sourced cinder (more information on this topic can be found in section 3.6 of the Ecosytem Mangement Chapter).

Troop Education

Outreach staff conducted presentations for Army troops, contractors and other active duty military personnel, highlighting the relationship between training activities and natural resources on Army training lands. In addition, as of April of this reporting year, OANRP outreach staff have resumed presentation of the natural resource concerns on Oahu Army training lands, at the bimonthly Officer-In-Charge/Range Safety Officer (OIC/RSO) briefs held at Schofield Barracks and once a month at Kaneohe Marine Corps Base. The brief provides rules and regulations pertaining to each Army training area on Oahu. Attendance is mandatory for representatives from each military unit that schedules time on Oahu training ranges.

Table 3. Summary of troop education 2017

Event	Description	Audience	Number of presentations	Number of People Served
Environmental Compliance Officer (ECO) training presentation: "Protecting Natural Resources"	A one-hour presentation for the ECO training courses held at Schofield Barracks	Soldiers, civilians, and contractors	6	134
Training Area Presentation: "Protecting Natural Resources in Makua"	A 15-minute presentation on natural resource considerations at Makua Military Reservation (MMR)	Soldiers training within MMR	11	635
Range Brief Presentation: "Environmental Requirements"	A 20-minute brief on natural resource considerations on training lands	Officers in Charge & Range Safety Officers	13*	822
Total number of people served:				**1,591**

*Includes two briefs given prior to "Lightning Forge" exercise at Schofield Barracks

Outreach Events

Outreach staff disseminated information on natural resources specific to Army training lands at local schools, community events and conferences. These activities are summarized in the table below. The total number of outreach activities was 18 for this reporting year.

- Total number of people served (approximated): 14,323

Table 4. Outreach activities for 2017

Event	Attendance	Audience
International Union for the Conservation of Nature (IUCN) World Conservation Congress	10,000	General Public
Hawaii Trail and Mountain Club Transportation Support for Trail Clearing Crew	37	
Camp Mokuleia Staff Development Day- Kaala Boardwalk Tour	9	
Waianae Neighborhood Board Seed Lab and Greenhouse Tour	2	
University of Hawaii Natural Resources and Environmental Management- Internship Class Presentation	50	Higher Education
University of Hawaii Resource Management and Biological Conservation in Hawaii- Class Presentation	30	
University of Hawaii Conservation Biology Class	21	
Chaminade University Biology Class Seed Lab and Greenhouse Tour	7	
Hawaii Pacific University Natural Resource Management Class Presentation	12	
University of Hawaii Earth Day Festival	100	

Kaelepulu Elementary School Career Day	105	K-12 Schools
Mililani High School Biology Class Kaala Boardwalk Tour	8	
Ka Pa Hula O Ka Lei Lehua (Hula Halau)- Kaala Boardwalk Tour	4	
Oahu Agriculture and Environmental Awareness Day	500	
Blanche Pope Elementary School 5th Grade Presentation	20	
Department of Defense Pesticide Certification Class- Natural Resource Applications	18	Military
Schofield Fun Fest	3000	
Schofield Earth Day	400	
Total Number in Attendance:	**14,323**	

Contributions to Conferences/Workshops

OANRP staff contribute to outreach by presenting research findings at various academic conferences and workshops. This reporting year, seven staff presented at the 2017 Oahu Weed Workshop in Haleiwa on March 7, 2017. Contributions at the workshop are listed in the table below.

Table 5. Contributions to Conference/Workshops

Presentation Title	Format	Author/leader name(s)	Venue	Date
Dirty Media: *Tibouchina longifolia* contamination of cinder and sanitation of plants grown for restoration	Oral presentation	Beachy, Jane; Lee, Julia Gustine	2017 Oahu Weed Workshop	07-Mar-17
Tool Tailgate: Aerial spray ball, Gigapan and other tools of the weed control arsenal explained	Outdoor demonstration	Lee, Julia; Marsh, Taylor; Akamine, Michelle; Koch, Linda; Bohling, Michael; Hawkins, Jessica	2017 Oahu Weed Workshop	07-Mar-17

Public Relations and Publications

Wrote articles, press releases, bulletins and scholarly journal articles; provided coordination and accurate information to the local, state, regional, and national media and agencies. Escorted reporters into the field for coverage of natural resource news. The table below summarizes all media and publications relating to OANRP management in reporting year 2017.

Table 6. Media coverage and publications in FY 2017

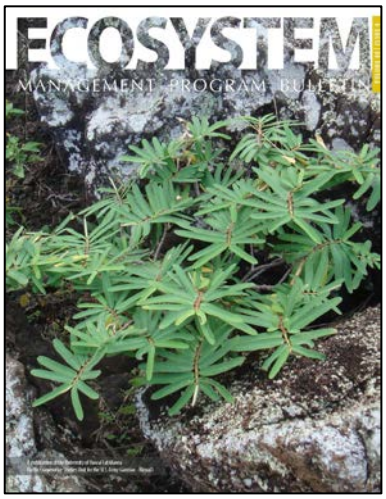
Title	Author	Publication	Date	Format
UH Manoa botanist wins global recognition for plant conservation	University of Hawaii System	University of Hawaii News (http://www.hawaii.edu/news/2016/09/06/uh-manoa-botanist-wins-global-recognition-for-plant-conservation/)	06-Sept-16	Online news article
Seven Bees Facing Extinction Added to Endangered Species List for First Time	Dan Zukowski	EcoWatch (https://www.ecowatch.com/bees-endangered-species-list-2028775271.html)	03-Oct-16	Online news article

You Can Help Make the World a Bit Safer for Bees	Jane Lear	Takepart (http://www.takepart.com/article/2016/10/19/endangered-bees-honey)	19-Oct-16	Digital news magazine
Microhabitat heterogeneity and a non-native avian frugivore drive the population dynamics of an island endemic shrub, *Cyrtandra dentata*	Lalasia Bialic-Murphy, Orou G. Gaoue and Kapua Kawelo	Journal of Applied Ecology (http://www.onlinelibrary.wiley.com/doi/10.1111/1365-2664.12868/abstract)	31-Jan-17	Scholarly journal
Army Natural Resources plays matchmaker to endangered plants	Kayla Overton	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/storage/2017/01/021717HAW_WEB.pdf)	17-Feb-17	News article
Army's heavy lifting helps protect endangered snails	Karen Iwamoto	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2017/03/17/armys-heavy-lifting-helps-protect-endangered-snails/)	17-Mar-17	News article
Volunteers help USAG-HI protect native habitats	Karen Iwamoto	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2017/04/21/volunteers-help-usag-hi-protect-native-habitats/)	21-Apr-17	News article
Schofield Barracks Soldiers Help Protect Endangered Snails	Karen Iwamoto	Midweek (http://midweek.com/pdf/Central/2017/0426/)	26-Apr-17	News article
Helicopters help tame wildfire on North Shore	Leila Fujimori	Honolulu Star Advertiser (http://www.staradvertiser.com/2017/06/09/hawaii-news/helicopters-help-tame-wildfire-on-north-shore/)	09-June-17	News article
Parting Shot: Snail Trail	Liz Barney	Hawaii Business (http://www.hawaiibusiness.com/parting-shot-snail-trail/)	June-2017	Magazine feature

Ecosystem Management Program Bulletin

During this reporting period, the outreach staff edited, produced and distributed the Ecosystem Management Program (EMP) Bulletin, a newsletter highlighting achievements made by the Army Environmental Division's Conservation Branch on Oahu and Hawaii islands. This year's publication marked a transition from two issues annually to just one per year at the request of the U.S. Army Garrison.

The EMP is posted online at http://manoa.hawaii.edu/hpicesu/dpw_emb.htm and at www.issuu.com/oanrp. It is also distributed to a comprehensive list of state, non-profit federal and educational institutions and OANRP volunteers. Articles from this publication are frequently picked up by other Army publications. A hard copy of the bulletin is also provided to the University of Hawaii at Manoa Hamilton Library.



Issue 2017 - Habitat

Volunteer Recognition

Each year, outreach staff nominate eligible volunteers for the President's Volunteer Service Award. The 2016 nominations include service from 01 July 2015 - 30 June 2016 and the 2017 nominations include service from 01 July 2016 - 30 June 2017.

Table 7. 2016 President's Volunteer Service Awardees

Award Level	Name	Hours of Service in 2016
Gold	Elaine Mahoney	540
Silver	David Danzeiser	458.5
Silver	Roy Kikuta	349.5
Bronze	Kathleen Altz	126

Table 8. 2017 President's Volunteer Service Awardees

Award Level	Name	Hours of Service in 2017
Gold	Elaine Mahoney	508
Silver	David Danzeiser	293
Silver	Kathleen Altz	256
Silver	Roy Kikuta	254
Bronze	Matthew Liang	112
Bronze	Serene Smalley	112

For adults 26 and older, award levels are based on number of hours of service:
Gold = 500+, Silver = 250-499, Bronze = 100-249

Grants

OANRP was awarded $5759.00 from the 2016 National Public Lands Day Department of Defense Legacy Grant to support volunteer efforts to control the invasive firespike plant (*Odontonema cuspidatum*) along the Kaala summit portion of the Schofield Barracks West Range Training Area. The funds were used to purchase volunteer tools (gloves, pruners and handsaws) and footwear (rubber boots and spiked tabis). Volunteers utilized this gear during the National Public Lands Day event at Kaala on September 24 and will have access to this gear on future volunteer trips.

Community volunteers join OANRP staff at the Kaala summit on National Public Lands Day to control firespike (*Odontonema cuspidatum*). Firespike, along with several other ornamental plantings, may have been used to landscape around the Kaala Federal Aviation Administration facility at the time of original construction in the early 1960s.

CHAPTER 3: ECOSYSTEM MANAGEMENT

Notable projects from the 2016-2017 reporting year are discussed in the Project Highlights section of this chapter. This reporting year covers twelve months, from July 1, 2016 through June 30, 2017.

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

Ecosystem Restoration Management Unit Plans (ERMUP) have been written for many MUs and are available online at http://manoa.hawaii.edu/hpicesu/dpw_ermp.htm. Each ERMUP details all relevant threat control and restoration actions in each MU for the five years immediately following its finalization. The ERMUPs are working documents; OANRP modifies them as needed and can provide the most current versions on request. This year, the Ekahanui, Kaena, Kaluakauila, Koloa, Pualii and Ohikilolo (Lower Makua) ERMUPs were revised; they are included as Appendices 3-1 to 3-6.

3.1 WEED CONTROL PROGRAM SUMMARY

MIP/OIP Goals

The stated MIP/OIP goals for weed control are:

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

Given the wide variety of habitat types, vegetation types, and weed levels encompassed in the MUs, these IP objectives should be treated as guidelines and adapted to each MU as management begins. Please see the 2010-2011 MIP and OIP Annual Report for a discussion of adaptive changes to these goals. The Ecosystem Restoration Management Unit Plans (ERMUPs) for each MU detail specific goals and monitoring expectations for each MU.

Staff preparing for a weed control sweep at Kahanahaiki

Weed Control Effort Summary

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

This year, OANRP spent 9,309 hours controlling weeds across 594 ha. These figures include both incipient and ecosystem control efforts by staff and volunteers but do not include survey efforts or travel time. The table below lists efforts for the previous six reporting cycles. Note that all reporting periods, including this year, were 12 months in length, except 2014-2015, which covered only nine months.

Table 1. Summary Statistics for Weed Control

Report Year	Effort (hours)	Area (ha)
2016-2017	9,309	593.9
2015-2016	8,447	539.5
2014-2015 (9 months)	4,654	325.9
2013-2012	7,600	286.5
2012-2013	6,967.6	267.7
2011-2012	5,860	275.7
2010-2011	5,778	259

Complementing control efforts, OANRP staff conducted early detection surveys on all primary training range roads and military landing zones (LZs), some MU access roads, and all secondary training range roads in KTA, SBE, MMR, and SBW. Results of these surveys are discussed in section 3.5 below.

Artwork by Daniel Sailer: invasive plants form a portrait of the ultimate invasive species - humans.

Incipient Control Areas

Incipient control efforts are tracked in Incipient Control Areas (ICAs). Each ICA is drawn to include one incipient taxon; the goal of control is eradication of the taxon from the ICA. ICAs are primarily drawn in or near MUs. Those not located within or adjacent to an MU were selected for control either because they occur on an Army training range (for example, *Cenchrus setaceus* in MMR) or are particularly invasive (*Arthrostema ciliatum* in Kaluaa). Many ICAs are very small and can be checked in an hour or less, and in some MUs multiple small ICAs can be checked in one day. In contrast, a few ICAs, like those for *Sphagnum palustre* in Kaala or *Chromolaena odorata* in Kahuku, are quite large and require multiple days to sweep completely. Typically, ICAs are swept repeatedly until eradication has been achieved and staff is reasonably confident there is no remaining seed bank. In the absence of data regarding seed longevity, staff does not consider a site eradicated until ten years after the last sighting. The goal of ICA efforts is to achieve local eradication of the target species. OANRP currently controls 57 taxa in 279 ICAs, and considers eradication to have been achieved at 33 ICAs.

Of the total 590 ha swept, ICA efforts covered 467.3 ha. This year, staff spent 2,573 hours on ICA management, treated 467.3 ha, and conducted 662 visits to 233 ICAs. This is the greatest effort spent and area managed for incipient weeds in a reporting period to date; see table below. Also, this is the greatest number of ICA sites visited in one year. ICA work accounted for 79% of the total area weeded and 28% of total weeding effort. This makes sense, as incipient control generally requires less time per acre than habitat restoration weed control.

Table 2. Summary Statistics for ICAs

Report Year	# ICAs	Visits	Effort (hours)	Area (ha)
2016-2017	233	662	2,572.8	467.3
2015-2016	175	539	2,452	388.1
2014-2015 (9 months)	147	333	1,537	245.6
2013-2012	157	389	1,753.6	196.41
2012-2013	152	311	1,369.2	184.34
2011-2012	115	260	1,661	219.27
2010-2011	130	281	665.5	164

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

While the majority of ICAs require minimal amounts of effort to monitor, some require significant investment of resources. Volunteers contribute significantly to ICA control efforts at Kaala and Palikea, which enables OANRP to divert staff time to more challenging taxa and/or work sites. A good example of this are ICAs for *Sphagnum palustre, Juncus effusus*, and *Crocosmia crocosmiiflora* along the boardwalk at Kaala. All of these taxa are highly invasive, but none of these boardwalk ICAs are located in direct proximity to IP taxa. Volunteer effort here frees staff to focus on *Hedychium gardnerianum*, which directly threatens rare plants and their habitat, while maintaining pressure on the less immediate threats, posed by the boardwalk ICA taxa.

This year, there were small increases in effort for a majority of ICA taxa, and large increases in effort for a select few, including *Angiopteris evecta, Cenchrus setaceus, Chromolaena odorata, Juncus effusus, Pterolepis glomerata,* and *Schizachyrium condensatum*. These increases outweighed large declines in

effort for *Crocosmia x crocosmiifolia, Melochia umbellata, Rhodomyrtus tomentosa,* and *Sphagnum palustre*. While the true measure of success is eradication, staff hope that eventually the effort needed to treat ICAs will decline as fewer individuals are found over subsequent visits. Of the 467.3 ha treated for ICAs this year, the majority of this, 448.9 ha, was for just ten taxa: *C. odorata, Acacia mangium, R. tomentosa, S. condensatum, M. umbellata, C. setaceus, A. evecta, Miscanthus floridulus, Acacia mearnsii,* and *Erythrina poepiggiana*.

The number of ICAs managed has increased steadily over the years. Part of this is due the difficulty of determining when a site has been extirpated; ten years is a long time to monitor. Each year, staff note new locations of known priority species, for example *Pterolepis glomerata* in the Waianae Mountains, or discover entirely new taxa, such as *Chelonanthes acutangulus*. While dispersal via Army training or OANRP management accounts for some of the new ICAs, some spread is likely due to public hikers, non-native animals, and wind events. Even with improved strategies and control techniques, the time required to address ICA work grows along with the number of ICA sites. Encouragingly, this year staff were able to confidently declare eradication at 16 ICAs, for a total of 33 eradications. Among these are three *Achyranthes aspera* sites (Kahanahaiki), three *Cenchrus setaceus* sites (two at SBE, one at KTA), one *Dicliptera chinensis* site (Kahanahaiki), five *Ehrharta stipoides* sites (Pahole and Pahole No MU), one *Fraxinus uhdei* site (Ohikilolo), one *Rubus argutus* site (Pahole), one *Syzigium jambos* site (Kaluakauila), and one *Tibouchina urvilleana* site (Whitmore).

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

The table below highlights the eleven taxa which required the most control effort in the past year. Effort from report year 2016 is presented for comparison. Note that effort hours do not include travel or trip preparation, or most time spent surveying outside of known ICA boundaries to define infestation areas. See the Invasive Species Update sections (3.7-3.8) for more detailed discussion of select priority targets.

Table 3. 2017 ICA Effort by Target Taxa

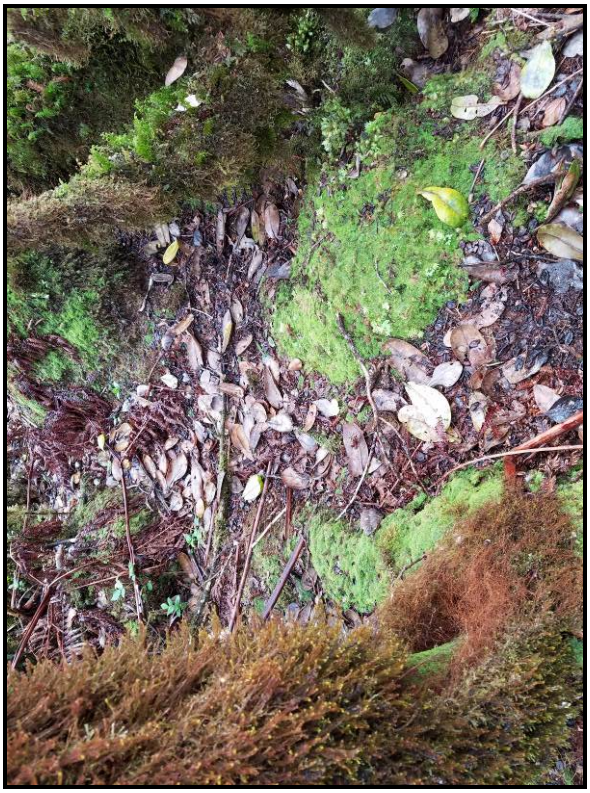
Taxa	2016 Control	2015 Control	Comments
Chromolaena odorata	1,128.75 hrs 161.28 ha 146 visits	1029.70 hrs 125.85 ha 133 visits	*Chromolaena* continues to be OANRP's top ICA priority. Staff efforts include treatments of hotspots, large sweeps, and aerial spraying; see discussion sections 3.4 and 3.7 below. OANRP continued to contract OISC to conduct work across half of the KTA infestation; see Appendices 3-7 and 3-8 for OISC's progress report. OISC efforts are not included in the totals in this table.
Schizachyrium condensatum	227.65 hrs 53.78 ha 36 visits	210.80 hrs 71.93 ha 45 visits	SBE remains the only location on Oahu with *Schizachyrium*. Last year, efforts focused on fully delimiting the infestation, which accounts in part for the high acreage swept. This year, efforts focused more on treatment of the 5 small ICAs and hotspots within the 2 large ICAs. While no new ICAs were discovered, no sustained downward trend in numbers of plants found is evident at any of the ICAs. This may be due the nature of this grass (cryptic, abundant seed production, fast-growing), complicating factors on range (regular disturbance from training and mowing), or crew related (detection ability, knowledge of sites). More frequent visits and more thorough surveys may be required to get a handle on this taxon
Crocosmia x *crocosmiiflora*	165.28 hrs 1.49 ha 27 visits	229.00 hrs 1.35 ha 23 visits	Volunteers conduct the majority of *Crocosmia* control at both Kaala and Palikea, removing the corms by hand. There was a major reduction in total effort this year, all of which came from Kaala, while Palikea efforts remained constant. However, the majority of

Taxa	2016 Control	2015 Control	Comments
			time (67%) still was spent at Kaala. There are 4 ICAs in Palikea, and two more just outside. Numbers of plants continue to decrease at all 6 sites, although one ICA was expanded greatly to include outliers on the summit slope. There are 7 ICAs at Kaala, all of which are located either on the road or directly around the FAA enclosure. While numbers of plants are decreasing at the ICAs along the boardwalk, little work has been attempted where the *Crocosmia* has formed dense banks, where hand removal is impractical. This year, staff installed a foliar spray trial based on a mix used in New Zealand; results suggest the mix is effective, although some corms do resprout. Staff will begin operational use of foliar sprays in select areas in the coming year.
Cenchrus setaceus	163.76 hrs 33.60 ha 34 visits	90.27 hrs 8.90 ha 20 visits	ICAs for this fire-prone grass are located in KTA, SBE, MMR, and Kahanahaiki. *Cenchrus* is a high priority taxon due to its association with fire and potential for negative impact to training ranges. Previous studies by the OANRP seed lab suggest seeds do not persist in the soil for longer than a year and half. Control efforts are discussed in section 3.8, below.
Juncus effusus	137.50 hrs 0.78 ha 26 visits	68.00 hrs 0.70 ha 15 visits	Volunteers conduct the majority of control on this species. Since the seeds are long-lived, control will be required for years to come. There are seven ICAs at Kaala and one East Makaleha. Most of the increase in effort this year is due to work at the two largest ICAs at Kaala, both of which were expanded to include recently found plants at the LZ, along the road, and at the shelter. Despite this, there is a downward trend in the number of plants found at all ICAs, particularly the smaller ones. Preventing further spread of this persistent rush is a priority.
Angiopteris evecta	126.25 hrs 12.13 ha 28 visits	58.41 hrs 12.21 ha 23 visits	This widespread fern has the potential to grow almost anywhere, from the wet Koolau summit to mesic Waianae forest. It is targeted for eradication in select MUs. Initial control is complete at all known sites, and the current strategy of annual maintenance checks appears to be effective. Staff continue to find large numbers of seedlings and immatures at many sites; it is unclear how long gametophytes and spores survive. Effort at all ICAs increased this year, particularly at Kapuna Upper, which accounts for 71% of all *Angiopteris* control. There are 7 ICAs in Kapuna Upper. Four are small outliers with few plants found, while the other 3 encompass large gulch areas. Plant numbers treated declined at the three largest ICAs this year, which supports the annual survey strategy. There is a large population of *Angiopteris* in neighboring West Makaleha, so continued ingress is expected. At Pahole, two new ICAs were found this year, suggesting that the full distribution of *Angiopteris* is yet to be determined in this MU. Additional effort was spent at the single ICA in Kahanahaiki, resulting in more thorough coverage. There is also a large source population to the northwest of Kahanahiki and Pahole, likely feeding spores into both MUs. There are two ICAs in Kaluaa; control efforts are going well, with no mature plants found for 10 years.
Pterolepis glomerata	108.30 hrs 1.34 ha 79 visits	77.40 hrs 0.90 ha 55 visits	This taxon is only a target in the Waianae Mountains, where it is a control priority at Kaala, Kahanahaiki, Makaha, Manuwai, Makaleha, Ohikilolo, Pahole, and Palikea. This year, 5 new sites were found: a ridge in Kahanhaiki II, the east end of the Lower Kaala NAR access road, the summit at Palikea, the east fence of Manuwai, and the Dupont Trail in Makaleha East. This continued

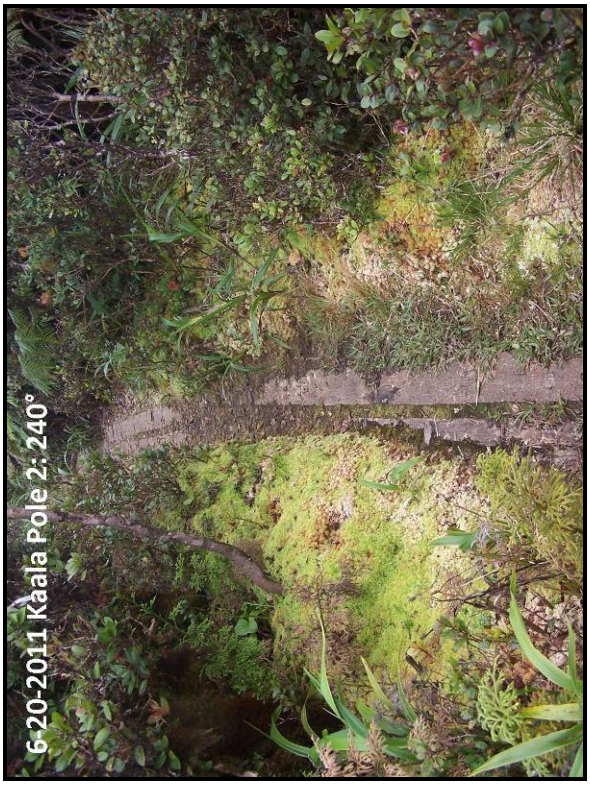
Taxa	2016 Control	2015 Control	Comments
			evidence of spread is concerning, and suggests that it may only be a matter of time before *Pterolepis* is established in the Waianaes. Several of the recent infestations are in areas not regularly accessed by OANRP, like Dupont Trail and Lower Kaala NAR road. OANRP will focus on keeping this threat out of MUs. It is thought *Pterolepis* forms a persistent seed bank. A biocontrol for a related species, *Tibouchina herbacea*, also attacks *Pterolepis* and may provide critical suppression; the biocontrol has not yet been released.
Sphagnum palustre	101.85 hrs 1.43 ha 18 visits	331.35 hrs 3.11 ha 27 visits	Control efforts have been very successful in removing the majority of the *Sphagnum* infestation on the Army side of the Kaala boardwalk; see photopoints below. This is reflected in the dramatic reduction in hours spent on *Sphagnum* control this year, although last year's numbers also included time spent on buffer surveys, which were not conducted this year. Likewise, the total amount of moss-killer used this year declined to 256 L from 460 L last year and 1,186 L in the first year of control (2012-2013). Volunteers conducted the majority of control efforts. While a few patches and small florets persist, they are so widely dispersed that this is no longer an effective project for volunteers, and staff will take over most treatment in the coming year. Unfortunately, staff did discover two new outlier ICAs this year. One is located on the transect trail, the other to the north of the FAA fence.
Rhodomyrtus tomentosa	98.00 hrs 56.93 ha 16 visits	111.70 hrs 25.58 ha 18 visits	*Rhodomyrtus*, a small tree with bird-dispersed fruit, is known from SBE and Pahole. At Pahole, only one plant was ever seen, in 2013 along the fence. Although short, the plant was mature; staff will monitor the site until 2023. The largest infestation is at SBE, where 99% of total *Rhodomyrtus* effort was spent. The *Rhodomyrtus* and *Schizachyrium* infestations overlap, and include large fields which are regularly mowed to facilitate training. This makes both taxa difficult to spot; mowed *Rhodomyrtus* can flower when they are less than a meter tall. Fortunately, staff can sweep for both taxa at the same time, which accounts for the dramatic increase in treatment area this year. In the largest ICA, *Rhodomyrtus* numbers have not declined over the past ten years, suggesting that more aggressive control is needed to reach eradication. Control efforts have been more successful at the other two ICAs. At one, only one immature was ever found, with no plants seen since 2013. This year, staff reduced *Rhodomyrtus* effort slightly, as it is a lower priority than *Schizachyrium*.
Ehrharta stipoides	50.55 hrs 2.97 ha 63 visits	49.15 hrs 1.97 ha 66 visits	This year, eradication was achieved at four ICAs in Pahole and one in Pahole No MU; all were located along the shared Pahole-Kahanahaiki ridge access trail. Previous trials suggest *E. stipoides* seeds do not persist longer than one year in soil. All 5 ICAs were monitored regularly for at least one to two years with no plants found before being declared extirpated. Frequent visits and a consistent observer were key to this success, as well as major declines in numbers of individuals found at 6 nearby ICAs in both Kahanahaiki and Pahole. Only one new ICA was identified this year, near the snail enclosure at Kahanahaiki. At Ekahanui and Huliwai, all three ICAs were monitored regularly and show declining numbers. At Kaluaa, no plants were found at the Hapapa ICA, but large numbers were found at the trail ICA, which expanded in area. Control at the four Ohikilolo ICAs continues to be challenging,

Taxa	2016 Control	2015 Control	Comments
			although regular quarterly visits and an increase in total effort (hours) have resulted in better coverage at three ICAs and declining numbers at two.
Melochia umbellata	45.00 hrs 35.56 ha 15 visits	66.50 hrs 33.56 ha 16 visits	This species, incipient to KTA, has been controlled by OANRP since 2002. It likely forms a persistent seed bank. Of the seven remaining ICAs, two have had no plants since 2011, and one has had no plants since 2013. The four remaining ICAs encompass the core of the infestation; numbers of plants found at each of these has steeply declined over the last 5 years, and may account for the decline in effort this year. Staff used aerial surveys to guide control efforts in the largest ICAs, and target control efforts around known hotspots and along roads. There are no known extant mature trees.

Top left: *Crocosmia* patch prior to treatment. Top right: Same patch four months post treatment. Bottom: Re-growth visible one year post treatment



Right: After six years of control, 07 November 2016



Left: *Sphagnum* at the beginning of control efforts, 20 June 2011

The fourteen MUs where most ICA effort was spent this report year are highlighted in the table below.

Table 4. 2017 ICA Effort in MUs

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
KTA No MU	6	*Acacia mangium* *Cenchrus setaceus* *Chromolaena odorata* *Melochia umbellata* *Miscanthus floridulus* *Senecio madagascariensis*	132	1015.75	39% of all ICA effort was spent at KTA this year. Overall effort increased by about 120 hrs over last year. KTA is a high priority for incipient control efforts because it is one of the most heavily used Ranges and hosts several ecosystem-altering weeds, including the largest population of *Chromolaena* in the State. *Chromolaena* control accounts for 94% of time spent at KTA. Hours recorded here do not include hours spent by OISC, which are included in Appendices 3-7 and 3-8. While all other ICA taxa require comparatively less effort, both *Melochia* and *A. mangium* infest large areas (35.6 ha and 82.7 ha, respectively) and have long-lived seeds. Numbers of both taxa continue to decline. Last year, *Rhodomyrtus tomentosa* was eradicated from the Range, as well as one of the two extant *Cenchrus* sites. A new *Senecio* site was found this year on the access road to KTA; this is the only known extant *Senecio* site on Army lands. Only 1 mature plant was ever found. The ICA was treated with pre-emergent herbicide, and no additional plants have been found thus far.
SBE No MU	8	*Cenchrus setaceus* *Chromolaena odorata* *Heterotheca grandiflora* *Rhodomyrtus tomentosa* *Schizachyrium condensatum* *Senecio madagascariensis* *Smilax bona-nox* *Vitex trifolia*	66	336.65	Located next to residential Wahiawa and heavily used for training, SBE is home to a diverse array of weeds not found on other Army lands. This year, 13% of all ICA effort was spent at SBE. Of this, 68% was spent on *Schizachyrium* and 29% was spent on *Rhodomyrtus*; both taxa are discussed in the table below. The one extant *Cenchrus* ICA was declared eradicated this year. No plants have been seen at the single *Senecio* ICA since 2008; this ICA will be declared eradicated in 2018 if no additional plants are found. No *Heterotheca* have been seen at any of the 3 ICAs since 2014-03, and much of the sand the plants were found in has been replaced. Staff will monitor these sites annually until 2024. Happily, no plants have been seen at the *Chromolaena* ICA since 2015-02, suggesting the infestation was removed before creating a seed bank. The *Smilax* ICA continues to persist, but has increased in area. While the plants do not appear to set seed, they can spread clonally. To eradicate this small ICA, staff may need to dig out roots, or use herbicides with better translocation. The two *Vitex* ICAs continue to be low priority, with few plants found this year
Kaala Army	8	*Anthoxanthum odoratum* *Crocosmia* x *crocosmiiflora* *Diplazium esculentum*	62	222.65	About 140 hrs less ICA effort was spent at Kaala Army this year compared to last year. This primarily was due to a reduction in effort on *Crocosmia* and *Sphagnum* ICAs due to reduced need. The bulk of effort (42%) was spent on 5 *Sphagnum* ICAs, including 2 new outliers, one on the transect trail and another north of the FAA exclosure. Diligent and detail-oriented volunteers have reduced *Sphagnum* levels in the core dramatically. Almost an equal amount of effort (40%) was spent controlling 6 *Juncus* ICAs. Four of these are outliers, with only a few plants ever seen.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Festuca arundinacea *Juncus effusus* *Pterolepis glomerata* *Setaria palmifolia* *Sphagnum palustre*			Since OARNP trials suggest *Juncus* seeds are very long-lived, these outliers may be monitored longer than 10 years to be sure they have been extirpated. *Juncus* continues to persist in moderate-low numbers at the larger 2 ICAs. Volunteers conduct much of the work on both *Juncus* and *Crocosmia*. There are 4 *Crocosmia* ICAs in the MU. Numbers continue to decline within the bog fence, but the other ICAs include dense banks of corms and will require more aggressive control. One of the most difficult species to detect is *Festuca* (4 ICAs). This grass may be well-established within the FAA fence; further surveys and discussion is needed to determine if further control is worthwhile. Staff continue to find low numbers of *Anthoxanthum* and *Diplazium* (1 ICA each), both of which have cryptic immatures. No plants were seen at either of the *Pterolepis* ICAs this year. While mature plants were found at both in the past, no plants have been seen at the boardwalk site since 2014 or the transect trail site since 2015. There is one old *Setaria* ICA along the spur fence. No plants have been seen since 2009, and barring future finds, hopefully can be declared eradicated in 2019.
Kaala NAR	5	*Crocosmia* x *crocosmiifolia* *Diplazium esculentum* *Juncus effusus* *Pterolepis glomerata* *Sphagnum palustre*	31	149.85	Almost 100 hrs less ICA effort was spent at Kaala NAR this year compared to last year. Last year, staff assisted NEPM with *Sphagnum* control on the State side of the boardwalk as part of a work swap. This work swap has not yet happened this year, and accounts for the drop in time. However, staff and volunteers did treat the *Sphagnum* ICA along the radio tower road; the moss spray is less effective at this infestation, as it is often submerged in water. Staff handpull it when possible and time treatment for dry conditions. The majority of effort (60%) was spent on the 3 *Crocosmia* ICAs. Staff and volunteers focused on plants along the forest edge, and saw a decline in numbers of plants found within the boardwalk fence. Work on 3 *Juncus* ICAs account for 29% of ICA effort. Again, volunteers performed much of this work. While the largest ICAs near the trailhead continue to persist at moderate numbers, no plants have been seen at the single outlier ICA since 2014. Staff continue to monitor the *Diplazium* ICA along the road and the *Pterolepis* ICA at the Kaala shelter. Both taxa are persistent and require regular monitoring.
SBW No MU	2	*Erythrina poepiggiana* *Chromolaena odorata*	30	140.50	*Chromolaena* control accounts for 93% of ICA efforts at SBW. There are 2 small, outlier ICAs and 2 large, densely infested ICAs. Regular efforts at the outlier ICAs were effective in keeping plant numbers low, although a patch of seedlings was found in an area that had been missed at one ICA. This highlighted the value of thorough sweeps to staff. Control efforts in the core continued to be a combination of ground and aerial treatment. Last year, 213 hrs were spent at this MU; the reduction is entirely due to fewer aerial sprays of *Chromolaena* needed. There are two *Erythrina* ICAs at SBW, an outlier, and a more established patch along Trimble road. The outlier contained an immature sapling, and no additional plants have been found since 2016-04. Staff began delimiting the Trimble road ICA.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Ohikilolo Lower	1	*Cenchrus setaceus*	11	120.16	Both ground control and aerial sprays were conducted at the *Cenchrus* infestation. Last year, 78.52 hrs were spent at this site; the increase is due to additional ground surveys. New hotpsots within the ICA were found during a valley-wide survey effort. While progress at the core is encouraging, cliff-dwelling plants continue to be challenging to reach with spray gear, timing sprays for optimal grass conditions is difficult (*Cenchrus* is most susceptible to herbicide when it is green, ie, soon after rain), and the continued spread of plants indicates more consistent visits are needed.
Kahanahaiki	11	*Acacia mearnsii* *Achyranthes aspera* *Angiopteris evecta* *Casuarina glauca* *Cenchrus setaceus* *Dicliptera chinensis* *Ehrharta stipoides* *Elephantopus mollis* *Pterolepis glomerata* *Setaria palmifolia* *Sphaeropteris cooperi*	58	99.45	Last year, ICA effort was limited to 3 taxa and 16.30 hrs. Efforts were renewed this year, with the full suite of ICAs receiving treatment. All 3 *Achyranthes* ICAs and 1 *Dicliptera* ICA were eradicated this year. Staff continued to make *Ehrharta* treatment a high priority. Although one new ICA was found near the Kahanahaiki Snail Enclosure, all 5 ICAs saw sharp declines in numbers of individuals, and may achieve eradication next year. Control has been effective at both *Elephantopus* ICAs, with no plants seen for more than a year. No plants have been seen at the *Pterolepis* ICA at the Chipper Site since 2012, when the ICA was buried by mulch. Staff hope any seeds were killed by the heat of the mulch. Staff found a new *Pterolepis* ICA on a ridge in Kahanahaiki II this year; control is on-going. Efforts resumed at both *Acacia* ICAs this year. No plants have been seen at the Schweppes site since 2014, but mature plants were found at the Black Wattle site. Staff plan regular annual sweeps to prevent this in future. For the first time, staff performed focused sweeps for both *Angiopteris* and *Sphaeropteris* in the main gulch, as opposed to treating plants opportunistically during other work. This resulted in more plants than ever controlled for both species. No plants were found at the Ethan's outlier *Angiopteris* ICA. Some control was done at the single *Casuarina* ICA, but rope work is needed to reach the remaining plants. A new *Setaria* ICA was found in Maile Flats; this grass likely was spread to the MU via contaminated staff or partner agency gear. OANRP asked collaborators to ensure gear was clean before entering the MU. Lastly, in August 2016, staff found an immature *Cenchrus* on the gulch fenceline. Bishop Museum confirmed it was a vegetative match for *Cenchrus*, but couldn't make a definitive identification given the lack of inflorescence. This discovery is discussed further in section 3.8.
Kapuna Upper	4	*Angiopteris evecta* *Ehrharta stipoides* *Rubus argutus* *Sphaeropteris cooperi*	18	93.25	ICA effort at Kapuna Upper doubled this year over last year; most of this is due to *Angiopteris*, which accounts for 96% of effort. Staff revised the *Angiopteris* ICA boundaries this year, expanding them to cover 20.9 ha (12.6 ha last year) and reshaping them to facilitate more streamlined, thorough surveys. Mature plants were found at only 2 of the 7 ICAs. Staff will continue to conduct annual surveys of all ICAs, which is sufficient to prevent the majority of plants from maturing. There are 2 *Rubus* ICAs, and no plants have been seen at either since 2010. One new *Sphaeropteris* site was discovered this year, adjacent to Subunit I. Additional delimiting surveys are needed at this site. Staff continue to find low numbers of plants are the other *Sphaeropteris* ICA in Subunit III. State staff lead *Ehrharta* control efforts.

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
Manuwai	4	*Caesalpinia decapetala* *Chromolaena odorata* *Dietes iridioides* *Pterolepis glomerata*	31	82.80	ICA effort more than doubled at Manuwai this year (from 33.21 hrs). While effort at all ICAs increased, the biggest change was at the largest *Pterolepis* ICA, on the ridge dividing Manuwai and Alaiheihe. This effort resulted in more thorough surveys conducted and a reduction in plants found. One new ICAs was found on the east fence this, for a total of 4 ICAs. At the smallest ICA, no plants have been seen since 2015-12. Given the persistence of *Pterolepis* seed, all ICAs will require years of management. This year, staff noted a decline in numbers of plants at the single *Dietes* ICA. No plants have been found at the lone *Caesalpinia* ICA since 2013. Unfortunately, staff discovered *Chromolaena* in 2017-02, likely spread via contaminated staff gear. While all three plants found were vegetative, one was large enough to have matured. Staff monitor the ICA quarterly and have begun delimiting surveys.
Palikea	4	*Crocosmia* x *crocosmiiflora* *Dicliptera chinensis* *Pterolepis glomerata* *Setaria palmifolia*	28	51.18	Effort spent at this MU increased by a third (from 39.25 hrs last year). The majority of time (85%) was spent on *Crocosmia* control and utilized volunteer labor. While plant numbers have declined dramatically since control began, in recent years they have plateaued at all 4 ICAs. This reflects the difficulty of removing each corm by hand. Foliar sprays may help push this taxon closer to eradication. There are 2 *Dicliptera* ICAs. No plants have been seen at the gulch ICA since 2009, and it will be monitored until 2019. Numbers of plants continued to decline at the slope ICA. One new *Pterolepis* site was discovered on the summit fence trail this year. Only one immature plant has been found at this location, suggesting there is no seed bank. One new *Setaria* ICA was discovered along the eastern fenceline, for a total of 4 *Setaria* ICAs. Two ICAs are approaching eradication, with no plants seen at one since 2013 and at the other since 2014. Heavy traffic across the MU due to expanded management may be a factor in new ICAs at Palikea; the importance of sanitation has been reiterated to staff and partners.
Ohikilolo	4	*Ehrharta stipoides* *Fraxinus uhdei* *Pterolepis glomerata* *Rubus argutus*	32	38.95	Last year, a range closure of MMR limited staff access to Ohikilolo. This year, staff were able to almost double ICA effort. 50% of this time was spent on *Ehrharta* control. While 1 of the 4 ICAs was not monitored due to its remote location, quarterly surveys of the other 3 were effective in achieving more thorough coverage than ever before. The single ICA of *Fraxinus* was declared eradicated. While no new *Pterolepis* sites were discovered, plants are consistently found at both ICAs, suggesting seed banks exist at both sites. Plants also continue to persist at all 3 *Rubus* ICAs. More consistent monitoring and use of more aggressive control techniques are needed for this taxon.
Kaluaa and Waieli	5	*Angiopteris evecta* *Casuarina equisetifolia* *Dovyalis hebecarpa*	10	24	ICA effort at Kaluaa increased slightly from last year, but fortunately, there are relatively few ICA in this large MU. No plants have been seen at the *Casuarina* ICA since 2014, and none have been seen at the *Dovyalis* ICA since 2013. These sites will be monitored annually until 2023/24. There are 2 *Ehrharta* ICAs. No plants have been seen at the Hapapa ICA since 2015-02. If no plants are seen by the end of 2017, it will be considered eradicated. Unfortunately, the ridge trail

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Ehrharta stipoides			ICA expanded, and will require additional surveys. Staff continue to find low numbers of plants at the *Solanum* ICA; annual surveys appear to be sufficient at this site. Almost half the ICA effort at Kaluaa was for *Angiopteris* (2 ICAs). At the steps ICA, only 1 immature has ever been found. At the large south gulch ICA, no mature plants have been found since 2007 and annual surveys are sufficient to control immatures before they produce spores.
		Solanum capsicoides			
Pahole	10	*Angiopteris evecta*	37	22.95	ICA effort did not change much from last year. Most of the ICAs at Pahole, with the exception of those for *Angiopteris* and *Dicliptera*, are found along the Makua/Pahole fenceline. This year, consistent effort on *Ehrharta* paid off, with 3 of 4 ICAs deemed eradicated. The remaining ICA (at the Pahole Snail Enclosure) will require at least another year of monitoring. The *Rubus* ICA was eradicated this year, with no plants seen since 2004. Both the *Dicliptera* and *Rhodomyrtus* ICAs are on the path to eradication, with no plants seen since 2013. More thorough surveys are needed at the *Tecoma* ICA; although no plants have been seen since 2013, part of the ICA is difficult to survey due to thick vegetation. Plants are regularly seen at both the *Axonopus* and *Pterolepis* ICAs; more consistent checks are needed at both sites. Two new ICAs were found along the Pahole/Kahanahaiki trail this year: 1 immature *Elephantopus* and 1 immature *Setaria*. In addition, a new *Angiopteris* ICA was identified in the gulch, for a total of 5 *Angiopteris* ICAs. While numbers of *Angiopteris* remain low, the wide distribution of ICA sites is suggests additional plants may be present elsewhere in the valley. Staff will continue to control and track *Angiopteris* wherever it is found.
		Axonopus compressus			
		Dicliptera chinensis			
		Ehrharta stipoides			
		Elephantopus mollis			
		Pterolepis glomerata			
		Rhodomyrtus tomentosa			
		Rubus argutus			
		Setaria palmifolia			
		Tecoma capensis			
Kaleleiki	1	*Chromolaena odorata*	4	22.00	*Chromolaena* was discovered at the small *Eugenia koolauensis* fence in 2016-09. Only small numbers of plants have been found. This site is a high priority for control.

Weed Control Areas

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

Table 5. Summary Statistics for WCAs

Report Year	Visits	Effort (hours)	Area (ha)
2016-2017	727	6,736	126.6
2015-2016	713	5,995	151.3
2014-2015 (9 months)	352	3,117	80.4
2013-2014	526	5,846	90
2012-2013	532	5,620	83.4
2011-2012	443	4,199	57
2010-2011	409	5,123	
2009-2010	353	3,256	
2008-2009	267	2,652	

This year, WCA efforts covered 126.6 ha. Staff spent 6,736 hours over 727 visits at 183 WCAs. WCA work accounted for 21% of the total area controlled and 72% of total effort. Much WCA control involves intensively working in small areas around rare taxa locations, and thus requires higher inputs of time per acre than for ICA management. The table above compares this report year's efforts to previous report years. The 2015-2016 reporting period covered only nine months, but all other reporting periods cover twelve months each. Area data from 2008 through 2011 was not collected as accurately as current practices and is not presented for comparison.

Table 6. Changes in Area Weeded between Report Year 2017 and 2016

IP Management Unit	Increase in Area (ha)	IP Management Unit	Decrease in Area (ha)
Kaala Army	+5.78	Makaha I	-15.77
Ekahanui	+3.97	Poamoho North	-6.32
Ohikilolo	+3.40	Makaha II	-6.05
Pahole	+2.13	Kahanahaiki	-3.72
Koloa	+2.02	Palikea	-3.28
		Makaha No MU	-2.81
		Kaena	-2.52
		Kaluaa and Waieli	-2.03

While overall area weeded decreased from last year, area weeded increased at 31 MUs and decreased at 24 MUs. Changes of 2 ha or more are summarized in Table 6. Most of the decrease is due to reductions in targeted canopy or single-species sweeps; this includes Makaha I and II, Kahanahaiki, Palikea, and Kaluaa and Waieli. Last year, all of Makaha I and II and Kahanahaiki were swept for *Grevillea robusta*. Similarly, selective thinning of *Morella faya* and *Cryptomeria japonica* occurred at Palikea. These actions do not need to be repeated annually. Staff continue to conduct canopy weed sweeps in new areas of Kaluaa and Waieli. The reductions in area seen at Poamoho North and Makaha No MU are due to infrequent events that occurred last year: assisting with State aerial sprays of *Angiopteris evecta* at Poamoho, and clearing the Makaha road. The Kaena MU contains one IP taxa and extensive weeding in the past has improved habitat; it was not a high priority this year. At the MUs which had large increases in area weeded, field teams prioritized work at Ekahanui, Ohikilolo, and Pahole. Increases at Kaala Army and Koloa are due to single-species sweeps by the Ecosystem Restoration (EcoRest) team.

Table 7. Changes in Weeding Effort between Report Year 2017 and 2016

IP Management Unit	Increase in Effort (hrs)	IP Management Unit	Decrease in Effort (hrs)
Kaala Army	+194.2	Kaluaa and Waieli	-174.0
Pahole	+184.75	SBW No MU	-151.9
Ekahanui	+167.0	Ohikilolo Lower	-56.5
Makaha I	+146.25	Manuwai	-55.25
Kahanahaiki	+125.6	Makaleha West	-51.75
Ohikilolo	+91.85	Makaha No MU	-49.0
Palikea	+56.25	Poamoho No MU	-41.0
Pualii North	+54.25	Waimea No MU	-40.0
Koloa	+50.5	Koko Crater No MU	-34.5
Kapuna Upper	+43.8	Opaeula Lower	-34.0
Makaha II	+43.7	Kamaili	-34.0
Kaluakauila	+43.0		
Keaau Hibiscus	+41.0		

Total effort spent weeding again increased this year. Effort increased at 32 MUs, but decreased at 24 MUs. Changes of 30 person hours or more are summarized in Table 7. At many of the MUs, the increase in effort is due to a renewed emphasis on weed control by field teams. This includes Pahole, Ekahanui, Kahanahaiki, Ohikilolo, Koloa, Kapuna Upper, Keaau Hibiscus, and Kaluakauila. At Ekahanui, efforts were boosted by an extensive trail clearing project to facilitate rodent control. Ohikilolo was closed by Range Control for part of last year; regaining access allowed staff to resume more management. Restoration projects contributed to the increases in effort at Kahanahaiki and Makaha I. High-priority target sweeps conducted by the EcoRest team contributed to much of the increase at Kaala Army and Koloa. Efforts expanded at Makaha II to include new rare plant reintroductions. Increased effort at Pualii North is due primarily to volunteer work in the gulch. At Palikea, huge amounts of effort were spent clearing weeds for a new snail enclosure. As a result, effort in other parts of Palikea declined, although there was a net gain. At the MUs which had a decrease in effort, some of this was due to decreased field team staffing or a decreased emphasis on the MU; this includes Kamaili, Opaeula Lower, Makaleha West, and Kaluaa and Waieli. In addition, there was a slight decrease in volunteer effort at Makaleha West, and a large volunteer decrease at Kaluaa and Waieli. At Manuwai, much of the decrease is due to less time spent on targeted canopy sweeps this year. At Ohikilolo Lower, the decrease suggests good news; a range closure last year severely limited access to the MU, and staff spent a lot of effort reestablishing fuel reduction zones. Less maintenance was required this year. Work at Waimea and Koko Crater is focused on rare plant living collections, and occurs only as necessary. Lastly, decreased effort at SBW No MU (West Base volunteer garden weeding), Makaha No MU (road clearing) and Poamoho No MU (State lead road-clearing) are due to one-time events which occurred last year.

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

Native plant recovery at the Palikea 'Banyan Bowl' site

The twenty MUs where the most effort was spent this reporting year are summarized in Table 8. Most of these MUs are large, host multiple rare IP taxa, contain large swaths of native forest, and are readily accessible; these include Kahanahaiki, Palikea, Kaala Army, Makaha I, Kaluaa and Waieli, Pahole, Ohikilolo, Lihue, Ekahanui, Manuwai, and Kapuna Upper. Koloa would fall in this group, but is more difficult to access due to its location in the northern Koolaus. Several of other MUs in the table are significantly smaller, but support several IP taxa and include patches of native forest; these include Makaha II, Makaleha West, Pualii North, Kaluakauila, and Opaeula Lower. Two MUs on the list are located in severely degraded habitat and host one or two IP taxa. Ohikilolo Lower is completely dominated by alien grasses. Maintaining the fuel reduction areas around the rare taxa is a high priority and requires consistent, large inputs of time. Similar habitat is found in Keaau Hibiscus. While there are no plans to create Ohikilolo Lower style fuel breaks here, this grass habitat requires regular maintenance. Lastly, Pahole No MU includes all weed maintenance along the Pahole Road and around the Nike greenhouse and LZ. Weed maintenance at the Nike Site helps to minimize the risk of accidental weed dispersal via staff activity. Roadside maintenance is required of OANRP by the State.

All MUs are managed by an assigned field team which is responsible for the bulk of weed control efforts, particularly any weed control at rare taxa sites. Other factors which contribute to overall effort in an MU include: targeted canopy or single species sweeps not focused around IP taxa (carried out by the assigned field team or roaming EcoRest team), active volunteer projects (led by the Outreach team), and active restoration projects incorporating aggressive weed control coupled with native taxa restoration (often

implemented by the EcoRest team). These three factors are included in the table below, and provide some insight into the levels of effort spent various MUs. Team weeding efforts at Kahanahaiki, for example, are bolstered by targeted sweeps for two priority weeds, volunteer work at two different sites, and four separate restoration projects. In contrast, management of Makaha II this year focused solely on rare taxa sites and was carried out by the field team.

Table 8. Top Twenty MUs with Highest WCA Control Effort

IP Management Unit	Effort (person hours)	# Visits	Area Weeded (ha)	Targeted Canopy or Single Taxa Sweeps Conducted?	Volunteer Projects Present?	Restoration Project On-going?
Kahanahaiki	1,232.13	124	6.35	Yes (*Montanoa hibiscifolia, Triumfetta semitriloba*)	Yes	Yes
Palikea	995.65	83	2.85	No	Yes	Yes
Kaala Army	614.85	51	20.73	Yes (*Hedychium gardnerianum, Psidium cattleianum, Toona ciliata*)	Yes	No
Makaha I	451.50	38	1.25	No	Yes	Yes
Kaluaa and Waieli	376.50	48	13.08	Yes (*Aleurites moluccana, Grevillea robusta, Spathodea campanulata, Toona ciliata, Trema orientalis*)	Yes	No
Pahole	344.75	40	4.79	No	No	No
Ohikilolo Lower	327.50	35	3.84	No	No	Yes
Ohikilolo	244.00	24	4.39	No	No	No
Lihue	230.55	32	10.50	No	No	No
Ekahanui	223.25	35	4.77	No	No	No
Makaha II	189.70	18	0.59	No	No	No
Makaleha West	186.25	16	0.64	No	Yes	No
Manuwai	185.00	24	13.43	Yes (*Coffea arabica, Grevillea robusta, Leucaena leucocephala, Psidium cattleianum, Schefflera actinophylla, Spathodea campanulata, Syzigium cumini, Toona ciliata, Trema orientalis*)	No	No
Kapuna Upper	157.50	19	1.23	No	No	No
Pualii North	117.75	14	1.53	No	Yes	No
Kaluakauila	76.00	16	2.01	No	No	No
Opaeula Lower	67.75	10	0.50	No	No	No
Keaau Hibiscus	61.00	6	0.21	No	No	No
Koloa	59.50	5	2.15	Yes (*Psidium cattleianum, Angiopteris evecta*)	No	No
Pahole No MU	47.00	7	8.05	No	No	No

Control efforts for all MU are summarized in Table 9. The table lists all MUs where WCA control was conducted in the past year. Data from the 2016 report is included for reference. This year's data is shaded and in bold. For each year, the total actual area weeded is reported; for example, if a one acre rare plant site 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). While these statistics are not a replacement for vegetation monitoring, they detail the investment OANRP has made over the years.

Table 9. MU WCA Weed Control Summary, Report Years 2017 and 2016

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Alaiheihe No MU	N/A	9.99	**3.72**	**2**	**6.00**	9.99	1	8.50	This area includes the Lower Kaala NAR access road. Staff sprayed roadside weeds, focusing on *Urochloa maxima* and *Caesalpinia decapetala*. Due to the poor condition of the road, only the portion closest to Manuwai was sprayed.
Ekahanui	87.5	91.66	**4.77**	**35**	**223.25**	0.80	13	56.25	Control efforts were split almost equally between clearing trails to facilitate rat control, and weeding around rare species sites, particularly reintroduction zones.
Ekahanui No MU	N/A	10.09	**0.01** ***(133 m²)***	**1**	**1.15**	0	0	0	While monitoring a Genetic Storage *Delissea waianaensis* site, staff also conducted weed control.
Haili to Kealia I	7.91	0.75	**0.10**	**4**	**22.50**	0.05 *(518 m²)*	3	21.00	Weed control targeted woody weeds and grasses around the *Hibiscus brackenridgii* subsp *mokuleianus* reintroduction along the Kealia trail.
Haili to Kealia No MU	N/A	3.37	**2.50**	**2**	**11.00**	0.43	1	1.00	This area encompasses the Kuaokala access road. Staff scoped a *Sphaeropteris cooperii* hotspot along the road; no plants were found. The crew also cleared fallen trees off the road in August 2016.
Helemano	60.63	61.86	**0.37**	**7**	**12.50**	0.21	1	2.00	Helemano is a low priority MU due to the small number of Tier 1 taxa, and is challenging to access due to weather. Staff monitored for *Setaria palmifolia* (a highly invasive grass that spreads easily along trails) along the fenceline, but none was found.
Huliwai	0.12	0.20	**0.12**	**3**	**6.00**	0	0	0	This small MU is centered at an *Abutilon sandwicensis* population. Weed control was targeted directly around the rare plants.
Huliwai No MU	N/A	9.44	**0.08** ***(801 m²)***	**1**	**3**	0.02 *(151 m²)*	1	6.00	While monitoring a *Cenchrus agrimonioides* var. *agrimonioides* site, staff also conducted weed control around it.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaala Army	49.02	51.53	**20.73**	**51**	**614.85**	14.94	47	420.66	*Hedychium gardnerianum* continues to be the primary weed target at Kaala, along with *Psidium cattleianum*. This year, the majority of area swept (79% of MU total) and effort (53%) were spent in Kaala-01, the largest WCA. Most of the remaining effort and area swept was in Kaala-05, on the eastern slopes. The remainder of weeding effort focused around rare taxa sites and reintroductions.
Kaala NAR	20.03	11.19	**0.01** ***(69 m²)***	**1**	**0.50**	0.70	3	4.00	Last year, staff assisted NEPM in multi-species sweeps across part of the bog. This year, efforts were limited to mowing and maintenance around the shelter/campsite area.
Kaena	10.06	3.28	**0.02** ***(190 m²)***	**3**	**11.50**	2.54	3	30	The vegetation matrix at Kaena appears to be relatively stable and requires little effort to maintain. Last year, staff swept across most of the WCAs. Efforts this year focused on the far western *Euphorbia celastroides* var. *kaenana* site, as well as the site within the exclosure.
Kaena East of Alau	14.51	0.89	**0.17**	**4**	**23.75**	0.89	4	39	Weed control efforts this year focused directly around the small *Euphorbia celastroides* var. *kaenana* site. Last year, additional time was spent on reducing fuels in the surrounding area.
Kahanahaiki	37.7	42.04	**6.35**	**124**	**1232.13**	10.07	125	1,106.5	Effort spent weeding again increased at this MU. This is due to continued emphasis on intensive restoration sites. 37% of effort was spent on three restoration sites in the gulch. 42% was spent on projects in Maile Flats, large grass sprays and follow-up control at the chipper site. Other weeding focused around rare taxa sites. No sweeps for *Grevillea robusta* were conducted this year, which accounts for the large drop in area treated.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaleleiki	0.12	0.80	**0.14**	**1**	**9.00**	0	0	0	This *E. koolauensis* population has been heavily impacted by the *Puccinia* rust. Staff swept the entire enclosure once, targeting woody weeds and *Urochloa maxima*. Weed control efforts are a low priority until new options for *Eugenia* management are discovered.
Kaluaa and Waieli	80.97	83.00	**13.10**	**48**	**376.50**	15.11	56	550.5	This year, targeted canopy sweeps using IPA continued across the MU, and account for much of the area treated. Staff continued to focus other weed control efforts around rare taxa sites, reintroductions, and the Hapapa Snail Enclosure.
Kaluaa No MU	N/A	14.23	**0.32**	**5**	**12.50**	2.26	5	30	Staff effort outside the MU is limited to trail, road, parking site and LZ maintenance, as well as management in a small TNC exclosure home to several rare taxa. This year, no work along the access road was required.
Kaluakauila	42.73	11.36	**2.01**	**16**	**76.00**	1.14	6	33	Staff expanded efforts from last year, focusing on grass control across the WCAs, general habitat sweeps, and weeding at reintroduction sites. Staff also controlled grass along the fence.
Kamaileunu No MU	N/A	0.96	**0.04** ***(428 m²)***	**1**	**7.00**	0.06 *(643 m²)*	2	6	All control was conducted at the LZ and campsite. In particular, the LZ requires regular maintenance as it quickly becomes overgrown.
Kamaili	2.57	3.92	**0.85**	**4**	**38.00**	0.71	12	72	This MU is divided into mauka and makai fences. Native dominated ridges were swept in the mauka fence, while weed control focused on rare taxa reintroductions in the makai one. Fence vegetation maintenance was conducted at both.
Kapuna Upper	172.35	179.20	**1.23**	**19**	**157.50**	2.59	21	113.7	Both this year and last year, control efforts were focused around wild and reintroduced rare taxa. In addition, weeds were removed from select portions of the fence.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaunala	1.98	2.24	**0**	**0**	**0**	0	0	0	Until effective techniques to combat *Puccinia* rust in the field are found, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Kawainui No MU	N/A	38.36	**0**	**0**	**0**	0.08 *(823 m²)*	1	0.5	Last year, staff opportunistically controlled *Leptospermum scoparium* on the summit trail. There is a large infestation of *L. scoparium* in the northern Kooalu mountains, although it is not established in Koloa.
Keaau Hibiscus	3.64	3.67	**0.21**	**6**	**61.00**	0.04 *(362 m²)*	1	20	All weeding effort focused around wild and reintroduced *H. brackenridgei*. Both herbaceous weeds and grasses were controlled as a priority. Future weeding will be conducted in concert with restoration plantings.
Koko Crater No MU	N/A	1.85	**0.90**	**1**	**9.00**	0.23	3	43.5	Weed control was conducted around rare plant living collections at Koko Crater Botanical Garden.
Koloa	71.54	73.16	**2.15**	**5**	**59.50**	0.12	1	9	Located at the summit of the Koolau Mountains, weather poses a major challenge to conducting effective weed control. This year, staff conducted several sweeps targeting *Psidium cattleianum*, which accounts for the majority of effort and area. In addition, staff also maintained weeds at a rare plant reintroduction site.
Lihue	711.92	714.91	**10.50**	**32**	**230.55**	12.14	35	227.75	This year, trail clearing and fenceline maintenance accounted for 68% of effort and 89% of area treated in the MU. Other effort focused around wild and reintroduced rare taxa sites, in particular reintroductions of *Gardenia mannii*, *Hesperomannia oahuensis*, and *Stenogyne kanehoana*.

Management Unit	MU area (ha)	Total WCA area (ha)	2017 Report Year			2016 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaha I	34.2	35.59	**1.25**	**38**	**451.50**	17.02	38	305.25	Last year, most of Makaha I was swept for *G. robusta*, and select gulches were swept for *Toona ciliata*; this accounts for the large area weeded. This year, efforts focused on wild and reintroduced rare taxa sites, as well as restoration projects. The increase in effort is primarily due to clearing and maintenance of two restoration sites on Camp Ridge. Volunteers continue to contribute greatly to *Coffea arabica* removal on Flag City Ridge.
Makaha II	26.69	6.85	**0.59**	**18**	**189.70**	6.64	23	146	Last year, all of Makaha II was swept for *G. robusta*, which accounts for the large area weeded. This year, efforts focused primarily around wild and reintroduced rare taxa sites. Efforts expanded to include several brand new reintroductions. In addition, some fenceline maintenance was performed.
Makaha No MU	N/A	16.65	**0**	**0**	**0**	2.81	3	49	Last year, staff cleared grass off the BWS access road.
Makaleha Central No MU	N/A	0.1	**0**	**0**	**0**	0.01 *(144 m²)*	1	5	Last year, staff weeded while monitoring a *Kadua degeneri* subsp. *degeneri* site. This MFS site is not within an MU, and is not a high priority for weed control at this time.
Makaleha East	111.99	3.59	**0.01 (133 *m²*)**	**1**	**0.60**	0	0	0	Staff controlled high priority weeds *Angiopteris evecta* and *Ehrharta stipoides* opportunistically while monitoring rare taxa.
Makaleha East West Branch	1.14	1.23	**0.00 (28 *m²*)**	**1**	**1.00**	0	0	0	Some weed control was conducted around *K. degneri* this year. In future, staff will work to incorporate weed control into the schedule while monitoring this rare taxa site.

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			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaleha West	38.04	1.50	**0.64**	**16**	**186.25**	0.59	20	238	This MU has two widely separated WCAs. No control was conducted at the northern WCA this year. At the 3-Points WCA, staff focused around rare taxa locations and on grass control, while volunteers focused on the fenceline and in a patch of *Psidium cattleianum*. The reduction in effort does not mean that less weed control is needed here, but that the team prioritized other MUs for extra effort this year.
Makaleha West No MU	N/A	0.52	**0.11**	**2**	**7.00**	0.17	2	1	Staff performed weed control as needed to maintain the access trail.
Manuwai	122.49	127.44	**13.43**	**24**	**185.00**	11.74	30	239.25	Effort at Manuwai was split equally between large landscape sweeps for canopy weeds and focused control around rare taxa sites, particularly those in the northwestern corner of the MU (42% each). Fenceline maintenance accounts for the remaining effort. Landscape sweeps account for most of the area treated.
Manuwai No MU	N/A	4.17	**3.90**	**5**	**25.00**	2.65	6	34.5	Staff cleared vegetation, primarily *Urochloa maxima*, along the western road and trail to facilitate access.
MMR No MU	N/A	19.49	**1.03**	**4**	**35.00**	1.8	4	32.5	This year, the majority of time was spent maintaining grasses along the Makua-Kuaokala fenceline. Staff also did some fenceline maintenance along the east rim of Makua. The *H. brackenridgei* living collection at Makua Range Control is not thriving, and staff spent minimal effort controlling weeds across it.
Moanalua No MU	N/A	86.33	**0.37**	**1**	**15.00**	0	0	0	Staff cleared trails in Moanalua to facilitate rodent control and elepaio monitoring.

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Nanakuli No MU	N/A	5.35	**2.16**	**2**	**32.00**	0.49	2	2.5	This leeward facing bowl stretches between the Palikea and Palikea IV MUs. Staff swept it for *Sphaeropteris cooperi* and *Angiopteris evecta*; both ferns are a priority to keep out of the MUs.
Napepeiaoolelo	0.75	0.48	**0.13**	**2**	**5.00**	0.07 *(724 m²)*	1	4	The *Hesperomannia oahuensis* protected by this fence has been dead since 2013. Staff continue to monitor and maintain the fenceline.
Ohikilolo	232.79	138.41	**4.39**	**24**	**244.00**	0.99	19	152.15	In the Lower Makua portion of the MU (31% of effort), staff weeded around rare taxa sites, but most effort was dedicated to sweeps of native-forest dominated ridges. In the Ohikilolo Ridge portion of the MU (69% of effort), staff focused efforts in native forest patches and rare taxa sites, and also performed grass control. Last year, MMR was closed for part of the year due to a safety incident, limiting weed control effort.
Ohikilolo Lower	28.75	4.54	**3.84**	**35**	**327.50**	3.72	27	382	The 3 WCAs surrounding rare taxa were completely swept multiple times this year. Effort decreased from last year, major clearing was needed to open the WCAs after a range closure. Outplantings of common native species are surviving, and hopefully will reduce weed control effort required in future.
Oio	1.33	1.39	**0**	**0**	**0**	0	0	0	Until effective techniques to combat *Puccinia* rust in the field are found, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Opaeula	50.93	50.42	**0.01 *(61 m²)***	**1**	**6**	0	0	0	This MU hosts primarily Tier 2 taxa, and thus is a low priority for weed control. Staff weeded around a new reintroduction of *Labordia cyrtandrae* this year.

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Opaeula Lower	10.15	6.80	**0.50**	**10**	**67.75**	0.9	8	101.75	Effort decreased this year. The field team has some staffing shortages, and since this MU has few IP rare taxa, it was deemed a lower priority than other areas. Staff weeding efforts focused around wild and reintroduced rare taxa sites, understory control in native forest patches, sweeps for *A. evecta*, and fenceline maintenance.
Pahipahialua	0.6	0.80	**0**	**0**	**0**	0	0	0	Until an effective strategy to combat *Puccinia* rust is created, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites.
Pahole	88.02	32.46	**4.79**	**40**	**344.75**	2.67	29	160	This year's large increases in effort and area treated cannot be attributed to one specific project, but represent an across the board improvement at almost all WCAs. Efforts continue to focus on rare taxa sites and surrounding habitat, and along the Kahanahaiki-Pahole ridge access trail.
Pahole No MU	N/A	13.00	**8.05**	**7**	**47.00**	6.61	11	57.25	Staff continues to control weeds along the Pahole road, around the Nike greenhouse and LZ, and on the access trail to the main gulch.
Palawai No MU	N/A	4.76	**0.02** ***(187 m²)***	**2**	**4.25**	0.48	4	13	This area immediately abuts the Palikea MU. This year, staff cleared vegetation to create a new LZ just below the fence. In previous years, control efforts here targeted *Sphaeropteris cooperi*. This project was not a priority this year, due to work on a new snail enclosure.

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Palikea	9.95	11.47	**2.85**	**83**	**995.65**	6.13	103	939.4	Work on the new Palikea North Snail Enclosure began in earnest this year. Clearing for the new snail enclosure accounts for 45% (450.5 hrs) of MU effort. As a result, weeding effort dropped at several of the other WCAs, although volunteer efforts and restoration projects led by the 'EcoRest' team contributed to an increase at some WCAs. Staff also continued to weed around rare taxa sites. Last year, large sweeps targeting gradual removal of *Morella faya* and *Cryptomeria japonica* were conducted; they account for the large area treated.
Poamoho No MU	N/A	119.78	**0**	**0**	**0**	1.38	3	41	Last year, OANRP participated in a State-led interagency road clearing effort at Poamoho.
Poamoho North	257.77	202.77	**3.99**	**3**	**192**	6.32	1	15	Last year, staff assisted NEPM with aerial spraying of *A. evecta*. One planned spray trip this year was cancelled due to weather. As resources allow, OANRP will continue to support this project. This MU is of moderate priority, as it contains few MFS IP taxa and is actively managed by two other agencies. OANRP assisted on one weed control camp trip this year; the high effort is due to partner collaboration.
Puaakanoa	10.7	1.07	**0.21**	**3**	**17.00**	0	0	0	Weed control efforts were hampered by the closure of MMR last year. Staff were able to resume management this year, and focused on grass and herbaceous weed control around *C. celastroides* sites.
Pualii North	7.99	10.98	**1.53**	**14**	**117.75**	0.66	10	63.5	This year, staff weeded at wild and reintroduced rare taxa sites, around native forest patches, and along the fenceline. Most of the increase in effort from last year is due to volunteer work in the lower part of the gulch. This gulch area contains patches of native forest, but few rare taxa.

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SBE No MU	N/A	4.16	**0.06** ***(602 m²)***	**2**	**5.00**	0.09 *(901 m²)*	3	3	Weeds were cleared at the sediment disposal site, to keep it open for future use by DPW.
SBW No MU	N/A	2.61	**1.33**	**10**	**14.50**	0.84	15	166.45	This year, staff began controlling weeds at the Kahua Living Collection site; this accounts for the increase in area weeded. Staff continue to regularly maintain weeds at West Base to reduce the potential for staff to act as vectors. Last year's effort was high due to 142 hours of volunteer effort in the West Base interpretive garden.
Waianae Kai	3.66	1.14	**0.06** ***(580 m²)***	**2**	**2.50**	0	0	0	Staff conducted limited weed control in this small MU, focusing around rare taxa sites and along fencelines.
Waimanalo to Kaaikukai No MU	N/A	2.35	**0.98**	**2**	**2.50**	0.83	1	3	This area encompasses the Palikea access trail. Staff controlled alien grasses along the trail to reduce the potential for weed spread.
Waimea No MU	N/A	0.37	**0**	**0**	**0**	0.34	4	40	Last year, weed control was conducted around living collections of *Nototrichium humile* at Waimea Valley botanical garden. Staff conduct weed management as needed.
TOTAL	N/A	2,528.5	**126.64**	**727**	**6,735.9**	151.3	713	5,995	Total effort and visits increased, while area treated decreased from last year. The decrease in area can be attributed to fewer single-species targeted sweeps, while the increase in effort can be attributed to a combination of more restoration projects and greater priority given to weed control projects by field teams.

3.2 INTER-AGENCY INVASIVE PLANT COLLABORATION

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

- Oahu Invasive Species Committee (OISC). OANRP serves on the OISC steering committee and the OANRP Ecosystem Restoration Program Manager recently completed two years as the OISC Chair. In the past year, joint projects have included *Cenchrus setaceus* and *Chromolaena odorata* control efforts. In addition, OARNP facilitated OISC access to SBE for *Miconia calvescens* surveys and SBW for Rapid Ohia Death early detection surveys.
- Bishop Museum. Plant samples were submitted to and identified by the Bishop Museum Herbarium staff. Noteworthy finds are discussed in section 3.5.
- College of Tropical Agriculture and Human Resources (CTAHR). OANRP continues to collaborate with Dr. James Leary on research into novel weed control techniques, in particular, Incision Point Application (IPA) and Herbicide Ballistic Technology (HBT). For a complete description of IPA and HBT, and a history of these projects, please see the 2009–2014 and 2016 MIP and OIP Status Reports. This year, staff installed two new IPA trials on *Citharexylum caudatum* and *Psidium cattleianum* var. *lucidum*. These trials are designed to run for two years. A previous trial on *C. caudatum* was unsuccessful, and the new trial tests a higher rate of herbicide per basal diameter. This is the first OANRP trial for *P. cattleianum* var. *lucidum*; this variety is prevalent in certain MUs, has yellow-fruit, and tends to form large trunked trees as opposed to trees with a cluster of small trunks. In the coming year, staff hope to install additional trials on *Syzygium cumini* and very large *Grevillea robusta*.

Psidium cattleianum var. *lucidum* tagged for IPA trial

- State of Hawaii, Dept. of Land and Natural Resources (DLNR), Natural Area Reserve System (NARS), Forest Reserves (FS), and Native Ecosystems Protection and Management (NEPM). OANRP staff continue to collaborate with NEPM on discoveries of new invasive weed sites and management actions. This year, OANRP assisted NEPM with disposal of contaminated media.
- Dr. Cliff Morden, University of Hawaii. Dr. Morden provided genetic analysis of an unknown Melastomaceae found in the OANRP greenhouse; see Section 3.6.
- Board of Water Supply (BWS). BWS reviews OANRP weed control actions in Makaha Valley.
- Koolau Mountains Watershed Partnership (KMWP). OANRP is a member of the partnership. The EcoRest Team joins one KMWP camp trip per year, targeting priority weeds in Poamoho.
- Puu Ohulehule Conservancy. Staff share and discuss weed control and restoration techniques with the Conservancy.
- Waianae Mountains Watershed Partnership (WMWP). OANRP is a member of the partnership.
- Waimea Valley. OANRP manages two rare taxa living collection sites at Waimea.
- Coordinating Group on Alien Pest Species (CGAPS). The Federal Biologist participates in the CGAPs working groups on mosquitoes and coconut rhinoceros beetle.

OANRP participates in Priority Oahu Native Ecosystems (ONE, formerly the Oahu Weed Working Group) meetings organized by NEPM. As part of a Priority ONE subcommittee, OANRP helped to plan the fourth Oahu Weed Workshop, hosted by Waimea Valley. OANRP staff also presented at the workshop. Both the workshop and Priority ONE meetings provide a valuable way to share information, data, and control techniques among local agencies conducting active weed control management work. OANRP staff also attended the Hawaii Conservation Conference, held in Honolulu, July 2016.

Sharing new gear at the Tool Tailgate at the Oahu Weed Workshop

3.3 VEGETATION MONITORING

This year, vegetation monitoring was conducted and analyzed for the Ohikilolo (Upper) MU (Appendix 3-9), Palikea *Morella faya* Incision Point Application trial (Appendix 3-10), and Makaha 'Giant Ohia' Restoration Area (Appendix 3-11). The results of these studies will be used to modify weed control plans at these MUs. Vegetation monitoring was also conducted across the Palikea MU and at the North Palikea Snail Enclosure; results will be analyzed and presented next year. In the coming year, staff plan to conduct belt transect monitoring at Kapuna Upper and Kahanahaiki MUs, as well as continue on-going monitoring of the Makaha Giant Ohia site, the Palikea *M. faya* trial, and the North Palikea Snail Enclosure.

3.4 INVASIVE SPECIES SPREAD PREVENTION ON ARMY TRAINING RANGES

The Army's potential to move weeds from one training area to another has been amply demonstrated. This year, OANRP continued to coordinate with Range Division, DPW, and contractors to increase the Army's awareness of alien weed threats and improve sanitation-related protocols, practices, and policies.

Soldier Training

- OANRP and the Federal Natural Resource Manager updated the Officer in Charge/Range Safety Officer (OIC/RSO) brief this year. The OICs and RSOs for each unit are required to attend this brief before they can schedule or conduct any training on Army lands. This is the most direct way for staff to highlight natural resources concerns to soldiers, particularly the need to clean vehicles and gear and report fires.
- The Natural Resources Office hosted high level unit commanders at the OANRP baseyard to provide an overview of environmental concerns/topics. One of the stations during this tour was an overview of invasive species concerns and how to prevent spread. Gear, vehicle and equipment cleaning were emphasized.

Integrated Training Area Management (ITAM), Range Division, DPW, and Contractors

- Following the discovery of two new outlier *C. setaceus* sites in mowed areas in MMR at the end of last report year, staff contacted the contract lead and provided her with a map and plant identification photos. She stated that she would brief her staff regarding this new threat.
- OANRP staff shared techniques for effective control of *Falcataria moluccana* and *Spathodea campanulata* with the facilities manager and pest control shops on Base.
- The Federal Natural Resource Manager reviewed a request to use sand from Loko Ea fishpond on range. There were no invasive species concerns, and if this project proceeds, staff will survey the sand as a preventative measure.

Wash Rack Status

- Use at the Central Vehicle Wash Facility (CVWF) continued this year with regular hours of operation: 0800-1600. Of the three wash rack facilities, CVWF was the most dependably functional this year.
- The SBE Wash Rack continues to suffer repair and maintenance issues. This year, it was not usable in July-August 2016, and was officially closed for repairs from September to November 2016. Repairs took longer than expected, and it eventually reopened April 2017. Range utilization reports suggest it was not used or scheduled once this year, which is not surprising given that it was not operational much of time. The SBE Wash Rack was similarly afflicted in 2014 and 2015. With the recent repairs and more consistent oversight by the DPW Engineering Division, staff hope that the SBE facility will be open for more consistent use in the coming year.
- For much of the year, the KTA Wash Rack suffered from problems which shut down part, but not all of the facility; such issues occurred off and on in July, August, September and October of 2016 and March of 2017. Fortunately, the facility was partially usable for much of this time. On a positive note, in July 2016, the Range Scheduling office made it mandatory for units to schedule the wash rack on the last day of a KTA mission. In addition, language reminding all users to use the wash rack was posted on the Range Control scheduling database (RFMSS). This is another important way to reach KTA users. Unfortunately, the log book which all users of the wash rack are required to sign does not appear to be maintained/enforced by KTA Range Control staff. In

addition, the process for scheduling and using the facility changed several times over the year. This led to challenges for OANRP staff, who are motivated to use the wash rack; it is unknown if the issues discouraged troops from using it.

- OANRP facilitated discussions between contractors and Range personnel to ensure staffing of the KTA Wash Rack during Rim of the Pacific (RIMPAC) training when high numbers of troops were expected on the range.
- Staff at the DPW Cultural Resources (CR) office have provided great support to OANRP in pushing for more consistent oversight and accountability of the wash rack facilities. CR staff drafted an in-house guide to wash rack use. OANRP also updated in-house wash rack info and vehicle washing guides (Appendices 3-12 and 3-13).
- The DPW Engineering Department submitted a work order signs reminding troops to use the wash racks to be placed on all exit gates at KTA (2 gates), SBE (3 gates), SBS (1) and SBW (2). The signs were reviewed by OANRP, but have not yet been installed. This proactive measure is greatly appreciated. DPW Engineering has been very responsive to requests from the Natural and Cultural Resources offices.

Landing Zones

- While reviewing the list of approved military LZs, staff noted that two LZs on Dole land (Nixon and Elephant's Foot) and one LZ on Kamehameha Schools land (Kainapuaa/Nixon) were on RFMSS, where they were visible to units scheduling training ranges. Both LZs are off-limits, as there is no lease in place for their use. Upon OANRP request, the Range Scheduling office noted these as 'dormant' in RFMSS, such that units are no longer able to view them.
- Staff surveyed the large Basilian LZ for the first time this year. This site is leased to the Army periodically and is located west of Drum Road on private land. No concerning invasive species were found.

KTA

- In preparation for the 2016 Lightning Forge training event, staff reviewed a request to conduct digging and excavation activities around the Combined Arms Collective Training Facility. While there are few native and no rare taxa in the region, *Chromolaena odorata* is present. Staff requested that no digging occur within a 20m buffer around any known *C. odorata* location.
- Range Division contacted the Natural Resources office in April regarding upcoming clearing work scheduled for several roads and trails in the Bravo 1 training range. This area is adjacent to the *C. odorata* infestation. Staff surveyed the area prior to the first stage of work in May, and no *C. odorata* were found along any of the trails and roads. The second stage of work is scheduled for August 2017.
- While conducting *C. odorata* surveys in the Delta 1 and 2 training ranges this year, staff noted unauthorized activity in area, including people driving ATVs on a jeep trail, tire tracks on other trails, and a large zipline tower. In 2015, staff noted unauthorized bulldozed trails in the same region and reported the incident to Range Control; while some follow-up occurred, OANRP do not know the extent of the military's investigation in 2015. The area directly abuts private land, and the property line is not clearly demarcated in the field. The tower belongs to Climbworks at Keana Farms, a business which runs zipline and ATV tours. OANRP reported the activity seen this year to Range Control and ITAM. A site visit by ITAM revealed three separate zipline towers on the Installation. The situation was turned over to the Department of Emergency Services for resolution. Unfortunately, staff also found *C. odorata* in the region. There is great potential for *C.*

odorata to be spread via ATVs and tours. OANRP shared the find with the Oahu Invasive Species Committee, and they plan to conduct surveys at Keana Farms in the coming year. OISC already has shared information about *C. odorata* with Climbworks.

SBW

- Staff conducted a site visit with a unit planning to train at Firing Point 212, which is on the edge of the *C. odorata* infestation. The area north of the FP is marked off-limits for training. Staff discussed the situation with the unit representatives and approved their use of the area. This is the second time in two years the Range Scheduling office referred a unit hoping to train north of the FP to OANRP and shows that Range staff understood the importance of the restrictions placed on the area by the Natural Resources office.
- A private contractor was hired to spray herbicide across much of the area within the firebreak road at SBW this year. OANRP staff worked with this contractor in the past and stored some of their gear at West Base. Staff provided the contractor with maps of sensitive habitat and 'no-spray' buffer areas, and ensured the contractor's gear was accounted for.

Pohakuloa Training Area (PTA)

- PTA Natural Resources staff shared a weed list titled "Primary, Secondary, and Invasive Species Proposed for Management at Pohakuloa Training Area, Hawaii" with the OANRP office. While some of these species are widespread on Oahu, others are unfamiliar to OANRP staff. Staff created a reference based on the list as an identification tool (Appendix 3-14), as there is a real possibility for a weed common at PTA to show up on Oahu. In fact, this year, staff found *Senecio madagascariensis* near Range Control at KTA; this herb is widespread across PTA. OANRP and PTA staff will share weed lists annually; this help both programs anticipate potential new weed introductions.
- Another PTA weed, *Parthenium hysterophorus*, was found on the Wheeler road survey this year. It was found in a pile of soil and debris at a stockpile location within Lyman gate. The source of the soil could not be determined. Bishop Museum records indicate it is already know from Oahu, but this is the first time it has shown up on any OANRP road survey. *Parthenium. hysterophorus* is a pasture weed, toxic to horses, which produces copious seed and colonizes bare soil.

Parthenium hysterophorus at Wheeler soil stockpile

- The Federal Natural Resource Manager asked the PTA office to reiterate the importance of cleaning vehicles to units departing for Oahu. PTA staff confirmed that this is a part of existing briefs and SOPs. In addition, OANRP reviewed a draft invasive species prevention SOP geared towards reducing the risk of invasive species spread on to PTA ranges.

Marine Corps Training Area Bellows (MCTAB)

- OANRP staff assisted MCTAB with a weed road survey at MCTAB and Bellows Air Force Station this year. OANRP was concerned about the potential of *C. odorata* to disperse to Bellows, given the large numbers of Marines who train at KTA and the recent discovery of a single *C. odorata* plant in nearby Lanikai. Fortunately, no plants were found. OANRP also assisted MCTAB staff with follow-up weed species identifications. Only one concerning species was seen on the survey: a small population of *Cenchrus setaceus*, which likely dispersed to the area from the infested Lanikai pillbox trail via wind or hikers. Due to the remote location and low number of plants found (four), it is unlikely *C. setaceus* will spread from Bellows to Army lands via training exercises.

Above: courtesy of MCBH staff, this map shows the northern portion of the Bellows survey area (outlined in yellow) and the *C. setaceus* site. Below: mature *C. setaceus*, with the training range in spread out beyond.

3.5 WEED SURVEY UPDATES: NEW FINDS

OANRP conducted surveys along Roads and Landing Zones (LZs) used by both natural resource staff and the Army. New surveys were conducted this year along roads on Tripler Army Medical Center and Fort Shafter. These surveys were conducted to look for targeted species such as *Chromolaena odorata* and *Cenchrus setaceus,* and to note other potentially invasive weeds. Staff were unable to drive several side-roads on Schofield Barracks East Range due to downed trees after heavy rain and wind events, and one road on Schofield Barracks West Range due to a range control blockade. All surveys where drivable roads may vary year to year are tracked and stored in Geographic Information Systems (GIS).

Three new OANRP LZs were surveyed for the first time this year. There was an overall increase in OANRP LZ surveys this year, likely due to a reminder alert when filling out helicopter plans in the OANRP database that was instituted this past year.

Staff also surveyed locations of potential introduction such as OANRP camp sites, Army washrack sediment disposal sites and MU access trails. This year the survey at the Schofield Barracks Quarry was not completed due to as the quarry has not been in use. Unusual and noteworthy plants found during the course of other field work are referenced as incidental in the Summary of Alien Taxa on Surveys table below. OANRP received support from the Bishop Museum to identify unknown species. This year a total of 21 submissions were sent to Bishop Museum for identification or to document new locales for select taxa.

Table 10. Summary of Surveys Conducted

Survey Type	Description	# Surveys Conducted this Year
Road Survey	All drivable roads on Army Training Ranges were surveyed. Access roads to OANRP Management Units are surveyed annually or every other year; this year most were on the schedule.	34 road surveys
LZ Survey	Actively used Army LZs are surveyed once per year. This year two Army LZs were discontinued due to inactivity and change of lease: LZ Elephant's Foot and LZ Nixon. OANRP LZs were surveyed if used within a quarter.	62 surveys on 35 LZs
Transect Survey	Surveys are conducted annually along high use access trails to OANRP MUs, and along selected MU fencelines and transects inside MUs.	9 weed transect surveys
Camp/Other Survey	Surveys are conducted at OANRP campsites and other potential locations of introduction such as washrack sediment disposal sites. Survey frequency varies based on location and use.	14 surveys at 8 sites

Locations of LZ and camp/other survey sites surveyed this year are depicted in the map below as points. The line features are locations of roads and transects surveyed.

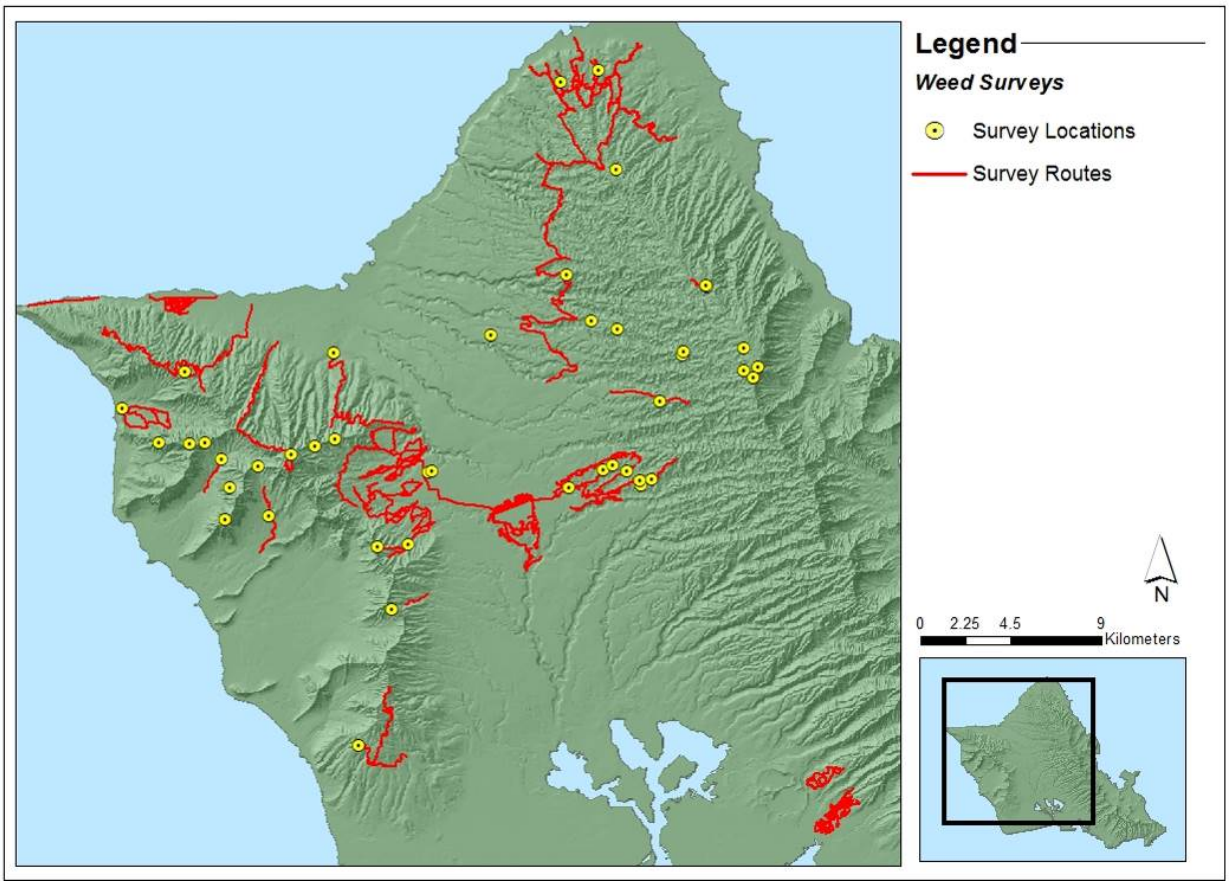


Figure 1. Map of Surveys Conducted in 2017

Survey data are tracked in the OANRP database and each year the list of new finds on each of those surveys is reviewed. Unidentifiable, or noteworthy species from surveys or incidental observations during regular work are submitted to Bishop Museum and are summarized below.

Table 11. Summary of Alien Taxa on Surveys

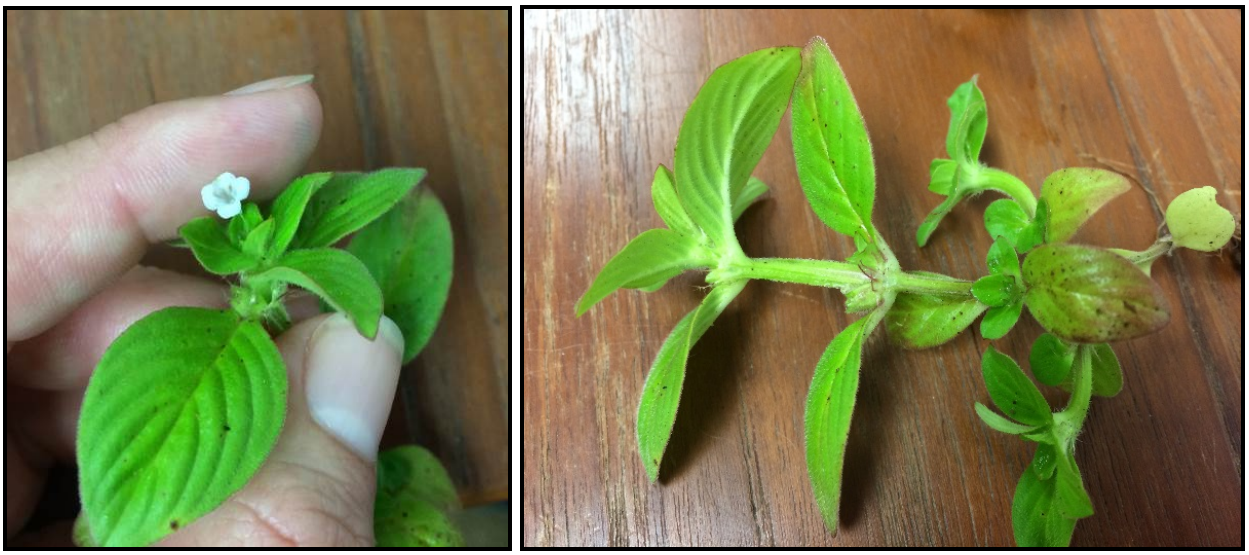
Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-KLOA-01**	*Cyperus involucratus*	This taxa is widespread on Oahu, and would be a priority for control if found at Poamoho LZ or trailhead to keep away from reaching the Koolau summit. Will monitor new distributions.
		Plantago debilis	Not widely established on Oahu. Not habitat altering and no control planned.
Road	**RS-KTA-07**	*Hedychium flavescens*	Staff will note where this taxon was seen on next year's survey (less surprising if found closer to residential side of road) to ensure that this taxa is not naturalizing close to the Koolau summit in natural areas.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
		Pimenta dioica	It is a surprise that this is the first sighting of this taxa on this survey given that *P. dioica* is known in high abundances elsewhere in KTA. This road does occur at a higher elevation on the range which could mean that there is potential for this taxon to continue to spread at higher elevations. No control is planned.
Road	**RS-KTA-08**	*Santalum album*	This taxon has been noted by staff to have naturalized in local populations across the range. There could be a possibility of hybridization with native *Santalum*. Staff will not control it, but will continue to document new locations of this species, and investigate its potential as an ecosystem altering taxa.
Road	**RS-KTA-09**	*Senecio madagascariensis*	A single mature plant was identified (and destroyed) 1 m from the Rd at the entrance to Kahuku Training Area. An ICA was created at this location and it will be treated for eradication. This taxon is treated for eradication in a few locations in the northern Koolaus on or near Drum Road by OISC.
		Chromolaena odorata	Several outlier immature plants were also found near the entrance to KTA on this Rd survey. An ICA was created around these and is regularly monitored. *C. odorata* continues to show up in new locations throughout KTA, often on roadsides, despite intensive control efforts in the larger infestation areas.
Road	**RS-LKN-01**	*Falcataria moluccana*	Much of the previously burned and fallow ranch lands below Lower Kaala NAR are prime habitat for *F. moluccana*. As this species increases at lower elevations, it will be important to keep it out of the NAR and Manuwai MU. New higher elevation sightings should be documented. This tree will be targeted when seen in Manuwai.
Road	**RS-MMR-01**	*Kalanchoe tubiflora*	This species should be tracked and noted if seen within the managed areas in Makua. Both *K. crenata* and *K. pinnata* are invasive on the dry, rocky, open areas, and compete with recruiting *Euphorbia celastroides* var. *kaenana* in this type of habitat. Control of this species will be conducted during regular weed control efforts if found.
		Hylocereus undatus	This ornamental plant, also farmed for its edible fruit, can tolerate dry, open areas. It may not be quick to naturalize, but it would be appropriate to document its location and monitor over time.
Road	**RS-Shafter-01**	*Citharexylum spinosum* *Coccinia grandis* *Filicium decipiens* *Jasminum fluminense* *Ochna sp.* *Santalum album*	This was the first year a survey was conducted at Fort Shafter. This survey was initiated to search for *Chromolaena odorata* and *Cenchrus setaceus* that occur on other military lands. Additionally, staff were looking to identify plants that may be naturalizing across the base, or to identify populations of invasive plants. The taxon listed here are worth noting for their establishment across the facility, but no control is warranted.
Road	**RS-Tripler-01**	*Antigonon leptopus* *Citharexylum spinosum* *Filicium decipiens* *Ochna sp.*	For the same reasons as the survey above, this was the first time a survey was conducted across roads around Tripler Army Medical Center. The species listed here were naturalized around the facility (most often in the wild areas surrounding the facility). No control will be conducted.
Road	**RS-WaiKai-01**	*Verbesina encelioides*	It is disappointing that this invasive aster continues to show up in locations across the leeward side of the Waianae Range. There is lots of suitable habitat there, and it is likely to become a permanent part of the ecosystem. It will be targeted during regular control efforts in leeward managed areas, but not targeted for eradication.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-Wheeler-01** Roads throughout Wheeler Army Airfield (WAA)	*Atriplex muelleri* *Datura stramonium* *Parthenium hysterophorus* *Portulaca oleracea* *Portulaca pilosa* *Trianthema portulacastrum*	During the road survey, particular attention was paid to a location on Wheeler Army Airfield where street sweeper biomass, and dirt and rubble piles are staged before pickup for removal. These taxa were found growing out of a dirt pile and are not believed to be invasive, but are not known from Wheeler/Schofield. *P. hysterophorus* is however known from PTA and is controlled in 2 satellite locations where it occurs in natural areas. No control will be conducted unless this taxa shows up closer to natural areas. *Atriplex muelleri*, was submitted to Bishop Museum for identification and is a New State Record. No control is planned. Surveys will continue at this site annually during the road survey to monitor spread to surrounding areas, or for presence of new species. Additional sightings of any of these species elsewhere on military lands will be documented. Sediment containment plans for the dirt piles was initiated by DPW after these new taxa were identified.
		Verbesina encelioides	This taxon was observed growing out of the remnants of a sandpile along a Wheeler Road near the airfield. Live plants were handpulled, but the sand had most likely been dispersed and no additional actions will be conducted.
Road	**RS-SBS-01**	*Spermacoce alata*	This species was determined to be a New State Record after it was found at Kumaipo on the ridge above Makaha Valley. The same staff that worked to identify *S. alata* there later noted it on this road survey. They remarked that it was possibly mis-identified in the past as *S. assurgens*. Staff will continue to hone in their identification skills and to submit additional vouchers of this species as it may be more widespread than previously thought.
Road	**RS-SBS-02**	*Hedypnois rhagadioloides*	This dandelion-like species was first submitted to Bishop Museum following a road survey at SBW in 2015 where it was seen in somewhat high abundance in the training areas around range control. At the time it was noted as a New State Record. It is not surprising that it is now being identified from SBS, but noteworthy to document its spread to new areas.
Road	**RS-SBW-04**	*Elephantopus mollis*	This weed is known to occur in disturbed habitats along trails and roadsides. It is targeted as an ICA in Kahanahaiki, and may be naturalizing in more locations. No control is planned unless found inside a MU.
		Sonchus asper	*S. asper* is not common on Oahu, and may not be documented from this island. If seen again, staff will collect a sample to document range extension for Bishop Museum. No control is planned.
LZ	**LZ-CHERRY-155**	*Plantago debilis*	This uncommon species is known also from the Pahole Road. No invasive threat record. No control planned.
LZ	**LZ-HON-215**	*Schefflera actinophylla*	This LZ was created this year to replace the LZ adjacent to the existing Palikea snail enclosure, and to facilitate access to both the old and new (Palikea North) snail enclosures. Several *S. actinophylla* individuals were also found while clearing vegetation for the Palikea North enclosure. There is anecdotal evidence for increasing frequencies of this taxon across Honouliuli Forest Reserve. It should be targeted when observed anywhere in Palikea MU, and is a high priority target during weed control sweeps.
LZ	**LZ-Kamaili-199**	*Montanoa hibiscifolia*	Dense patches of *M. hibiscifolia* are known from Kamaili, and efforts are made to keep this weed out of ungulate exclosures around rare resources. Targeted control of stands of this taxon are recommended as time permits.

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
LZ	**LZ-KLOA-022**	*Setaria palmifolia*	There is already one ICA for this species in the Lower Opaeula MU. This newest find around the LZ needs to be evaluated as it is an extension of a population that occurs outside the fence. All plants will be controlled, either as ICAs or during WCA control after population size outside the fence is evaluated. *S. palmifolia* is a high priority target for this MU.
LZ	**LZ-MAK-096**	*Coccinia grandis*	*C. grandis* is widespread on Oahu, although not usually found in highly native habitats. This LZ occurs at the end of the road in Makaha valley surrounded by alien forest. It is a high priority to keep out of Makaha MU and will be controlled there if seen.
		Dicliptera chinensis	*D. chinensis* is known from one other location in Makaha MU. No control is planned, but staff will continue to document distribution.
Other	**OS-SBE-01**	*Solanum torvum*	Known elsewhere from SBW training areas, *S. torvum* was identified on a survey where sediment from the Central Vehicle Wash facility is deposited. This serves as a good example that vehicles do indeed pick up seed on the ranges and would otherwise spread them from range to range if not washed after use. Vegetation growing out of the sediment piles is treated quarterly.
Other	**OS-SBW-03**	*Datura stramonium*	This survey is conducted around a staging area for sand/gravel at SBW. Both these taxa were also found growing out of a dirt pile on Wheeler this year. It appears that the same suite of weeds is often found in the same type of source material (ie. sand, dirt, etc.) for range maintenance. It would be prudent to ensure that the source of these materials run through a more rigorous sterilization or inspection process. At the very least OANRP is tracking locations of these staging piles so that regular inspections and treatment can be made as needed.
		Portulaca oleracea	
Incidental		*Cenchrus setaceus*	A single clump of grass looking like *C. setaceus* was found on the northeastern Kahanahaiki fence and submitted to Bishop Museum for identification. The sample was dried out, but looked to be a vegetative match for *C. setaceus.* While known from the southeastern rim of Makua valley, no plants have been found this distant from the known infestation area. Targeted surveys were conducted in the valley this year, along with helicopter surveys around the location of this plant on cliffs below, inaccessible on foot. For additional discussion, see section 3.8.
Incidental		*Spermacoce alata*	This herb was found growing in the burn site at Kumaipo Ridge above Makaha. It is a new state record. No invasive threat record. No control planned.
Incidental		*Tibouchina longifolia*	Greenhouse staff noted an unknown Melastomataceae growing out of several planted pots in the greenhouse. Plants were submitted to Bishop Museum and Dr. Cliff Morden at UH Manoa for DNA testing to verify the species. This species is not known to occur anywhere on Oahu. The plants in the pots resulted from contaminated cinder imported from the Big Island. Thousands of valuable plants in the greenhouse potted with the contaminated cinder lot were bare rooted, and re-potted. It was a massive staff effort to decontaminate plants, and dispose of the contaminated media. See Section 3.6 for further discussion.

Above: Photos of New State Record *Atriplex muelleri*, found growing out of soil staging area on Wheeler



Above: Photos of New State Record *Spermacoce alata* found on Kumaipo ridge and the Makaha access road.

3.6 EARLY DETECTION: *TIBOUCHINA LONGIFOLIA*, WHITE FLOWER TIBOUCHINA

In August-September 2016, OANRP staff discovered seedlings in the Melastomaceae family growing out of potting media at both the Schofield Barracks Nursery and OANRP Nike Nursery. Unable to identify the seedlings, horticultural staff potted several up to grow them large enough for a positive identification. In the meantime, Dr. Cliff Morden, UH, offered to run genetic sequencing on a leaf sample at his lab; he determined the plant was *Tibouchina longifolia*. The plants flowered in December, producing small white flowers. Specimens submitted to the Bishop Museum Herbarium likewise were identified as *T. longifolia*. This represents the first time this taxon has been documented from Oahu. Previously, *T. longifolia* was only known from the Hilo and Puna regions of the Big Island, and from nowhere else in the State. The entire *Tibouchina* genus is on the Hawaii Noxious Weed list. The Hawaii-Pacific Weed Risk Assessment score for *T. longifolia* is 8, giving it a 'High Risk' rating. Other taxa in the same family are known to have long-lived seeds. The very fact that it spread to Oahu confirms the invasive potential of this taxon. In all, staff found approximately thirty to fifty seedlings.

Left to right: *T. longifolia* seedling growing out of a potted pilo; 3-4 month old plant; blooms at 6 months.

Staff strongly suspect that cinder in the potting media mix is the source of the *T. longifolia* contamination. There are several reasons for this. Firstly, there is no *T. longifolia* source population on Oahu. The greenhouses are fully enclosed with shade cloth, minimizing any possible likelihood of dispersal from the surrounding environment and potential unknown *T. longifolia* populations via birds or wind. All pots used were brand new, and all potting media was stored in covered containers in the greenhouses. The potting media was a mix of cinder (Hawaii Island), Sunshine Mix #4 (Canada), Perlite (Oregon, extreme heat used in manufacturing), and Vermiculite (purchased in 2014, unlikely source). *Tibouchina longifolia* is a tropical species, not known from North America, according to the Centre for Agriculture and Biosciences International (www.cabi.org), which maintains the online Invasive Species Compendium. *Tibouchina longifolia* is well established on Hawaii Island, in the same Puna/Hilo region where cinder production companies are located. Lastly, the only feature universal to all pots in which *T. longifolia* was found was a transplant date on or after May 17, 2016. OANRP purchased cinder in May and September of 2016, and it is possible that one or both of these orders were contaminated.

In October 2016, OANRP drafted a letter to HDOA regarding *T. longifolia*, and notified the cinder vendor of the find. After talking with the vendor, HDOA informed OANRP that the cinder is transported in open top containers from Puna to Honolulu, and is not guaranteed to be free of vegetative debris or weed seeds. While transporting a noxious pest is prohibited, HDOA inspection of previously unopened bags of OANRP cinder did not identify any *T. longifolia* seeds and further action could not be pursued. OANRP staff monitored several trays of cinder in the greenhouse, but did not find any *T. longifolia* seedlings. It is worth noting that the unopened bags inspected were from the September 2016 purchase only, as the May 2016 cinder already had been mixed into media.

OANRP horticultural staff follow Hawaii Rare Plant Restoration Group (HRPRG) phytosanitation guidelines, available online at http://laukahi.org/hrprg. Staff work to promote a sanitary culture in the greenhouses and communicate about pests found. Prior to outplanting, the top half inch of media is removed, and plants are visually inspected. If pests are found, plants are treated. Plants that cannot be cleaned are not planted. In addition, independent experts inspect the greenhouses twice during reintroduction season. These protocols were effective in identifying *T. longifolia* before any outplanting occurred. This is the first instance of contamination by a Melastomaceae seen by OANRP in almost 15 years of operation. Cinder is no longer used in OANRP horticultural operations.

Left: experts inspecting plants prior to outplanting. Right: *T. longifolia*, 4-5 months old

The discovery of *T. longifolia* and the threat posed by local cinder as a potential vector was shared directly with OANRP partners, as it directly impacted reintroduction plans. Staff also publicized the find to the larger conservation community via notices posted to listservs in October 2016 and February 2017 (Appendices 3-15 and 3-16), and a presentation at the March 2017 Oahu Weed Workshop. Partners in the State NEPM program discovered suspicious seedlings at their field nursery at Kaala. While the seedlings were too small to identify positively, they were very similar to those found by OANRP, and were also grown in media containing local cinder.

To avoid spreading this noxious pest, particularly to native forest work sites, staff cleaned approximately 2,400 plants destined for outplanting, setting back outplanting schedules about 6 weeks. Media was carefully washed from each plant, which was then re-planted into sterile media. This replacement media cost about $2,000. The process of bare-rooting is stressful to plants and some did not survive. In some cases, cuttings were taken instead and the original plant discarded. In all, cleaning took about 420 person hours and created 2,200-2,800 lbs of contaminated media and plant material. Disposing of this material was difficult. Unopened bags of cinder were donated to the Bishop Museum for consumption in a lava exhibit. After investigating options ranging from H-Power (media inflammable), to the landfill (high potential for dispersal), to autoclaving (prohibitively expensive, small capacity), to the Navy's air curtain

burner (small capacity, media would need to be mixed with organic matter), OANRP eventually decided to bury the contaminated material in a little used corner of West Base. The material was placed in a deep pit, covered with ground cloth, then buried under several feet of dirt. The location was marked with a pole and can easily be monitored in future. OANRP disposed of potentially contaminated media from the NEPM field nursery in the same pit.

While staff are confident that the *T. longifolia* is unlikely to show up again in the greenhouses, mitigating this threat required significant time, effort, money, and logistical creativity. If *T. longiofolia* was present in cinder purchased prior to 2016, there is a chance it could be found at older outplanting sites. Staff will monitor reintroductions for *T. longifolia* and other pests in the coming years.

Left to right: contaminated media drying in pots; dumping media into West Base pit; weed mat covering media.

Left: washing media off plants prior to re-potting. Right: burying media under several feet of soil.

3.7 INVASIVE SPECIES UPDATE: *CHROMOLAENA ODORATA*, DEVIL WEED

Control of *C. odorata* is a high priority for OANRP. Please see the 2011 Year End Report, Appendix 1-2 to view the draft management plan for *C. odorata* control. This year, *C. odorata* control efforts alone accounted for 44% (1,129 hours) of the time spent on ICA work, and 12% of the total time spent conducting all weed control. Although high, these statistics under-represent the resources required to combat *C. odorata*, as they do not include time spent conducting surveys outside of ICAs, developing and maintaining spray equipment, managing detailed data sheets, ordering dedicated gear, coordinating with Range and DPW staff, or OISC contract effort.

The status of *C. odorata* management is mixed. The KTA infestation expanded in size this year, both on and off-range. A small infestation expansion was seen at SBW. A new infestation was found at Manuwai, and off-duty staff discovered an outlier plant in Lanikai. There continues to be no effective way to restrict motocross riders to the official State Motocross Park in Kahuku, and no progress in working with the State to build wash facilities for park users. In better news, no plants were seen at SBE, surveys were negative for *C. odorata* at Bellows, and staff assisted OISC in aerially spraying the Kahana infestation for the first time. No plants have been found at a handful of small KTA outlier ICAs for several years. Area treated via aerial spray at KTA increased dramatically over previous years and includes both the primary core in Pahipahialua gulch and a secondary core in Kaunala gulch. Aerial spray acreage did not increase at SBW, but the core was fully treated once this year before the 2016-2017 flowering season. While control efforts at outlier infestations and designated hotspots are going well, with declining numbers of plants found, OANRP has not succeeded in stemming the spread of *C. odorata* into adjacent and new areas.

OISC continues to manage infestations at Kahana, Keamanea/Haleiwa, and Aiea/Camp Smith; see Appendices 3-7 and 3-8. No *C. odorata* surveys have been conducted outside of known infestation areas on Oahu, so it is possible that new infestations may be found in the future. To date, all discoveries off of Army training ranges have been opportunistic. In order to better understand the scope of *C. odorata* invasion on Oahu and set realistic goals for control, island-wide surveys are needed.

Current resources are insufficient to conduct planned treatment at all known infestations, much less survey potentially infested lands, and more aggressive tools are needed. OANRP is investigating biocontrol options for *C. odorata* which have been successful in other parts of the world. OANRP has begun discussions with OISC and other members of the Chromolaena odorata Working Group (COWG) to figure out the steps necessary to release one of the most promising biocontrols: *Cecidochares connexa*, a gall-forming fly. Staff hoped to obtain funding for biocontrol work this year, but need to wait until the OANRP contract renews in order secure monies for this important project.

Seed Longevity Trial Update

In 2011, staff installed a five-year trial at KTA to determine how long *C. odorata* seeds persist in soil. See the 2016 Year End Report for a description of the trial and partial results. The last two buried seed packets were scheduled to be dug up in July 2016, but staff were unable to locate them at the time. Fortunately, the seed packets were found in May 2017; this seed is currently undergoing testing in the seed lab. The fourth year seed could not be used to assess overall seedbank persistence, due to low numbers (7 seeds remaining of 2,500 buried). Fortunately, there were no similar problems with the seed recovered in 2017 (sixth year). Currently, it appears that *C. odorata* forms a short-term, persistent seed bank, with 36% germination at three years. Two of the seven seeds recovered from the four-year packets germinated. Full results of this trial will be presented in next year's report. A second buried seed trial was installed at SBW in May of 2016. Staff continue to monitor this trial, which is set up to run as long as ten

years, if needed. Between the two trials, staff hope to gain greater insight into the longevity of the *C. odorata* seed bank and any differences in seed persistence between sites.

The last seed packets from the KTA trial, after six years in the ground.

Sanitation

As a result of the discovery of *C. odorata* in Manuwai, OANRP invested in gear dedicated solely to *C. odorata* control. This greatly improves OANRP sanitation procedures. In spring of 2017, all staff assigned to control *C. odorata* were issued separate tabis. In addition, staff share a stash of small day packs, wire and nylon brushes, and gloves. All dedicated gear is clearly labeled. The brushes are not just for cleaning *C. odorata* gear at the end of a field day, but also for cleaning in the field when moving out of an area with a high density of plants. Staff will avoid work in dense infestations during fruiting season (March-May). The need for a stronger culture of sanitation was reinforced, embarrassingly, by the discovery of a *C. odorata* seedling growing in a planter at West Base. The planter, along a busy walkway, is right next to the H-Power bin where staff dispose of material from all of the highly invasive taxa OANRP controls. Seed may have been dropped near the planter when someone tossed a bag of vegetation into the bin, or when someone decontaminated field gear nearby.

OANRP staff Emily Long contemplating the *C. odorata* seedling she found at West Base.

KTA Update

Control efforts at KTA account for 38% of all incipient control effort this report year. In addition, OANRP continues to contract OISC to conduct control across almost half of the primary infestation. See Appendices 3-7 and 3-8 for a summary of OISC's work, including maps of areas treated this year.

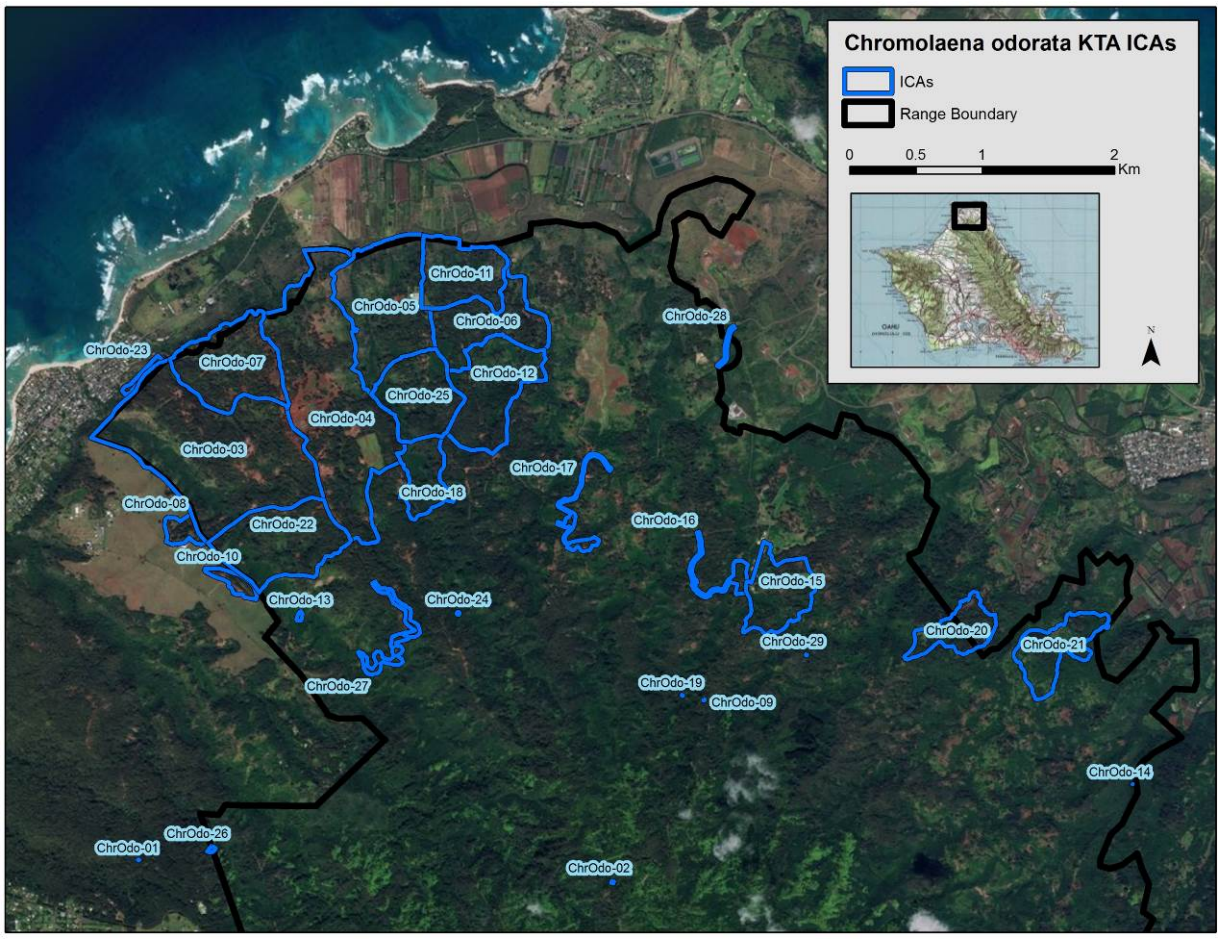


Figure 2. *C. odorata* Incipient Control Areas at KTA

- New ICAs. Four new ICAs were created this year, numbers 26-29.
    - ICA #26, Kaleleiki: In September 2016, staff found a single mature *C. odorata* at a small fence protecting a *Eugenia koolauensis* site. Unluckily, the plant had already dropped its seeds. This find prompted a full sweep of the exclosure, but only one additional plant, a seedling, was found. In all, only three plants have been found at Kaleleiki. In 2011, staff surveyed much of the surrounding area for *E. koolauensis*; although *C. odorata* was not part of that mission, if a large infestation were present, it is probable staff would have noted it. The likely source of the Kaleleiki infestation was contaminated OANRP gear.
    - ICA #27, Kaunala Road: One immature *C. odorata* was found along the Kaunala road during annual road surveys in March 2017. This is the first time *C. odorata* has been found along this particular road. On subsequent surveys, four additional immature plants were found. Although not in the State motocross park, this road is just mauka of it and is an irresistible draw for many riders. While occasionally used for military training, motocross use is much more frequent.

- ICA #28, Charlie Road: This ICA was also found during road surveys in March 2017. One mature and seven immature plants were found along the KTA access road, just below Range Control, between the Charlie 2 gate and engineer's union driveway. This road is heavily used by the military, the most likely vector. The road is also used by neighboring landowners and motocross riders.
- ICA #29, Delta Road: A single immature plant was found along the road leading from the CACTF to the Delta ranges during March road surveys. The surrounding area is heavily forested, not ideal *C. odorata* habitat, and it seems likely this plant was spread by a contaminated vehicle or road maintenance equipment.

- ICA Changes. Five ICAs were expanded to include new patches of *C. odorata* just outside their borders: ICAs 06, 12, 16, 21, and 23. The very large ICA 05, which encompassed the core of the infestation in Pahipahialua gulch, was split into two: ICA 05 is the northern end of the gulch, and contains the bulk of the infestation, including most of the aerial spray zone; ICA 25 is the less heavily infested area just to the south. This split assists with scheduling and logistics of control efforts.
- Control Summary. All control efforts are summarized in Table 12. Area, effort and number of visits are reported for the 2017 and 2016 report years. The dates of the most recently removed mature and immature plants are included. The *C. odorata* infestation now covers 606.5 ha in KTA. This is a huge area, and staff are unable to sweep every inch of it, despite contracting OISC to work in the motocross park, the highest priority area. Different strategies are employed in different ICAs as a means of stretching limited resources. The core of the infestation is divided between ICAs 03, 04, 05, 07, and 25. The other ICAs are either on the fringes of the core, represent separate infestations, or are outliers. The strategies used at each ICA are detailed in the 2016 Year End Report, and the "Type/ Strategy" column provides a quick reference to management approach at each ICA:
    - Outlier. These are geographically small sites, usually with very few individual plants found. After discovery, these ICAs are monitored quarterly. After several years with no plants found, the monitoring interval decreases to once or twice a year.
    - OISC contract + OANRP hotspot. OISC is contracted to sweep several ICAs fully twice a year. The ICAs covered by the contract are numbers 03, 04, and 07; they span the western end of the primary infestation and include the State Motocross Park. Hotspots are drawn around high densities of plants. OANRP sprays the hotspots 1-4 times per year with pre-emergent herbicide.
    - Sweep + Hotspot. Strategy at these ICAs includes rigorous sweeps across the whole ICA, in addition to more intensive monitoring and treatment with pre-emergent herbicides at Hotspots. Hotspots are tracked and monitored within ICAs. Whenever possible, staff use highly effective power sprayer equipment at Hotspots.
    - Sweep + Hotspot + Aerial Spray. As above, except aerial sprays are used to treat large, remote patches of plants which are either inaccessible to the power sprayer or located on steep cliffs.
    - Trails + Roads + Hotspots. Management at these ICAs is limited to surveys of all trails and roads 1-2 times per year, rather than landscape-wide sweeps. Staff observed that *C. odorata* spreads easily into new areas along trails and roads. Hotspots are tracked and aggressively treated. This approach is used only in ICAs with low plant density.
    - Trails + Roads + Hotspots + Sweep. As above, except portions of these ICAs are fully swept. This approach is used when *C. odorata* density is high in select areas of an ICA.
    - Private Land. OANRP does not have permission to work on infestations on private land, but OISC does. Staff assist OISC at these ICAs as feasible.

Table 12. KTA Control Efforts

ICA Code	ICA Area (ha)	2017 Report Year			2016 Report Year			Date Last Mature Plant Found	Date Last Immature Plant Found	Type/Strategy
		Area Weeded (ha)	Effort	# Visits	Area Weeded (ha)	Effort	# Visits			
WaimeaNoMU-ChrOdo-01	64 m²	64 m²	1.0	2	63 m²	2.5	2	none	2011-04-05	Outlier
KTA-ChrOdo-02	328 m²	328 m²	0.5	1	328 m²	0.5	1	none	2011-08-22	Outlier
KTA-ChrOdo-03	118.43	7.71	214.0	16	7.06	216.5	15	2017-06-29	2017-06-29	OISC Contract + OANRP hotspot
KTA-ChrOdo-04	111.63	10.40	94.0	10	6.77	107	12	2017-03-22	2017-06-28	OISC Contract + OANRP hotspot
KTA-ChrOdo-05	57.96	40.82	258.5	21	25.62	228	17	2017-06-14	2017-06-14	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-06	32.62	31.68	103.5	7	1.9	32.5	2	2016-10-12	2016-10-12	Sweep + Hotspot
KTA-ChrOdo-07	41.26	4.18	33.0	6	4.72	59.35	6	2017-06-28	2017-06-28	OISC Contract + OANRP hotspot
AimuuNoMU-ChrOdo-08	4.59	0.59	1.0	1	0	0	0	N/A	2016-08-16	Private Land. OISC.
KTA-ChrOdo-09	78 m²	78 m²	0.5	1	78 m²	1.5	2	2013-01-09	2013-09-10	Outlier
AimuuNoMU-ChrOdo-10	3.73	0	0	0	0.36	1	1	N/A	2016-01-21	Private Land. OISC.
KTA-ChrOdo-11	28.74	18.64	41.5	5	17.98	40	2	2016-07-28	2016-08-03	Sweep + Hotspot
KTA-ChrOdo-12	39.29	4.23	19.0	2	6.02	37	3	2017-04-04	2017-05-17	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-13	0.23	457 m²	1.0	1	3 m²	0.25	1	2015-12-23	none	Outlier
KTA-ChrOdo-14	6 m²	6 m²	0.5	1	6 m²	1	2	2014-01-07	none	Outlier
KTA-ChrOdo-15	23.51	3.96	18.5	2	3.58	11.25	4	2016-12-06	2017-03-07	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-16	4.04	1.44	3.5	3	0.79	0.75	1	2016-12-06	2016-12-06	Trails + Roads + Hotspots
KTA-ChrOdo-17	3.73	1.98	4.0	3	2.67	4.75	2	2014-01-14	2017-05-17	Trails + Roads + Hotspots
KTA-ChrOdo-18	16.43	2.34	23.5	2	0.23	2.5	2	2014-10-29	2016-08-11	Trails + Roads + Hotspots
KTA-ChrOdo-19	78 m²	78 m²	0.5	1	0	0	0	none	2014-09-24	Outlier
KTA-ChrOdo-20	15.74	4.87	42.0	3	3.07	10.25	4	2016-12-06	2017-06-20	Trails + Roads + Hotspots + Sweep

ICA Code	ICA Area (ha)	2017 Report Year			2016 Report Year			Date Last Mature Plant Found	Date Last Immature Plant Found	Type/Strategy
		Area Weeded (ha)	Effort	# Visits	Area Weeded (ha)	Effort	# Visits			
KTA-ChrOdo-21	21.31	4.48	35.0	3	11.38	23	4	2017-06-20	2017-06-20	Trails + Roads + Hotspots
KTA-ChrOdo-22	43.8	0.94	20.5	3	4.8	24.5	4	2017-03-21	2017-03-21	Roads + Trails + Hotspots + Sweep
KahukuLaie-ChrOdo-23	1.52	0.13	1.25	1	0.48	2.75	2	2016-04-27	2016-09-27	Private Land. OISC manage?
KTA-ChrOdo-24	316 m²	316 m²	3.0	3	18 m²	0.1	1	2016-03-02	none	Outlier
KTA-ChrOdo-25	31.28	5.78	35.0	6	N/A	N/A	N/A	2017-06-27	2017-06-27	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-26	0.18	0.18	22.00	4	N/A	N/A	N/A	2016-09-08	2017-02-21	Outlier
KTA-ChrOdo-27	5.73	1.54	3.5	3	N/A	N/A	N/A	none	2017-04-04	Trails + Roads + Hotspots
KTA-ChrOdo-28	0.69	0.35	1.0	1	N/A	N/A	N/A	2017-03-07	2017-03-07	Trails + Roads + Hotspots
KTA-ChrOdo-29	78 m²	20 m²	0.5	1	N/A	N/A	N/A	none	2017-03-07	Outlier
TOTALS	**606.53**	**146.36**	**981.75**	**113**	**98.1**	**807**	**90**			

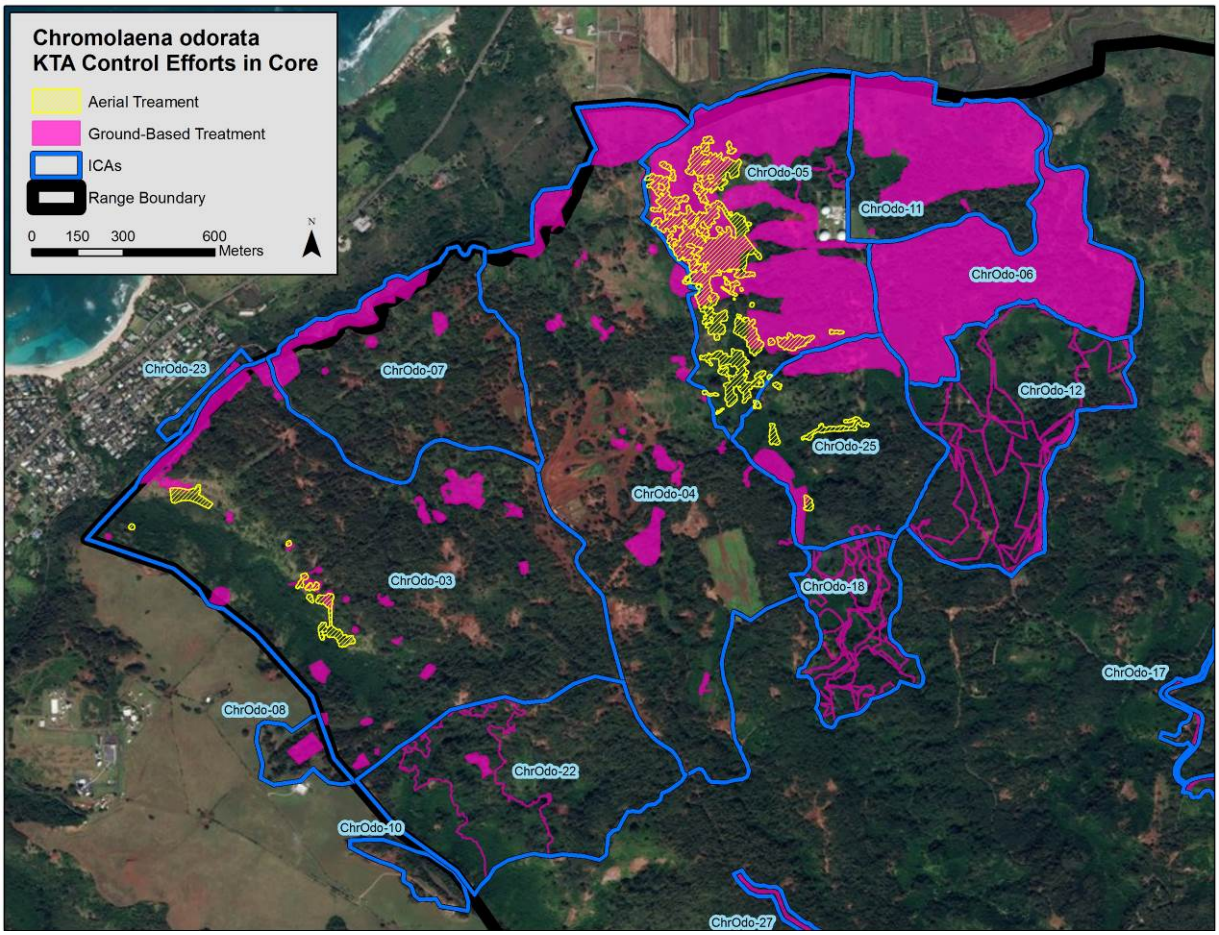


Figure 3. Aerial and Ground Treatment in the KTA Core Infestation

- Aerial Sprays. This year, 13.36 ha were sprayed aerially and 140.87 ha were treated on the ground, for a total of 146.36 ha of *C. odorata* controlled (ground and aerial treatments overlapped). The map above shows aerial and ground control efforts across the primary infestation. Aerial sprays were conducted in four different ICAs this year. While efforts focused on ICA 05 (11.08 ha), areas directly adjacent in ICA 25 (0.76 ha) and ICA 04 (495 m²) were also sprayed. A new spray zone was designated in ICA 03 to include several different hotspots, and 1.47 ha were sprayed. Staff noted that in ICA 05, few to no seedlings have been seen on follow-up visits, and sprays appear to successfully kill large mature plants. Due to helicopter budget limitations, no spray operations were conducted in the first six months of 2017, but staff expect to restart spraying prior to the winter 2017 *C. odorata* flowering season, when the detectability of plants increases. The efficiency of spray operations continued to improve this year, with tweaks to the aerial spray rig and continually growing pilot and staff experience with project operations.

Table 13. KTA Aerial and Ground Treatment Area

Report Year	Total Area Treated (ha)	Aerial Spray Area (ha)	Ground-Based Treatment Area (ha)
2016-2017	146.36	13.36	140.87
2015-2016	98.24	6.36	91.89
2014-2015	71.27	3.98	67.29

Dead *C. odorata* and alien grasses, treated via aerial spray.

- Outlier ICAs. Control efforts at the outlier ICAs have been successful, see Table 14. All outlier ICAs were monitored at least once this year. Staff will monitor outliers for at least ten years after the last plant was seen, or until more information is known about seed longevity.

Table 14. KTA Outlier ICA Status

ICA Code	Plant Type	Status
WaimeaNoMU-ChrOdo-01	Immature only	None seen since 2011
KTA-ChrOdo-02	Immature only	None seen since 2011
KTA-ChrOdo-09	Both mature and immature plants	None seen since 2013
KTA-ChrOdo-14	Mature only	None seen since 2014
KTA-ChrOdo-19	Immature only	None seen since 2014
KTA-ChrOdo-13	Mature only	None seen since 2015
KTA-ChrOdo-24	Mature only	None seen since 2016
KTA-ChrOdo-26	Both mature and immature plants	New this year
KTA-ChrOdo-29	Immature only	New this year

- ICA Discussion. Highlights of ICA management are summarized in the table below. The ICAs discussed are shown in Figures 2-4.

Table 15. KTA ICA Highlights

ICA Code	Discussion
KTA-ChrOdo-03	This ICA contains the largest number of hotpots, 38. Of these, 8 are now inactive. Another 8 are most easily reached from private land to the west, and OISC leads management of these. Several of the hotspots are large, and while treatment has been effective, getting these sites under control will take more time. Aerial sprays are needed at ten hotspots, all of which run along a line of grassy cliffs. Next year, staff will switch from just spraying the hotspots to treating the entire cliff.
KTA-ChrOdo-04	OANRP treat all hotpots in this ICA. Of 24 hotspots, 6 are now inactive, 5 show clear declines in numbers, and control efforts are progressing well at the remaining 13. Aerial sprays supplement ground efforts at 4 hotspots.
KTA-ChrOdo-05	Landscape sweeps were conducted across much of the eastern slopes of this ICA, and hotspots were treated several times. These efforts complement intensive aerial sprays. Some patches of plants were found on the makai end of the ICA. Staff hope to prevent plants from dispersing to the agricultural fields below.
KTA-ChrOdo-06	This ICA was fully swept once this year and was expanded to include a small patch of plants found in a gulch to the north. Control efforts have been quite successful here; there is a clear downward trend in the number of *C. odorata* found over the years.
KTA-ChrOdo-07	OANRP staff focus on hotspot treatment. Of 8 hotpsots, 2 are inactive, plant numbers are declining at 3, and control efforts are progressing well at the remaining 3. The highest numbers of plants are found on the north edge of the ICA.
KTA-ChrOdo-11	All areas not swept last year were surveyed once this year, and the distribution of *C. odorata* in the ICA is clearly defined. The majority of plants were found in the southwest corner of the ICA, closest to the Pahipahialua core. One hotspot was designated around a large mature patch just off the Opana road. A single mature plant was found on the east ridge. No plants were found on the northern slopes. The northern slopes will be surveyed with binoculars and sweeps every 2-3 years, while the southern flats will be surveyed annually.
KTA-ChrOdo-12	The numbers of plants found has increased greatly since 2014. This is due, at least in part, to improved coverage and the discovery of a hotspot. More frequent trail surveys and hotspot treatments may be needed. Through landscape sweeps may be needed to get numbers down.
KTA-ChrOdo-15	While staff surveyed all trails and roads in this ICA, there was a small increase in numbers of plants found. More consistent surveys may be helpful.
KTA-ChrOdo-16	In previous years, all plants in this ICA were found in the vicinity of a large clearing where gravel is stored. This year, plants were found down the road to the west. While numbers remain low, this dispersal is concerning.

ICA Code	Discussion
KTA-ChrOdo-17	The roadside portions of this ICA were monitored, but several outlier points within the ICA were not surveyed. More consistent coverage is needed. This year, there was bump in the number of plants controlled; this is entirely due to a cluster of immatures found at the site of one large treated mature plant.
KTA-ChrOdo-20	While staff consistently survey know trails in this ICA, there is no decline in the number of plants treated per year. Pre-emergent sprays have not been conducted at this ICA, and may be helpful in reducing numbers.
KTA-ChrOdo-21	Staff surveyed new areas to the north of the ICA this year, and found quite a few *C. odorata*, as well as a zipline tower (discussed in section 3.4 above). Further surveys are needed to completely delimit this ICA. Given the number and distribution of plants, staff may need to transition to landscape sweeps in addition to trail surveys. Also, pre-emergent sprays will assist in reducing plant numbers.
KTA-ChrOdo-22	This large ICA is directly south of ICA 03, which is surveyed by OISC. All trails within it were surveyed last year, and *C. odorata* distribution appears to be limited. This ICA needs to be assigned to one field team for more thorough coverage.

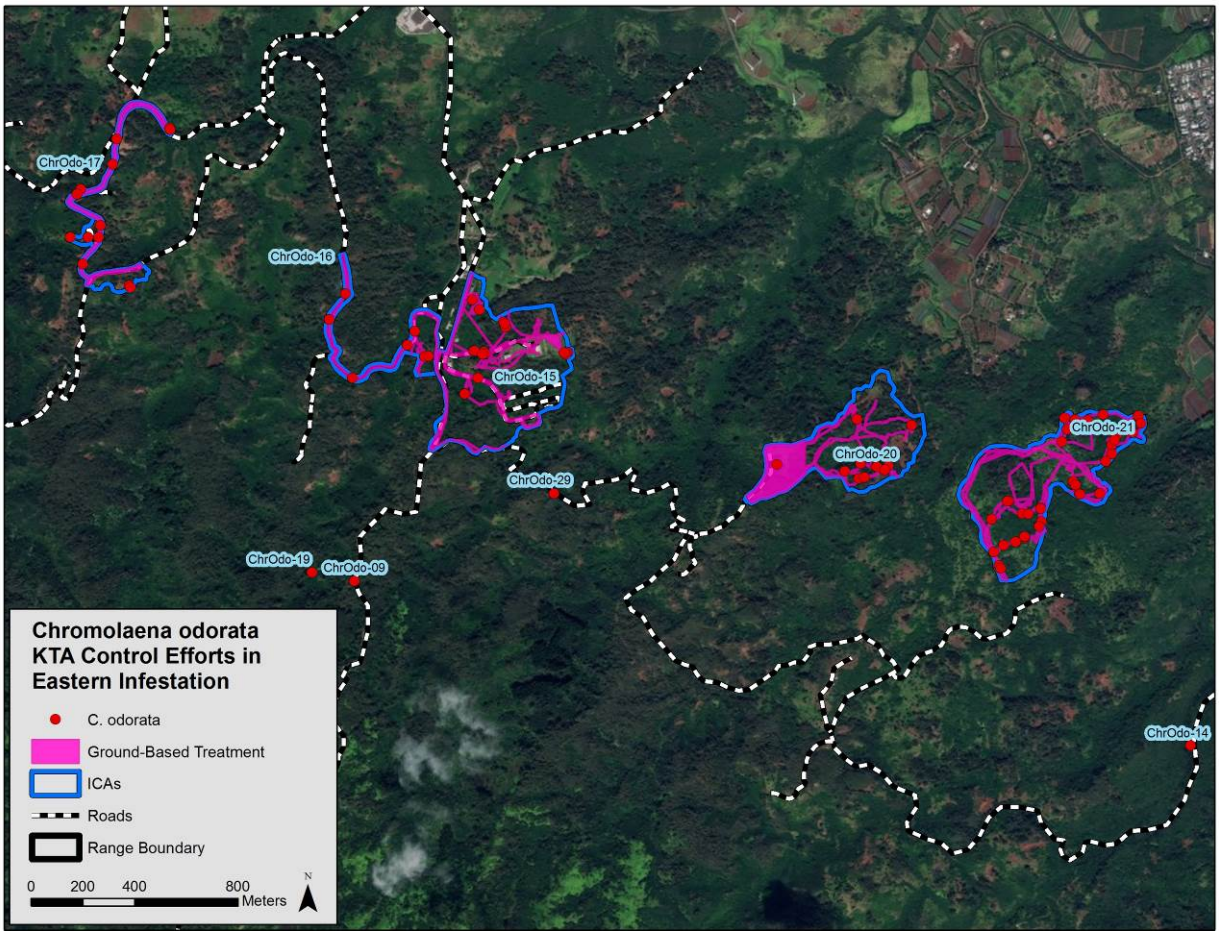


Figure 4. Treatment in the Eastern ICAs at KTA

- ICAs on Private Land. Last year, OANRP and OISC conducted surveys at KahukuLaie-ChrOdo-23 and at the Waialee Agricultural Research Station. No additional ground surveys were done this year, but staff expanded ICA 23 after noting that plants from Hotspot 37 in ICA 03 had spread off of KTA onto the steep slopes below. OANRP will share this find with OISC, and strategize how best to work in this area. OANRP was able to conduct one aerial survey of the region, but would like to expand these efforts again next year.

SBW Update

Control efforts at SBW are limited by range availability and the need for an UXO escort in the area. OANRP has been able to take advantage of regularly scheduled range maintenance 'cold' days, which have provided sufficient access. The table below summarizes control efforts at SBW in 2017. No new *C. odorata* ICAs were found on SBW this year.

Table 16. SBW Control Efforts

ICA Code	2017 Report Year				2016 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBWNoMU-ChrOdo-01	22.28	5.60	56.7	11	14.77	56	9
SBWNoMU-ChrOdo-02	1.10	0.88	7.0	3	0.73	7.5	4
SBWNoMU-ChrOdo-03	0.49	0.46	9.5	3	0.40	6.5	4
SBWNoMU-ChrOdo-04	23.51	7.79	56.8	9	11.66	140.5	19
TOTAL	**47.39**	**14.72**	**130.0**	**26**	27.56	210.5	36

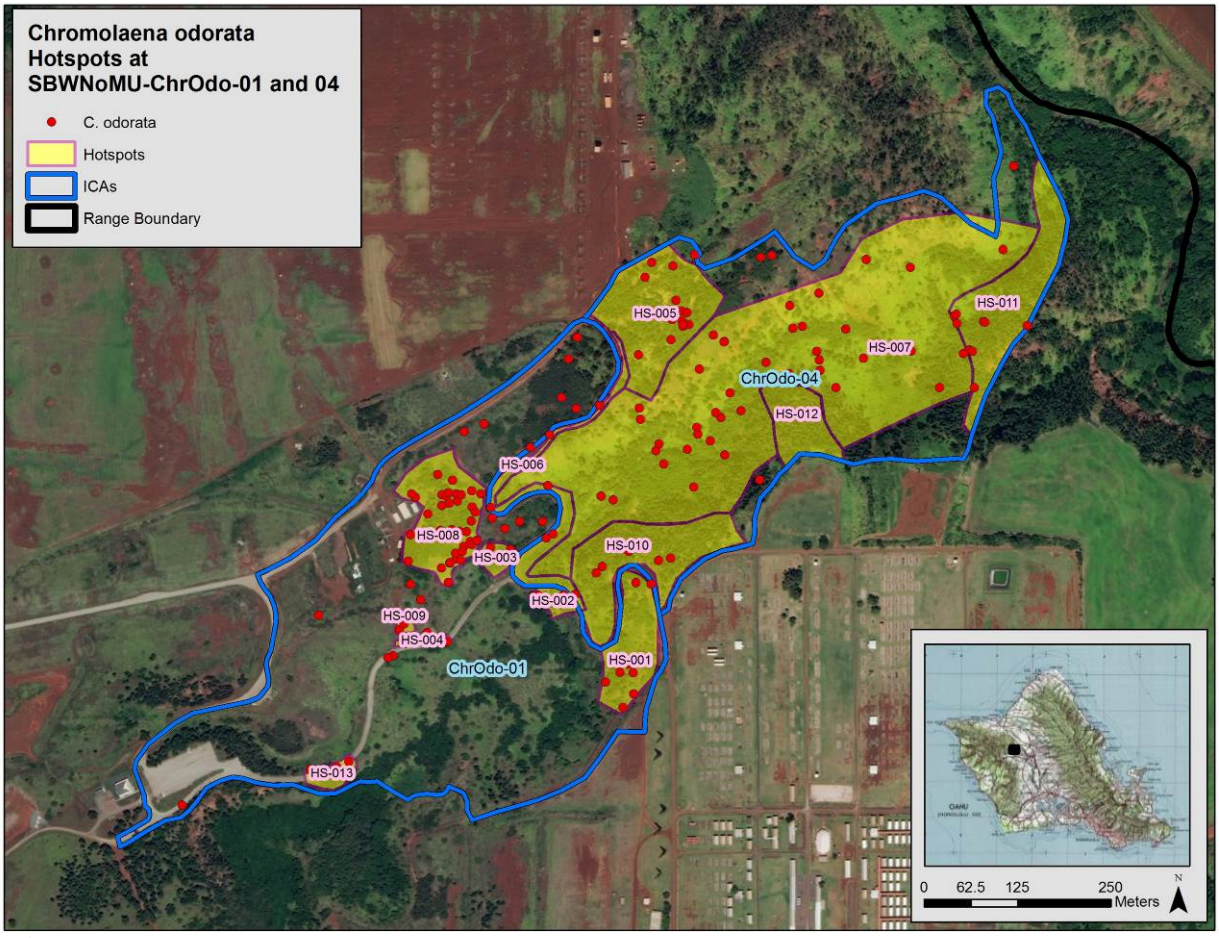


Figure 5. Hotspots in SBW Core ICAs

- SBWNoMU-ChrOdo-01. This ICA covers the western half of the primary *C. odorata* infestation. Bordered by roads to the north and east, the center of this ICA is dominated by dense stands of *Urochloa maxima*. The grass is so thick in some areas that *C. odortata* doesn't appear to easily colonize it, unless a disturbance creates bare ground. These grass patches are unsafe to survey due to UXO concerns. Next year, staff will survey them from vantage points using binoculars, and

possibly conduct an aerial survey. These surveys were done last year, but not this year, and account for the change in area swept this year. Geographic hotspots are designated around concentrations of plants to facilitate efficient and thorough coverage of this large ICA (see map above). This year, staff swept all hotspots except one, HS-003, which was partially sprayed from the air (see map below). In addition, the northern finger of the ICA was thoroughly swept; several outlier plants were found during the sweeps, but no large patches. Staff expanded HS-008 to include a narrow, deep gulch on the edge of the finger. There is a large patch of *C. odorata* in the gulch, but control efforts are limited by the presence of a very low-lying electrical cable, only a couple feet off the ground at its lowest point. The cable hazard was reported to DPW and Range Control. If it cannot be fixed, OANRP will ask if it can be temporarily turned off in order for staff to safely treat the gulch. One new hotspot was designated this year, HS-013. This hotspot stretches from the road down a steep slope into a gulch. Treating this hotspot is a priority, as seed can easily disperse down gulch. The ICA was expanded to include HS-013 and an outlier plant found along the road near a large building. Despite this expansion, staff note that the hotspot strategy seems to be effective in reducing plant numbers in those locations.

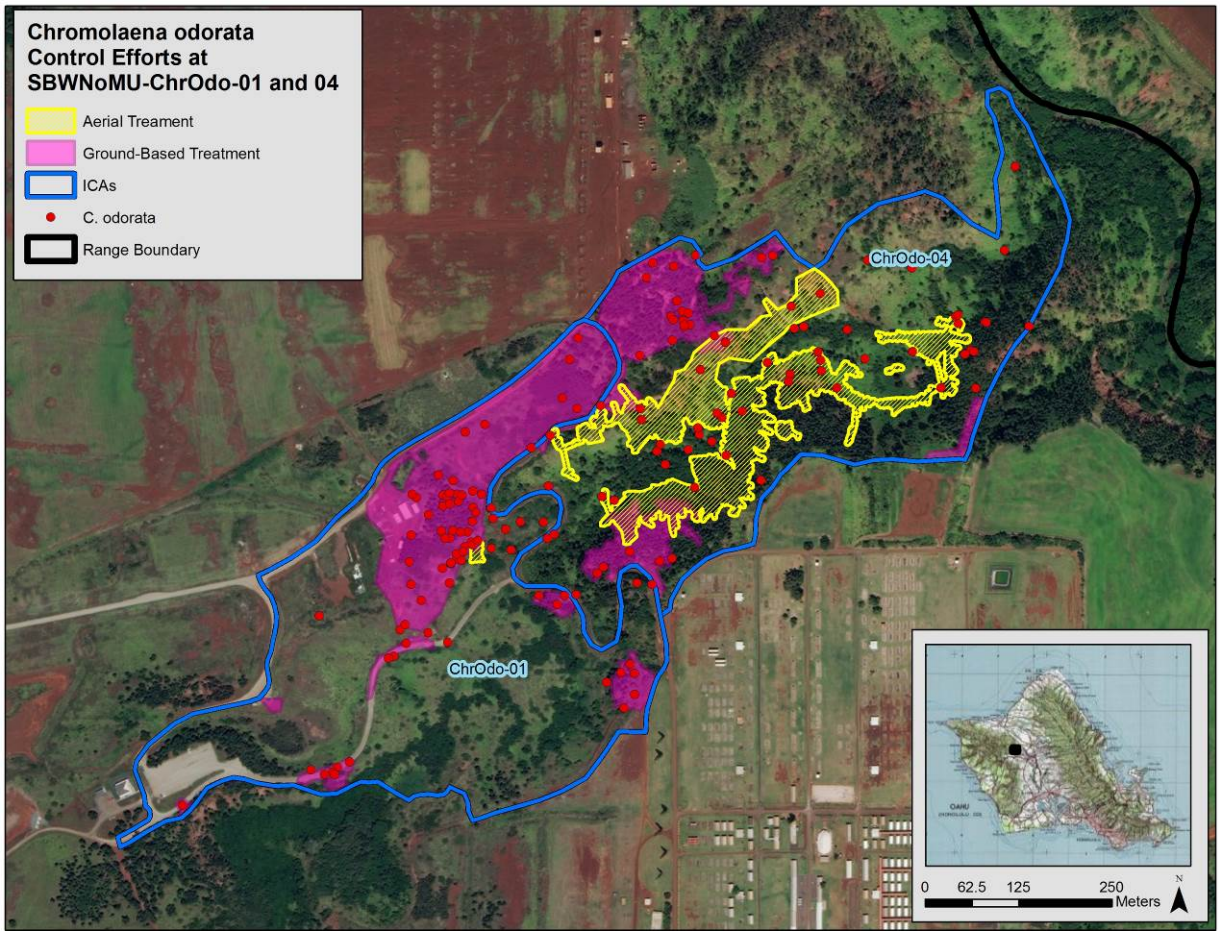


Figure 6. Aerial and Ground Treatment in SBW Core Infestation

- SBWNoMU-ChrOdo-02. The most northerly of the ICAs at SBW, control at this site is complicated by the fast-growing, thick *U. maxima* which dominates it. Regular sprays are needed to keep grass from growing over the ICA, which would prevent staff from thoroughly surveying it and reduce control efficacy. This year, only 9 immatures and 1 seedling were found at this ICA, the lowest annual number since it was discovered in 2014. The last mature plant was removed in

April 2016. These promising results may indicate that the seed bank at the ICA is successfully being depleted. No plants were seen along the road this year, making it two years since any roadside plants have been found. Staff continue to use pre-emergent herbicide to reduce potential *C. odorata* germination and reduce grass cover. In the coming year, staff will work to maintain consistent pressure on this ICA.

- SBWNoMU-ChrOdo-03. Over the years, relatively few plants have been found at this ICA, including just 7 mature plants. However, this year, staff found the highest number of plants ever seen, including 1 mature, two immatures, and a tight cluster of 250 small immatures. The cluster of immatures was found next to an orange flag which marked a previously controlled mature plant, and appeared to be in an area which was not monitored recently. Thorough coverage of the entire ICA is critical. This ICA is located next to a firing target and UXO has been identified in the area. Parts of the ICA are covered by dense patches of tall grass. Due to UXO risk, it is unsafe to walk wherever grass obscures the ground. In the coming year, staff will use the power sprayer to safely treat grass patches from a distance. This should allow staff to conduct more thorough surveys of the entire ICA while maintaining safety.
- SBWNoMU-ChrOdo-04. This ICA encompasses the eastern portion of the primary *C. odorata* infestation, including the core. The terrain is challenging. Portions of the gulch are dominated by dense grass, the slopes are very steep, and there is a high UXO hazard which limits ground access. As in ChrOdo-01, hotspots were drawn around concentrations of plants. Some of the hotspots are treatable from the ground, but the largest, HS-007 is best treated via aerial sprays. This year, 4.97 ha were aerially sprayed and 5.56 ha were treated on the ground. In contrast, 8.14 ha were aerially sprayed last year and 4.38 ha treated on the ground. Only one round of aerial sprays occurred this year, due to helicopter budget constraints, as opposed five rounds last year. This also accounts for the drop in effort from 2016 to 2017. Despite this, staff did manage to aerially spray the majority of HS-007 this year, a testament to the success of last year's efforts. Staff focused ground control efforts on the westernmost hotspots, but little work was done on the east end of the ICA. In the coming year, staff hope to expand ground control in the east and south of the ICA and maintain a regular aerial spray schedule.

View of the core looking south, towards Area X. Note the bare ground on the slopes beneath the Eucalyptus.

- UAV Trial. *C. odorata* is difficult to detect in thick vegetation both on the ground and from the air, even with experienced staff. This year, OANRP worked with Cultural Resources to test the potential of UAVs in spotting *C. odorata* at SBW. Cultural Resources staff have both a UAV and a certified UAV pilot, and have already received clearance to conduct flights at SBW. They conducted a test flight in October 2016, flying over a previously identified patch of plants, as well as across a large swath of the north slope of Mohiakea gulch. While it was difficult to spot *C. odorata*, with a more tailored flight path, low flight altitude, and higher resolution camera, detection would be improved. Staff also experimented with geo-referencing the images. Again, there were some difficulties, but these appear fixable with mastery of select software.

Above: OANRP and Cultural Staff conducting UAV flight. Below: *C. odorata* is visible but difficult to pick out.

Above and below: two different angles of the same *C. odorata* patch, marked with an arrow. The different perspectives are useful but somewhat nauseating to review. Unfortunately, *C. odorata* does not have a strong visual element to cue into.

SBE Update

First discovered in October 2014, only 15 plants have ever been found at SBE, all in one ICA: 14 immatures in October of 2014 and 1 mature in February 2015. Although the single mature did set seed, the area around it was treated with pre-emergent herbicide, and no plants have been found since then. This makes almost two and a half years with no plants found, which strongly suggests that no seed bank was formed. Control efforts are summarized in the table below.

Table 17. SBE Control Efforts

ICA Code	2017 Report Year				2016 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBE-ChrOdo-01	0.18	0.18	3.25	3	0.18	12.25	7

A 200 meter buffer survey around the infestation site was completed last year and this accounts for the high number of visits and effort in 2016. This year, control focused solely on the known ICA. Both last year and this year, staff noted that the area appears to be sprayed regularly by some other group. Since the ICA is directly adjacent to powerline poles, it could be HECO. In any case, these sprays keep the area open and easy to survey. The ICA will continue to be monitored for at least five to ten years from the date of the last mature plant, although the monitoring frequency will decrease to once a year after five years. As seed longevity trials progress, staff will revise plans based on the best available data.

Given the intensity of training at SBE and the high number of plants at KTA and SBW, there is a chance that *C. odorata* will be reintroduced to SBE. Fortunately, staff already survey or sweep much of SBE. Road surveys are conducted once a year and include all drivable trails. Large areas are regularly swept in the course of ICA control work on *S. condensatum* and *R. tomentosa*. Staff hope these efforts will detect any new *C. odorata* infestations in a timely manner.

Lanikai Discovery and Update

While enjoying her weekend in September 2016, an OANRP staff was horrified to find a single immature *C. odorata* peeking out from the naupaka hedge lining the Kuailima Street access to Lanikai beach.

Beach access where the two-branched *C. odorata* was found. The plant was removed prior to this photo.

The plant was handpulled and submitted to the Bishop Museum Herbarium. Staff have many theories as to how the *C. odorata* got to the beach access, but all are pure speculation: a recreational hiker or motocross rider with dirty gear could have walked by, or staff from OANRP or OISC, or a solider off-duty; someone could have parked next to the (now removed) large *C. odorata* bush in the Camp Smith parking lot and picked it up there before heading to the beach; a tourist from Guam may have transported it; or, worst case, it could be an outlier from a new infestation in the Kailua/ Lanikai/Waimanalo region. OANRP reported the find to OISC, who surveyed the publicly accessible portions of the surrounding neighborhood. No additional *C. odorata* were found. The OANRP staff who found the plant also happens to sit on the board of the non-profit Lanikai Association. With OISC's support, she brought up the find at the board's next meeting to increase public awareness of *C. odorata* and OISC's mission.

OANRP also reported the find to MCBH staff, as the Marine Corps Training Area Bellows and Bellows Air Force Station is located less than 1.5 km to the south. Marines train both at Bellows and on Army lands, particularly KTA. The risk of *C. odorata* spreading to Bellows via training is high. Bellows has excellent habitat for *C. odorata*, with dry, scrubby forest and open, disturbed clearings. In February 2017 OANRP staff joined MCBH, OISC, and Air Force staff on a survey of the roads and trails across the Bellows facilities. The map below shows the proximity of the Lanikai plant to Bellows. The group divided into three survey teams; the ground surveys on the map are only for survey team with OANRP staff and don't include areas monitored by the other two teams. The beach and cabin areas were not surveyed. Encouragingly, there does not appear to be a large *C. odorata* infestation at Bellows, as no plants were found.

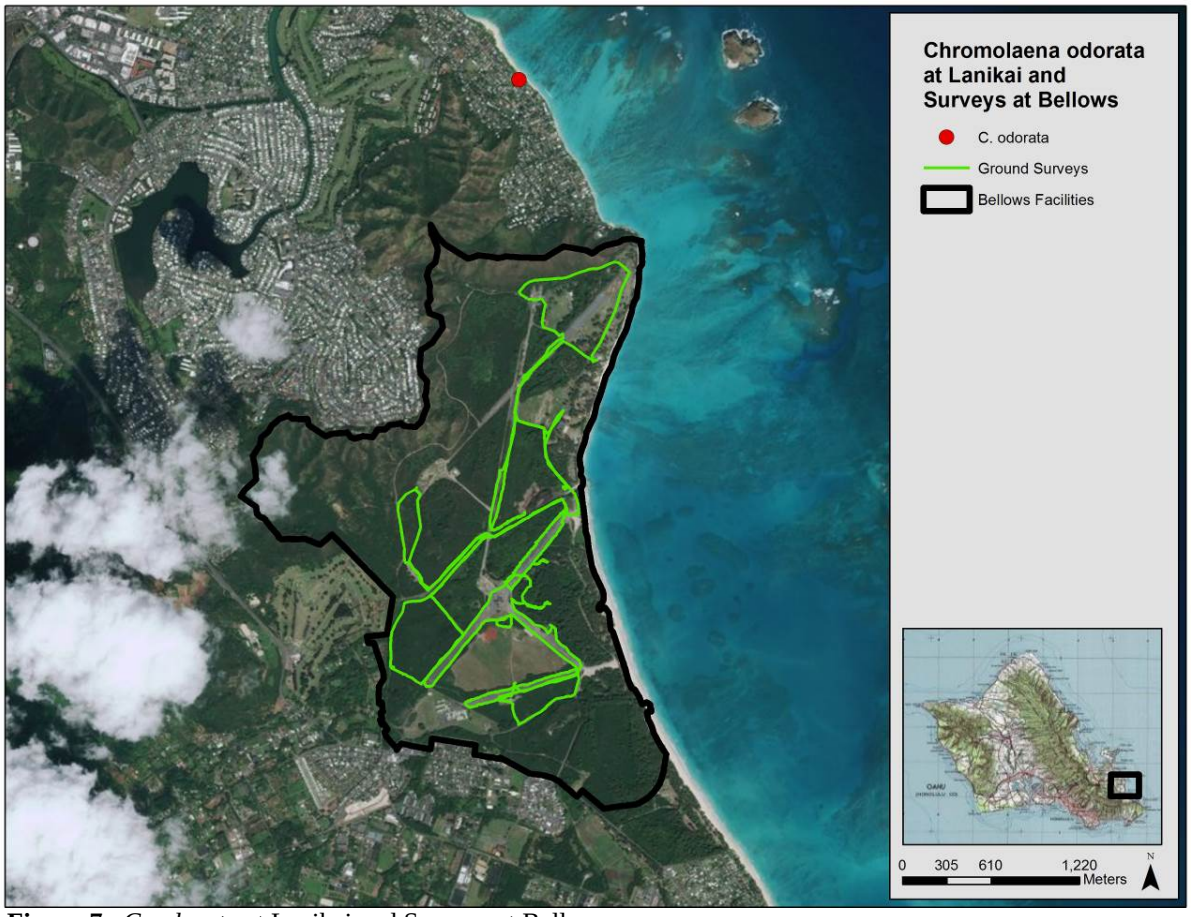


Figure 7. *C. odorata* at Lanikai and Surveys at Bellows

Manuwai Update

On February 23, 2017, staff found one *C. odorata* along the eastern end of the interior Manuwai fenceline, near a tree stump which often serves as a resting spot for staff hiking this steep trail. The plant was large enough to have flowered the previous flowering season (starting December 2016), but was vegetative and did not have any obvious signs of spent inflorescences. Staff did not have time to conduct a survey of the surrounding area that day. Returning to the site in early March, two smaller immature plants were found. The ground in the area was sprayed with pre-emergent herbicide, and staff surveyed the nearby trails on the ridge and along the interior fenceline to the gulch bottom to delimit the ICA (see map below). No other plants were found. This discovery of *C. odorata* was very disheartening, not only because it spread to an entirely new location, but also because Manuwai is a steep and challenging area to work, and most importantly, because OANRP staff were very likely the vector. This incident prompted OANRP's move to having field gear dedicated to *C. odorata* control.

The two immature *C. odorata* found March 2, 2017 at Manuwai.

After looking at records of management in Manuwai, staff determined the dispersal likely occurred during a camp trip either in January 2016 or December 2015. On both trips, staff walked past the stump site and had worked in KTA on *C. odorata* in the preceding days. Seed could have hitched a ride via packs, footwear, or other improperly cleaned gear. The focus of both camp trips were large sweeps treating alien canopy trees. In total, 9.26 ha were swept across a total of six different WCAs; these are the 'Potentially Contaminated' purple polygons in Figure 8. While portions of the MU seem like marginal *C. odorata* habitat, the open ridges, grassy slopes and northern forest patches all are ripe for *C. odorata* invasion. Rather than surveying a 200m buffer around the ICA, staff plan to prioritize surveys of the 'Potentially Contaminated' polygons, as well open habitat within the 200m buffer. These surveys are a priority in the coming year. Thus far, survey efforts have been limited to frequently used trails. Surveys will be challenging, as terrain is steep and visibility through surrounding vegetation is poor (particularly in areas where alien canopy was controlled, leading to increased light and understory growth), meaning the potential of detecting any *C. odorata* present will be low. Unfortunately, there is no easy way to improve this. Aerial surveys have limited utility, as the canopy is tall and *C. odorata* is cryptic. However, staff

may be able to identify areas which appear to be particularly good habitat via aerial survey, and spend more time surveying them on the ground. All staff have been briefed to look for *C. odorata* in the course of other management work.

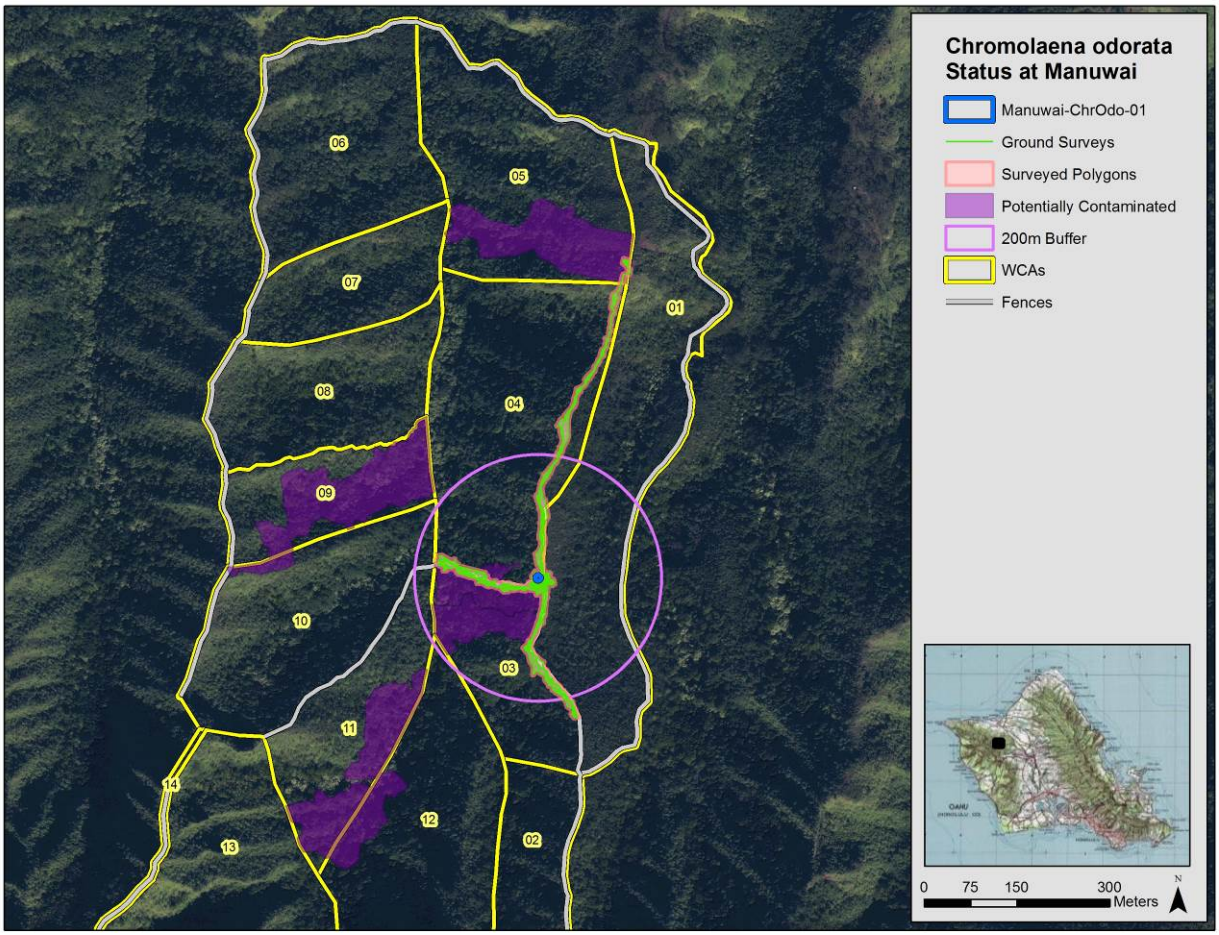


Figure 8. *C. odorata* Status at Manuwai

Control efforts for the year are summarized in the table below. No plants have been found since March 2017 thus far, and the site will be checked quarterly in the coming year.

Table 18. Manuwai Control Efforts

ICA Code	2017 Report Year				2016 Report Year		
	ICA Area (m^2)	Area Weeded (m^2)	Effort (hours)	# Visits	Area Weeded (m^2)	Effort (hours)	# Visits
Manuwai-ChrOdo-01	78	78	13.75	4	n/a	n/a	n/a

The discovery of *C. odorata* at Manuwai and Lanikai this year, as well as its spread to new sites previously documented by OANRP and OISC in years past, drives home the need for a viable biocontrol. If OANRP and partners are successful in releasing *Cecidochares connexa*, reputed to be capable of infecting widely scattered *C. odorata* plants across the landscape, eradication is possible. This aggressive invasive plant requires aggressive control measures.

3.8 INVASIVE SPECIES UPDATE: *CENCHRUS SETACEUS*, FOUNTAIN GRASS

Cenchrus setaceus is a priority for control whenever found on Army training lands due to its invasive behavior, documented fire risk, and ability to thrive on steep rocky habitats where IP taxa dwell. *C. setaceus* is easy to kill. As a general rule, staff always clip and bag any inflorescences for later disposal at H-Power. Plants may be hand-pulled or treated with a foliar spray of glyphosate. A pre-emergent herbicide is often mixed with the glyphosate to reduce recruitment of seedlings. Aerial sprays are effective in killing plants. However, herbicide is most effective when applied to actively growing plants and many of the ICAs are found in dry habitats; herbicide application needs to be timed to coincide with wetter periods when plants are green.

A buried seed trial conducted by OANRP staff found that it forms a transient seed bank (seeds viable for up to 1.5 years; see 2016 YER Appendix 3-9). For this taxon, OANRP conservatively declares a site eradicated if consistent monitoring finds no plants at a site for twice the time of seed persistence, in this case, three years. If the site is difficult to survey and staff do not have high confidence in the detectability of *C. setaceus*, monitoring may be extended for several more years. This taxon is eradicable, particularly from discrete infestations, and OANRP has indeed successfully extirpated it from six different ICAs over the years. Three of these eradications occurred this year. The table below summarizes all eradications to date. Note that the number of plants removed from DMR is likely an underestimate, as records from the early 2000s are incomplete. All of the eradicated ICAs were located in areas with easy access and flat or easily navigable terrain. All the eradicated ICAs were discovered before infestations spread widely.

Table 19. Eradicated *C. setaceus* ICAs, Data Totaled for All Years of Control

ICA Code	Total Area ICA (m^2)	Date First Found	Date Eradicated	Total Effort (hrs)	Total # Visits	Total # Plants Removed
DMR-CenSet-01	6,057	2001-08-30	2015-08-03	9.95	13	12
KTA-CenSet-01	4,739	2000-07-01	2014-01-06	57	31	806
KTA-CenSet-02	960	2012-04-11	2017-04-05	21.75	13	86
MMR-CenSet-01	2	2006-03-13	2012-03-12	0.51	6	1
SBE-CenSet-01	15	2004-09-21	2016-08-15	4.85	11	1
SBE-CenSet-02	98	2012-02-06	2016-08-15	8.8	13	12

Table 20 summarizes control efforts for this year. Last year, 8.9 ha were weeded over 90.27 person hours on 20 visits. This year's totals are much higher, mostly due to an increase in area surveyed across Makua Valley and parts of Keaau and additional time spent in the core on the makai portion of Ohikilolo ridge. Ten ICAs were monitored this year. Of these, three were eradicated, as mentioned above. Two were newly discovered, one in Makua valley and the other in Kahanahaiki. Five of the active ICAs, including the two newest, are small in area and have a good prognosis for eradication, with clear declines in plant numbers. The remaining two ICAs, MMR-CenSet-02 and KeaauNoMU-CenSet-03, cover the most area and are home to the most plants. Both continue to pose management challenges. Given that *C. setaceus* is widespread at PTA, well-established along at least two popular southeast Oahu hiking trails, and there is an illegal trail on Ohikilolo ridge, it is likely new ICAs will be found on Army lands in future. Sanitation measures are in place to clean military vehicles leaving PTA, but there is currently no effective way to prevent recreational hikers from becoming vectors.

In November 2016, staff discovered a new infestation of *C. setaceus* on high cliffs in the Waianae Kai Forest Reserve. The find was shared with the State. OANRP plans to assist the State with aerial spraying of the infestation. In addition, staff will also assist OISC and KMWP with aerial sprays of another infestation above Aiea.

Table 20. 2017 Report Year *C. setaceus* Control Efforts

ICA	ICA Total Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Comments
KeaauNoMU-Censet-03	21.51	6.64	8	2	This year, staff conducted surveys from Ohikilolo ridge using binoculars and found that the infestation was much larger than previously thought, extending to about 2,000 ft. elevation. A few plants were handpulled, but most were inaccessible and well below the fence. OISC manages this ICA, which is on private property. The owner denied all OISC requests to use herbicide, which means aerial sprays are not an option. Given the infestation extension found this year, aerial sprays are likely necessary for eradication. OANRP will continue to assist OISC as requested.
KTA-CenSet-02	0.1 (960m^2)	0.1 (960m^2)	2	2	Eradicated this year. The last plants were seen in 2013. Initial treatment removed 16 matures and 63 immatures, with few plants found on subsequent trips. This small site was monitored consistently since its discovery, and this regular follow-up contributed to its rapid eradication.
KTA-CenSet-03	0.77	0.34	2	2	The last plants were seen in February 2015, and this site is approaching eradication. While quite a few plants were removed when it was first discovered (84 mature and 42 immature), fewer than 10-20 plants were found on any subsequent visit. This ICA is in the highly trafficked Kahuku Motocross Park.
MMR-CenSet-02	37.45	26.48	120.16	11	This is the largest infestation on Army land, and the largest in the Waianae Mountains. It is discussed in detail below.
MMR-CenSet-03	0.01 (78m^2)	0.01 (78m^2)	2.75	4	Three mature and nine immature plants were discovered and removed in January 2016. No plants have been found on subsequent visits, a promising trend. Located along the firebreak roads of MMR, this ICA likely is the result of dispersal from nearby MMR-CenSet-02.
MMR-CenSet-04	0.01 (78m^2)	0.01 (78m^2)	1.35	4	One mature plant was discovered and removed in January 2016. No plants were found on subsequent visits. This ICA is located in the mowed area bordering the firebreak road in MMR. *C. setaceus* thrives in disturbed habitat, and likely dispersed to the area from the established MMR-CenSet-02.
MMR-CenSet-05	0.01 (78m^2)	0.01 (78m^2)	26.3	5	In August 2016, staff found a single immature plant along the western edge of the Kahanahaiki fence. This ICA is discussed in detail below.
MMR-CenSet-06	0.01 (78m^2)	0.01 (78m^2)	0.45	2	This site was discovered in March 2017 during a MMR road survey. Three mature plants were removed, but none have been found since. The ICA is on a road crossing a large mowed field east of MMR-CenSet-02.
SBE-CenSet-01	0.001 (15m^2)	0.001 (14m^2)	0.25	1	Eradicated. This site is along a well-used training road. The likely vector was a contaminated vehicle from PTA. One plant was found in 2004 but none have been seen since. Due to very irregular monitoring intervals, this site was monitored for several extra years.
SBE-CenSet-02	0.01 (98m^2)	0.01 (98m^2)	0.5	1	Eradicated this year. No plants have been found since 2012. Since monitoring intervals were somewhat irregular, staff monitored the site for an extra year. This site is along a well-used training road. The likely vector was a contaminated vehicle from PTA.
TOTAL	**59.86**	**33.60**	**163.76**	**34**	

MMR Status

This year, the bulk of *C. setacus* management time and effort was spent in MMR. ICAs are located in the valley (outside of any MU), in Ohikilolo Lower MU, in Kahanahaiki MU, and just outside the training range in Keaau.

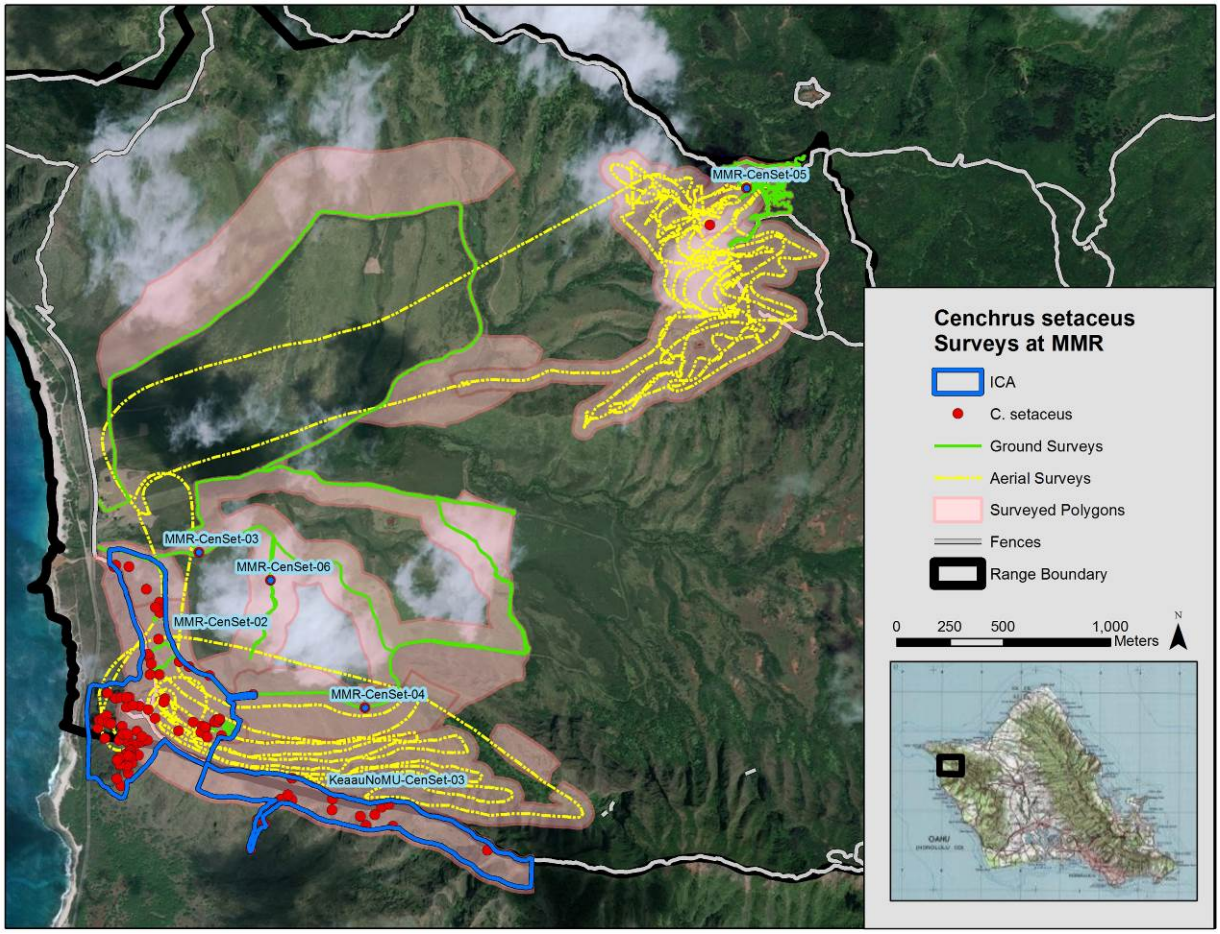


Figure 9. Ground and Aerial Surveys in MMR

- Makua Valley Surveys. In November 2016, staff conducted a large-scale survey of appropriate *C. setaceus* habitat in MMR. It had been five years since similar surveys were done following the discovery of the core infestation in late 2011. The map above shows the scope of survey efforts. Staff conducted both aerial and ground surveys, using binoculars to scan cliffs from safe vantage points. Due to UXO, it is not safe to survey the valley without EOD support, and even with EOD densely grassy areas are unsafe. Crews surveyed down Ohikilolo ridge from White X LZ, drove the firebreak road and scanned nearby cliffs, swept the Hibiscus and Akoko WCAs and binocular-surveyed the slopes between them, and surveyed parts of Kahanahaiki (discussed below). While no brand new sites were found, both the MMR-CenSet-02 and KeaauNoMU-CenSet-03 ICAs were expanded to include plants found outside their old borders. At MMR-CenSet-02, several clusters of *C. setaceus* were found close to the Hibiscus WCA, while another cluster was found south of the Upper Akoko WCA. Additional plants were found north of the Lower Akoko WCA, with one cluster on the northern toe of Ohikilolo Ridge. At KeaauNoMU-CenSet-03, staff mapped clusters of plants extending up the southern slopes of Ohikilolo Ridge, almost up to White X LZ. Most of these plants were quite far from the fence, in Keaau proper.

Aerial surveys spanned the slopes between the Upper Akoko Patch to Koiahi gulch, and from C-Ridge to just north of Kahanahaiki Gulch.

- Kahanahaiki, MMR-CenSet-05. Staff discovered an immature plant along the western, gulch section of the Kahanahaiki fence in August 2016. It was submitted to Bishop Museum and determined to be a vegetative match for *C. setaceus*, but without an inflorescence, identification cannot be confirmed. One re-sprout was found and treated in November 2016 and no plants have been seen since. The site of the ICA is unusual for *C. setaceus*: a forested slope, heavily shaded but with an open understory, on the lower slope of a mesic gulch. Generally, dry, open, sunny slopes are its preferred habitat. It is possible staff were the vector for this plant, or more disturbingly, the vector could have been the wind. A 200 m buffer was drawn around the plant, see map below. Most of this buffer included densely forested slopes in the actively managed Kahanahaiki fence. Trails and appropriate habitat within the buffer were prioritized for ground surveys. Parts of the buffer were surveyed from vantage points using binoculars, while staff walked other, more-accessible areas. No additional plants were found within the buffer.

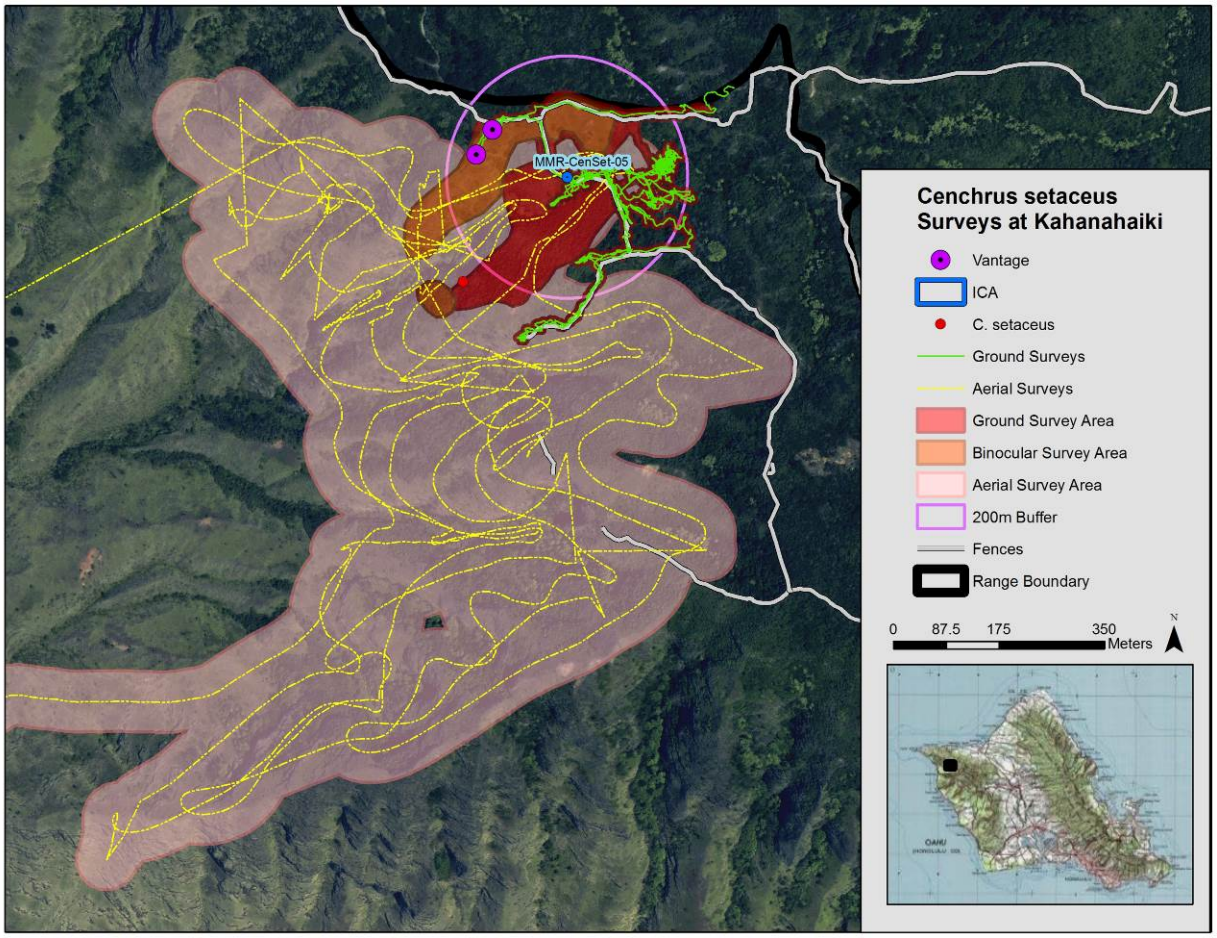


Figure 10. Ground and Aerial Surveys at Kahanahiki

- Kahanahaiki Outlier. However, staff did note a suspicious plant outside of the Kahanahaiki buffer, on a cliff across the gulch, south of the Makua-Kuaokala fence (see map above). The plant is more than 200m from the best vantage points, and was not reproductive either when it was initially seen in November 2016, or on a second survey date in February 2017. Aerial surveys took place the day before the plant was seen by ground-based staff in November. No *C. setaceus* was identified on these aerial surveys, although several patches of another, native clumping grass

were seen. The photo below gives a sense of the difficulty of identifying such a remote plant. In the coming year, staff plan to survey the site again to make a definitive identification via helicopter or drone or spotting scope. As a last resort, staff will attempt to rappel to the site. If it is not possible to identify the plant, staff will attempt to aerially spray it as a conservative measure. The plant could be the result of wind dispersal from the core.

Possible *C. setaceus* outlier west of Kahanahaiki MU, with landmarks noted.

- MMR Road Surveys. During the annually scheduled road survey, MMR-CenSet-06 was found. This is the third ICA to be found within or on the firebreak roads, in a mowed area. It is unsurprising that *C. setaceus* takes advantage of open, disturbed areas. This find further illustrates the importance of the annual road survey. Fortunately, mowed, open areas are relatively easy to survey and monitor.
- Core Infestation, MMR-CenSet-02. The primary *C. setaceus* infestation is entirely within MMR-CenSet-02. Due to its large size, challenging terrain, thick *Urocholoa maxima* cover, split ownership and the presence of UXO in MMR, multiple actions are needed to treat the entire site. Please see last year's report for a detailed breakdown of the control strategy for this ICA. Figure 11 details different Control Regions within the ICA; the red line estimates the boundary between MMR and private land in Keaau.
    - Both ground-based control and aerial sprays were conducted at ICA #2 this year and are shown in the map below, Figure 12. This year, 26.48 ha were treated in ICA #2. Of this, 2.92 ha were treated from the air and 24.87 ha were swept on the ground (ground and

aerial treatments overlapped). In 2016, 8.39 ha were swept, with 4.11 ha of aerial treatment and 5.89 ha of ground treatment, while in 2015, 3.81 ha were swept, with 2.80 ha aerial and 2.42 ha of ground. Note that WCA areas (in red on map) were swept multiple times during the course of ecosystem weed control work in both report years, but only time and area spent specifically controlling *C. setaceus* is counted in these totals. Aerial treatment centered over the steep infestation core in the Aerial Spray Zone this year, although one outlier patch on the north side of the ICA was also treated. Only two days of aerial spraying (130 gal of RangerPro 2% dilution in water) were conducted, due to helicopter budget limitations. Ground sweeps covered most Control Regions, including follow-up treatment in the core. Few plants were found in WCAs. The area covered in ground sweeps is particularly high this year, due to surveys conducted between the Hibiscus and Akoko patches.

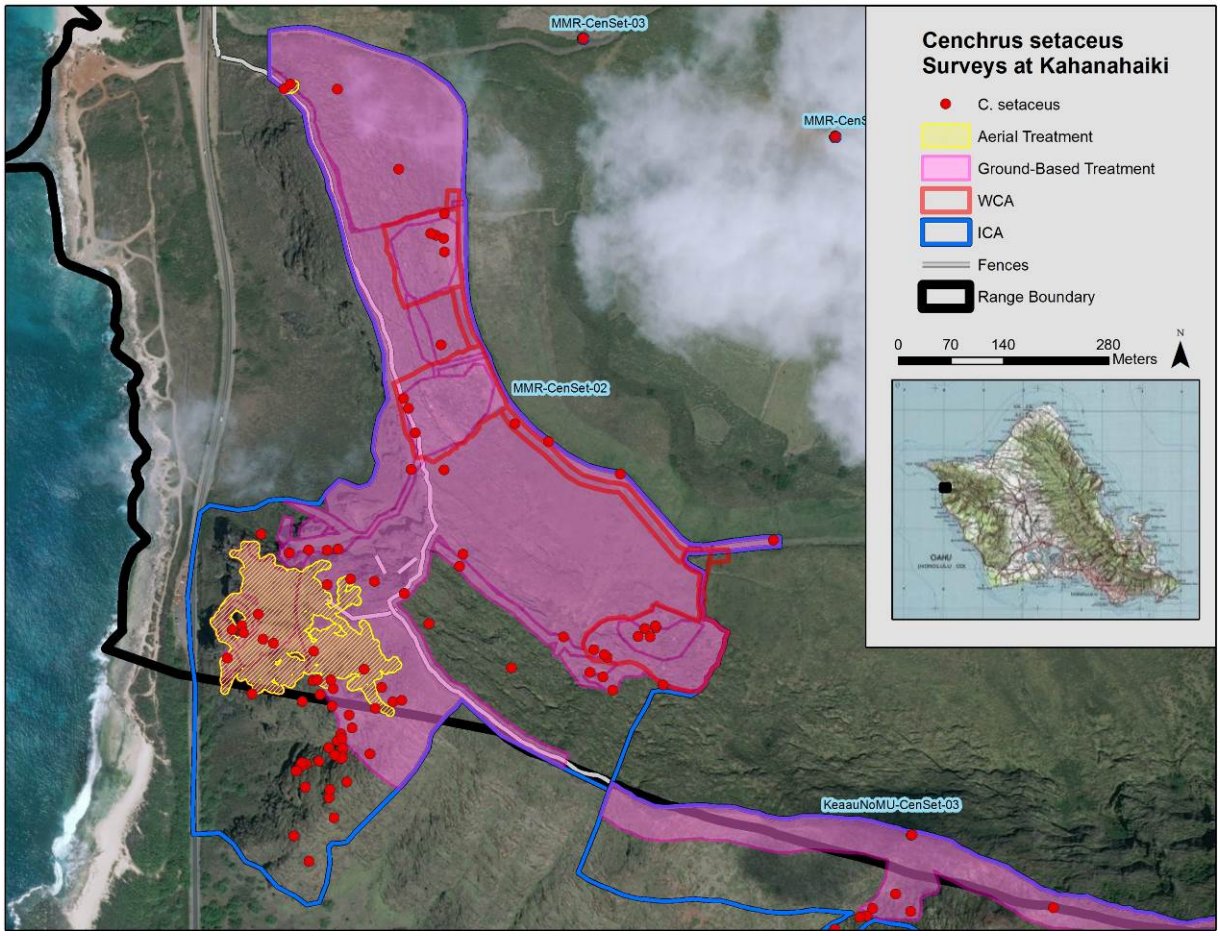


Figure 11. MMR-CenSet-02 Treatment

- The *Melanthera* Cliff zone did not receive treatment this year. This area will be a priority in the coming year, as gigapan analysis conducted last year noted an increasing number of plants in the area. Prior to treatment, the area will be monitored for any remaining *Melanthera tenuifolia* (IP taxa) at a historical site on the cliffs.
- The Cliff Bottom zone also did not receive treatment this year. Comparatively few plants have been found here over the years, however, the area includes an unofficial trail used by trespassing hikers. In future, this area will be a higher priority. The entire infestation must be treated to reach eradication.

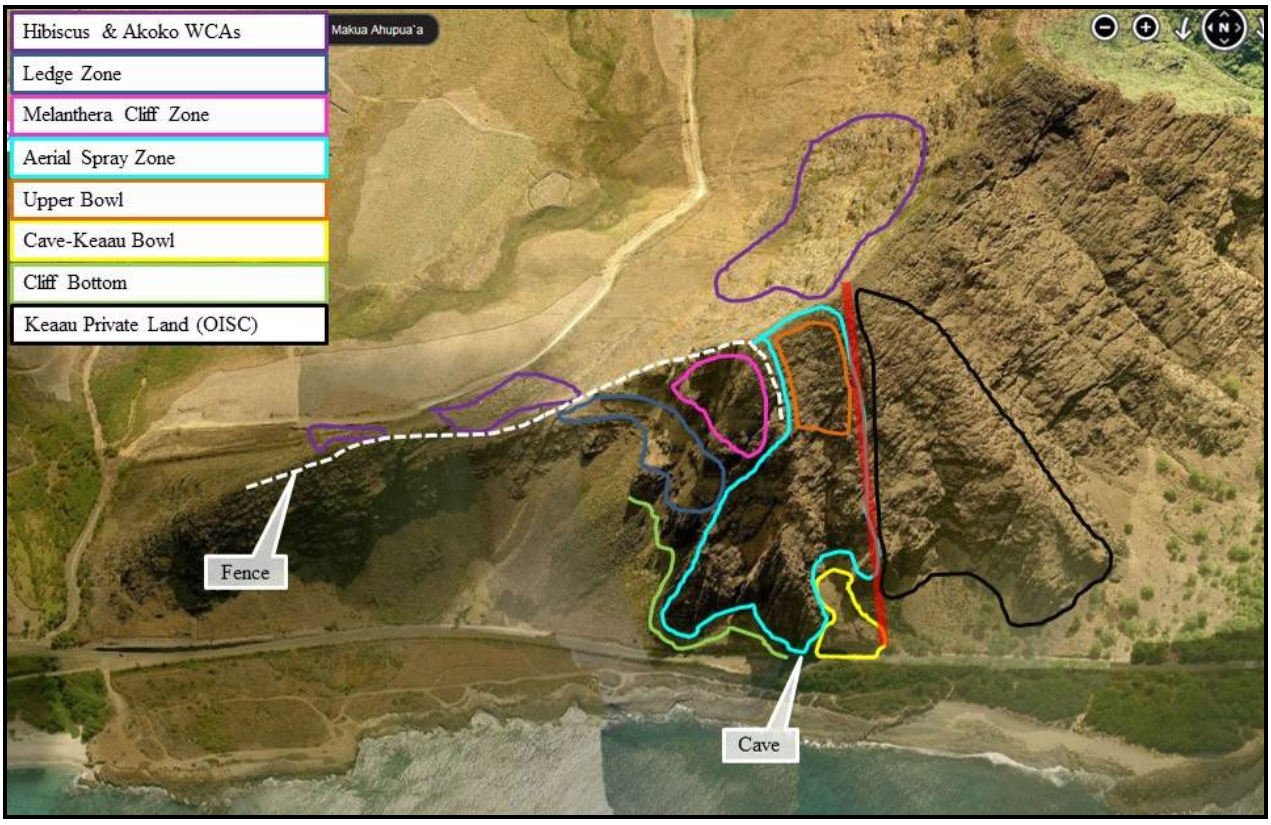


Figure 12. MMR-CenSet-02 Control Regions

- Of particular concern are cliff side plants which are either not reachable with the aerial spray rig, or too close to the road to spray without closing Farrington Highway. Staff need to both determine the feasibility of either temporarily closing the road, and work with Dr. James Leary of CTAHR to use HBT to treat these plants; an appropriate herbicide must first be encapsulated in the HBT projectiles.
- The grassy zones between the WCAs, between the fence and highway, and all other areas not in a Control Region will be surveyed once a year. This year's surveys were successful in identifying outlier plants.
- In the past, OISC has conducted control in the Keaau Private Land zone. OANRP does not have permission to access this area. This year, OISC was not able to treat this area regularly due to competing priorities. A complicating factor was the landowner's restriction of all herbicide use, which makes control efforts less efficient. OANRP will continue to support OISC in working at Keaau and also seek support from WMWP.
- In the coming year staff would like to test the efficacy of non-EPA regulated weed control products with natural ingredients, such as Burnout by Bonide®. The active ingredients in Burnout are citric acid and clove oil. While such products are rarely as effective as traditional herbicides, the private landowner in Keaau may be open to the use of a natural product. Currently, OARNP does not have a location for a trial, but will investigate the feasibility of a greenhouse study and enlist support from OISC. If Burnout is at all effective, it may be possible and worthwhile to use it to aerially spray both the Keaau portions of MMR-CenSet-02 and all of KeaauNoMU-CenSet-03.

Left: Aerial sprays at MMR. Right: Dead, brown *C. setaceus* treated via aerial spray

- The illegal trail running from Farrington Highway to the upper Makua cave continues to be popular with hikers, despite 'No Trespassing' signage. The Ohikilolo Cabin is also a major attraction, despite efforts to lock it securely. Hikers may spread *C. setaceus* from MMR to other regions, or re-introduce it to MMR from other known infestations. The entire Ohikilolo ridge is good *C. setaceus* habitat.
- With aggressive treatment and consistent, thorough coverage, *C. setaceus* may still prove eradicable at MMR, as other incipient populations of have been successfully extirpated by OANRP.

The worst case scenario for Oahu: rolling fields of *C. setaceus*, as seen at PTA.

3.9 RESTORATION ACTIONS UPDATE

This year, restoration actions continued in high priority Weed Control Areas. Restoration activities aim to complement weed control efforts in areas with high weed recruitment, to restore connectivity and structure to native forest patches, and to replace vegetation following removal of dense patches of alien species. Many of OANRP's restoration efforts require dedicated project planning and follow-through. Many are started with the goal of removing all alien canopy from a defined site within a WCA, and outplanting, sowing seeds and planting divisions of native plants for multiple years until native cover goals are reached. Frequent weed control is often required right after non-native canopy is removed, but effort reduces as native plant cover increases via restoration efforts. Ideally, a restoration site is complete when MU native cover goals are met, and weed control can be conducted on a reasonable maintenance level to remove encroaching understory weeds, or MU target species. There are however other restoration actions that are completed with very specific goals in mind such as increasing native canopy around a specific population of rare plant, creating a vegetative fire break, or as a host species for an endangered *Drosophila*, to name a few.

Restoration actions continued in several of the same Management Units as last year including: Kahanahaiki, Kaluaa and Waieli, Ohikilolo Lower, Palikea, and Makaleha West. This year restoration efforts increased substantially in Kahanahaiki, Makaha, Palikea, and Makaleha West. Maps of these sites follow below. No restoration actions were conducted at Ohikilolo due to greenhouse space limitations, or at Kaala, where restoration efforts are a lower priority.

The total area over which a given restoration action takes place is recorded in ArcMap, and restoration details including species used, propagule type and number, source populations, etc. are recorded in the OANRP access database.

Winnowing *Dodonea viscosa* seed

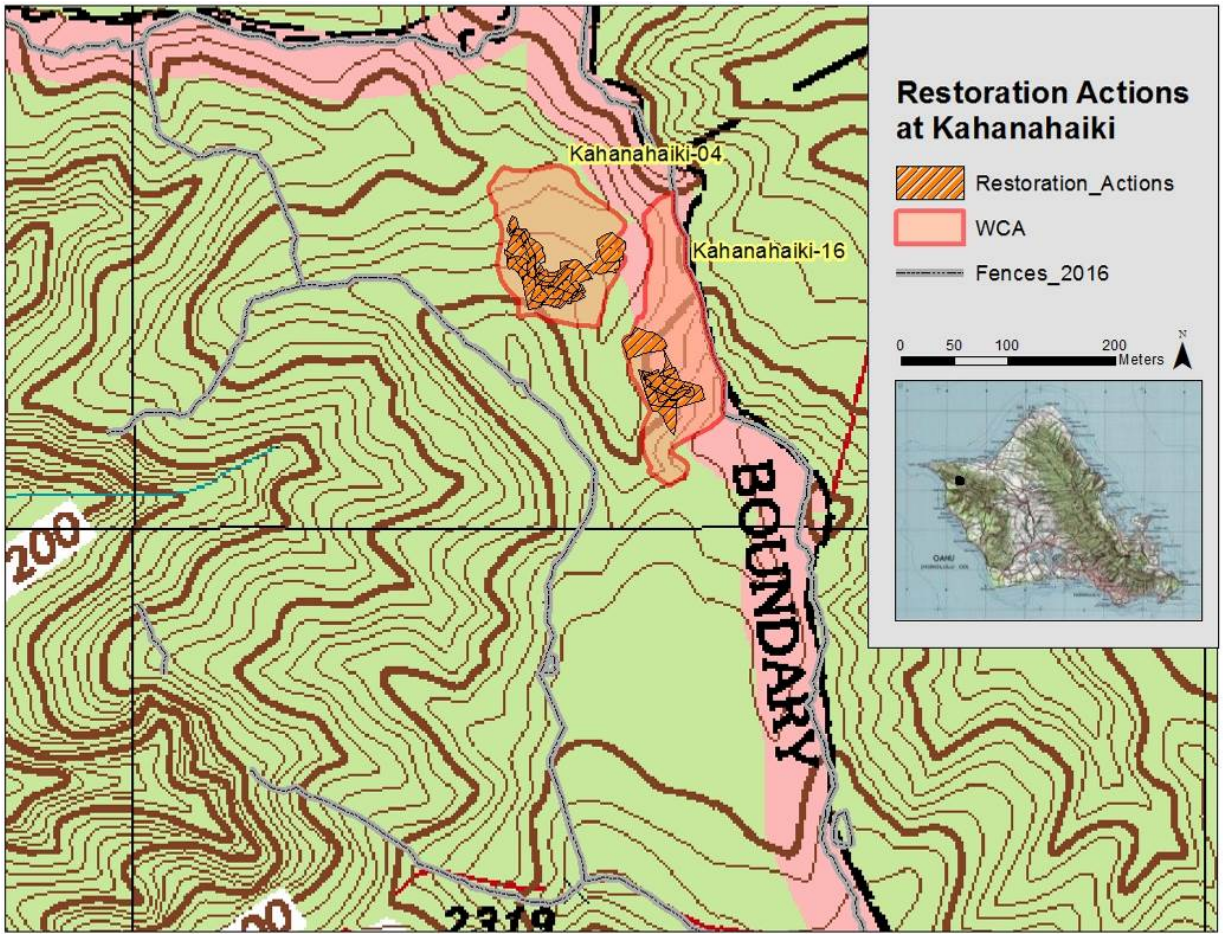


Figure 13. 2017 Report Year Restoration Actions at Kahanahaiki

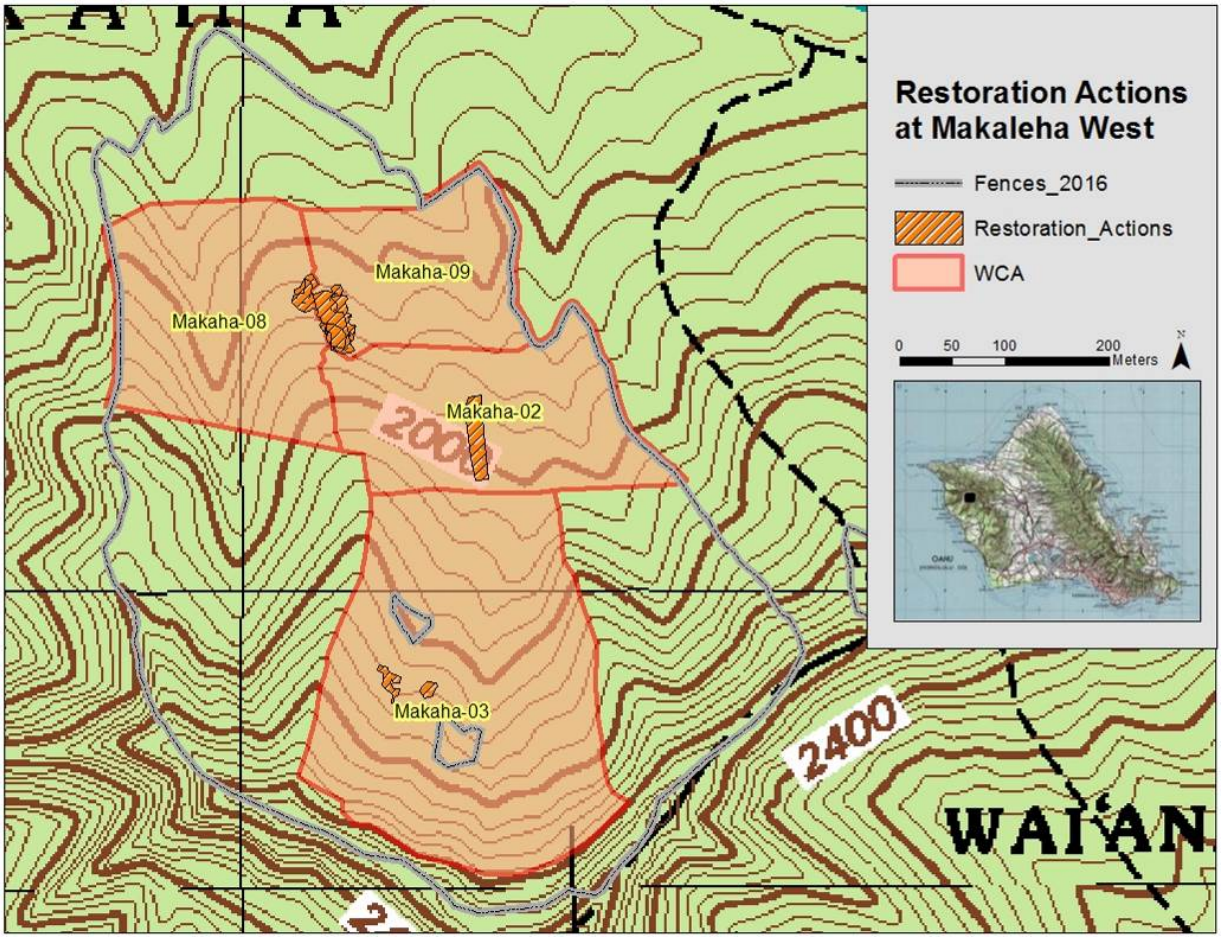


Figure 14. 2017 Report Year Restoration Actions at Makaha

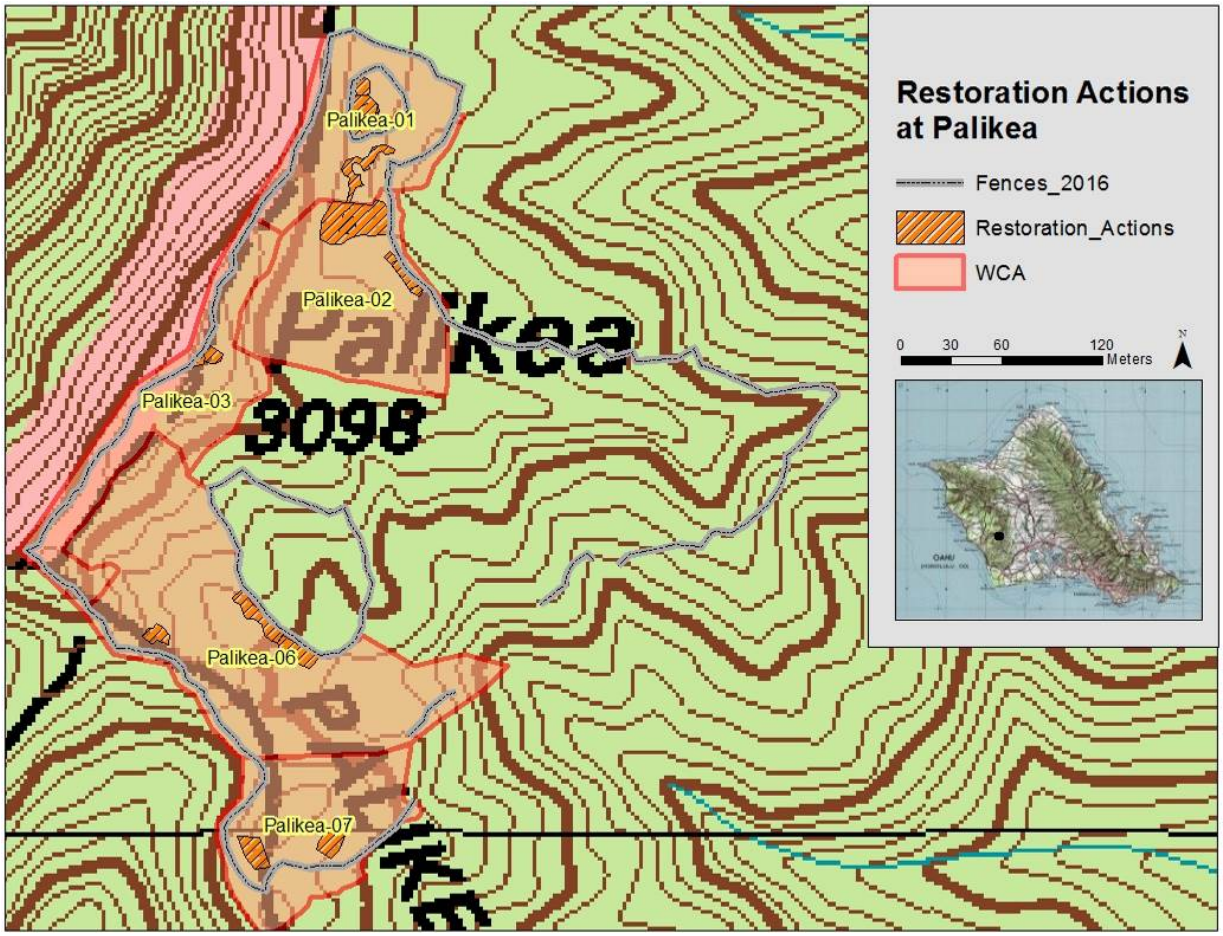


Figure 15. 2017 Report Year Restoration Actions at Palikea

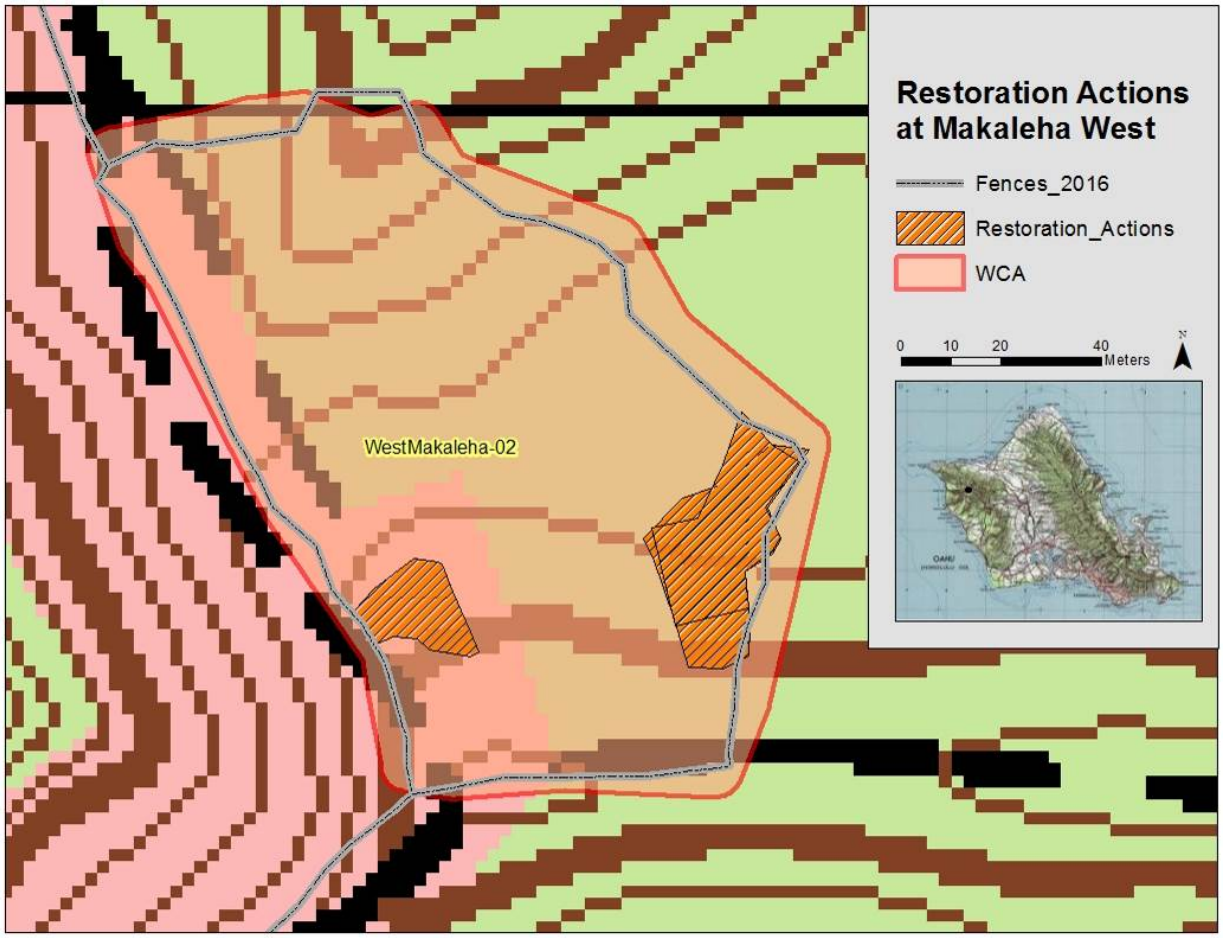


Figure 16. 2017 Report Year Restoration Actions at Makaleha West

The table below details MU restoration efforts for this report year. Restoration actions are tracked within WCAs, as they are a pre-existing system used to track management efforts within MUs. Restoration actions are tracked as two types: 1) outplantings; and 2) seed sows, divisions, transplants (SDT). Outplantings require a higher level of planning and effort, and SDT actions can be done opportunistically and as needed.

Table 21. Summary of Restoration Actions by WCA

'Area' for each restoration type is calculated by merging all the efforts into a single geographic footprint within a given WCA for the year (overlapping areas are not additive).

MU	WCA code	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Kaala	Kaala-01	SDT	n/a	61	*Pipturus albidus*	*P. albidus* was sown on the Army side of the boardwalk in an open area where *Juncus effusus* removal is ongoing. This location is particularly wet (isolated patches of standing water) and sows were targeted on higher ground. No significant efforts will be conducted here in the coming year.
Kahanahaiki	Kahanahaiki-04	Outplanting	430	1616	*Acacia koa, Carex wahuensis, Hibiscus arnottianus subsp. arnottianus, Kadua affinis, Myrsine lessertiana, Pisonia* spp.	Intensive restoration work continued at 'The Shire' this year with 2 outplanting efforts. Planting was focused in locations with the fewest existing outplants. Weeding efforts at the site were expanded to connect with a new adjacent restoration area in the same WCA. At the new site, 'Mirkwood', *Psidium cattleianum* and *Schinus terebinthifolius* were controlled, and plants were outplanted. Additional reintroductions are planned this coming year for the same sites in WCA-04.
		SDT	n/a	3658	*Bidens torta, Dianella sandwicensis, Pipturus albidus*	12 seed sow or transplanting efforts were conducted at the 'Shire' restoration site. Staff continue to anecdotally observe increases in cover using these methods.
	Kahanahaiki-16	Outplanting	94	227	*M. lessertiana, K. affinis, A. koa*	A new set of taxa were outplanted in the 'Schweppes' restoration site this year (~.5 acre site). Restoration efforts will expand in the coming year by clearing an adjacent stand of *Psidium cattleianum*; outplants will follow.
		SDT	(n/a)	1843	*Alyxia stellata, B. torta, D. sandwicensis, P. albidus*	4 seed sow or transplanting efforts were conducted at the 'Schweppes' restoration site. *D. sandwicensis* divisions have been noted by staff to perform substantially better when planted as a larger clump.
Kaluaa and Waieli	Kaluaa and Waieli-02	Outplanting	22	1563	*Freycenetia arborea, Antidesma platyphyllum*	Plants were outplanted inside the Hapapa snail enclosure to increase cover levels of the important snail host species *F. arborea*.

MU	WCA code	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Makaha I	Makaha-02	SDT	n/a	1186	*A. stellata, Coprosma foliosa, Diospyros sandwicensis, Nestegis sandwicensis, Pisonia umbellifera, Psychotria mariniana*	With a group of Youth Conservation Core staff, a variety of species were transplanted into regularly weeded locations.
	Makaha-03	Outplanting	55	478	*H. arnottianus subsp. arnottianus, Perrottetia sandwicensis*	These taxon were planted around a reintroduction of *Cyanea superba* var. *superba* in open areas regularly invaded by weeds.
	Makaha-08	SDT	n/a	540	*B. torta, P. albidus*	Seed sow efforts were conducted in this WCA following a weed sweep in the area.
	Makaha-09	SDT	n/a	1644	*P. albidus*	Seed sow efforts were conducted in the 'Giant Ohia' restoration area in Makaha where *P. cattleianum* was removed (see Appendix 3-11 for monitoring details pre- and post-clearing). Common native plants will be outplanted at this site in the coming year. A new restoration project in the WCA adjacent to this one will commence this coming year.
Ohikilolo Lower	Lower Ohikilolo-02	Outplanting	683	3978	*Dodonea viscosa, Myoporum sandwicense, Erythrina sandwicensis, Scaevola taccada*	Outplantings have been conducted for 2 reintroduction seasons around a managed population of *Euphorbia celastroides* var. *kaenana* to suppress weeds and fire-prone grasses, and improve habitat. Additional plantings of *D. viscosa* were planted densely on a shelf above the wild *E. celestroides. M. sandwicensis* and *Scaevola taccada* were scattered in open pockets this year. This coming year, a similar suite of plants will be planted a few hundred meters away in Lower Ohikilolo-03 around a population of *Hibiscus brackenridgei* var. *mokuleianus*.
Palikea	Palikea-01	Outplanting	20	357	*Cheirodendron trigynum*	Outplants and seed sows continued inside the Palikea snail enclosure. Restoration efforts inside this snail enclosure will continue until all non-native canopy vegetation is removed over the long term.
	Palikea-01	SDT	n/a	553	*P. albidus*	
	Palikea-02	Outplanting	314	830	*C. trigynum, Coprosma longifolia, K. affinis, Psychotria hathewayi, Scaevola gaudichaudiana, Urera glabra*	Restoration activities expanded in Palikea-02 this year to include the area surrounding a new reintroduction of the *Cyanea grimesiana* ssp. *obatae*. Canopy weed species were removed and a variety of native shrub and tree species were
	Palikea-02	SDT	n/a	227	*P. albidus*	

MU	WCA code	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
						planted. *P. albidus* seed sows were also conducted on several occasions.
	Palikea-03	Outplanting	16	47	*Rumex albescens, K. affinis, C. longifolia*	Additional outplantings and seed sows were conducted to shade out grasses on an open slope along the crestline, adjacent to known snail populations.
	Palikea-03	SDT	n/a	94	*B. torta*	
	Palikea-06	Outplanting	41	125	*C. longifolia, K. affinis*	Outplants continued this year in shallow bowls and slopes off the crestline. *Morella faya* has been targeted in these areas, and outplants are being used to fill in light gaps. *P. albidus* was sown on a couple of occasions in an ongoing restoration site in a small gulch in this WCA. This coming year more intense restoration efforts will begin higher in that same gulch (closer to the crest).
	Palikea-06	SDT	n/a	539	*P. albidus*	
	Palikea-07	Outplanting	125	440	*C. trigynum, Coprosma longifolia, K. affinis, Psychotria hathewayi, Scaevola gaudichaudiana*	The Ecosystem Restoration crew completed the removal of *P. cattleianum* at a site in WCA-07, and outplants were planted in light gaps created by removing alien canopy.
Makaleha West	West Makaleha-02	Outplanting	151	801	*A. platyphyllum, Clermontia kakeana, Coprosma longifolia, Metrosideros polymorpha, Perrottetia sandwicensis*	These taxa were planted and sown in locations where canopy weed control has taken place. Filling in light gaps quickly is important at this location where *Rubus argutus* is present and known to invade open areas.
	West-Makaleha-02	SDT	n/a	289	*P. albidus*	

Table 22. 2017 Report Year Summary of Restoration Actions by Management Unit

MU	Total # Outplants/Total Area(m²)		SDT Total Area(m²)	
	2017	**2016**	**2017**	**2016**
Kaala	0	69/95	61	0
Kahanahaiki	524/1843	358/3639	5501	3236
Kaluaa and Waieli	22/1563	82/575	0	184
Makaha I	55/478	0	3370	0
Ohikilolo Lower	683/3978	578/3354	0	0
Ohikilolo	0	250/1286	0	0
Palikea	516/1799	323/1220	824	66
Makaleha West	151/801	83/751	289	238
Year End Totals	1951 plants 10462 m²	1743 plants 10920 m²	10045 m²	3724 m²
Total Restoration Area 2016:	11,750 m²			
Total Restoration Area 2017:	20,164 m²			

Previously established vegetation monitoring methods are ongoing to track vegetation change within small restoration sites. Vegetation monitoring techniques vary at each site including: vegetation plot monitoring, point-intercept vegetation monitoring, photopoints, and Gigapan Imagery analysis. Post-clearing monitoring was completed this year at the Makaha 'Giant Ohia' restoration site and the discussion about pre- and post-clearing comparisons can be found in (Appendix 3-11). There is also the anticipation that restoration actions including large scale canopy weed removal, outplantings, and SDTs will accelerate efforts towards reaching MU vegetation cover goals and will be observed in the large-scale MU vegetation monitoring conducted across MUs.

Watering *Dianella sandwicensis* transplants at Kahanahaiki

Pipturus albidus fruit collected for sowing

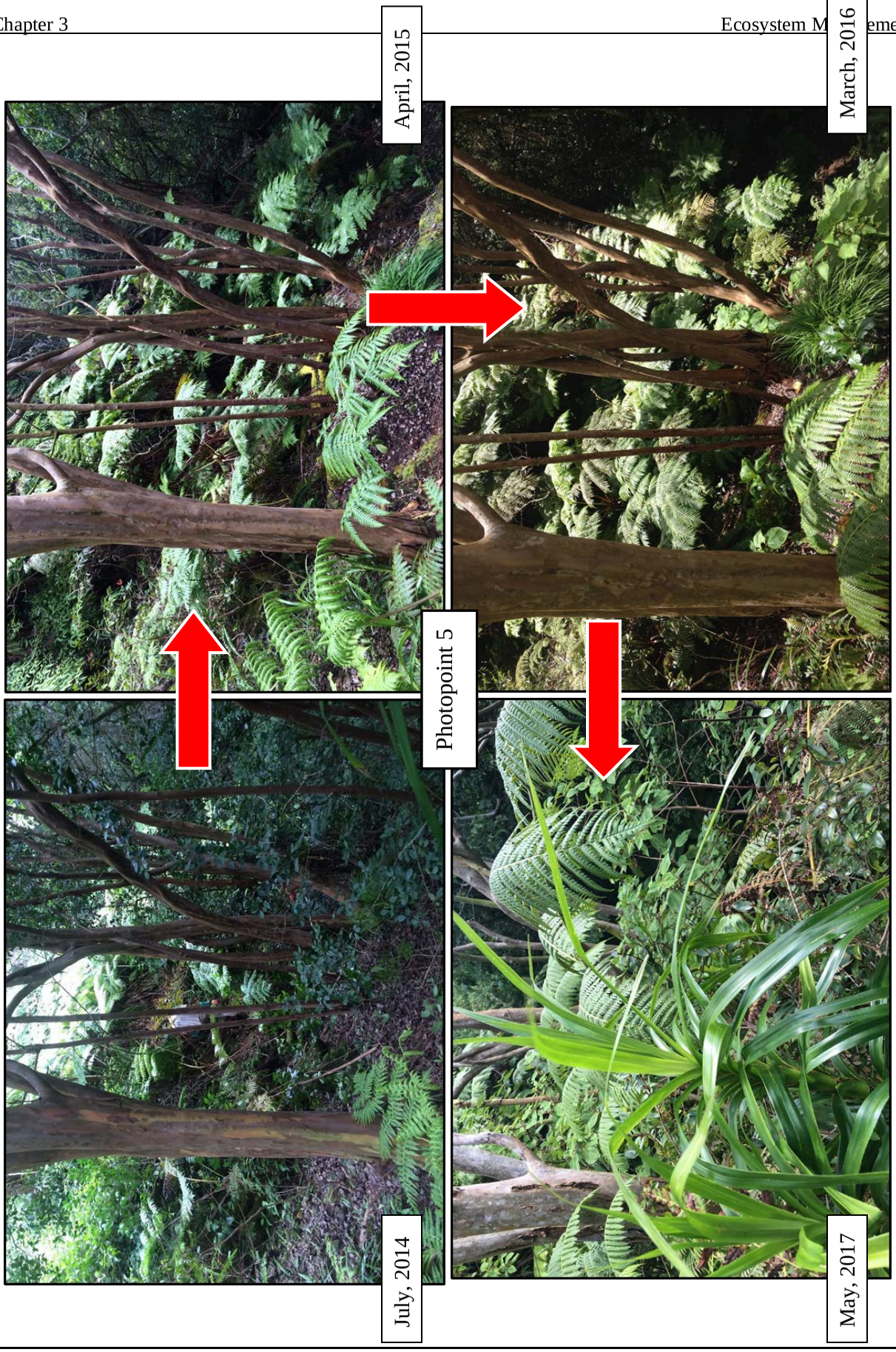
The photopoints below document change at intensive restoration sites. All sites pictured below began with high levels of non-native canopy that were all treated. Some large trees were left standing, but most were cut down and bucked up into slash piles on site. *P. albidus* recruitment after sowing large amounts of seed on several occasions can be seen in all of the Kahanahaiki restoration sites.

The photopoints below document change from July, 2014 (top left) through May, 2017 (following arrows) at the 'Shire' site in Kahanahaiki-04.

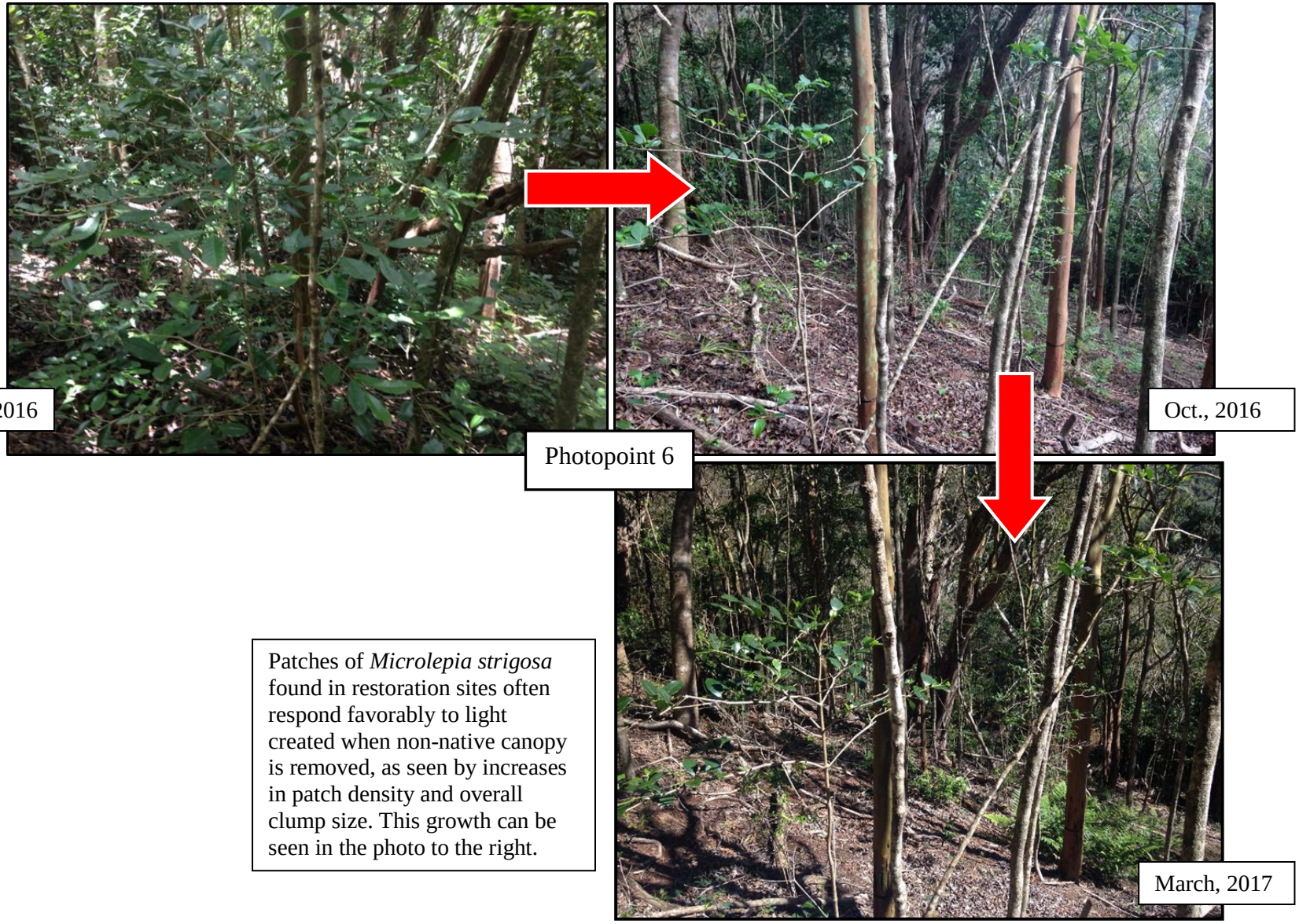

Sept., 2015
June, 2016
Photopoint 2
July, 2014
May, 2017


Sept., 2015
June, 2016
Photopoint 3
July, 2014
May, 2017

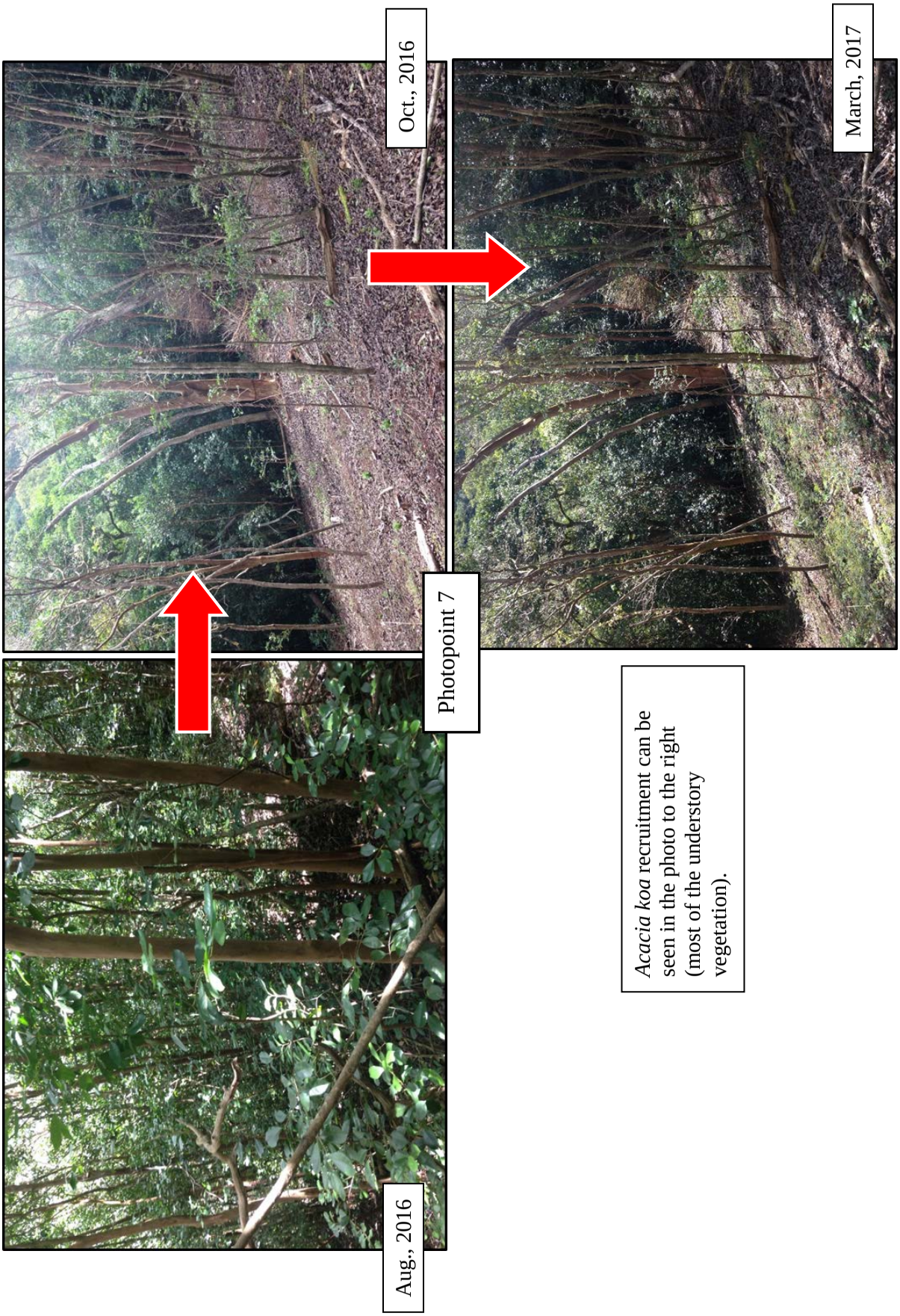
The photopoints below document change from July, 2014 (left) through May, 2017 (following arrows) at the 'Schweppes' site in Kahanahaiki-16.


April, 2015
March, 2016
Photopoint 5
July, 2014
May, 2017

The photopoints below document change from August, 2016 (left) through March, 2017 (following arrows) at the 'Giant Ohia' site in Makaha-09.



Patches of *Microlepia strigosa* found in restoration sites often respond favorably to light created when non-native canopy is removed, as seen by increases in patch density and overall clump size. This growth can be seen in the photo to the right.


Oct., 2016
March, 2017
Photopoint 7
Aug., 2016
Acacia koa recruitment can be seen in the photo to the right (most of the understory vegetation).

Common Native Species Collection

This year efforts were made to target and collect seed from an increased diversity of common native species and populations in support of ongoing restoration actions in high priority weed control areas. To inform seed collection targets, a list of 57 restoration species was developed (Table 23). This list includes species commonly used in OANRP restoration outplantings and seed sows, as well as species not used in past actions, but which exhibit traits beneficial to OANRP restoration goals. Common native seed collections are processed and curated in the OANRP Seed Lab until they are withdrawn for the propagation of restoration plant materials or to develop seed storage and/or propagation protocols for those species where this information is lacking. The "Propagation Protocol Developed" column lists "yes" if any method of OANRP propagation is currently used, including propagation from cuttings.

Table 23. Summary of taxa for OANRP restoration projects

Taxa	Family	Growth Habit	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions 2017
*Acacia koa**	Fabaceae	Tree	Yes	Yes	21169	12	4
*Alyxia stellata**	Apocynaceae	Vine/Shrub	Yes	Yes	827	9	7
*Antidesma platyphyllum**	Phyllanthaceae	Tree	Yes	Yes	0	0	0
*Asplenium kaulfussii***	Aspleniaceae	Fern	Unknown	No	NA	0	0
*Bidens torta**	Asteraceae	Forb/Herb	Yes	Yes	413509	19	10
*Carex meyenii***	Cyperaceae	Graminoid	Yes	No	16729	3	3
*Carex wahuensis***	Cyperaceae	Graminoid	Yes	Yes	18258	11	10
*Cheirodendron trigynum**	Araliaceae	Tree	Yes	Yes	12437	5	4
*Chenopodium oahuense**	Chenopodiaceae	Shrub	Yes	Yes	17816	3	1
*Cibotium spp.***	Dicksoniaceae	Fern	Unknown	No	NA	0	0
*Coprosma longifolia**	Rubiaceae	Tree/Shrub	Yes	Yes	2320	17	2
*Cyperus hillebrandii var. hillbrandii***	Cyperaceae	Graminoid	Unknown	No	0	0	0
*Cyperus polystachyos***	Cyperaceae	Graminoid	Unknown	No	0	0	0
*Deparia prolifera***	Athyriaceae	Fern	Unknown	No	NA	1	1
*Dianella sandwicensis**	Xanthorrhoeaceae	Forb/Herb	Yes	Yes	816	2	2
*Diplazium sandwichianum***	Athyriaceae	Fern	Unknown	No	NA	0	0
*Dodonaea viscosa**	Sapindaceae	Tree/Shrub	Yes	Yes	201641	92	21
*Doodia kunthiana***	Blechnaceae	Fern	Unknown	No	NA	1	1
*Eragrostis grandis**	Poaceae	Graminoid	Yes	Yes	14879	3	3
*Eragrostis variabilis**	Poaceae	Graminoid	Yes	Yes	7088	1	0

Taxa	Family	Growth Habit	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions 2017
*Erythrina sandwicensis***	Fabaceae	Trees	Yes	Yes	2208	18	2
*Freycinetia arborea**	Pandanaceae	Vine/Shrub	Yes	Yes	32294	7	2
*Gahnia beecheyi***	Cyperaceae	Graminoid	Yes	No	4091	4	3
*Hibiscus arnottianus subsp. arnottianus**	Malvanceae	Tree/Shrub	Unknown	Yes	0	0	0
*Ilex anomala**	Aquifoliacea	Tree/Shrub	Yes	Yes	8131	5	5
*Kadua acuminata**	Rubiaceae	Shrub/ Subshrub	Yes	Yes	0	0	0
*Kadua affinis**	Rubiaceae	Tree/Shrub /Vine	Yes	Yes	42811	31	6
*Labordia kaalae**	Loganiaceae	Tree/Shrub	Yes	Yes	1515	2	0
*Luzula hawaiiensis**	Juncaceae	Graminoid	Yes	Yes	158	0	0
*Machaerina angustifolia***	Cyperaceae	Graminoid	Yes	No	0	0	0
*Melicope oahuensis***	Rutaceae	Tree/Shrub	Unknown	No	0	0	0
*Metrosideros polymorpha**	Myrtaceae	Tree/Shrub	Yes	Yes	3269802	73	56
*Microlepia speluncae***	Dennstaedtiaceae	Fern	Unknown	No	NA	1	1
*Microlepia strigosa var. strigosa**	Dennstaedtiaceae	Fern	Unknown	Yes	NA	2	2
*Myoporum sandwicense**	Scrophulariaceae	Tree/Shrub	Yes	Yes	1612	2	2
*Myrsine lessertiana**	Primulaceae	Tree/Shrub	Yes	Yes	0	3	2
*Nephrolepis exaltata ssp. hawaiiensis***	Nephrolepidaceae	Fern	Unknown	No	NA	0	0
*Nestegis sandwicensis**	Oleaceae	Tree	Yes	Yes	0	0	0
*Perrottetia sandwicensis**	Dipentodontaceae	Tree/Shrub	Yes	Yes	0	0	0
*Pipturus albidus**	Urticaceae	Tree/Shrub	Yes	Yes	1839	1	0
*Pisonia brunoniana**	Nyctaginaceae	Tree/Shrub	No	Yes	0	0	0
*Pisonia sandwicensis***	Nyctaginaceae	Tree/Shrub	Unknown	No	0	0	0
*Pisonia umbellifera**	Nyctaginaceae	Tree/Shrub	No	Yes	0	0	0
*Planchonella sandwicensis**	Sapotaceae	Tree/Shrub	No	Yes	0	0	0
*Plumbago zeylanica**	Plumbaginaceae	Shrub	Unknown	Yes	0	0	0

Taxa	Family	Growth Habit	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions 2017
*Polycias sandwicensis***	Araliaceae	Tree	Yes	Yes	0	0	0
*Psychotria hathewayii**	Rubiaceae	Tree	Unknown	Yes	407	9	3
*Psydrax odorata***	Rubiaceae	Tree/Shrub	Yes	Yes	0	0	0
*Pteris excelsa***	Pteridaceae	Fern	Unknown	No	NA	1	1
*Rumex albescens**	Polygonaceae	Shrub/ Subshrub	Yes	Yes	4260	3	0
*Santalum spp.***	Santalaceae	Tree/Shrub	Yes	Yes	87	3	1
*Scaevola gaudichaudii***	Goodeniaceae	Shrub	Unknown	No	0	0	0
*Scaevola gaudichaudiana**	Goodeniaceae	Shrub	Yes	Yes	24	1	1
*Scaevola taccada**	Goodeniaceae	Shrub	Yes	Yes	0	0	0
*Sida fallax***	Malvaceae	Shrub	Yes	Yes	1865	1	1

*= Native species outplanted or seeded in past restoration efforts

**= Native species targets for future restoration efforts

Common native species seed production for seed based restoration efforts

OANRP has largely relied on sourcing seed from wild populations in support of its seed based restoration efforts. However, obtaining the necessary provenance and quantity of seed from wild plant populations can be difficult due to access, availability, and unpredictable seed production from year to year. In order to overcome shortages of genetically appropriate native seed necessary to restore ecological function, connectivity, and structure of native remnant vegetation, and to replace cover following the treatment and removal of exotic and invasive species, OANRP will establish native seed production plots or areas at Kahua to ensure a reliable source of seed for future programmatic seed based restoration efforts. Seed production areas are a viable source of seed for post wildfire restoration, however, production would have to be appropriately scaled to ensure the necessary volume of seed is available for effect post fire revegetation. See Appendix 4-7 for a detailed description of this new seed production site.

The goal of seed production at Kahua is to produce a reliable source of genetically appropriate seed adapted to the specific areas where OANRP restoration efforts are taking place. The aim is to maximize seed production while implementing management strategies to minimize intentional and unintentional selection throughout the production process that may result in maladaptation in the wild.

Seed production areas exist at many scales; at Kahua these areas will be small-sized, intensively managed seed plots likely ranging from 500-2000 square feet. Planting stock for production plots will be sourced from wild populations and propagated in OANRP greenhouses. Ideally, each plot will include stock representing a minimum of 50 wild individuals. Plots will be irrigated by hand initially; however, the current catchment-based automated irrigation system can be expanded if necessary. Harvested seed will be processed in the OANRP Seed Lab and stored for the short term until utilized in the field. Alternatively, harvested seed can be stored as foundation seed for the establishment of larger seed production areas. To initiate seed production activities at OANRP two plots will be established, *Bidens torta* and *Carex wahuensis* (Table 24). Both of these species can be characterized as workhorse species, locally adapted native plants that are abundant across a wide range of ecological contexts, establish

quickly and produce ground cover on disturbed sites. Base wild collections were targeted in March and April 2017 at Makaha and Kahanahaiki for *C. wahuensis* and Palikea for *B. torta*. Weed control began on site in March 2017 and will continue through August 2017. Planting is estimated to take place in September 2017 for *B. torta* and November 2017 for *C. wahuensis*. Stock plant will be planted in 12" rows, 12" apart into woven ground/weed cloth.

Bidens torta production in the OANRP greenhouse.

Table 24. Seed Production Plot Details

Taxa	Source Population (s)	# of Wild Individuals Represented	Plot Size (m^2)	Plants/Plot	Estimated Planting Date
Bidens torta	Palikea	30 (more individuals to be added through time)	175	1476	September, 2017
Carex wahuensis	Kahanahaiki and Makaha	68	93	1000	November, 2017

CHAPTER 4: RARE PLANT MANAGEMENT

4.1 PROJECT HIGHLIGHTS

During this reporting period, OANRP outplanted a total of 1,755 individuals of 11 MIP and OIP taxa. In the last year, OANRP made 469 observations at *in situ* sites and outplanting sites of IP taxa. For a detailed taxon status summary see Appendix 4-1. Some of this year's highlights include:

- *Cyanea grimesiana* subsp. *obatae* (MIP & OIP): This is a continuation of the update from the controlled breeding study in 2014. This project was initiated to conduct supplemental pollination experiments to compare the fitness of progeny from self-pollinated, intra-population and inter-population hand crosses. This project was designed to address concerns for difficulty of *ex situ* propagation and poor survival and lack of recruitment at outplantings and wild sites. Two outplantings of the progeny from this study were planted this past year, one site at Palikea and another at Makaha. Locations and methods were approved by OANRP, NARS, and OPEPP staff. The Palikea reintroduction site contained almost 800 plants and of those reintroduced, 99% have survived. Additionally, the Makaha reintroduction added another 250 plants to the totals and should provide a great seed source for future testing and storage.

- *Gardenia mannii* was recently outplanted into Lihue, and was the first attempted reintroduction for this species. These plants are thriving and show promise for establishing a new population with mature individuals that can be used for crossing, as *G. mannii* does not flower regularly in the greenhouse. Additionally, mature fruit with viable seeds was collected from an *in situ G. mannii*, the first such occurrence in nearly 15 years. We plan to continue reintroductions of *G. mannii* into the Koolau PU in the coming year.

- Laboratory experiments were conducted to assess seed viability of *Delissea waianaensis* and *Cyanea grimesiana subsp. obatae* following fruit senescence, and data was used to determine the effect of seed viability on recruitment. Details of these experiments can be found in Appendix 4-2 and 4-3.

- In addition to laboratory experiments, field trials were conducted at numerous sites for *Cyanea superba* subsp. *superba* to examine environmental influences on germination at existing and potential manage for stability sites, and to determine if seed sowing of *Tetramolopium filiforme* var. *polyphyllum* is a viable option for establishing reintroduction sites. Details of these experiments can be found in Appendix 4-4 and 4-5.

- Included in the appendices is also a five year plan for *C. longiflora* (Appendix 4-6).

- Executive Summary Appendix ES-2 also has instructions for utilizing the database to generate reports on each species explaining Taxon Status, Threat Control, and Genetic Storage Summary Tables.

- Kahua Fence: In an effort to reduce greenhouse space for the living collection of some species, as well as reduce field time needed for seed collection, a fence was constructed at the now decommissioned site of the former Schofield Barracks Landfill. This fence and surrounding area will be referred to as the Kahua Site. This site will be used in the future for seed production and as a living collection for some rare plant species. For a detailed description of rare species and future plans for this site, see Appendix 4-7.

- The past year has brought numerous staffing changes to the Rare Plant Program, including a new Rare Plant Program Manager, Nursery Manager, and Propagule Management Specialist.

4.2 THREAT CONTROL SUMMARY

The Threat Control Summary for each IP taxon is included as Appendix 4-8 and shows the current status of fence construction and removal of pigs and goats from Management Units, invasive plant, rat and slug control, and preventing wildfire. "Yes," "No," or "Partial" is used to indicate the level of threat management. Additionally "Partial" management includes a percentage based upon the number of mature plants being protected.

Ungulate threat control and fence repairs are ongoing, and all areas known to be free of ungulates are listed as "Yes." PUs where ungulates have been seen inside the fence or where it is uncertain if they are still present are listed as "Partial" for threat control until it is confirmed that ungulates have been removed.

Weed control continues at most MU, and is a threat to all taxa in all PU. See Chapter 3 for more detailed description of weeding efforts and long term plans. The weed control status was determined by overlaying weed control efforts with IP taxa population sites in GIS. A 50m radial buffer around IP taxa sites was created. If weed control efforts covered the entire buffer for a particular population reference code, it was counted as full management, and assigned a 'Yes.' Four population sites for four different taxa meet the goals of full weed management, this is unchanged from the previous year. If only part of the buffer was weeded, it was assigned a 'Partial'. Of the 133 MFS PU, 97 PU receive 'Partial' weed control status. This is an increase of 2% from the previous year.

Rats are considered a potential threat to most IP taxa, as they consume fruit, as well as damage stems and seedlings of plants. Rat control continued around many PU in the last year in large grids around entire MUs and in smaller grids targeting individual populations. Although rats potentially threaten most IP taxa, they are only controlled around sites where significant damage has been observed. There are situations where occasional damage to a few plants is observed. In those cases, if the damage is not observed again, control is not immediately installed and the site is monitored more closely. Rats are considered a threat to 20 of the 39 taxa in the MIP and OIP and are controlled at 93 population sites. This is an increase of 11% from the previous year. Future plans for rat threat management will include the addition of more A24 automatic resetting traps which should improve time efficiency and control of rats around rare taxa.

Slugs are a threat to seedling survival and recruitment of many native plants and they are noted as a threat to 25 of the 39 MIP and OIP taxa. Slugs are currently controlled at 26 of the 83 MFS PUs with those taxa, which is an increase of 6% from the previous year. Decisions on where to initiate control are based on site accessibility, slug impact on recruitment, and the presence or absence of native snails. These variables will be taken into account when planning future outplantings and site selection for IP taxa.

4.3 GENETIC STORAGE SUMMARY

The Genetic Storage Summary for each IP taxon is included in Appendix 4-9. Every year, OANRP collects propagules from IP taxa for *ex situ* genetic storage. The amount of propagules needed to meet these goals were pre-determined in the MIP and OIP. In general, each wild plant (up to 50 plants from each PU) needs either 50 viable seeds (as estimated at the time of collection) or 3 ex-plants/plants held in

tissue culture or as a living collection in the nursery. This year we reported only the collections that have not expired, *i.e.* have not been stored for longer than the species re-collection interval.

This year there were 54 PU that reached their storage goal. This is a decline of 12 PU from last year, and is attributed to the expiration of collections in the seed bank inventory. There are an additional 1,640 plants that met their storage goal in 137 other PU (where the PU genetic storage effort is not 100% complete) an 18% increase in plants from last year. However, due to the expiration of collections in the seed bank inventory, overall 116 fewer plants met their genetic storage goals in 2017 compared to 2016. Seed Lab staff are currently conducting an analysis of viability assays in order to update species re-collection intervals. Once updates are complete, there will be an expected increase in the number plants meeting genetic storage goals.

Chapter 5: *ACHATINELLA MUSTELINA* MANAGEMENT

5.1 BACKGROUND

In this chapter, OANRP *Achatinella mustelina* management is outlined for the next three years: July 2017-June 2018, July 2018-June 2019 and July 2019-June 2020. Highlights of the past two years and progress toward the goals set for the Evolutionary Significant Units (ESUs) are also summarized. There are a total of eight managed populations within the six ESUs (Figure 1). ESU-B and ESU-D have two managed populations each because of their large geographic spread. The Makua Implementation Plan (MIP) set a goal of 300 snails in each of the eight managed populations. The snail populations within the ESUs are divided into Population Reference Sites (PRS). Each PRS is a discrete grouping of snails. There are many PRS in each ESU given the fragmented status of the populations.

In addition, *A. mustelina* predators must be managed at select PRSs. These include black rats (*Rattus rattus*), rosy wolf snails (*Euglandina rosea*), and Jackson's chameleons (*Trioceros jacksonii xantholophus*).

OANRP has made significant progress toward these goals over the years. At five of the eight managed populations in the ESUs, the goal of 300 snails is met (Table 1). At three ESUs (ESU-A, D, and F) enclosures are used to protect PRS from all threats. Populations within all enclosures are stable or increasing. In many ESUs rat control is ongoing. See ESU tables in each section for the threat control status at individual PRS.

Construction is underway for a new enclosure at Palikea North for ESU-E. OANRP plan to complete construction in the summer of 2017. Plans are being developed for two additional enclosures. OANRP plan to construct enclosures at Kaala (ESU-C) and West Makaleha (ESU-B) by the summer of 2018. With the completion of these additional enclosures and successful translocation efforts, all six ESUs will be protected from predators.

Figure 1. Map of Six ESUs.

Table 1. ESU population, rat control, and enclosure status 2017

ESU	# Snails in MFS PRS	# Snails in No Mgmt. PRS	# Snails in PRS with Rat Control	# Snails in Enclosures	Current and Future Enclosure Location
A	243	0	243	215 (Kahanahaiki) 28 (Pahole)	Kahanahaiki/Pahole
B1	337	7	344	0	West Makaleha†
B2	467	192	498	0	West Makaleha†
C	261	10	261	0	Kaala†
D1	805	0	805	805 (Hapapa)	Hapapa
D2	313	0	131	0	
D*	0	449	0	0	Hapapa
E	69	28	78	0	Palikea North†
F	628	13	631	163 (Palikea)	Palikea

*Snails from this portion of the ESU are not managed for stability in the MIP
†Enclosure not yet constructed; the Palikea North enclosure is currently being built.

5.2 ESU-A

ESU-A *Achatinella mustelina*

Map removed to protect rare resources

Figure 2. Map of ESU-A

5.2.1 Management History and Population Trends

Spanning parts of Kahanahaiki Gulch and Pahole Natural Area Reserve, there are 14 PRS at ESU-A (Figure 2). The two enclosure sites are designated Manage for Stability (MFS) and the remaining are No

Management (NM)(Table 2). The MFS PRS have 243 counted snails while the NM PRS snails have all been moved into one of the two snail enclosures. OANRP manages the enclosure at Kahanahaiki (MMR-A) and successful habitat restoration efforts are ongoing with gradually increasing native habitat and cover throughout the enclosure and snails utilizing reintroduced plants for food and cover. SEPP manages the Pahole enclosure (PAH-B) and native cover is also increasing at that enclosure following restoration efforts. Clearing has begun around the Pahole enclosure to rebuild it in the near future to increase its size and improve the level of predator protection. *Euglandina rosea* are assumed to be ubiquitous across the habitat. *Trioceros jacksonii xantholophus* have not been seen in this area.

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

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: A	**Pahole to Kahanahaiki**											
KAP-A	No Management	0	2015-10-14	0	0	0	0	Yes	No	No	No	No
Just below Makua rim on trail above hunter's cabin.												
KAP-B	No Management	0	2013-10-08	0	0	0	0	Yes	No	No	No	No
Chaher weeding site												
KAP-C	No Management	0	2015-10-28	0	0	0	0	Yes	No	No	No	No
One Acre Site												
LEH-F	No Management	0	2016-03-30	0	0	0	0	Yes	No	No	No	No
West Makaleha off of Keawapilau ridge												
MMR-A	Manage for stability	215	2017-05-02	86	107	22	0	Yes	Partial	Yes	Yes	No
Kahanahaiki Exclosure												
MMR-C	No Management	0 *	2016-08-24	0	0	0	0	Yes	Partial	Yes	No	No
Maile Flats												
MMR-D	No Management	0	2015-03-11	0	0	0	0	Yes	Partial	Yes	No	No
Kahanahaiki Gulch												
MMR-M	No Management	0 *	2017-01-17	0	0	0	0	Partial	No	No	No	No
East Rim 2A ridge												
MMR-N	No Management	0	2015-03-11	0	0	0	0	Yes	Partial	Yes	No	No
Kahanahaiki gulch at Steph Joe's slug boxes												
MMR-O	No Management	0	2015-12-07	0	0	0	0	Yes	Partial	Yes	No	No
Giant Olopua												
PAH-A	No Management	0	2011-07-15	0	0	0	0	Yes	No	No	No	No
Cyasup Pahole gulch reintro lower site												
PAH-B	Manage for stability	28	2016-06-20	8	13	7	0	Yes	Partial	Yes	Yes	No
Pahole Exclosure												
PAH-C	No Management	0 *	2015-11-04	0	0	0	0	Yes	Partial	Yes	No	No
below Pahole snail exclosure												
PAH-D	No Management	0 *	2016-06-20	0	0	0	0	Yes	No	No	No	No
Along Makua Rim west of Kapuna fence												
	ESU Total:	243		94	120	29	0					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

(When there is an asterisk under the "Total Snails" column, it means that some snails from that population have been translocated or reintroduced. If there is a 0*, that means that snails have been translocated from

that site and when surveyed again later, 0 snails were found. If there is a 5*, that means that 5 snails have been translocated from that site and it has not been resurveyed since that time.)

5.2.1.1 MMR-A Kahanahaiki Enclosure PRS

The 76m² enclosure at Kahanahaiki is the focus of OANRP's management within ESU-A as all of the observed snails in Kahanahaiki have been translocated to the enclosure. Monitoring of the *A. mustelina* population within the enclosure has continued quarterly, including timed count monitoring (TCM) and ground shell plot (GSP) monitoring. There has been no evidence of predator incursion. Following the overhaul of the enclosure which was completed in early 2014, until the end of 2016, the overall trends observed during monitoring were increasing TCM numbers over time (even after translocations into the enclosure dropped to very low numbers), and low GSP counts (Figure 3).

However, in early 2017 staff began noticing numerous ground shells in the enclosure. Initial thoughts were that possibly *E. rosea* had somehow crossed our barriers and gotten into the enclosure, but with further searching an *A. mustelina* shell was found with rotting tissue mass. This seemed unusual for *E. rosea* since they are known to devour their prey entirely and do not leave food behind.

Staff became particularly alarmed when 50 ground shells were found on February 8, 2017, considering that in all of 2016 only 32 ground shells were found in the enclosure. It was speculated that the mortality could be due to high wind events that occurred around that time. Staff began monitoring the site every 1-3 weeks, and shells continued to be found in higher than expected numbers through the end of April. Snails on the ground were still alive at times but seemed sickly or lethargic. All size classes of snails were represented among the shells (Figure 4). The ongoing high mortality seemed to suggest that high winds from earlier in the year were not to blame. No *E. rosea* were ever found, and staff were unable to determine the cause of mortality.

OANRP arranged with SEPP to collect a fresh sample and preserve it in formalin for analysis. However, the high mortality event ceased before a sample could be collected. In May 2017, mortality rates returned to low numbers, and have remained low through the preparation of this document. Whether the mortality observed between January and April of 2017 resulted from disease or weather remains unknown.

During this extended period of unusually high mortality, a total of 130 ground shells were collected. While the number of snails observed during the first quarter TCM (February 15) remained high (273 snails counted), there were indications of a population decline by the second quarter (May 2), with only 215 snails counted. Though there were some lower than expected timed-counts in prior years, those were instances of data with low confidence due to either inexperienced staff or weather conditions. The most recent timed-count in May represents high confidence data, as monitoring conditions were favorable, and the most highly skilled observers were used. It is anticipated that if mortality remains low, the population will return to its previous trend of increasing numbers over time.

The unprecedented occurrence of a sudden and extended period of mortality within a snail enclosure gives OANRP further confidence in our quarterly monitoring protocol, as opposed to annual or biannual monitoring as has been suggested in the past. This allows us to track population trends and mortality more closely, with the potential to respond to possible crisis situations in a timelier manner. Though we were unable to obtain a sample for analysis during this episode, we now have the tools at hand to quickly obtain a proper sample for analysis if warranted in the future, and a resource established for conducting pathology analysis.

In the past year, 7 snails were added to the existing population from MMR-C and MMR-M. The number of potential snails remaining outside of the enclosure is likely very small.

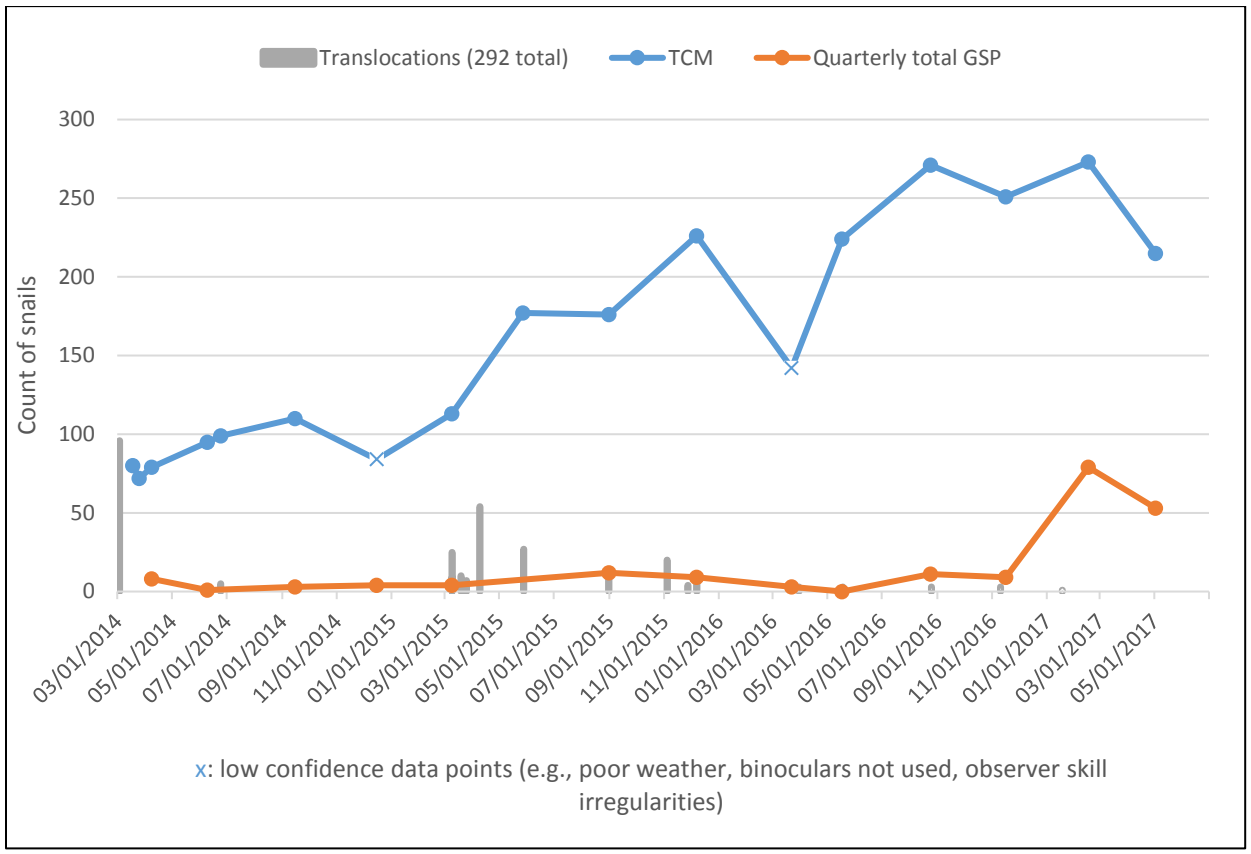


Figure 3. Quarterly timed-count monitoring (TCM) and ground shell counts (GSP) for *A. mustelina* in the Kahanahaiki snail enclosure from the first quarter of 2014 to the second quarter of 2017, with numbers of snails translocated into the enclosure over time. Note: TCM data represents a subsample of the population, as not all snails are detectable at any one time.

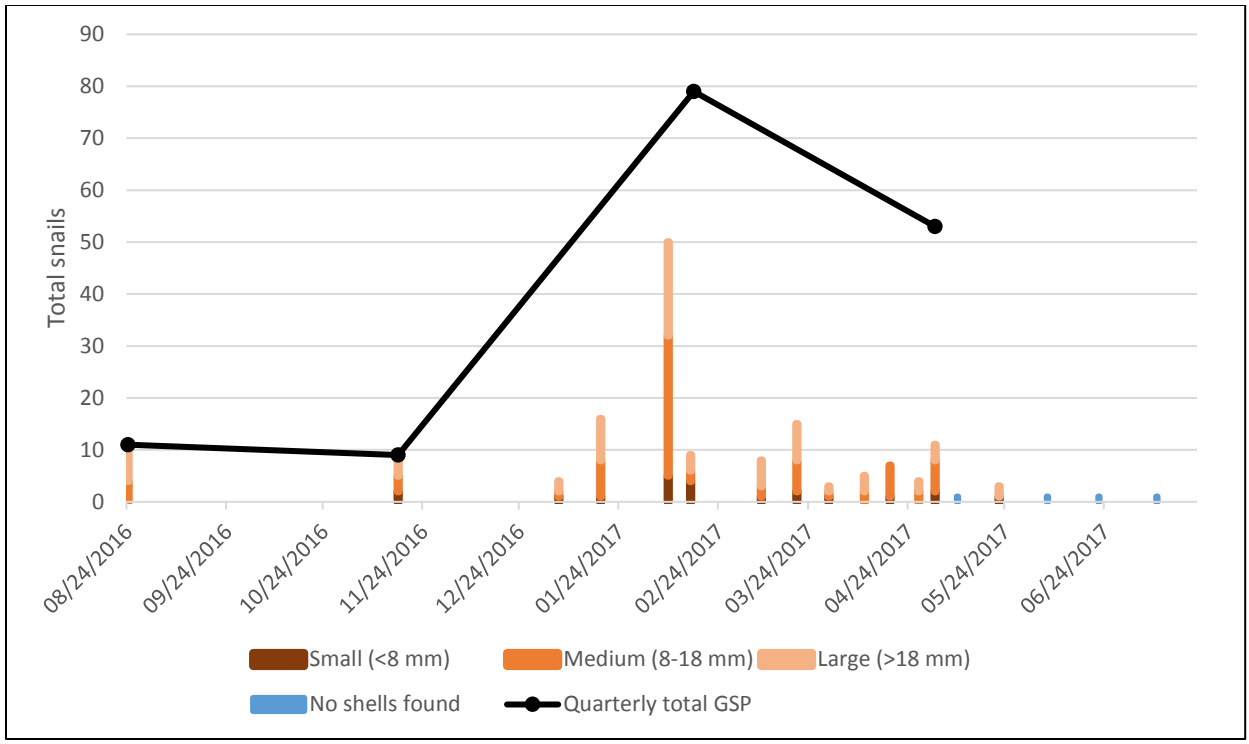


Figure 4: Ground shells found over the last reporting year (July 2016 to June 2017) by size class, showing the trend line for quarterly total ground shell counts. The Kahanahaiki snail enclosure ground shell plot covers the entire enclosure, given its small size. Ground shell plot (GSP) monitoring normally occurs on a quarterly basis coinciding with quarterly timed-count monitoring, but due to higher than expected mortality in 2017, more frequent GSP monitoring was initiated. Quarterly GSP numbers in 2017 were obtained from cumulative numbers from GSP between timed-count monitoring intervals.

5.2.1.2 PAH-B PRS

The enclosure at Pahole is the focus of SEPP's management in this area. Currently SEPP has secured funds to reconstruct the wall and increase the enclosure size. OANRP will assist in these efforts. TCM by SEPP in sampled areas in the enclosure suggest the population is relatively stable, though counts have dropped slightly over the past two years (Figure 5). There were once many more snails inside the enclosure but the habitat declined and snails disappeared. However, through DOFAW and SEPP's weed control and outplanting efforts, the habitat is improving, and with construction funded the future is optimistic. It is noteworthy that the high mortality that occurred only 300 m away at the MMR-A Kahanahaiki Enclosure PRS in 2017 did not occur here.

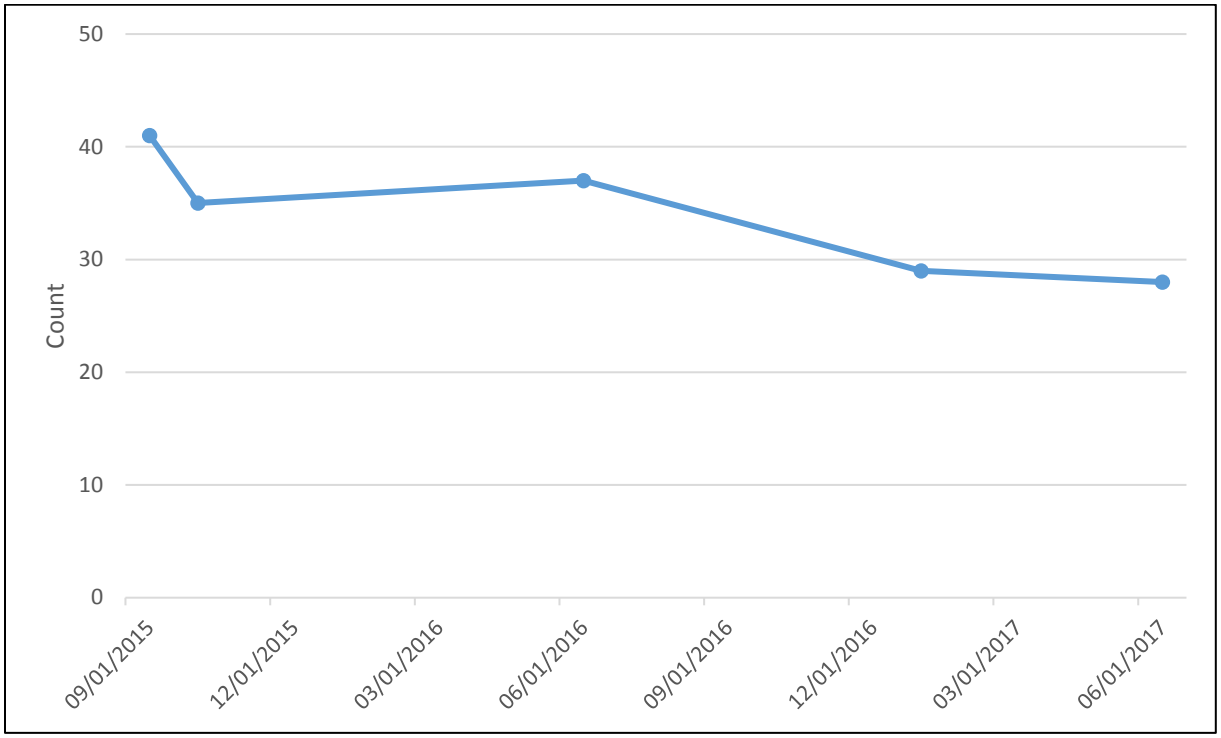


Figure 5: Timed-counts of *Achatinella mustelina* in sampled areas of PAH-B, Pahole Enclosure, monitored by SEPP.

5.2.1.3 No Management PRS

All snails found at NM-PRS within ESU-A have been translocated to the Kahanahaiki snail enclosure. OANRP visit each site at least three times to ensure any remaining snails are translocated. As time allows staff return for additional searches. Table 3 below summarizes the translocation efforts completed this year. A total of 7 snails were translocated.

Table 3. Translocations into MMR-A Kahanahaiki enclosure 2016-2017

Translocation Date	Population Reference Site	Small	Medium	Large	Total
2016-08-24	MMR-C Maile Flats	0	2	1	3
2016-11-10	MMR-M East Rim	0	2	1	3
2017-01-18	MMR-M East Rim	0	0	1	1

5.2.2 Future Management

OANRP will continue to work according to the monitoring plan (Table 4), and additional translocation efforts will be completed as outlined in the Three-Year Action Plan below (Table 5). Threat control will continue around the existing enclosures, including tracking tunnels for *R. rattus*, and searches for *E. rosea*, and *T. jacksonii xantholophus*. Weed control and habitat improvements will continue cautiously to ensure there are no impacts on the snails. Installation of the remote monitoring system which will alert staff if there should ever be a treefall at the Kahanahaiki snail enclosure has been delayed due to needed upgrades of the system by our vendor technicians. A new remote monitoring system will be installed in the near future. OANRP continues to investigate a debris alarm system. Once a suitable system is

developed it will be deployed at Kahanahaiki and Pahole. OANRP will consider doing additional planting of snail host trees within the Kahanahaiki enclosure to enhance habitat.

Table 4. ESU-A Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-A Kahanahaiki Enclosure	TCM	quarterly	all	Conduct night TCM with 2 personnel 2 hours each, for 4 person-hours total; quarterly
	GSP	quarterly	all	GSP MMR-A.
PAH-B Pahole Enclosure	TCM/GSP	quarterly	all	Assist OSEPP as needed

Table 5. Three Year Action Plan for ESU-A

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
MMR-A Kahanahaiki Enclosure	• Implement monitoring plan • Rat control • Install Remote Monitoring system • Install debris alarm • Maintain enclosure and monitor for predators • Improve habitat via weed control and restoration planting	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Conduct additional outplanting if needed • Improve habitat via weed control and restoration planting	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Improve habitat via weed control and restoration planting
PAH-B Pahole Enclosure	• Assist SEPP with installation of remote monitoring system	• Assist SEPP with installation of remote monitoring system	

5.3 ESU-B

ESU-B covers a large geographic area and is therefore divided into two units: ESU-B1 along the north-facing slopes of the southern Makua rim and ESU-B2 along the north-facing rim of the Mokuleia Forest

Reserve. The subdivision of ESU-B has some genetic basis, see Makua Implementation Plan 2001. Management of ESU-B1 is focused at Ohikilolo (Figure 6). ESU-B2 includes the gulches in Makaleha (Figure 7).

Figure 6. Map of ESU-B1

5.3.1 ESU-B1 Management History and Population Trends

There are two MFS PRS within ESU-B1, MMR-E (Ohikilolo Mauka) and MMR-F (Ohikilolo Makai) (Table 6). A combined total of 330 snails were observed during the most recent TCM at these PRS. There are seven NM-PRS (not all are depicted in (Table 6). These sites had low numbers when last monitored more than ten years ago, and have not been monitored since.

The Ohikilolo MU (Management Unit) remains unique in that *E. rosea* have never been recorded in the area. *T. jacksonii xantholophus* have also never been seen. Rats are controlled across the known snail habitat with an A24 and Victor snap trap grid. Occasionally, goats breach the fenceline into the upper portions of the MU, therefore the ungulate control is designated as partial control.

Table 6. ESU-B1 population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: B1 Ohikilolo												
MMR-E	Manage for stability	78	2016-07-21	53	19	6	0	Yes	Partial	Yes	No	No
Ohikilolo Mauka												
MMR-F	Manage for stability	252	2016-07-20	160	68	24	0	Yes	Partial	Yes	No	No
Ohikilolo Makai												
MMR-G	No Management	0	2016-04-20	0	0	0	0	Yes	No	No	No	No
Ohikilolo Alemac Site												
MMR-H	No Management	0 *	2016-07-19	0	0	0	0	Yes	No	Yes	No	No
Ohikilolo Kolahi Prikaa Reintro Site												
MMR-I	No Management	2	2002-06-03	2	0	0	0	Yes	No	No	No	No
Hedpar MMR-B												
MMR-J	No Management	5	2000-11-27	0	0	0	5	Partial	No	No	No	No
One ridge east of Lower Makua Camp												
MMR-K	No Management	0	2016-08-30	0	0	0	0	Partial	No	No	No	No
Ctesqu ridge												
MMR-L	No Management	0	2016-08-30	0	0	0	0	Partial	No	No	No	No
Myrsine along Ohikilolo fence from 3 pts												
	ESU Total:	337		215	87	30	5					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

5.3.1.1 MMR-E Ohikilolo Mauka PRS

OANRP did not conduct monitoring at the PRS in the last year. Monitoring is scheduled to occur in 2018, every other year. Anecdotal observations indicate the PRS is doing well.

5.3.1.2 MMR-F Ohikilolo Makai PRS

OANRP did not conduct monitoring at the PRS in the last year. Monitoring is scheduled to occur in 2018, every other year. Anecdotal observations indicate the PRS is doing well.

For the future, OANRP is proposing to only monitor the entire PRS every four years and monitor a smaller subset area with qualified staff every two years. This is proposed given the amount of staffing effort required to monitor the entire PRS, to lessen trampling impacts to habitat, and the apparently stable numbers. Monitoring a subset every two years should still allow us to be able to detect population trends owing to increased or decreased predation or other factors. For rat control, OANRP will investigate the possibility of expanding the rat control grid to include snail areas that are currently outside the grid.

5.3.1.3 No Management PRS

MMR-H was discontinued as a MRS in 2015-2016 due to declines in numbers. OANRP planned to make three translocation trips to move all snails found up to MMR-F. The third trip was made to MMR- H in the last year (Table 7). As six snails were still found OANRP will make one additional trip in the following year to search for any remaining snails as time allows. All other NM-PRS are not a management priority as numbers are low and monitoring dates are old.

Table 7: Translocation of *A. mustelina* into MMR-F Ohikilolo Makai 2016-2017

Translocation Date	Population Reference Site	Small	Medium	Large	Total
2017-03-21	MMR-H Koiahi	0	1	2	3

5.3.2 ESU-B1 Future Management

OANRP will continue monitoring as indicated below (Table 8). Rat control and the use of tracking tunnels will continue across the MU (Table 9). Searches for *E. rosea*, and *T. jacksonii xantholophus* during other work will also continue. A subset of snails from ESU-B1 will be moved into the future planned enclosure at 3 Points/West Makaleha along with the ESU-B2 following enclosure completion.

Table 8. ESU-B1 monitoring plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-E Ohikilolo Mauka	TCM	Every 2 years	2018, 2020	Eight person-hours day survey with binoculars
	GSP	Annual	All	GSP MMR-E-1
MMR-F Ohikilolo Makai	TCM	Every 2 years	2018, 2022	TCM with binoculars. Effort to be determined based on chosen areas.
	TCM	Every 4 years	2020	46 person-hours day TCM with binoculars
	GSP	Annual	All	GSP MMR-F-4

Table 9. Three Year Action Plan for ESU-B1

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
MMR-E Ohikilolo Mauka	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Consider moving a sample of snails to 3 Points enclosure
MMR-F Ohikilolo Makai	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Consider moving a sample of snails to 3 Points enclosure
MMR-H Ohikilolo Koiahi	• Translocate at least one more time to MMR-F		

Map removed to protect rare resources

Figure 7: Map of ESU-B2

5.3.3 ESU-B2 Management History and Population Trends

There are two MFS PRSs within ESU-B2, both located below the Kaala Road: LEH-C (Culvert 69) and LEH-D (Culvert 73) (Table 10). Together these PRS have 467 observed snails. There are nine NM-PRS, many of which have not been surveyed for many years. Numbers have likely declined at these sites. OANRP are working to construct an enclosure at West Makaleha by the summer of 2018 to manage the snails in this portion of ESU-B. NM PRS will be visited to translocate snails once the enclosure is

complete. Currently rats are controlled with A24s at LEH-C along the ridge crest and also at LEH-D. While *E. rosea* are assumed present throughout ESU-B2, *T. jacksonii xantholophus* have not been observed. The goat population and habitat damage has increased over the last several years. With the recent completion of the Kaala Road fence, and additional strategic fencing planned for the upper Makaleha area, aggressive goat and pig control is needed to eliminate populations as their impacts will now be in a more concentrated area.

Table 10. ESU-B2 population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: B2	**East and Central Makaleha**											
AAVI-A Kaawa Gulch	No Management	20	2016-04-06	11	5	4	0	No	No	No	No	No
LEH-A Central Makaleha (culvert 39)	No Management	49 *	2011-05-18	29	15	5	0	No	No	No	No	No
LEH-B East Makaleha (culvert 45)	No Management	33	2011-04-19	11	12	10	0	No	No	No	No	No
LEH-C East Branch of East Makaleha (culvert 69)	Manage for stability	378	2016-12-31	267	99	12	0	No	Partial	Yes	No	No
LEH-D East Branch of East Makaleha (culvert 73)	Manage for stability	89	2017-05-04	56	28	5	0	No	No	Yes	No	No
LEH-E East Makaleha (culvert 56-57)	No Management	31	2011-04-20	16	7	8	0	No	No	Yes	No	No
LEH-G East Makaleha (culvert 59)	No Management	3	2006-04-17	3	0	0	0	No	Partial	No	No	No
LEH-H East Makaleha (culvert 54)	No Management	34	2000-03-23	0	0	0	34	No	No	No	No	No
LEH-I East Makaleha (culvert 67)	No Management	16	2000-03-23	16	0	0	0	No	No	No	No	No
LEH-J East Makaleha (culvert 69 - lower down	No Management	2	2006-11-16	2	0	0	0	No	No	No	No	No
LEH-K Culvert 43 Ridge	No Management	0	2016-11-09	0	0	0	0	No	No	No	No	No
LEH-L 3 Points	No Management	4	2014-04-07	3	0	1	0	Yes	Partial	No	No	No
	ESU Total:	659		414	166	45	34					

Size Class Definitions

SizeClass	DefSizeClass
Large	> 18 mm
Medium	8-18 mm
Small	< 8 mm

*=Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

5.3.3.1 LEH-C East Branch of East Makaleha Culvert 69 PRS

OANRP conducted a TCM in 2016 and 378 snails were observed. OANRP will conduct the next TCM in Quarter 4 of 2018. There is not a suitable site here for a GSP because most of the snails are found while on rappel and the area in general is very steep.

5.3.3.2 LEH-D East Branch of East Makaleha Culvert 73 PRS

This area is also very steep with a predominant uluhe understory and is determined to be inappropriate for GSP monitoring. In place of a GSP, TCM will be performed annually (Figure 8). OANRP will establish TCM here in Quarter 1 of 2018.

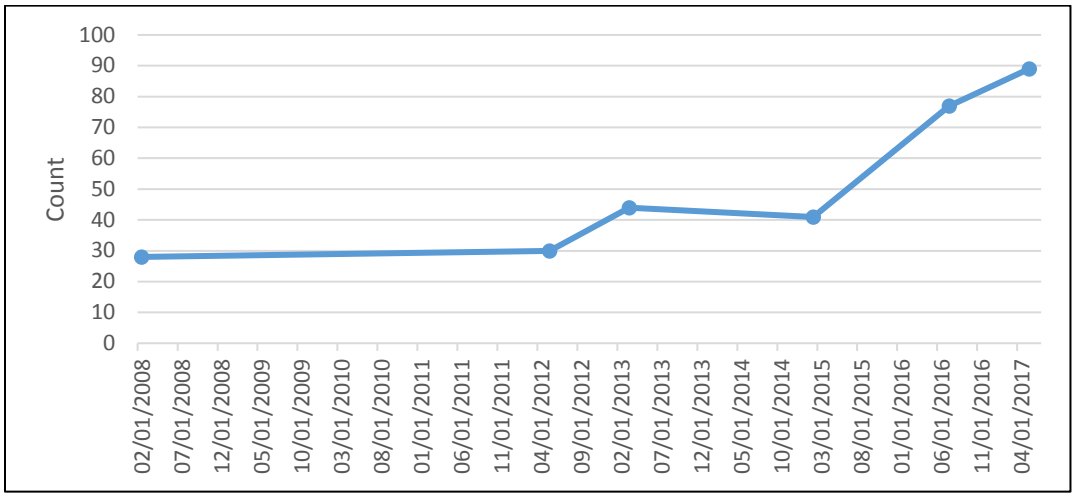


Figure 8. Counts of *Achatinella mustelina* at LEH-D East Branch of East Makaleha (Culvert 73). Search areas were expanded in 2016 and 2017, such that numbers do not reflect population trends, but rather more snails found in new areas.

5.3.3.3 No Management PRS

The nine NM PRS are not a priority for OANRP. These sites will be visited opportunistically. Once the West Makaleha enclosure is completed, OANRP will translocate snails into it from at least the larger sites and opportunistically visit the smaller sites.

5.3.4 ESU-B2 Future Management

OANRP will conduct monitoring as outlined below (Table 11). Rat control will continue at LEH-C (Culvert 69) and LEH-D (Culvert 73) (Table 12). OANRP will pursue building a snail enclosure at West Makaleha/3-Points for ESU-B snails in Makaleha. Once the enclosure construction is underway, OANRP will finalize translocation plans with the IT. OANRP will also likely be assisting State of Hawaii NARS staff with material transport of fencing materials for the strategic fences along sections of the Makaleha area and with future goat and pig control efforts.

Table 11. ESU-B2 Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
LEH-C East Culvert 69	TCM	every 2 years	2016, 2018	Conduct night TCM for 5 person-hours, and day TCM for 18 person-hours in steep areas of site (see prior notes to replicate search areas).
LEH-D East Culvert 73	TCM	annual	all	Conduct day TCM for 4 person-hours.

Table 12. Three Year Action Plan for ESU-B2

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
LEH-C East Culvert 69	• Implement monitoring plan • Rat control • Construction of enclosure at 3 Points	• Implement monitoring plan • Rat control • Construction of enclosure at 3 Points	• Implement monitoring plan • Rat control • Translocate snails to 3 Points enclosure
LEH-D East Culvert 73	• Implement monitoring plan • Rat control • Pursue construction of enclosure at 3 Points	• Implement monitoring plan • Rat control • Pursue construction of enclosure at 3 Points	• Implement monitoring plan • Rat control • Translocate snails to 3 Points enclosure
NM PRS			• Translocate snails to 3 Points enclosure

5.4 ESU-C

Figure 9. Map of ESU-C

5.4.1 ESU-C Management History and Population Trends

There are two MFS PRS with 261 observed snails at ESU-C: SBW-A (North Haleauau Hame Ridge) and SBW-W (Skeet Pass) (Table 13). There are several NM PRS that have very few total observed snails and have not been monitored recently. OANRP conducts rat control at both MFS PRS. *Euglandina rosea* are present across the ESU. *Trioceros jacksonii xantholophus* was seen once in the lower elevation area of Lihue MU and do not seem to be common across the area, but distribution is not well known. OANRP plan to construct an enclosure on the slopes of Kaala by the summer of 2018 (Figure 9). This enclosure will be geographically closer to the ESU-D *A. mustelina* than the ESU-C snails. A translocation plan will be developed with the IT once enclosure construction is underway. Ungulate control for pigs and goats is ongoing. Goats are occasionally observed along the ridgeline between Manuwai and Lihue MU near the historic snail populations. Low numbers of pigs are still present in the Lihue fence.

Table 13. ESU-C population structure and threat control summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: C	**Schofield Barracks West Range, Alaiheihe and Palikea Gulches**											
ALI-A	No Management	0	2009-06-02	0	0	0	0	No	No	No	No	No
Palikea gulch												
ALI-B	No Management	0	2009-06-02	0	0	0	0	No	Partial	No	No	No
Palikea gulch west Just east of Alaiheihe/Palikea dividing ridge.												
ANU-A	No Management	1	2004-06-02	0	1	0	0	Yes	No	No	No	No
Manuwai gulch												
IHE-A	No Management	0	2005-03-22	0	0	0	0	No	No	No	No	No
Alaiheihe Gulch Western Most Site												
IHE-B	No Management	3	2009-06-02	1	2	0	0	No	No	No	No	No
Alaiheihe middle site "Ptemac Site"												
IHE-C	No Management	0	2005-03-22	0	0	0	0	No	No	No	No	No
Alaiheihe below Nalu's LZ, TT's spot												
SBW-A	Manage for stability	30 *	2017-01-25	16	14	0	0	Yes	Partial	Yes	No	No
North Haleauau Hame Ridge												
SBW-B	No Management	0	2017-01-25	0	0	0	0	Yes	Partial	Yes	No	No
North Haleauau one ridge north of Hame												
SBW-C	No Management	0	2009-09-06	0	0	0	0	Yes	No	No	No	No
North Haleauau just above Pouteria pair territory												
SBW-P	No Management	0	2015-09-21	0	0	0	0	Yes	No	No	No	No
South Water gulch by Stenogyne kanehoana												
SBW-W	Manage for stability	303	2014-08-27	190	89	24	0	Partial	Partial	Yes	No	No
Skeet Pass												
SBW-X	No Management	1	2009-11-23	0	1	0	0	Yes	No	Partial	No	No
elepalo #4												
SBW-Y	No Management	3	2009-11-23	0	3	0	0	Yes	No	Partial	No	No
Elepalo #8												
SBW-Z	No Management	2	2017-04-19	1	1	0	0	Yes	No	No	No	No
Clair's Ridge												
	ESU Total:	343		208	111	24	0					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

5.4.1.1 SBW-A North Haleauau-Hame Ridge PRS

SBW-A is located in the UXO area. OANRP has been documenting steady declines in recent years and has submitted a proposal to begin to translocate the remaining snails to SBW-W where there is no enclosure. OANRP would like the IT to act on this topic such that management can be carried out in the next year. See Appendix 5-1 for details.

5.4.1.2 SBW-W Skeet Pass PRS

On September 20, 2017, a total of 231 snails were counted while surveying. Because a slightly different monitoring style was used compared with the 2014 survey, not as many snails were counted. It is very steep habitat and ropes have been used to access some of the areas. The site will be monitored again in Quarter 3 of 2018.

5.4.1.3 No Management PRS

There is a total of 12 sites in this category and many of them have not been surveyed recently. Although most of them only had a few snails, as time allows OANRP will conduct surveys to ascertain whether there are any snails surviving.

5.4.2 ESU-C Future Management

OANRP will conduct monitoring of the MFS PRS (Table 14) and construction of the enclosure at Kaala will be pursued (Table 15) as outlined below. OANRP will work with the IT to develop a translocation plan for snails once construction of the enclosure is underway. OANRP looks forward to determining a plan of action for the SBW-A snails with the IT. Searches for *E. rosea*, and *T. jacksonii xantholophus* in the course of other work will also continue. Ungulate control will also be ongoing.

Table 14. ESU-C Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
SBW-A North Haleauau	TCM	annual	all	Conduct night TCM for 6 person-hours.
SBW-W Skeet Pass PRS	TCM	every 2 years	2016, 2018	Conduct night TCM for 9.25 person-hours

Table 15. Three Year Action Plan for ESU-C

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
SBW-A North Haleauau	• Implement monitoring plan • Rat control • Begin construction of enclosure at Kaala	• Implement monitoring plan • Rat control • Complete construction of enclosure at Kaala	• Implement monitoring plan • Rat control • Translocate snails to Kaala enclosure
SBW-W Skeet Pass PRS	• Implement monitoring plan • Rat control • Begin construction of enclosure at Kaala	• Implement monitoring plan • Rat control • Complete construction of enclosure at Kaala	• Implement monitoring plan • Rat control • Translocate snails to Kaala enclosure
NM PRS			• Translocate snails to Kaala enclosure

5.5 ESU-D

ESU-D covers a large geographic area and is therefore divided into three units: ESU-D1 in the Kaluaa area (including Hapapa) (Figure 10), ESU-D2 in Makaha Valley (Figure 13) and ESU-D (Figure 12) in the Lihue area. ESU D1 and D2 have MFS PRS, however ESU-D does not. The geographic extremes were picked for management by the IT so that the greatest genetic diversity could be represented. These three groups will be discussed below from South to North in the following order D1, D, and D2.

Map removed to protect rare resources

Figure 10: Map of ESU-D1

5.5.1 ESU-D1 Management History and Population Trends

There is one MFS PRS at KAL-G (Puu Hapapa Snail Enclosure) (Table 16). During TCM, 805 snails were observed and the population appears to be stable or increasing. There are 10 NM PRS with few to no snails as they have been translocated into the enclosure. Habitat restoration efforts in the Puu Hapapa Enclosure are largely complete with a nearly continuous sub-canopy of native host plants now established to facilitate genetic communication of snails across the enclosure. Improvements to the barrier alarm and electric deterrence and alarm system for *E. rosea* are ongoing. Staff will continue to opportunistically survey and translocate snails if found at the 10 NM PRS. Threats are abundant outside of the enclosure with *E. rosea* and *T. jacksonii xantholophus* commonly seen. Pigs occasionally disturb snail habitat in the unfenced area of PRS SBS-B.

Table 16. ESU-D1 Population Structure and Threat Control Summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D1	**North Kaluaa, Waieli, Puu Hapapa, and Schofield Barracks South Range**											
ELI-A	No Management	5 *	2016-11-07	4	1	0	0	Yes	No	No	No	No
South Waieli Gulch North Branch												
ELI-B	No Management	2 *	2016-06-15	1	1	0	0	Yes	No	No	No	No
South Waieli Gulch, North Side of Ridge												
KAL-A	No Management	0 *	2014-03-06	0	0	0	0	Yes	Partial	Yes	Partial	Partial
Land of 10,000 snails												
KAL-B	No Management	0 *	2015-02-12	0	0	0	0	Yes	Partial	No	No	No
Gulch 1 Kaluaa												
KAL-C	No Management	0 *	2015-01-27	0	0	0	0	Partial	Partial	No	No	No
North Kaluaa												
KAL-D	No Management	0 *	2015-01-14	0	0	0	0	Yes	Partial	No	No	No
Gulch 3												
KAL-E	No Management	1 *	2016-08-29	0	1	0	0	Yes	No	No	No	No
Gulch 2												
KAL-F	No Management	0 *	2016-06-06	0	0	0	0	Yes	No	No	No	No
Central Kaluaa South Branch												
KAL-G	Manage for stability	805	2017-06-07	544	189	72	0	Yes	Yes	Yes	Yes	Yes
Puu Hapapa snail enclosure												
MIK-A	No Management	0	2012-10-04	0	0	0	0	No	No	No	No	No
Mikilua Gulch												
SBS-A	No Management	0	2012-12-19	0	0	0	0	Yes	No	No	No	No
Moho Gulch Lamsan and Amamic exclosure												
SBS-B	No Management	0 *	2013-12-11	0	0	0	0	No	No	No	No	No
Puu Hapapa												
SBS-D	No Management	2 *	2016-12-08	2	0	0	0	No	No	No	No	No
Two gulches west of Moho gulch enclosure												
	ESU Total:	815		551	192	72	0					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

5.5.1.1 KAL-G Puu Hapapa Snail Enclosure PRS

A total of 805 snails were observed during TCM on June 7, 2017 (This figure may possibly be 50-75% of what is actually present) (Figure 11). Though TCM counts oscillate, the population appears to be stable if not increasing. This is most strongly supported by data since July 2014, as numbers rose over time while new translocations dropped to very low numbers after that time. Staff continue to conduct TCM here on a quarterly basis. The habitat continues to improve and the snails have been observed spreading out into new vegetation as outplanted trees grow larger. In the past year, no *T. jacksonii xantholophus* or *E. rosea* have been found inside the enclosure. Staff have been diligent in trimming the trees along the fence walls to prevent ingress of any *T. jacksonii xantholophus*. SEPP monitors other rare snail taxa which they have translocated into the enclosure, including *Amastra spirizona* from Makaha, *Laminella sanguinea* from the Waieli side of Puu Hapapa, *Amastra intermedia* from Mikilua and Daniel Chung's captive propagation project, *Cookeconcha* sp. from Puu Hapapa, and *Leptachatina* sp. from Mikilua.

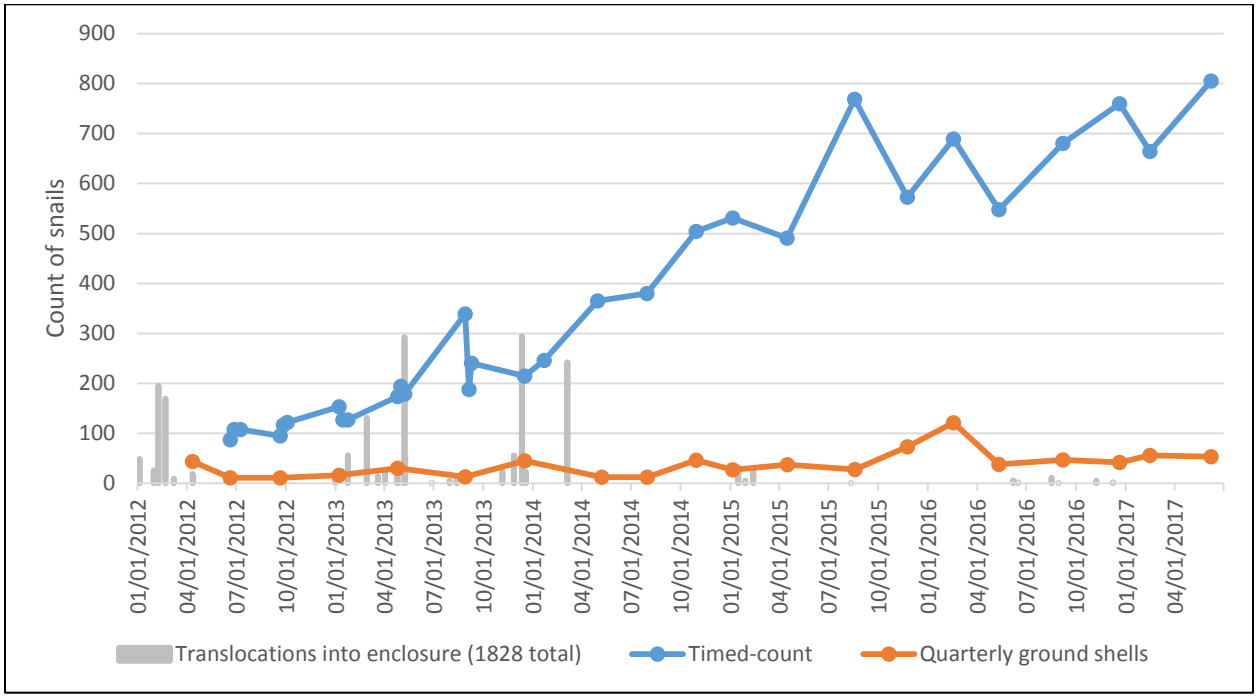


Figure 11. Timed-counts and ground shell counts for *A. mustelina* in Hapapa snail enclosure from June 2012 to June 2017, with numbers of snails translocated into the enclosure over time. Note: TCM data represents a subsample of the population, as not all snails are detectable at any one time.

5.5.1.2 No Management PRS

The ten NM PRS are not monitored regularly. With a high abundance of threats, these sites will likely continue to decline. OANRP staff opportunistically translocate the few snails remaining into the enclosure. Table 17 shows the number of snails from which populations were translocated into the snail enclosure in the past year.

Table 17. Translocations of A. mustelina into KAL-G Hapapa Enclosure 2016-2017

Translocation Date	Population Reference Site	Small	Medium	Large	Total
2016-08-16	SBS-D Puu Hapapa	0	3	8	11
2016-08-29	KAL-E Kaluaa Gulch 2	0	1	0	1
2016-11-07	ELI-A South Waieli Gulch North Branch	0	1	4	5
2016-12-08	SBS-D Puu Hapapa	0	0	2	2

5.5.2 ESU-D1 Future Management

OANRP staff will continue monitoring KAL-G (Puu Hapapa Snail Enclosure) (Table 18) and management will continue as described in Table 19. Threat control will continue around the existing enclosure, including tracking tunnels for *R. rattus*, and searches for *E. rosea*, and *T. jacksonii xantholophus*. Weed control and habitat improvements will continue. Improvements to the barrier alarm system and electric deterrence system for *E. rosea* will also be installed in the coming year. Habitat improvements will continue in the area surrounding the enclosure. Pig control at the SBS-B population will be done as needed as well as any further translocations from this PRS.

Table 18. ESU-D1 Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
KAL-G Puu Hapapa Snail Enclosure	TCM	quarterly	all	Conduct night TCM with 4 personnel for 7 person-hours total. Consider limiting TCM to twice a year.
	GSP	quarterly	all	GSP KAL-G-1

Table 19. Three Year Action Plan for ESU-D1

PRS	MIP YEAR 13 July 2016 – June 2017	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019
KAL-G Puu Hapapa Snail Enclosure	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Improve habitat via weed control and restoration planting	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators

5.5.3 ESU-D No management PRS

Figure 12. Map of ESU-D

None of these populations are being managed and many have not been surveyed recently (Table 20). OANRP plan to survey this sites in the coming year to obtain current data and recommend moving some of these snails into the Puu Hapapa snail enclosure given the high level of predation (Appendix 5-2).

Table 20. ESU-D Population Structure and Threat Control Summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D	**No Management ESU Sites of Waianae Kai, Kaluaa, Puhawai, SBS, and SBW**											
PHW-A	No Management	1	2017-02-22	0	1	0	0	No	No	No	No	No
Lualualei, Puhawai below Tetfil finger												
SBS-C	No Management	0 *	2012-12-19	0	0	0	0	No	No	No	No	No
Lower Moho Gulch - Jennifer Crummer's spot												
SBW-AA	No Management	12	2012-10-25	7	5	0	0	Yes	No	No	No	No
Mt Kaala below blue trail fence												
SBW-BB	No Management	15	2013-10-10	6	5	4	0	Yes	No	No	No	No
Below transect 790												
SBW-D	No Management	1	2000-02-18	0	0	0	1	Yes	Partial	No	No	No
Kaala-Kalena ridge on "M" in Military												
SBW-E	No Management	1	2000-02-18	1	0	0	0	Yes	No	No	No	No
Kaala-Kalena ridge between Military and Reservation												
SBW-F	No Management	4	2006-06-22	3	0	1	0	Yes	No	No	No	No
North Mohiakea Banana Gulch												
SBW-G	No Management	0	2003-10-14	0	0	0	0	Yes	Partial	No	No	No
South of Puu Kalena												
SBW-H	No Management	9	2015-06-23	5	2	2	0	Yes	No	No	No	No
North Branch of South Mohiakea												
SBW-I	No Management	8	2016-06-21	6	1	1	0	Yes	No	No	No	No
South Mohiakea Sicyos site												
SBW-J	No Management	10	2000-05-17	10	0	0	0	Yes	Partial	No	No	No
Zandip site along Kalena-Kumakalii Ridge												
SBW-K	No Management	47	2009-11-05	30	9	8	0	Yes	No	No	No	No
Kumakalii-Kalena ridge-"TR" gulch on the map by "Wahiawa District"												
SBW-L	No Management	36	2017-02-23	24	10	2	0	Yes	No	No	No	No
Kalena-Kumakalii Ridge-Dike rock gulch												
SBW-M	No Management	8	2017-02-23	5	1	2	0	Yes	No	No	No	No
Puu Kumakalii												

SBW-N	No Management	0	2009-06-24	0	0	0	0	No	No	No	No	No
1st Peak North of Kolekole Pass												
SBW-O	No Management	0	2014-11-16	0	0	0	0	Yes	Partial	No	No	No
North of Puu Kalena Alstri Notch												
SBW-Q	No Management	81	2007-08-21	47	32	2	0	Yes	No	No	No	No
North of Puu Kalena below Schtri Notch												
SBW-R	No Management	121	2014-09-11	92	25	4	0	Yes	Partial	No	No	No
Mt. Kaala southern end of Haleauau fencline												
SBW-S	No Management	4	2007-08-29	3	1	0	0	Yes	No	No	No	No
Upper Banana Gulch												
SBW-T	No Management	33	2009-06-10	25	1	7	0	Yes	No	No	No	No
Albizzia Gulch												
SBW-U	No Management	17	2007-08-22	13	3	1	0	Yes	No	No	No	No
Gulch #1/Tri Gulch Camp												
SBW-V	No Management	31	2007-08-22	21	9	1	0	Yes	No	No	No	No
Gulch #4/Tri Gulch Camp												
WAI-A	No Management	10	2000-06-26	0	0	0	10	No	No	No	No	No
Waianae Kai - Hesarb site												
	ESU Total:	449		298	105	35	11					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes=Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina

5.5.4 ESU-D2

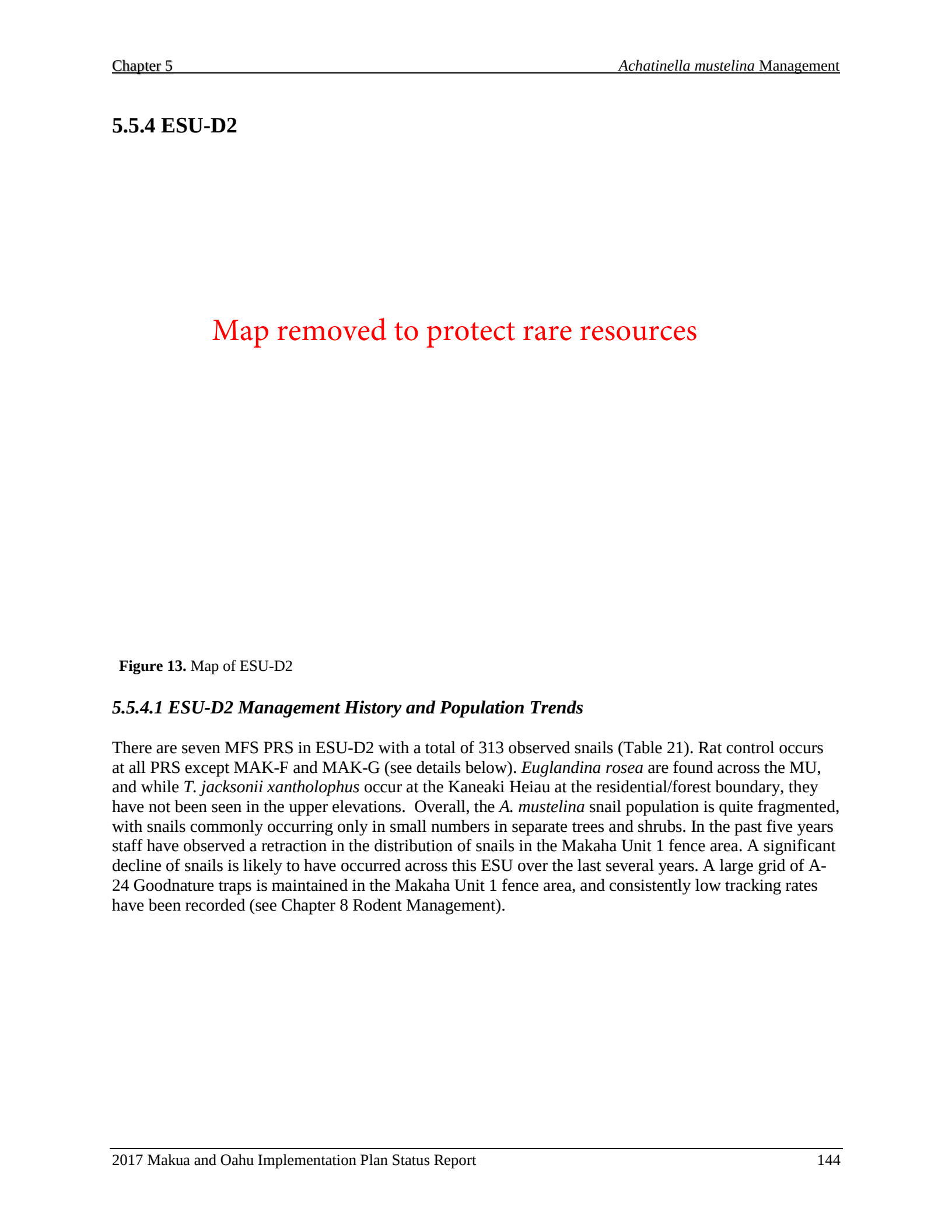


Figure 13. Map of ESU-D2

5.5.4.1 ESU-D2 Management History and Population Trends

There are seven MFS PRS in ESU-D2 with a total of 313 observed snails (Table 21). Rat control occurs at all PRS except MAK-F and MAK-G (see details below). *Euglandina rosea* are found across the MU, and while *T. jacksonii xantholophus* occur at the Kaneaki Heiau at the residential/forest boundary, they have not been seen in the upper elevations. Overall, the *A. mustelina* snail population is quite fragmented, with snails commonly occurring only in small numbers in separate trees and shrubs. In the past five years staff have observed a retraction in the distribution of snails in the Makaha Unit 1 fence area. A significant decline of snails is likely to have occurred across this ESU over the last several years. A large grid of A-24 Goodnature traps is maintained in the Makaha Unit 1 fence area, and consistently low tracking rates have been recorded (see Chapter 8 Rodent Management).

Table 21. ESU-D2 Population Structure and Threat Control Summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D2 Makaha												
MAK-A	Manage for stability	9 *	2016-09-19	4	4	1	0	Yes	Partial	Yes	No	No
Isolau ridge												
MAK-B	Manage for stability	14	2017-02-01	11	1	2	0	Yes	Partial	Yes	No	No
Kumaipo ridge crest												
MAK-C	Manage for stability	14	2015-06-16	11	3	0	0	Yes	Partial	Yes	No	No
Near pinnacle rocks. Includes Hesarb ridge.												
MAK-D	Manage for stability	34	2016-09-19	15	18	1	0	Yes	Partial	Yes	No	No
On ledge below ridge crest above MAK-A site.												
MAK-E	Manage for stability	60	2015-06-18	47	10	3	0	Yes	Partial	Yes	No	No
Ridge east of Cyasup exclosure												
MAK-F	Manage for stability	145	2016-09-19	101	37	7	0	No	Partial	No	No	No
Waianae Kai trail to Kaala												
MAK-G	Manage for stability	37	2016-04-05	28	5	4	0	No	No	No	No	No
Upper Makaha 3850 ft.												
	ESU Total:	313		217	78	18	0					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

5.5.4.1.1 MAK-A Kumaipo Isolau Ridge PRS

This PRS was last surveyed on September 19, 2016 when 9 snails were counted. Incidental observations indicate that there have been declines since the last TCM.

5.5.4.1.2 MAK-B Kumaipo Ridge Crest PRS

Many of the trees at this site that used to harbor snails have died and snail numbers have since declined. On the February 1, 2017 survey a total of 14 snails were observed and all of these were off of the main ridge trail. During the survey on January 19, 2010 a total of 21 snails were counted and most of these were on the main ridge trail. OANRP will survey this site as time allows, and if numbers are low it will be re-designated as NM. This PRS is not a priority due to the low number of snails.

5.5.4.1.3 MAK-C Near Pinnacle Rocks PRS

Fourteen snails were seen in June of 2015. OANRP will survey this site in 2017 to update numbers.

5.5.4.1.4 MAK-D On Ledge Below Ridge Crest Above MAK-A Site PRS

This PRS was last surveyed on September 19, 2016 and will be surveyed again next year to monitor trends. The most recent TCM indicates that there have been declines since the last TCM in 2014.

5.5.4.1.5 MAK-E Ridge East of Cyasup Exclosure PRS

This PRS has the second highest number of snails in the ESU. OANRP will monitor the site in 2017 to track trends.

5.5.4.1.6 MAK-F Waianae Kai Trail PRS

This site was last surveyed on September 19, 2016. A total of 145 snails were found here with the aid of ropes and three rappellers. There is still more area that needs to be explored to understand the full extent of the PRS. It is a difficult and steep area with thick vegetation. OANRP staff will continue to explore the area in the next year to determine the extent of the PRS.

5.5.4.1.7 MAK-G Upper Makaha PRS

This is a new site discovered by state staff while searching for rare plants in November 2015. OANRP staff surveyed on April 5, 2016 and found a total of 37 snails (4 small, 5 medium and 28 large). OANRP staff will return to the PRS this year to further explore the area and determine the extent of the PRS. This PRS is located just 150 ft. lower than the summit bog at 3850 ft., and is the highest elevation site for *A. mustelina* in the entire universe.

5.5.4.2 ESU-D2 Future Management

With recent finds at higher elevations OANRP is optimistic that there may be more snails to discover (Table 22). However threat control will be challenging in these steep inaccessible areas. OANRP will continue to explore higher elevation areas in the next year to determine numbers and consider possible threat control options (Table 23). Since the snails in Makaha show genetic similarities with the snails on Ohikilolo and because the weather conditions are also similar, OANRP proposed translocating snails

from Makaha to Ohikilolo. There are presently data loggers in both areas and they will be collected and analyzed in the near future to determine climate similarity

Table 22. ESU-D2 Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MAK-A Isolau Ridge	TCM	every 2 years	2016, 2018, 2020	Conduct night TCM with 3 personnel 2 hours each, for 6 total person-hours.
MAK-C Near Pinnacle Rocks	TCM	every 2 years	2017, 2019, 2021	Conduct night TCM for 6 person-hours.
MAK-D On Ledge	TCM	every 2 years	2016, 2018, 2020	Conduct night TCM for 10 person-hours. Five hours in the lower area and 5 in the upper.
MAK-E Ridge East of Cyasup	TCM	every 2 years	2017, 2019, 2021	Conduct night TCM for 4 person-hours.
MAK-F Waianae Kai	TCM	every 2 years	2016, 2018, 2020	Conduct night TCM for 4 total person-hours. Conduct day TCM on rope for 4 person-hours.
MAK-G Upper Makaha	TCM	every 2 years	2017, 2019, 2021	Conduct night TCM for 4 total person-hours. Conduct day TCM on rope for 4 person-hours.

Table 23. Three Year Action Plan for ESU-D2

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
MAK-A Isolau Ridge	• Resurvey • Implement monitoring plan	• Rat control	• Implement monitoring plan • Rat control
MAK-C Near Pinnacle Rocks	• Implement monitoring plan • Rat control	• Rat control	• Implement monitoring plan • Rat control
MAK-D On Ledge	• Implement monitoring plan • Rat control	• Rat control	• Implement monitoring plan • Rat control
MAK-E Ridge East of Cyasup	• Rat control	• Implement monitoring plan • Rat control	• Rat control
MAK-F Waianae Kai	• Determine PRS extent • Investigate rat control	• Implement monitoring plan • Rat control	• Rat control
MAK-G Upper Makaha	• Determine PRS extent • Investigate rat control	• Implement monitoring plan • Rat control	• Rat control

5.6 ESU-E

Map removed to protect rare resources

Figure 14. Map of ESU-E

5.6.1 ESU- E Management History and Population Trends

There are seven MFS PRS (Figure 14) that include 69 observed snails and seven NM PRS with twenty-eight observed snails at ESU-E (Table 24). The larger PRS were surveyed during the past year. Overall OANRP suspects that the declines observed in 2014 have continued. Most of the PRSs are included in the larger rat control grid in the Ekahanui MU. *Trioceros jacksonii xantholophus* have been seen once in Ekahanui but do not seem prevalent. *Euglandina rosea* are common and thought to be the major cause of decline. ESU-E is an area of considerable management focus given steep declines in snail numbers. Plans were made with the IT in 2015 to translocate snails to a permanent enclosure at Palikea. In order to temporarily maintain all remaining ESU-E snails in a highly protected location pending completion of a larger permanent enclosure at Palikea, OANRP has begun to collect snails and deposit them at the SEPP lab.

Table 24. ESU-E Population Structure and Threat Control Summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: E	**Puu Kaua / Ekahanui**											
EKA-A	Manage for stability	34 *	2017-04-12	20	13	1	0	Yes	No	Yes	No	No
Mamane Ridge and Near Piapripri EKA-A												
EKA-B	Manage for stability	7 *	2017-04-12	6	1	0	0	Yes	Partial	Yes	No	No
Below north population of Tetlep. Between Piapri EKA-A, EKA-B and EKA-C												
EKA-C	Manage for stability	28 *	2017-04-12	24	2	2	0	Yes	Partial	Yes	No	No
At Piapripri EKA-C site												
EKA-D	Manage for stability	0	2017-05-31	0	0	0	0	Yes	No	No	No	No
Puu Kaua												
EKA-E	No Management	8	2014-05-28	6	1	1	0	Yes	No	Yes	No	No
Amastra site												
EKA-F	No Management	1	2015-08-12	1	0	0	0	Yes	No	Yes	No	No
from Piapri-C head along blue trail under cliffs mauka												
EKA-G	No Management	0	2013-02-17	0	0	0	0	Yes	Partial	Yes	No	No
Cenagr												
EKA-M	Manage for stability	0	2016-12-19	0	0	0	0	Yes	No	Yes	Yes	Yes
Mamane Ridge snail enclosure												
EKA-S	Manage for stability	0	2016-12-07	0	0	0	0	Yes	No	Yes	Yes	Yes
Spirizona snail enclosure												
HUL-A	No Management	3	2016-05-25	2	1	0	0	No	No	No	No	No
North Huliwai South Branch												
HUL-B	No Management	1	2007-06-18	1	0	0	0	No	No	No	No	No
South Huliwai Gulch												
HUL-C	No Management	7	2016-05-25	5	2	0	0	No	No	No	No	No
Off Ridge Crest South of Puu Kanehoa												
HUL-D	No Management	8	2016-06-01	6	1	1	0	No	No	No	No	No
Puu Kanehoa												
	ESU Total:	97		71	21	5	0					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

5.6.1.1 EKA-A Mamane Ridge PRS

This site was surveyed on April 11, 2017 and a total of 45 snails were counted. Among those 11 were collected and given to SEPP for captive propagation. Staff have collected *E. rosea* here and it appears that this predator is having a detrimental effect on the snails. During the survey of September 28, 2016 a total of 31 snails were counted here.

5.6.1.2 EKA-B Below Tetlep PRS

This site also appears to be showing a decline, likely due to *E. rosea.* On April 12, 2017, a total of 7 (1 medium, and 6 large) *A. mustelina* were found, all of which were collected and given to SEPP for captive rearing.

5.6.1.3 EKA-C Plapri PRS

This is one of the two primary sites in the entire ESU. Staff have found and controlled *E. rosea* while surveying here. On April 11, 2017 a total of 41 *A. mustelina* were found, from which 13 (3 medium, and 10 large) were collected and given to SEPP for captive propagation.

5.6.1.4 EKA-D Puu Kaua PRS

Snails at this site have been in serious decline since a dieback affected most of the *M. lessertiana* trees in the area. *E. rosea* have also been a serious problem here. On May 31, 2017 a total of 5 *A. mustelina* were collected here and given to SEPP. Staff plan to return to this site and search again for any remaining snails.

5.6.1.5 EKA-H South Ekahanui North Branch PRS

This site was last surveyed on June 29, 2017 when a total of 10 snails were collected and given to SEPP. On this trip staff did not have ropes to search the steep habitat that had been searched in 2013. OANRP plan to return with ropes in the near future to survey and collect any remaining snails from the area.

5.6.1.6 EKA-M Mamane Ridge PRS and EKA-S Spirizona PRS Temporary Snail Enclosures

The most recent timed-counts at these sites in December 2016 found no live snails remaining (Figure 15). As discussed in detail in last year's report, the cause of the failure of the temporary enclosures remains unknown. OANRP does not intend to utilize such temporary enclosures in the future.

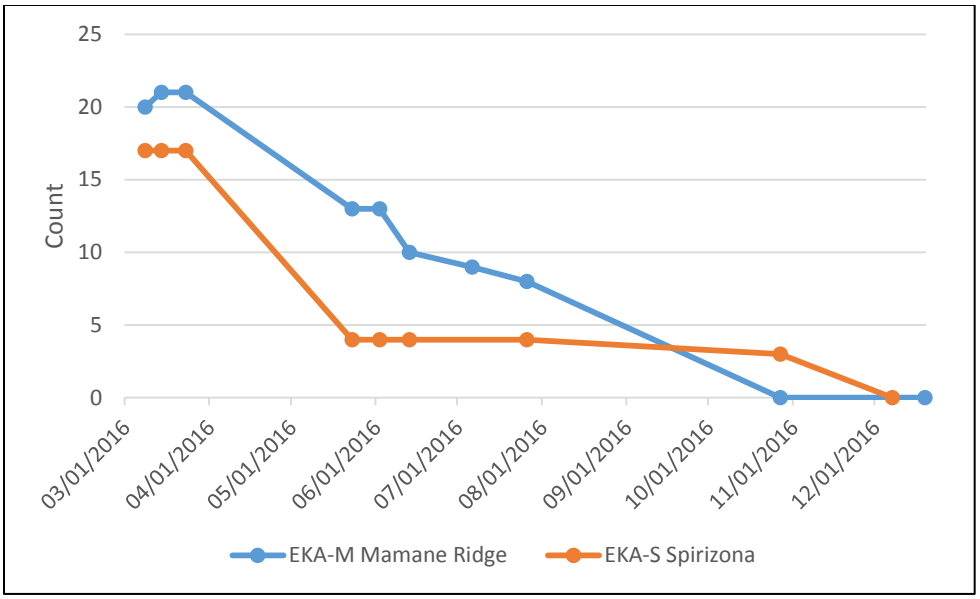


Figure 15. Timed-counts of *Achatinella mustelina* at EKA-M Mamane Ridge and EKA-S Spirizona temporary snail enclosures following the translocation of 20 snails into each enclosure.

5.6.1.7 HUL-D Puu Kanehoa PRS

A small population consisting of 8 snails was found here on June 1, 2016. This site is close to the study site used by Dr. Michael Hadfield in 1976. During his study he estimated the population to be approximately 200+ snails, but at the completion of his research in 1979, all of the snails had disappeared due to *E. rosea*. It always gives a feeling of hope to find snails in an area where they were thought to have been extirpated 40 years ago. This area will be included in translocation efforts.

5.6.1.8 No Management PRS

Most of these sites have few snails surviving but when SEPP has enough room to accommodate all of the snails in Ekahanui, an effort will be made to survey all potential sites.

5.6.1.9 OANRP Euglandina removal efforts

In an effort to maximize survival of remaining snails in Ekahanui OANRP focused on predator removal around known snail hot spots at EKA-A and B. OANRP made trips bimonthly for a total of 13 trips between December of 2016 and June of 2017. Over these trips a total of 80 hours were spent on the effort. Figure 16 records the results of these efforts. It is disappointing to see that despite consistent removal there is no apparent impact on *E. rosea* numbers. This figure illustrates that hand removal alone is not an effective technique to reduce *E. rosea* numbers. However, it was worth the effort in this case as the snails are becoming so rare all efforts are warranted.

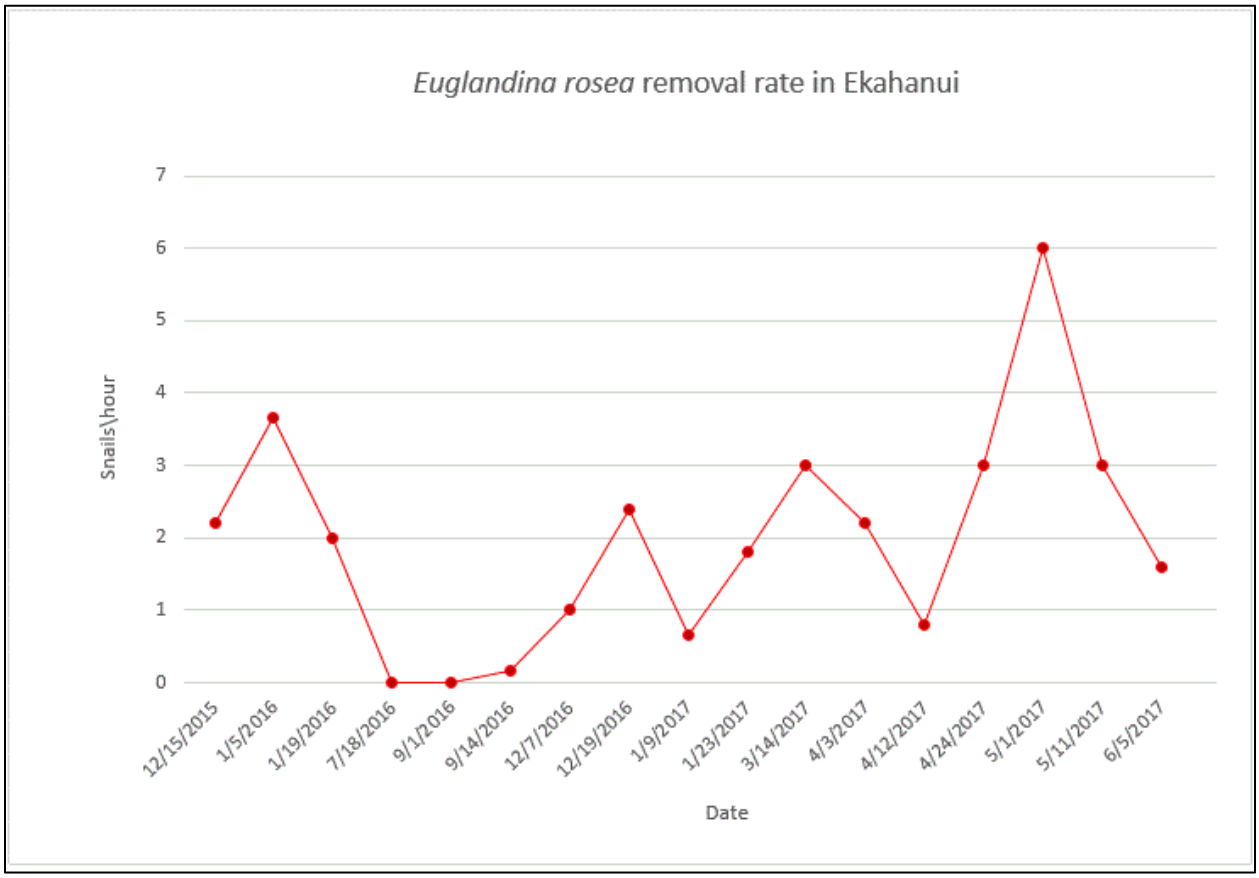


Figure 16. A total of 32 small (<25mm) and 141 large (>25mm) *Euglandina rosea* were removed from Ekahanui over 108 search hours between December 2015 and May 2017.

5.6.1.10 OANRP collections for captive propagation

As approved by the IT in December 2016 OANRP has been working with the SEPP lab to collect Ekahanui snails for safe keeping until the North Palikea snail enclosure is ready for translocation. Efforts began in April 2017 with a total of 6 trips (Table 25). Thus far the lab has been highly successful, with very few deaths and multiple births. A total of 71 snails have been collected (Table 26). With many births in the lab, there are currently 100 snails (Table 27).

Table 25. Collections of *A. mustelina* from ESU-E given to SEPP for Captive Propagation and Remaining Snails in Wild

Population	Date	Small in Lab	Medium in Lab	Large in Lab	Small in Wild	Medium in Wild	Large in Wild
EKA-A	4/11/2017	2	4	5	1	13	20
EKA-B	4/12/2017	0	1	6	0	0	0
EKA-C	4/11/2017	0	3	10	2	2	24
EKA-D	5/31/2017	0	2	3	0	0	1
EKA-H	6/29/2017	0	4	6	0	0	0

Table 26. Ekahanui snails deposited at SEPP Lab

Date	Population	Number
4/13/2017	EKA-A, B, C	31
6/1/2017	EKA-D	5
6/30/2017	EKA-E	10
7/13/2017	EKA-F	18
7/13/2017	EKA-G	7
TOTAL		71

Table 27. SEPP Lab Populations of Ekahanui *A. mustelina*, July 2017

PRS	Juvenile	Sub-adult	Adult	Total
EKA- A, B	17	6	10	33
EKA-C	10	6	5	21
EKA-D	2	4	1	7
EKA-E	2	4	5	11
EKA-F	4	11	6	21
EKA-G	0	5	2	7
TOTAL	35	36	29	100

5.6.1.11 Palikea North construction update

The Palikea North Snail Enclosure is currently under construction and will be completed by September 2017. Clearing the vegetation from the area for the enclosure began in June of last year. Due to the discovery of *A. mustelina* within the site, the project was halted from July through December 2016. After the Conjunction with Intensive Weed Management Protocol for Oahu Army Natural Resources Program (Appendix 5-3) were adjusted and finalized, the project resumed January 2017. Clearing was complete in early February. During the clearing process, snail surveys were conducted before and after clearing a sector (Appendix 5-4). About 152 person hours were spent surveying at night for *A. mustelina* for the duration of tree clearing; no snails were found within the area zoned for clearing since June 2016. The person hours spent cutting, dragging and chipping totaled 909.5 hours.

After clearing the area of non-native vegetation, several native species including *M. polymorpha*, *F. arborea*, *C. foliosa*, and *Broussaisia arguta* remained standing. The removal of vegetation around the *F. arborea* created an unsuitable habitat (too hot and dry) causing them to wilt. To create shade and increase ground moisture, shade cloth was installed over the *F. arborea* patches, tarp was laid down uphill of two of the larger patches to divert rain surface runoff to the patches, an additional water catchment was built and a sprinkler system was installed

In April 2017, the contract was finalized and construction of the snail enclosure began. Following the PCSU technical report, Development of tree snail protection enclosures: from design to implementation (#194, 2016), the enclosure was built with a few modifications. The wall structure consists of 4”x4” reinforced plastic posts in concrete footings with a 2”x12” baseboard installed 5” below ground level and a 2”x6” top board measuring at a height of 60” for the frame (Figure 17). A high-density polyethylene (HDPE) geomembrane sheet creates the wall barrier. The rat hood is attached at the top edge of the HDPE geomembrane and has a minimum 6” diameter. To prevent incursion from the bottom of the fence and erosion control, the HDPE geomembrane extends from the wall by a foot, lies on the ground and is held down by the Geoweb® geocells filled with gravel. The *E. rosea* barriers consist of the angle, cut mesh and electrical. The angle barrier is attached to the wall with a minimum of 8” above the ground from the

bottom edge to allow ease of checking under the angle. The cut mesh attaches just above the angle and the electrical barrier is added to the flat-face of the cut mesh barrier perpendicular to the ground (Figure 18).

Figure 17. Palikea North snail enclosure wall frame, inside of enclosure

Figure 18. Palikea North snail enclosure wall with *E. rosea* barriers, rat hood and erosion control

During the construction of the enclosure, the interior still contained many small branches/sticks/rocks and the numerous cut-stumps posed a safety hazard. To ensure the enclosure to be free of *E. rosea*, ground cover was raked down to the topsoil to remove hiding places for *E. rosea*. Clearing the ground cover involved about 257 person hours of raking, weed whacking the stumps, using a leaf blower to clear out any crevices and holes, and dumping the ground cover outside the walls.

A 10m x 10m grid was laid out dividing the entire area within the enclosure to aid in weeding, *E. rosea* searches and in the future for planting. Photopoint poles were initially installed with PVC and later replaced permanently with metal pipes.

Euglandina rosea sweeps will begin in September 2017 and pending results of sweeps restoration planting is scheduled for October-November. Once restoration is underway OANRP will begin planning for reintroduction of ESU E SEPP lab snails. Reintroduction will hopefully be possible in early 2019, if vegetation has grown in sufficiently to provide adequate host plants and shade. For more details on restoration plans see Palikea North Enclosure Restoration Plan (Appendix 5-5).

5.6.2 ESU-E Future Management Plans

Future management focuses on maximizing collections from Ekahanui (Table 28). OANRP will continue to closely work with SEPP to plan collections. In addition OANRP will continue to work in the field to minimize impacts by collecting *E.* rosea from PRS with remaining snails. No monitoring or ground shell plots are planned (Table 29).

Table 28. ESU-E Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
EKA-A Mamane Ridge	Translocate to SEPP	quarterly	2017, 2018	Coordinate with SEPP
	Euglandina search	quarterly	2017, 2018	Focus on wet season
EKA-B Below Tetlep	Translocate to SEPP	quarterly	2017, 2018	Coordinate with SEPP
EKA-C Plapri	Translocate to SEPP	quarterly	2017, 2018	Coordinate with SEPP
	Euglandina search	quarterly	2017, 2018	Focus on wet season
EKA-D Puu Kaua	Translocate to SEPP	annually	2017, 2018	Coordinate with SEPP
EKA-H South Ekahanui	Translocate to SEPP	annually	2017, 2018	Coordinate with SEPP

Table 29. Three Year Action Plan for ESU-E

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
EKA-A Mamane Ridge	• Rat Control • *E. rosea* searches • Collect for SEPP	• Rat Control • *E. rosea* searches • Collect for SEPP	
EKA-B Below Tetlep	• Rat Control • Collect for SEPP	• Rat Control • Collect for SEPP	
EKA-C Plapri	• Rat Control • *E. rosea* searches • Collect for SEPP	• Rat Control • *E. rosea* searches • Collect for SEPP	
EKA-D Puu Kaua	• Rat Control • Collect for SEPP	• Rat Control • Collect for SEPP	
EKA-H South Ekahanui	• Rat Control • Collect for SEPP	• Rat Control • Collect for SEPP	
HUL-A	• Collect for SEPP	• Collect for SEPP	
HUL-C	• Collect for SEPP	• Collect for SEPP	
HUL-D	• Collect for SEPP	• Collect for SEPP	

5.7 ESU-F

Map removed to protect rare resources

Figure 19. Map of ESU-F.

5.7.1 Management History and Population Trends

A total of 572 snails have been detected by TCM in the three MFS PRS in ESU-F (Table 30). Most of the snails from the NM PRS in Palikea are listed as zero as snails from these PRS were moved into the enclosure (Figure 19), and no monitoring has been conducted at them since. There are 8 snails in the NM PRS from Palawai which will likely be translocated to the existing enclosure in the near future. Small snail populations are still occasionally found in the Palikea Fence and those populations will be assessed for translocation based on their population sizes and risk of predation (e.g. if *E. rosea* are found nearby they will likely be moved). All PRS in the Palikea Fence are within the large rat control grid. SEPP maintains a rat grid around the NM PRS at PAL-B (Delsub Lama Fence). The other NM PRSs in Palawai have no rat control. *E. rosea* is present in PRSs outside of the enclosure and are routinely collected from under the angle barrier. There has only been one *T. jacksonii xantholophus* collected in this ESU. It was found in close proximity to the enclosure on June 24, 2014. Another chameleon was seen on March 14, 2017 but it managed to escape. However, there have not been any additional sightings in many hours of night surveying in the ESU and it is assumed they are in very low densities.

Table 30. ESU-F Population Structure and Threat Control Summary

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: F Puu Palikea												
KAA-A Mauna Kapu (Palehua)	No Management	0 *	2016-01-25	0	0	0	0	No	No	No	No	No
PAK-A Puu Palikea-Ohia spot	Manage for stability	0 *	2015-09-28	0	0	0	0	Yes	Partial	Yes	No	No
PAK-B Iele Patch	Manage for stability	6 *	2017-04-25	2	3	1	0	Yes	Partial	Yes	No	No
PAK-C Steps spot	Manage for stability	0 *	2017-05-23	0	0	0	0	Yes	Partial	Yes	No	No
PAK-D Joel Lau's site	Manage for stability	0 *	2016-05-05	0	0	0	0	No	Partial	Yes	No	No
PAK-E Exogau site	Manage for stability	0	2015-10-07	0	0	0	0	Yes	Partial	Yes	No	No
PAK-F Dodonaea site	Manage for stability	0 *	2016-10-25	0	0	0	0	Yes	Partial	Yes	No	No
PAK-G Hame and Alani site just above Cyagri fence	Manage for stability	0 *	2016-10-25	0	0	0	0	Yes	Partial	Yes	No	No
PAK-H Mike Hadfield's study site at Puu Palikea	Manage for stability	0 *	2017-04-05	0	0	0	0	Yes	Partial	Yes	No	No
PAK-I One ridge truck side of E and F	Manage for stability	3 *	2017-04-25	3	0	0	0	No	Partial	Yes	No	No
PAK-K Pilo site	Manage for stability	92	2015-10-08	56	33	3	0	Yes	Partial	Yes	No	No
PAK-L Olapa site north of Puu Palikea	Manage for stability	48 *	2017-04-05	34	11	3	0	Yes	Partial	Yes	No	No
PAK-M Middle Site	Manage for stability	316	2016-06-07	205	82	29	0	Yes	Partial	Yes	No	No
PAK-N Campside of Lobelia Ridge	No Management	0 *	2015-10-07	0	0	0	0	No	Partial	No	No	No
PAK-O Below camp fence	No Management	1	2009-09-23	1	0	0	0	No	Partial	Yes	No	No

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; in some cases the threat may be present but not actively preying on A. mustelina.

Number of Snails Counted

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
PAK-P Palikea snail exclosure	Manage for stability	163	2017-06-20	107	45	11	0	Yes	Partial	Yes	Yes	Yes
PAK-Q outside snail enclosure	Manage for stability	0 *	2016-10-25	0	0	0	0	Yes	Partial	Yes	No	No
PAK-R 4 Trail Junction	Manage for stability	0 *	2016-10-25	0	0	0	0	Yes	Partial	Yes	No	No
PAK-S Palikea North	No Management	0 *	2016-06-30	0	0	0	0	Yes	Partial	Yes	No	No
PAL-A Palawai next to Pri sp.	No Management	8	2014-05-14	6	1	1	0	No	No	No	No	No
PAL-B Delsub Lama Fence	No Management	0	2014-12-22	0	0	0	0	No	No	Yes	No	No
PAL-C Palawai Hesarb trail	No Management	0	2013-05-13	0	0	0	0	No	No	No	No	No
	ESU Total:	637		414	175	48	0					

Size Class Definitions

SizeClass	DefSizeClass
Large	>18 mm
Medium	8-18 mm
Small	< 8 mm

*=Total Snails were Trans Located or Reintroduced

= Threat to Taxon at Population Reference Site

No Shading = Absence of threat to Taxon at Population Reference Site

Yes= Threat is being controlled at PopRefSite

No=Threat is not being controlled at PopRefSite

Partial=Threat is being partially controlled at PopRefSite

Table shows the number of snails, size classes, and threats to the snails in the ESU sites. Yes = threat is being controlled; In some cases the threat may be present but not actively preying on A. mustelina.

5.7.1.1 PAK-H Hadfield's PRS

This PRS was surveyed on April 5, 2017 and no snails where found. Some restoration work had been performed here and after some trees were trimmed and ground cover removed, the area dried out considerably and the snails disappeared.

5.7.1.2 PAK-K Pilo PRS

OANRP staff conducted TCM on October 8, 2015 and a total of 92 snails were counted. This appears to be a healthy population and will not be translocated into the enclosure. It is due to be resurveyed in Q3 of 2017.

5.7.1.3 PAK-L Olapa PRS

This site had 76 snails when OANRP staff conducted TCM on October 7, 2015. The habitat is comprised of many native trees but when staff surveyed here in March of 2017, freshly dead shells were found still stuck on leaves in the trees. They appeared very fresh since rain hadn't washed them onto the ground yet. Staff returned the following week and found one live *E. rosea* in the uluhe ferns under the snail trees and decided to move the surviving snails into the snail enclosure. On April 5, 2017 a total of 48 *A. mustelina* were translocated into the enclosure.

5.7.1.4 PAK-M Middle Site PRS

This is the largest population in the ESU and on June 7, 2016 a total of 316 snails were counted during the TCM. This population appears stable and will not be translocated into the enclosure unless the level of predation increases and significant declines are detected. The area has many native trees and shrubs. Some habitat improvements may be made to control encroaching weed trees in the lower reaches of the area.

5.7.1.5 PAK-P Enclosure PRS

OANRP staff have translocated snails into the Palikea snail enclosure and have begun TCM on a quarterly basis (Figure 20). Snails outside the enclosure in small populations will continue to be brought inside for protection from predators. On May 22, 2017 TCM was performed during the day with 2-person hours spent in each of two separate plots within the enclosure for a total of 65 snails counted. Once a year, a night TCM is performed for 4-person hours covering the entire enclosure. Future translocations from some of the other PRS (e.g. PAK-M) may occur if sharp declines are observed in population sizes. On June 20, 2017 a total of 163 *A. mustelina* (11 small, 45 medium, and 107 large) were counted. The previous high TCM was 114 on April 13, 2016.

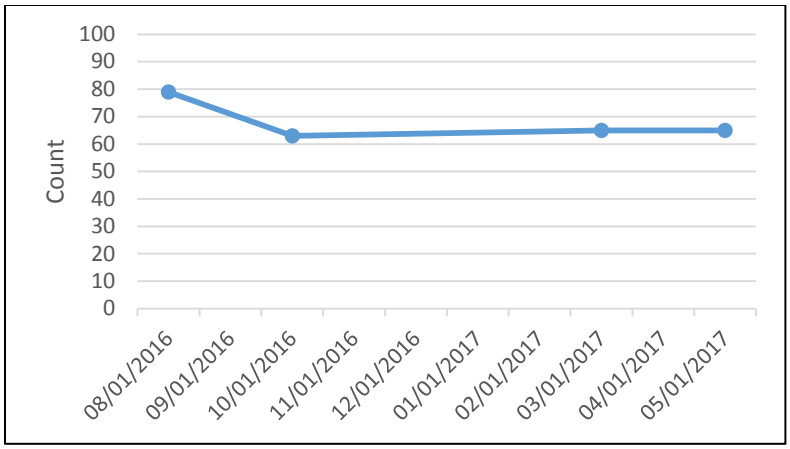


Figure 20. PAK-P Quarterly TCM

On May 8th, 2017, during a night survey around the Palikea snail enclosure, an *E. rosea* was spotted on vegetation inside. After further searches that night, another *E.rosea* was found climbing on the wall. Since then, intensive searches and ground cover removal to facilitate these searches have been performed (Table 31).

Table 31. Euglandina rosea search effort in Palikea enclosure

Week	Dates	Person Hours	# *E. rosea* Found
1	May 16-19, 2017	52.15	2 Large, 1 egg cache
2	May 23-24, 2017	34	5 Large, 2 egg caches
3	May31, 2017	12	None (SEPP)
4	June 5-8, 2017	27.5	None
5	June 15, 2017	21	2 Large
6	June 19-20, 2016	8	None
7	June 26-28, 2017	13	None
8	July 5-6, 2017	25	None
9	July 10-12, 2017	41	None
10	July 19, 2017	2	None
11	July 26, 2017	17.25	None
12	August 1, 2017	17	None
13	August 8, 2017	6	None
Total		275.9	9

In the Palikea Enclosure, a careful reduction of some ieie (*Freycenetia arborea*) is currently being conducted for snail monitoring purposes as the ieie is becoming considerably dense in some areas of the enclosure. The barriers on the enclosure continue to function and prevent predator ingress. OANRP will make 1-2 trips in the next year to complete erosion control work around the enclosure wall. The debris alarm system will be installed once the system under development is finalized.

5.7.1.6 PAK-S Palikea North Enclosure Site PRS

Since June 2016, there has been no *A. mustelina* found within the enclosure site. OANRP followed protocol developed with the US Fish and Wildlife Service (FWS).

5.7.1.7 No Management PRS

These sites have historically had very few snails and declining numbers. Translocations completed in 2016-2017 are outlined below (Table 32).

Table 32. Translocations of *A. mustelina* into PAK-P Palikea Snail Enclosure in 2016-2017

Translocation Date	PRS Translocation Source	Small	Medium	Large	Total
2016-08-01	KAA-A	0	1	1	2
2016-10-25	PAK-F	0	2	4	6
2016-10-25	PAK-G	0	0	4	4
2016-10-25	PAK-I	0	1	10	11
2016-10-25	PAK-Q	0	0	1	1
2016-10-25	PAK-R	0	0	3	3
2017-01-10	PAK-S	0	0	1	1
2017-04-05	PAK-I	0	0	1	1
2017-04-05	PAK-L	3	11	34	48
2017-04-05	PAK-R	0	2	6	8
2017-04-25	PAK-B	1	3	2	6
2017-04-25	PAK-I	0	0	3	3
Total		4	20	70	94

5.7.2 ESU-F Future Management

OANRP will continue monitoring and managing as described in Tables 33 and 34. The majority of the translocations are complete from NM PRS. OANRP will continue to translocate snails from small declining NM PRS. Each of these sites will be visited a minimum of three times. The six PRS listed below (Table 33) require additional visits. Unlisted NM PRS have been visited three times.

As mentioned earlier, small snail populations are still occasionally found in the Palikea MU. They will be translocated based on numbers and risk of imminent predation. Threat control will continue in the MU, including quarterly tracking tunnels for *R. rattus*, and searches for *E. rosea*, and *T. jacksonii xantholophus*. Weed control and habitat improvements will continue cautiously in known snail habitat to ensure there are no impacts to the snails. Habitat improvements across the MU will include gradual removal of non-native trees in snail areas and outplanting of natives to fill in light gaps and provide more host species.

Table 33. ESU-F Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
PAK-B Ie ie Patch	Translocate to enclosure	quarterly	2017, 2018	
PAK-K Pilo	TCM	every 2 years	2017, 2019, 2021	Conduct day TCM for 4 person-hours.
PAK-L Olapa	Translocate to enclosure	quarterly	2017, 2018	
PAK-M Middle	TCM	every 2 years	2016, 2018	Conduct baseline night survey, recording hours to use as standard.
PAK-P Palikea Enclosure	TCM	Quarterly	2016, 2017, 2018	Conduct day TCM for 4 person-hours.
PAK-P Palikea Enclosure	Survey	annual	2016, 2017, 2018	Conduct night survey to determine dispersal and perform *T. jacksonii xantholophus* search for a total of 4 person-hours.

Table 34. Three Year Action Plan for ESU-F

PRS	MIP YEAR 14 July 2017 – June 2018	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020
KAA-A Mauna Kapu	• Translocate to enclosure	• Translocate to enclosure	
PAK-G Hame	• Translocate to enclosure	• Translocate to enclosure	
PAK-K Pilo	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control
PAK-L Olapa	• Translocate to enclosure • Rat Control	• Translocate to enclosure • Rat Control	• Rat Control
PAK-M Middle	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control	• Implement monitoring plan • Rat Control
PAK-P Palikea Enclosure	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Improve habitat via weed control and restoration planting	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Conduct additional outplanting if needed	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators
PAK-I One Ridge Truck side of E and F	• Translocate to enclosure		
PAK-F Dodonea Site	• Translocate to enclosure		
PAK-S Palikea North	• Complete surveys • Translocate to enclosure		

CHAPTER 6: RARE VERTEBRATE MANAGEMENT

OANRP manages or monitors three vertebrate species, Hawaiian Monarch Flycatcher (Oahu Elepaio), Hawaiian Goose (Nene), and the Hawaiian Hoary Bat (Opeapea). There have been no sightings this year of Nene on Army Installations and thus there is no Nene update included in this chapter. Results of our management and monitoring efforts for Oahu Elepaio and Opeapea are presented below.

6.1 OIP ELEPAIO MANAGEMENT 2017

6.1.1 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, the Oahu Army Natural Resources Program (OANRP) is required to manage a minimum of 75 Oahu Elepaio pairs. Management of a pair includes monitoring and rodent control during the breeding season. The OANRP is required to conduct on-site management at Schofield Barracks West Range (SBW) for as many of the 75 pairs as possible, with the remaining number managed at off-site locations with cooperating landowners. The OANRP has conducted rodent control and Elepaio monitoring at Schofield Barracks Military Reservation (SBMR) (1998-present), Ekahanui Gulch in the Honouliuli Forest Reserve (2005-present), Moanalua Valley (2005-present), Palehua (2007-present), Makaha Valley (2005-2009), and Waikane Valley (2007-2008). This chapter summarizes Elepaio reproduction results at each of the sites currently managed, and provides recommendations for improving the Elepaio stabilization 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.

6.1.2 Methods

Monitoring

Throughout the nesting season, from early January to late June, each managed Elepaio territory was visited at one or two-week intervals depending on breeding activity. Single male and paired territories without rodent control are also monitored for breeding activity whenever possible, though their results are not included with that of managed pairs. The location and age of all birds observed and color band combination (explained below), if any, was noted on each visit. Nests were counted as successful if they fledged at least one chick. Nest success rate was calculated by the number of successful nests per the number of active nests. Active nests are nests known to have had eggs laid in them as determined by observations of incubation. Reproductive success (fledglings/managed pair) was measured as the average number of fledglings produced per managed pair. Some nests were abandoned for unknown reasons before eggs were laid. If a nest is abandoned after an egg is laid it is considered to have failed.

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

weighed, measured, inspected for molt, fat, overall health, and then released unharmed at the site of capture within 20 minutes.

Figure 1. Oahu Elepaio with a bromeliad mosquito (*Wyeomyia mitchellii*) at Palehua. Prevalence of avian pox in Oahu Elepaio has declined over time, suggesting they are becoming resistant to the deadly virus (2016 OANRP YER).

Rodent Control

This breeding season OANRP again used a combination of small and large-scale trapping grids containing only Victor® rat snap traps baited with peanut butter. Small-scale grids, deployed throughout the territories of Elepaio pairs at SBW and Moanalua Valley, consisted of 12-15 snap traps tied to trees or rocks to prevent scavengers from removing them. Territories labeled as single or vacant may have also contained snap traps baited throughout the breeding season. These territories once contained an Elepaio pair, but one or both birds have not recently been observed. These territories continue to be baited to help control rodents throughout the management area. Traps were counted as having caught a rodent if hair or tissue was found on the trap. Traps were cleaned with a wire brush after each capture so previous captures were not counted twice. Rodent control was conducted for the duration of the Elepaio nesting season. At Ekahanui, a large-scale rat trapping grid containing over 600 snap traps was deployed in 2011 for management of all Elepaio territories in the management unit. A second large-scale grid containing 192 snap traps was deployed in 2015 at Palehua to ensure rodent protection for all resident pairs. Traps at all four sites were checked and re-baited every two weeks during the breeding season (December – June). Due to Army training at SBW, staff were allowed access only one week each month. Therefore,

frequency of baiting was twice during that week of access to maximize the number of rodent kills. Pono Pacific was contracted to conduct rodent control at each of the four sites: Moanalua, SBW, Ekahanui and Palehua. OANRP conducted the monitoring of birds at each of these MUs.

Figure 2. Summer intern, Deann Nishimura Thorton, with a juvenile Elepaio at SBW. The first thing people notice when handling an Elepaio is how weightless they are. The average weight of a bird is just 13 grams, or a little less than 3 nickels.

6.1.3 **Results**

With 89 Elepaio pairs managed during the 2017 breeding season, the OANRP fulfilled the required 75 pairs for species management. The results of management conducted for each area during the 2017 breeding season are compiled below. The results from each area are presented in two ways. First, a map presents a compilation of all the known Elepaio territories within each Elepaio MU. The map denotes all of the territories that were baited. Second, the data is presented in tabular form with the number of territories that had single males or contained pairs. The table also presents the number of paired territories in which rodent control was conducted, the number of active nests observed, total successful and failed nests, how many fledglings were observed, and the ratio of fledglings per pair.

Schofield Barracks West Range

Figure 3. Schofield Barracks West Range Territory Occupancy Status and Rat Control 2017

Table 1. Schofield Barracks West Range Site Demographic Data

SBW	2017	2016	2015	2014	2013	2012	2011
Singles	9	16	16	17	18	16	15
Pairs	81	66	58	57	60	58	56
Pairs with Rat Control	27	28	26	22	29	28	31
Active Nests[1]	19	14	14	16	18	23	34
Successful Active Nests[2]	10/19=53%	10/14=71%	8/14=57%	8/16=50%	9/18=50%	16/23=70%	22/34=65%
Unknown Nest Outcome[3]	5	2	2	3	0	0	0
Failed Active Nests	5	4	4	5	9	7	12
Family Groups Found[4]	8	7	5	8	15	11	11
Fledglings Observed[5]	19	21	14	20	28	28	46
Fledglings/Managed Pair[6]	0.70	0.75	0.54	0.91	0.97	1	1.48

[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, 53% (10/19) were successful in producing 11 fledglings, while 26% (5/19) of the active nests failed. Five 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). Another eight fledglings were found with eight managed pairs where no nesting had been observed (family groups). A total of 19 fledglings were observed in territories benefiting from rodent control management. Another four fledglings were observed in territories not protected from rats.

Figure 4. Two nestlings contend for a meal from their father. It is common for only one chick to survive this competitive two week "begathon."

Summary

Access at SBW remains limited to four or five days per month due to increased training by the Army. This allows for approximately one day per month of access for monitoring to each of the three managed gulches in SBW. This reduces the time available during the breeding season for the OANRP to detect active nests and fledglings. Despite the limited access for monitoring and rebaiting of rat traps, the population continues to increase reaching an impressive 81 pairs in 2017. Largely responsible for this increase is a follow-up survey of the South Haleauau drainage, which is not monitored during the breeding season and was last surveyed in 2010. South Haleauau is the largest drainage inside the management area. It is also the least accessible, which is why there is not regular monitoring or rodent control at Elepaio paired territories. It had been six years since the first detailed survey was conducted and an updated survey was needed to have accurate population data for the entire MU. During the survey in 2010 staff found 17 pairs and 11 single birds. This year staff observed 27 pairs and four single birds, which amounts to a 29% increase in the resident population. Such an increase may be the result of successful breeding within South Haleauau and offspring from the nearby managed drainages immigrating to another gulch with suitable habitat. Without consistent monitoring it is difficult to explain such an increase, but this is very encouraging to see and there are likely more pairs scattered throughout this large drainage in areas we were unable to access.

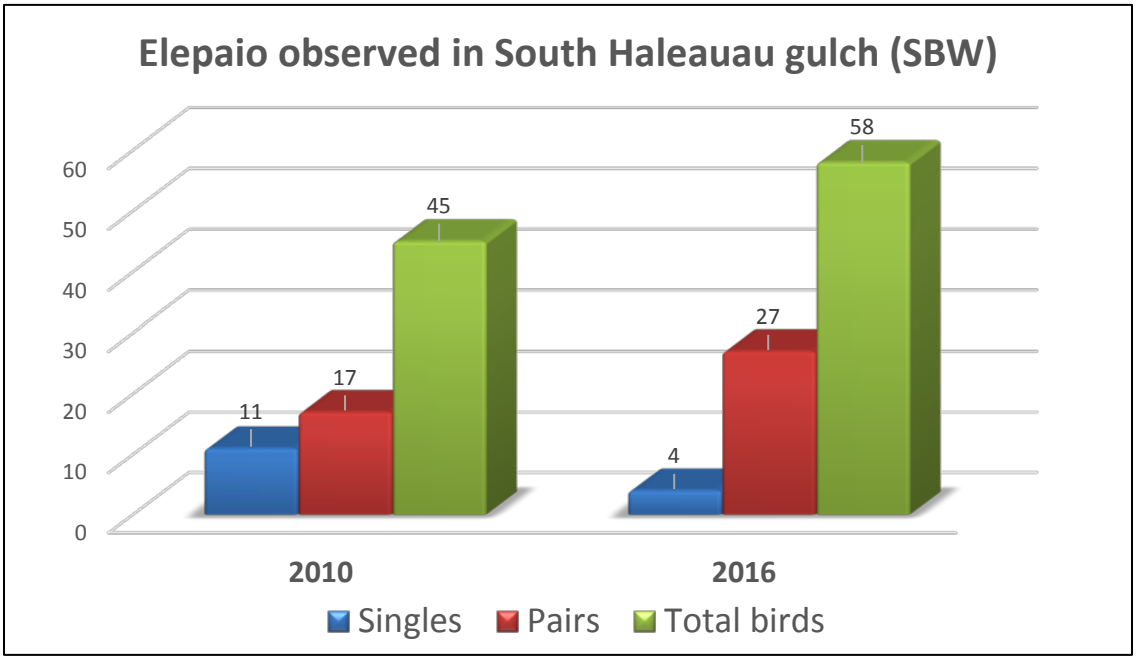


Figure 5. In six years without rodent control, South Haleauau saw a 29% increase in the resident population.

Honouliuli Forest Reserve – Ekahanui

Figure 6. Ekahanui Territory Occupancy Status and Rat Control 2017

Table 2. Ekahanui Site Demographic Data

EKA	2017	2016	2015	2014	2013	2012	2011
Singles	4	2	0	5	1	11	14
Pairs	42	40	39	30	39	31	30
Pairs with Rat Control	37	37	37	28	36	29	30
Active Nests[1]	11	12	23	14	26	21	15
Successful Active Nests[2]	6/11=55%	8/12=67%	13/23=56%	7/14=50%	17/26=65%	9/21=43%	8/15=53%
Unknown Nest Outcome[3]	0	1	5	3	3	0	1
Failed Active Nests	5	4	6	6	9	12	6
Family Groups Found[4]	25	22	6	12	8	6	15
Fledglings Observed[5]	36	36	24	21	29	18	26
Fledglings/Managed Pair[6]	0.97	0.97	0.65	0.75	0.81	0.62	0.87

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

Reproductive Results

Of the active nests monitored, 55% (6/11) were successful, producing eight fledglings, and 45% (5/11) of active nests failed. Twenty-eight fledglings were found in twenty-five managed pairs where no nesting had been observed (family groups). A total of 36 fledglings were observed in territories benefiting from rodent control management. Another three fledglings were observed in territories not protected from rats.

Summary

The Elepaio had another productive breeding season at Ekahanui with 36 fledglings being detected. This is also the second year in a row that we observed nesting prior to December with 11 fledglings found. Normally when the breeding season is completed in June/July the birds molt and no nesting is observed until December. Any nesting that does occur is considered early nesting. The reason for this early nesting is unknown, but possibly due to favorable weather conditions in September-November. The total population reached an all-time high this year at Ekahanui with 88 birds.

Figure 7. The Oahu Elepaio is part of the family of Monarch flycatchers, which includes over 100 worldwide species of insectivorous songbirds. Most are territorial, generally monogamous, decorate small cup-like nests, and, unfortunately, are on the decline.

Palehua

Figure 8. Palehua Territory Occupancy Status and Rat Control 2017

Table 3. Palehua Site Demographic Data

HUA	2017	2016	2015	2014	2013	2012	2011
Singles	5	2	1	2	0	0	0
Pairs	12	11	15	11	17	16	17
Pairs with Rat Control	12	11	15	10	17	16	17
Active Nests[1]	6	6	6	8	16	8	13
Successful Active Nests[2]	4/6=67%	2/6=33%	3/6=50%	4/8=50%	11/16=69%	3/8=38%	10/13=76%
Unknown Nest Outcome[3]	0	0	0	0	0	0	2
Failed Active Nests	2	4	3	4	5	5	1
Family Groups Found[4]	5	5	1	4	5	3	5
Fledglings Observed[5]	12	8	5	10	21	6	16
Fledglings/Managed Pair[6]	1	0.72	0.33	1	1.24	0.38	0.94

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

Reproductive Results

Of the active nests monitored, 67% (4/6) were successful and produced a total of five fledglings, while 33% (2/6) of the nests failed. Seven fledglings were found with five managed pairs where no nesting had been observed (family groups). A total of twelve fledglings were observed in territories benefiting from rodent control management.

Summary

Our smallest and southernmost Elepaio population in the Waianae mountain range had a fairly good 2017 breeding season. The population grew slightly over last year and there was a significant increase in fledglings found. Again, we saw early nesting for the second consecutive season with three fledglings found in three separate pairs in November 2016. The birds are likely taking advantage of favorable weather conditions in the fall months.

Figure 9. Mist-netting and banding juvenile birds before they acquire their adult plumage allows us to accurately track their age from year to year. Currently, the oldest known Elepaio is a male in SBW. He is 22 years old and is the oldest known living Elepaio in the state of Hawaii. He is the 3rd oldest Elepaio ever known, with the title going to a bird that lived to be 23 years and 2 months at Hakalau NWR on the Big Island. The only known Hawaiian passerine to live longer than this bird was an Alala, which was 24 years old when it died in captivity.

Moanalua Valley

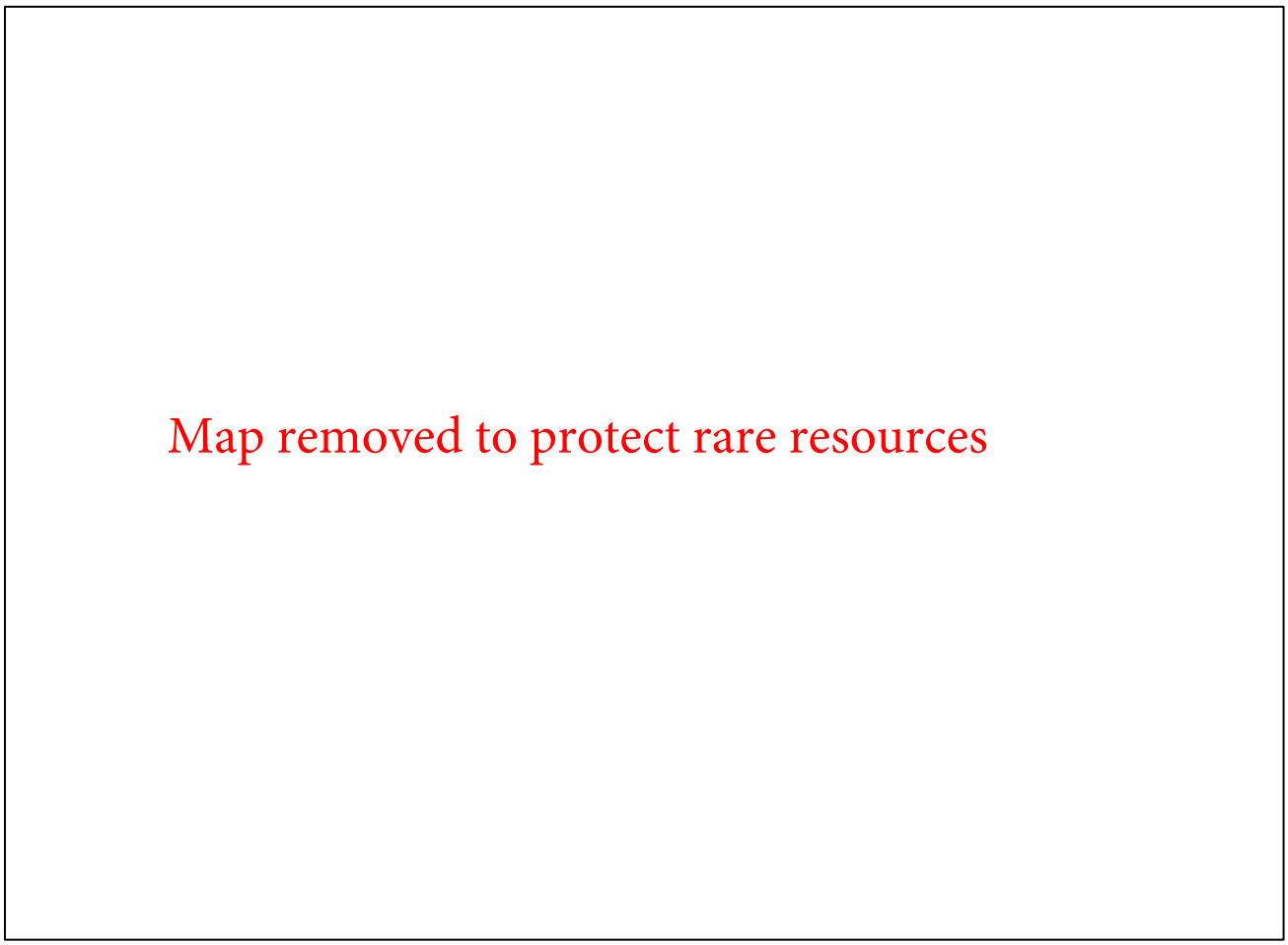


Figure 10. Moanalua Territory Occupancy Status and Rat Control 2017

Table 4. Moanalua Site Demographic Data

MOA	2017	2016	2015	2014	2013	2012	2011
Singles	7	6	6	7	14	19	10
Pairs	39	34	33	32	33	32	21
Pairs with Rat Control	13	12	19	22	23	24	16
Active Nests[1]	9	3	7	16	17	15	13
Successful Active Nests[2]	7/9=78%	1/3=33%	3/7=43%	5/16=31%	14/17=82%	10/15=67%	5/13=38%
Unknown Nest Outcome[3]	1	2	1	7	6	2	5
Failed Active Nests	1	2	3	6	3	5	3
Family Groups Found[4]	1	2	4	4	2	2	3
Fledglings Observed[5]	10	3	7	11	17	13	9
Fledglings/Managed Pair[6]	0.77	0.25	0.37	0.5	0.74	0.54	0.56

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

Reproductive Results

Of the active nests monitored, 78% (7/9) were successful in producing nine fledglings, and 11% (1/9) failed. One nest had an unknown outcome (nests with sufficient time gap between visits in which a nest could have fledged with no subsequent detection of a fledgling). One fledgling was found in one managed pair where no nesting had been observed (family groups). A total of ten fledglings were observed in territories benefiting from rodent control management. Another three fledglings were observed in territories not protected from rats.

Summary

Moanalua Valley had a much improved breeding season over the last few years. There was a higher number of successful active nests and the total population is the largest ever seen. New Elepaio territories continue to be found lower down in the valley, as well as close to the road allowing for added management protection. Unfortunately, previous managed territories in the back of the valley still remain cut off from monitoring and rodent control due to poor road conditions, but we are hopeful to one day revisit these territories to confirm their current status.

Figure 11. With a rapid series of wheezy calls, a fledgling Elepaio begs for food from nearby adults. Not long from now the young bird will have to be fast enough to capture its own live insect prey.

6.1.4 OIP Summary

Management Action Highlights 2017

- Conducted rodent control in a total of 89 territories with pairs at four management sites.
- Completed a follow-up survey of South Haleauau gulch in SBW to update the original survey that was conducted in 2010.

- Table 5 below summarizes the number of managed pairs and reproductive output since 2006.

Table 5. Summary of Elepaio Management

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings	Fledglings/ Managed Pair
2017[1]	89	26	36	73	0.82
2016[1]	88	21	36	68	0.77
2015[1]	97	27	20	50	0.52
2014[1]	81	24	28	62	0.77
2013[1]	105	51	38	95	0.90
2012[1]	97	38	22	65	0.67
2011[1]	94	47	34	96	1.02
2010[1]	87	18	15	39	0.45
2009[2]	81	29	24	60	0.74
2008[3]	74	25	20	56	0.76
2007[3]	78	18	26	46	0.59
2006[4]	69	11	17	33	0.48

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

Management Actions 2018

- Continue to mist-net and band all adult and juvenile Elepaio within the MUs to improve yearly demographic monitoring. In the process, record songs and calls in order to expand our collection of Oahu Elepaio vocalizations at all MUs.
- Conduct surveys within and beyond MUs to monitor bird movements and population growth of the species. This will include conducting the 5th survey since 2009 of the two drainages north of the Ekahanui MU. Since that time the Elepaio population north of Ekahanui has increased 303% with the number of breeding pairs increasing from 1 to 14.
- All Victor® rat snap traps in both large and small-scale rodent control grids will be replaced with A24 traps with automatic lures. This will hopefully increase rat kills within Elepaio breeding areas and decrease the number of staff hours needed to reset the traps.
- Increase the use of motion sensor cameras to monitor nesting activity at night and document Elepaio nest predation.
- Conduct rodent control and Elepaio monitoring at Ekahanui, SBW, Palehua and Moanalua to meet required 75 managed pairs.

6.1.5 Terms and Conditions for Implementation

Minimize direct impacts of military activities on survival and reproduction of Oahu Elepaio within the action area at Schofield Barracks Military Reserve (SBMR).

1. *The Army will report to the Service in writing at least semiannually (twice per year) the number of high explosive rounds that land above the fire break road, the locations where such rounds land, and whether these locations are within any known Elepaio territories.*

[No high explosive rounds landed above the firebreak road]

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

[No fires affected any known Elepaio territories during the 2017 breeding season]

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

[No training actions have occurred above the firebreak road]

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

[No specimens were collected by OANRP staff]

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

1. *The Army will report to the Service in writing on a semi-annual (twice per year) the number of fires above the fire break road, the area burned by each fire above the fire break road, including the amount of critical habitat burned, and how each fire was ignited or crossed the fire break road.*

[No fires occurred above the firebreak road]

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

[All training was conducted in accordance with the WFMP]

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

1. *The Army will report to the Service in writing annually the number of Elepaio territories in which rats were controlled, the location of each territory in which rats were controlled, the methods by which rats were controlled in each territory, the dates on which rat control activities were conducted in each territory, and the status of Elepaio in each territory from the previous year.*

[This report documents all of the above requirements]

2. *The Army, Service, and ornithological experts will formally reassess all impacts to Oahu Elepaio and Elepaio critical habitat that have occurred during the first five years following completion of this biological opinion. This formal review will occur before the end of calendar year 2008 and its purpose will be to reassess impacts from training exercises and, if necessary, correct any outstanding issues that are still impacting Elepaio and resulting in the loss suitable Elepaio habitat at SBMR. The feasibility of restoring critical habitat areas that have been lost also will be reassessed during this formal review.*

[Completed]

Figure 12. Spiders are an important resource for the Elepaio. Not only do the birds use their webs to hold the tightly packed nest together, but they are also a nutritious snack for the nestlings.

6.2 MIP ELEPAIO MANAGEMENT 2017

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. A term and condition in this 2007 BO was to construct ungulate-proof fencing around Makua Military Reservation and control rodents using aerially broadcast rodenticide when authorized.

Methods/Results

The methods section and the presentation of the results are in the same format as in the OIP Elepaio management section of this year-end report.

Figure 13. Small Vertebrate Specialist, Tyler Bogardus, with a juvenile Elepaio. Younger birds are easier to capture than adults due to their aggressiveness as they search for a territory and a mate.

Makua

Figure 14. Makua Territory Occupancy Status and Rat Control 2017

Table 6. Makua Site Demographic Data

Makua	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Single Males	2	2	N/A	0	2	2	2	2	1	1	2	4
Single Females	0	0	N/A	0	0	0	0	0	0	1	1	1
Pairs	0	0	N/A	0	0	0	0	0	2	2	2	1
Pairs with Rat Control	0	0	N/A	0	0	0	0	0	2	2	2	1
Active Nests[1]	0	0	N/A	0	0	0	0	0	1	1	0	0
Successful Active Nests[2]	0	0	N/A	0	0	0	0	0	0	0	0	0
Unknown Active Nests[3]	0	0	N/A	0	0	0	0	0	1	0	0	0
Failed Active Nests	0	0	N/A	0	0	0	0	0	0	1	0	0
Family Groups Found[4]	0	0	N/A	0	0	0	0	0	0	0	0	0
Fledglings Found[5]	0	0	N/A	0	0	0	0	0	0	0	0	0
Fledglings/Pair[6]	0	0	N/A	0	0	0	0	0	0	0	0	0

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

Reproductive Results

In 2017, two surveys of the valley were conducted in February and August. Previous occupied territories and other areas containing suitable breeding habitat were surveyed with the help of digital recordings of Elepaio songs and calls specific to Makua Valley. During each 3-day camping trip two adult males were found, both defending separate territories in gulches deep within the valley. A breeding pair of Elepaio has not been observed in Makua Valley since 2009.

MIP Summary

Management Actions 2017

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

Management Actions 2018

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

Figure 15. The sun sets over Makua Valley, now home to just two male Elepaio.

6.3 OPEAPEA MANAGEMENT 2017

6.3.1 Background

OANRP originally conducted acoustic monitoring for the Hawaiian Hoary bat (*Lasiurus cinereus semotus*) or Opeapea from 2010 to 2013 on all Oahu Army Training Areas: Dillingham Military Reservation (DMR), Kahuku Training Area (KTA), Kawailoa Training Area (KLOA), Makua Military Reservation (MMR) and Schofield Barracks Military Reservation (SBMR). These surveys were conducted for over 301 nights in order to establish bat presence or absence and if possible document potential seasonal use of habitats by the Opeapea. OANRP found Opeapea present at all Oahu Training Areas (Fig. 13) but seasonality of habitat use could not be determined. Specific foraging behavior was documented from KTA, DMR and Schofield Barracks West Range (SBW). In general, bat detections on Oahu are much lower than from data collected on Hawaii, Maui and Kauai islands (C. Pinzari pers. comm.).

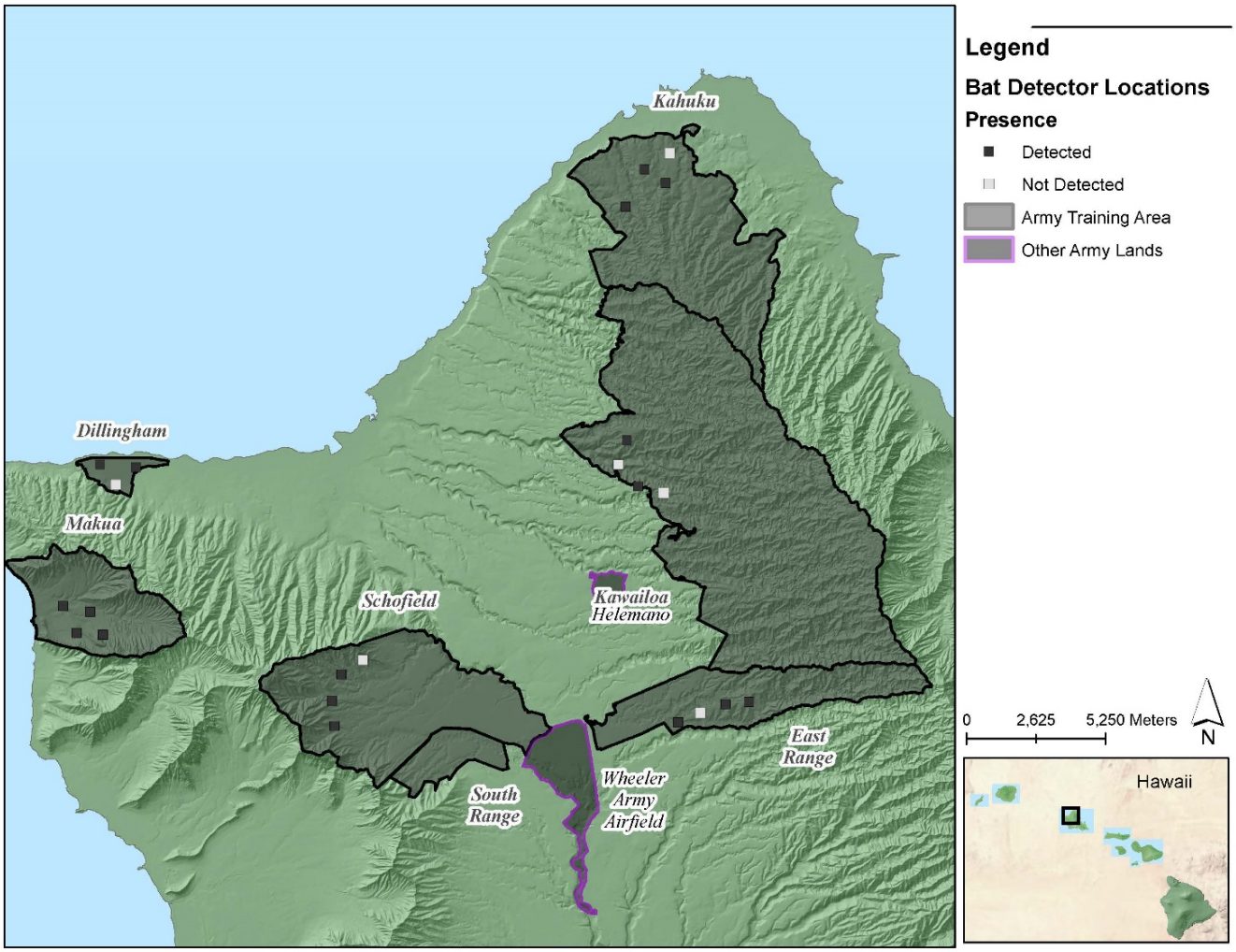


Figure 16. OANRP bat survey sites on Army Training lands.

6.3.2 Opeapea Management Summary

OANRP secured funding in FY 15 to conduct more intensive acoustic monitoring surveys across a majority of the Army installations on Oahu, including cantonment areas. The survey period was originally from January 2015 to January 2016 but due to range scheduling conflicts the recorders were left out until March 2016. Figure 14 displays all of the locations that the bat acoustic recorders were placed throughout the duration of the study. A total of 30 monitoring stations were run nightly for this study. Final results are forthcoming in calendar year 2018 as a Hawaii Cooperative Studies Unit Technical Report. Preliminary results from the study are, 20 out of the 30 sites had bat presence, but the detection rates were very low (Figure 13). The highest detection rates were at a station in Dillingham Airfield (0.05) and at the stations spread across the West Range (0.04 up to 0.355). All other stations had much lower detectabilities, most around 0.01 and below. Foraging activity was recorded across West Range and one station at East Range (C. Pinzari pers. comm.). This report will be used in the upcoming consultation with the USFWS.

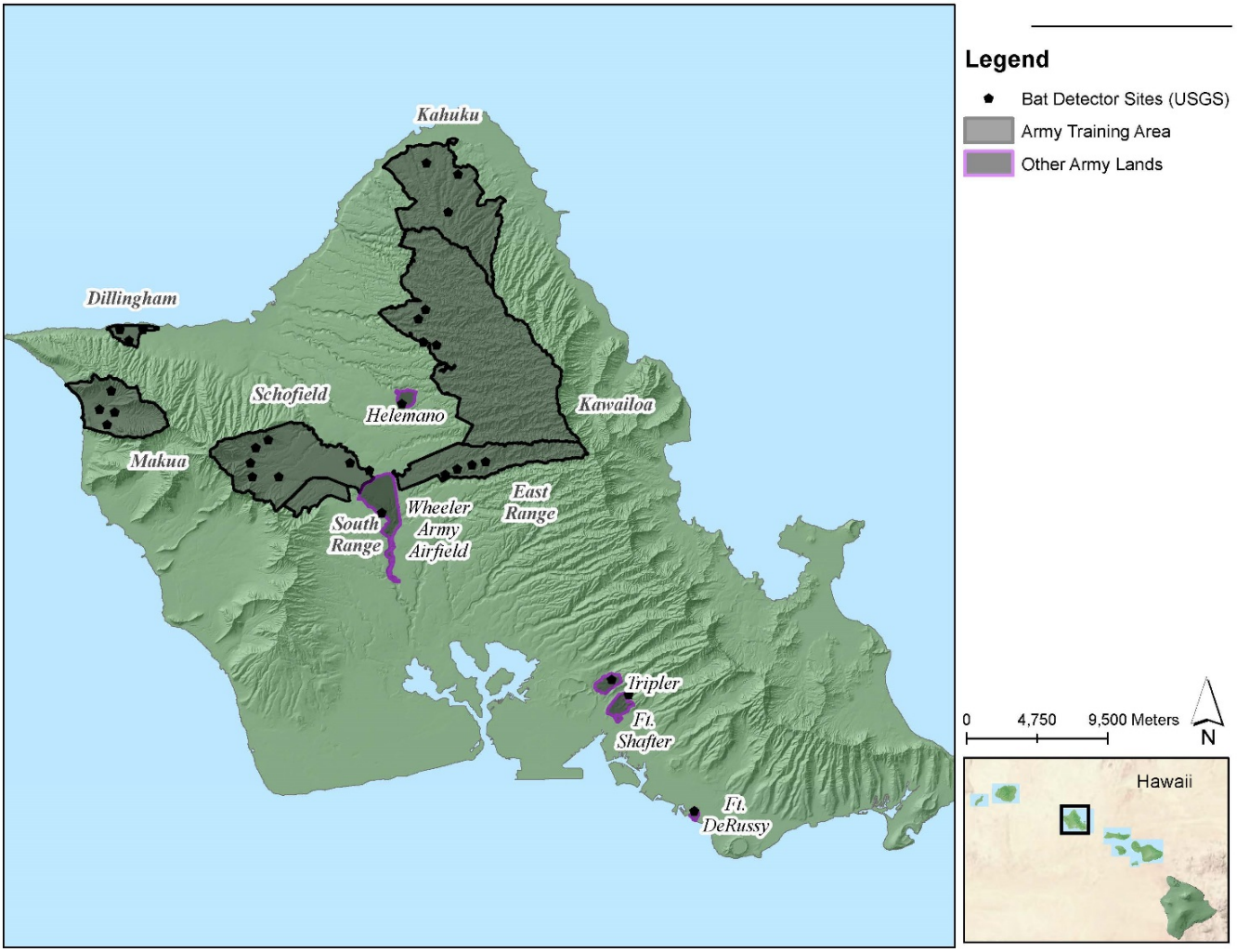


Figure 17. USGS survey sites for Opeapea on Army controlled lands.

OANRP continues to abide by the restrictions provided by the USFWS to minimize impacts to bats through an informal consultation. Refer to the 2016 OANRP YER for further details on the restrictions. During the 2017 pupping season, permission was given to remove trees that were safety hazards or necessary for ongoing construction projects. In each case, OANRP employed a combination of acoustic monitoring (Echo meter Touch or SM2 Bat Songmeter) and thermal imager (Fluke 400T) surveys to determine if bats were utilizing the trees for roosting and if pups were present. OANRP also recorded whether any other wildlife was observed during the surveys. Results of all the surveys are listed in Appendix 6-1 to 6-7. Table 7 shows that a total of eight surveys were conducted by OANRP before the end of this reporting period. All totaled, ~16 hours were spent conducting these surveys (not including transportation time) in 83 trees (six different species). Zero roosting or flying bats were detected during the course of the thermal surveys but a preliminary acoustic survey for the 19 July survey did detect bats flying through the site three times in two nights (Appendix 6-2).

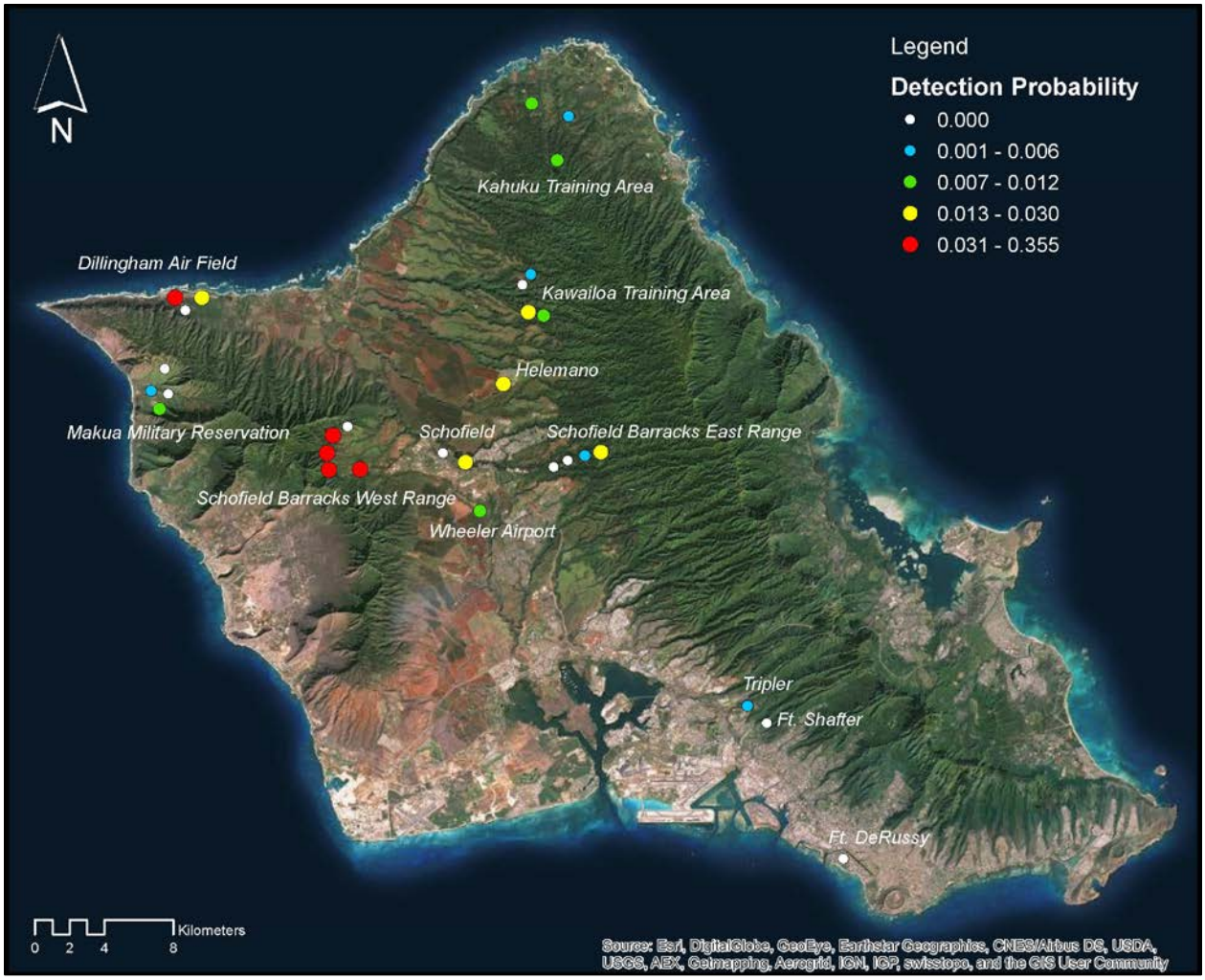


Figure 18. Draft map of the general results from USGS study

Table 7. 2017 Opeapea Acoustic/Thermal Surveys, showing number of trees by species surveyed

SURVEY DATE	2017-06-05	2017-07-19	2017-07-20	2017-07-21	2017-07-24	2017-07-26	2017-08-03	2017-08-24
INSPECTOR	M. Burt	M. Burt	M. Burt P. Smith	P. Smith	M. Burt	P. Smith	P. Smith	K. Kawelo J. Rohrer T. Bogardus
THERMAL OR ACOUSTIC SURVEY	Both	Both	Both	Both	Thermal	Both	Both	Both
START TIME	05:00	5:00	4:40	4:40	05:00	06:00	05:30	05:30
END TIME	06:30	6:30	6:30	7:30	06:30	07:20	06:30	06:30
TOTAL TIME	1.5 Hr	1.5 Hr	1.8 Hr	2.8 Hr	1.5 Hrs	1.20 Hrs	1 Hr	1 Hr
BAT DETECTED (T/A)	No	No/Yes	No	No	No	No	No	No
WILDLIFE DETECTED	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WEATHER	Clear, Light wind	Clear, Light wind	Clear, Light wind	Clear, Light wind	Rainy	Clear, light wind	Clear, light wind	Rain, Drizzling
ARMY INSTALLATION	SBMR	SBMR	SBMR	SBMR WAAF	SBMR	SBMR	TAMC	SBMR
AFRICAN TULIP					6	2		
EUCALYPTUS SPP.				4	7	10		5
MONKEY POD			5	2	1			
ALBIZIA SPP.	3	25			1		3	
KUKUI						1		
IRONWOOD						8		
HOURS SUBTOTAL	1.5	1.5	3.6	2.8	1.5	1.2	1.0	3.0
TOTAL HOURS								**16.1**

CHAPTER 7: *DROSOPHILA* SPECIES MANAGEMENT

7.1 BACKGROUND

Fourteen species of Hawaiian picture wing *Drosophila* flies are currently listed as threatened or endangered, and many more are equally rare. Six listed species are endemic to Oahu, and three – *D. montgomeryi*, *D. obatai*, and *D. substenoptera* – are currently known to occur on Army lands. OANRP work on *Drosophila* began in March 2013, focusing on monitoring known populations, surveying for new ones, and restoring habitat.

This year's surveys were significantly reduced compared to previous years due to unforeseen personnel issues, and were mostly limited to monitoring of existing sites. The El Nino weather pattern that began in the summer of 2015, with a wet summer in leeward areas followed by a dry winter, continued through late 2016 and has resulted in seriously depressed populations of both common and rare *Drosophila* species (along with many other insects). Some had brief comebacks in the spring of 2017, but the summer has been extremely dry and they dropped back to very low levels (typical of the summer months) by the end of the reporting period.

7.2 SURVEY METHODS

Many species of Hawaiian *Drosophila*, including the picture wing group to which all of the endangered species belong, are readily attracted to baits of fermented banana and mushrooms. Both baits are spread on a cellulose sponge which is hung from a tree in a cool, shaded, sheltered site, and checked for flies after about one hour. Depending on the quality of the site (number and size of host plants, and microclimate) and the density of baiting spots, surveys typically consist of setting out 16-24 sponges, in groups of 4 or 8 with groups separated by 20-100 m. Baits are checked at least every hour, as flies do not necessarily stay at baits for long periods; number and species of all picture wings on each sponge are recorded at each check. The greatest activity is typically during the cooler hours before 10 AM and after 2 PM, but flies may appear at any time. Direct quantification of *Drosophila* populations is difficult, since populations may fluctuate not only seasonally but from day to day. However, repeated surveys can yield useful data on long-term trends. Abundance numbers are reported as the maximum number of individuals observed on a survey day (compiled by adding the maximum observed at each discrete group of bait sponges at any one time, assuming that the same individual flies may move between sponges within a group but are unlikely to be seen at two different groups), since numbers fluctuate through the day.

Known, significant populations of *D. montgomeryi* at Kaluaa MU and *D. substenoptera* at Palikea MU, where flies occur relatively consistently, are monitored monthly in order to determine approximate population trends through the year. For *D. montgomeryi*, Pualii (designated as a management site for *D. montgomeryi*) and Waianae Kai (not a managed population, but the largest known population) were designated to be monitored quarterly; however, due to apparent loss of the population at Pualii due to a demographic gap in the host plant, and higher priorities elsewhere, only one monitoring visit was made to each this year (see below for other actions). Other known populations (Kaala and Lower Opaeula for *D. substenoptera*, Lihue and Manuwai for *D. obatai*) are visited periodically through the year, typically quarterly or less. New populations of endangered *Drosophila* were searched for by looking in similar habitat both in areas suggested by other staff as having host plants, at historic collecting localities, and in new sites where surveys have been minimal. Numbers of *Vespula pensylvanica* (western yellowjacket), a potentially serious invasive predator, are monitored at Palikea and Puu Hapapa with 10 traps at each site baited with heptyl butyrate and checked monthly.

Figure 1. Distribution of *Drosophila montgomeryi* observations in the 2016-17 reporting year and earlier records from 2009-15, with known *Urera* spp. sites and all survey points in the Waianae range.

7.3 RESULTS

7.3.1 *Drosophila montgomeryi*

Drosophila montgomeryi is a small yellow-brown species that breeds in rotting bark of *Urera kaalae* and *Urera glabra* (opuhe). While *Urera glabra* occurs widely across the Waianae range, it often occurs as scattered clumps of a few or only one individual, unsuited for survival of *D. montgomeryi* and probably not viable for long-term survival of this dioecious, wind-pollinated tree. *Urera kaalae* is critically endangered and only a handful of wild plants remain, although several hundred have been outplanted. *Drosophila montgomeryi* is currently known from ten sites that are regarded as five population units (PUs), effectively covering nearly its entire historic range in the Waianae mountains (Figure 1). However, it has not been found at the Pualii or Palikea PUs in over two years, and the Lihue PU has not been surveyed recently due to access issues. Field work this year has focused on monitoring known populations rather than searching for new sites, but sites in the northwest part of the range from Pahole west continue to be searched (Table 1).

Kaluaa & Waieli MU

Three sites in this MU – Puu Hapapa, North Kaluaa, and Central Kaluaa gulch 1 – have been monitored monthly since June 2013 (though not every site was visited each month) over a total of 114 survey days. In past years abundance of *D. montgomeryi* has followed a distinct seasonal pattern, increasing

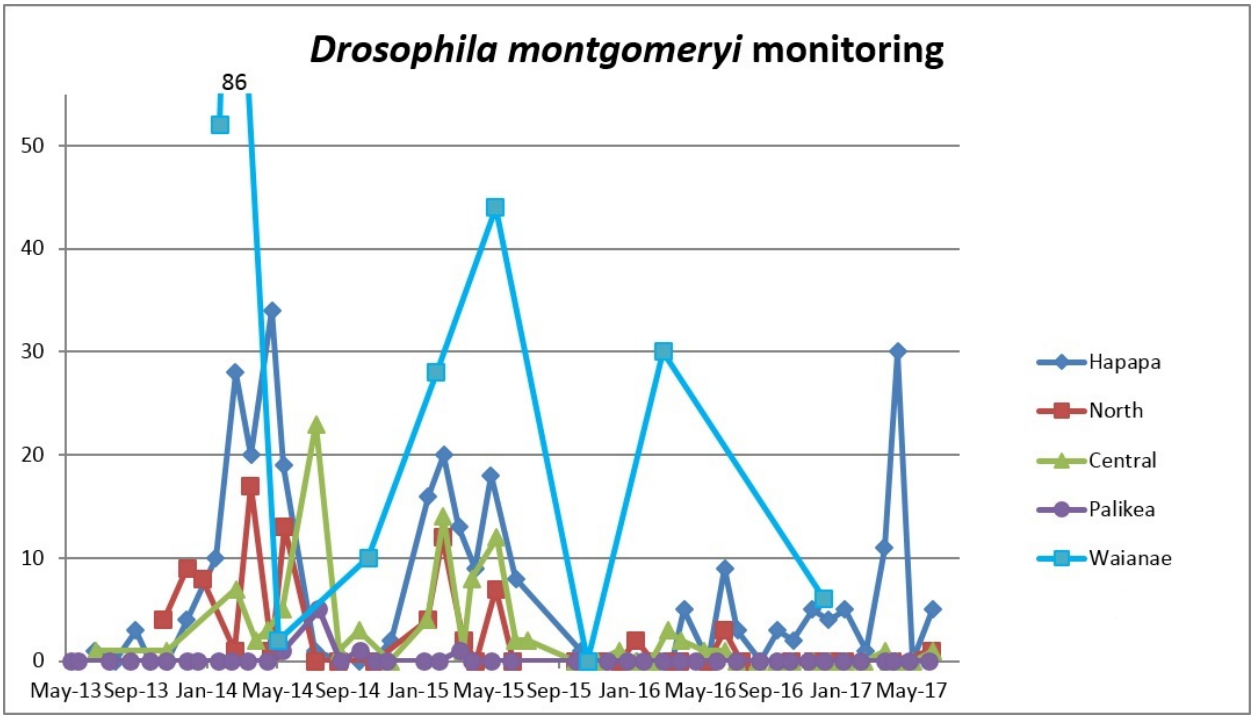


Figure 2. *Drosophila montgomeryi* numbers during monthly monitoring at three sites in Kaluaa PU (Puu Hapapa, North Kaluaa, and Central Kaluaa) and Palikea, and quarterly monitoring at Waianae and Pualii. Y axis is the maximum number observed across the entire site on the survey day (see Survey Methods, section 7.2).

dramatically over the winter months to a peak between January and May (Figure 2), more or less in synchrony with several common *Drosophila* species. This is most likely due to increased rain and treefalls from storms that cause death or branch breakage of *Urera* near monitoring sites. During 2015-16 and again in the 2016-17 sampling season, there was no such winter pulse in *D. montgomeryi*, with only relatively few scattered individuals. There was a brief late spring spike at Puu Hapapa only; at Kaluaa they were very low (Central) or absent (North). The common species *D. inedita* and *D. ambochila* did both have similar winter seasons as in previous years, although they did not reach as high abundance as usual.

Pualii

This site was visited for the first time in 2014, and quarterly monitoring began in 2015. At the time of the first visit, the last wild *Urera kaalae* tree in North Pualii Gulch had recently fallen and the decaying trunk was supporting a large number of *D. montgomeryi*. Unfortunately, the fly has not been seen since the second visit there, and the survival of this population is uncertain. Only one of the original *U. kaalae* outplants remains, but at least 10 natural offspring of these plants have grown up, and several have now reached substantial height. This appears to be the only site where outplanted trees of this species are successfully recruiting. There are no *U. glabra* aside from recent outplants, which have not grown as much as those at other sites. Nevertheless, it is an area of high-quality native habitat, both in the immediate vicinity and further downslope in the gulch, where light gaps provide better outplanting spots. It may be a potential reintroduction site after additional host plant restoration.

Site	Days	Max No.
Kaluaa - Central	13	1
Kaluaa - North	7	1
Puu Hapapa	12	30
Palikea	12	0
Moho Gulch	1	0
Pualii	1	0
Waianae	1	6
Kawaiu	1	0
Pahole	1	0

Table 1. Survey effort for *D. montgomeryi* across all potential sites in 2016-17 reporting period, in survey days. "Max No." is the highest number of flies observed in a single day.

In July 2016, big-headed ants (*Pheidole megacephala*) were found in the lower portion of the fenced unit around the recent *Urera kaalae* outplantings. Although present in the gulch well below the fence, they had not previously been noted at this site, and would be a threat to *Drosophila* there. The ant population was determined to be relatively confined to the bottom of the gulch, and control will be attempted using granular bait in summer 2017.

Palikea

Despite continuous monitoring here since May 2013 (targeting *D. substenoptera*, which is consistently found in the area), *D. montgomeryi* was not detected until May 2014. Three of the four records of *D. montgomeryi* here have been of single individuals, indicating that the population remains low. After a year of occasional sightings, it has not been seen here since March 2015, possibly due in part to drying of the site from canopy clearing. However, there are other patches of *Urera* around the Palikea MU that may also harbor populations of *D. montgomeryi*. The area where they were found is already a target for weed management and restoration, and has high potential for management to benefit *D. montgomeryi*. *Urera glabra* had already begun to increase naturally as weed control reduced alien cover, and outplanting has significantly boosted the population. Outplanted *U. glabra* here has done exceptionally well – many of them are 6–8 feet tall after only 18 months. *Urera kaalae* has also been planted here by Oahu PEPP, and are also thriving. Weed control is ongoing as some parts of the restoration area lack canopy cover and are susceptible to heavy invasion by weeds such as *Rubus rosifolius*, *Buddleia asiatica*, and *Erechtites valerianifolia*.

Figure 3. Habitat restoration for *D. montgomeryi* at Palikea. The photos in each column were taken from the same viewpoint on opposite ends of a clearing where invasive plants had been removed (October 2014) and *Urera glabra* and other natives planted in February 2015. Note the large stump in the left photos and the hapuu in the right ones for reference.

Waianae Kai

The largest known population of *D. montgomeryi* occurs in the northeastern subgulches of Kumaipo stream, Waianae Valley. Four sites have been discovered so far, all at the base of Mt. Kaala and consisting of small patches (~0.5 ha) of diverse native forest constrained by alien-dominated vegetation above and below. All are located on or just below steep slopes that are vulnerable to landslides, which may preclude fencing as a matter of practicality. The largest has been surveyed repeatedly and had a very large population of flies, but this has been severely reduced by damage from falling boulders and subsequent weed invasion. A fifth potential site was discovered this year to the east in Hiu drainage, but it has not yet been surveyed. Much of the area further east in Hiu and Honua drainages, as well as the western half of Kumaipo, remains to be surveyed and may contain additional sites.

Habitat restoration

This was the second year of active habitat management for *Drosophila montgomeryi*. Last year, approximately 50 *U. glabra* grown from cuttings were planted at each of North Kaluaa, Pualii, and Palikea, and 35 at Central Kaluaa, between November 2014 and April 2015. In December 2015, an additional 35 *U. glabra* were planted at Central Kaluaa, and 25 *U. glabra* and 50 *U. kaalae* at North Kaluaa (see Restoration section for details). Approximately 50 *U. kaalae* each were also planted at Palikea, Central Kaluaa, and Pualii by the OPEPP program. All sites are exhibiting high survivorship (87-–100%) and good growth, especially Kaluaa and Palikea (Figure 3). Observations of some individuals

Figure 4. Underside of a *Urera kaalae* leaf at Puu Hapapa, showing a dense covering of yellow urediniospores characteristic of heavy mamaki rust (*Pucciniastrum boehmeriae*) infection.

suggests that pruning of tip shoots of *U. glabra* may promote extremely vigorous growth of side branches and ultimately larger, more robust trees that will be better habitat for flies in a few years. Recent clearing of dense weed patches at Pualii and a major treefall at North Kaluaa in the past year and a half have created new outplanting opportunities, and more plants will be placed at those sites in the coming year.

In May 2016, the alien fungal pathogen mamaki rust (*Pucciniastrum boehmeriae*) was first noticed on *Urera kaalae* (Figure 4), and positively identified by HDOA. Although it manifests differently than in mamaki (*Pipturus albidus*), without any scorching or wilting of the leaves, the leaves are much more heavily covered in fungal spores and may fall off easily. The full effect of the rust is unknown. After a significant dieoff of *U. kaalae* in 2015 at Puu Hapapa from unknown causes, the situation has stabilized there and there has not been any mortality at other sites despite some having very heavy infections.

7.3.2 *Drosophila substenoptera*

Surveys for this species have focused on finding new populations. Based on collection records, it requires moderately tall, non-boggy wet forest with its host plants, *Cheirodendron* spp. (olapa) and *Polyscias* (=*Tetraplasandra*) *oahuensis* (ohe mauka), a habitat which is relatively uncommon since these trees tend to occur most abundantly in boggy, short-stature forest near summit crestlines. Compared to other islands, *Cheirodendron* is rather uncommon on Oahu relative to available habitat, and a large proportion occurs on steep slopes or in the bottom of drainages that are weedy and difficult to access. Currently, there are three known PUs for *D. substenoptera* – Palikea, Kaala-Kalena, and Opaeula (Figure 5). PU trends are

Site	Days	Max No.
Palikea	12	6
Kaala	4	0
Lihue	2	0
Lower Opaeula	5	0

Map removed to protect rare resources

Figure 5. Distribution of *Drosophila substenoptera* observations in the 2016-17 reporting year and earlier records from 2013-16.

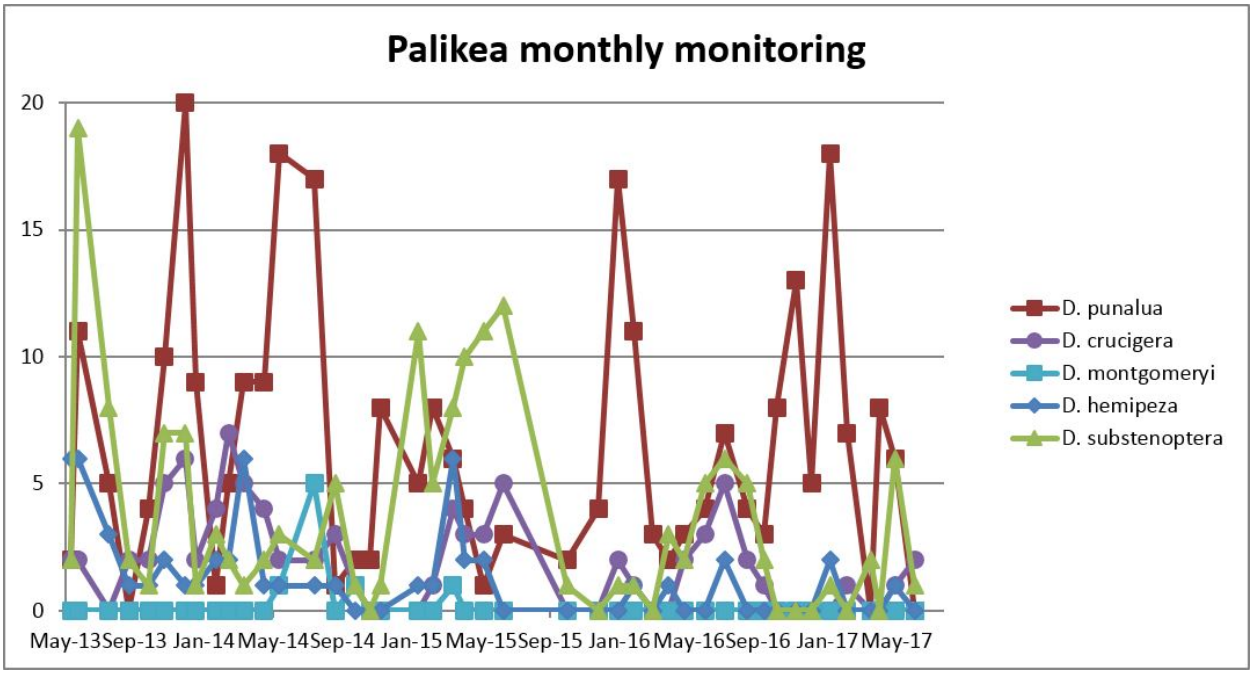


Figure 6. Monthly monitoring results for all picture-wing *Drosophila* species at Palikea, from May 2013 to June 2017.

only graphed for Palikea as the other two PUs have insufficient numbers of survey days. At other PUs *D. substenoptera* is highly sporadic, typically occurring as single individuals observed only once during a day. This rarity has undoubtedly hampered our ability to detect it at new sites.

Site	Days	Max No.
Palikea	12	6
Kaala	4	0
Lihue	2	0
Lower Opaeula	5	0

Table 2. Survey effort for *D. substenoptera* and number of flies found across all potential sites in 2016-17 reporting period, in survey days. "Max No." is the highest number of flies observed in a single

Waianae Range

Monthly monitoring in the northern portion of Palikea MU has been ongoing since May 2013 (54 survey days total, 12 in the current reporting period; Table 2). Aside from a large flush in late May 2013, numbers of *D. substenoptera* and another endangered species, *D. hemipeza*, have been consistently low to modest, but they have almost always been present. In contrast to *D. montgomeryi*, abundance of *D. substenoptera* tends to increase in the summer rather than winter, somewhat correlated with *D. hemipeza* and the common *D. crucigera* but not *D. punalua* (Figure 6), indicating differences in host availability. At the Kaala-Kalena PU, five sites were surveyed (Kalena summit ridge, Kaala transect, and Kaala west, southeast, and northeast faces). No flies were found, but the Kaala sites are promising and will be revisited.

Koolau Range

In December 2013, a single *D. substenoptera* was observed at Opaeula Lower MU, the first record of the species in the Koolau range since 1972. In early 2015, it was sighted again in the same area. Historically, *D. substenoptera* was more widespread and abundant on this side than in the Waianae range. However, collection effort has been limited due to the difficulty in accessing areas of intact habitat for this species. OANRP survey trips in the Koolaus are now relatively few due to higher priorities elsewhere, and concentrated in only a few sites. In 2016-17, Lower Opaeula was visited twice for a total of five days; none were found. Finding additional Koolau populations is a high priority for this species; Helemano, Poamoho, and Kaukonahua have yet to be surveyed. Lower Opaeula and Koloa will continue to be

checked given the extremely high quality of habitat there and low observation rate at sites where *D. substenoptera* is known to be present.

7.3.3 *Drosophila obatai*

Site	Days	Max No.
Manuwai	4	1
Lihue – Pulee	4	0
East Makaleha	1	0
Central Makaleha	1	0

Table 3. Survey effort for *D. obatai* across all potential sites in 2016-17 reporting period, in survey days.

Drosophila obatai was rediscovered in Manuwai Gulch MU in 2011, 40 years after the previous record in 1971. It breeds in rotting stems of *Chrysodracon* (=*Pleomele*) spp. (halapepe), which suffers from very low reproduction rates but remains widespread in the northern Waianae range thanks to its longevity. It is currently known from seven sites in four potential PUs (Makaleha, Manuwai, Palikea Gulch, and Pulee), although three of these are within 1,200 m of each other and could potentially form one contiguous population. While the populations were almost certainly contiguous until recently, native forest in general and *Chrysodracon* in particular is now much more fragmented, and moving between patches of host trees is more difficult for the flies.

Surveys for *D. obatai* in 2016-17 were few due to limited survey time available and focus on monitoring *D. montgomeryi* (Table 3). Three sites at Manuwai, two in Pulee (SBW), and two in Makaleha were

Map removed to protect rare resources

Figure 7. Distribution of *Drosophila obatai* observations from 2013-17, with known *Chrysodracon* spp. sites and all survey points in the Waianae range.

visited; only a single *D. obatai* was seen, at Manuwai. While this is disturbingly few, it is nevertheless the first record of the species since June 2015, with relatively low survey effort. In the coming year staff will attempt to increase surveys for *D. obatai*, as it is the most threatened of the three managed species.

7.3.4 Other Rare *Drosophila*

During the course of surveys, four additional rare but non-listed *Drosophila* were found in management units where *D. montgomeryi* and *D. substenoptera* occur (Table 4). A fifth, *D. craddockae*, was found at Makua. Most of the rare species that had been found as of 2014 (*D. flexipes*, *D. kinoole*, *D. paucicilia*, *D. reynoldsiae*, *D. sobrina*, *D. spaniothrix*, and *D.* n. sp. nr. *truncipenna*) were not seen this year, due to the generally poor conditions (dry winter and wet summer) and reduced survey effort.

Table 4. Non-target rare *Drosophila* observed during surveys, July 2016–June 2017

Species	Sites	Total Observed	Max. No.
D. craddockae	Lower Opaeula	2	1
D. divaricata	Kaluaa, Hapapa	43	8
D. hemipeza	Palikea, Hapapa	5	2
D. nigribasis	Kaala	11	4
D. oahuensis	Kaala, Koloa	6	4
D. pilimana	Manuwai	1	1

Drosophila craddockae is closely related to *D. pullipes* of Hawaii and *D. grimshawi* of Maui Nui. Like the former, it is a specialist on *Wikstroemia* spp., an unusual host for *Drosophila*. While its host is abundant, *D. craddockae* is rarely observed, and has been found only sporadically at widely separated localities in recent years. Only two were seen, at Lower Opaeula, where it has been most abundant in the past.

Drosophila divaricata is closely related to the more common *D. inedita*, but can be easily distinguished by its much larger size and slightly different wing pattern. The host plant is unknown. It is generally rare, but has been observed regularly in Kaluaa Gulch. This year it was unusually abundant at both North and Central Kaluaa during the months of the winter and spring peak.

Drosophila hemipeza is the only listed endangered species on Oahu that is known to be extant but does not occur on Army lands or OIP/MIP action areas, although it historically occurred at Kahuku Training Area and West Makaleha Gulch adjacent to Makua. It has been consistently found at Palikea MU for several years but always in low numbers; occasional individuals have shown up at Puu Hapapa as well. It has only been seen three times (total of five individuals) in the past year's monthly monitoring, and none at Hapapa.

Drosophila nigribasis breeds in *Cheirodendron*; it is related to *D. substenoptera* but appears to favor wetter habitats. In our surveys, it is restricted to Koloa and the vicinity of Kaala summit.

Drosophila oahuensis is also a *Cheirodendron* breeder, and appears to span the habitat range of *D. nigribasis* and *D. substenoptera*, including both the near-summit area of Kaala and wet-mesic sites such as North Haleauau Gulch in Lihue. The majority of both *D. nigribasis* and *D. oahuensis* came from one site on the west side of Kaala. A total of only six were found this year, all from Kaala.

Drosophila craddockae, widespread but extremely rare and sporadic.

Drosophila hemipeza, very similar to *D. substenoptera* and also often seen waving its wings.

7.3.5 *Vespula pensylvanica*

This highly invasive social predatory wasp is considered a major factor in the decline of picture wing *Drosophila* on Maui and Hawaii. Little is known of its impacts on Oahu, where it is present but much less conspicuous. The typical life cycle of a yellowjacket colony consists of an individual fertilized queen starting a nest in the spring, building up numbers of workers slowly at first but with exponential growth, peaking in the fall when new reproductives (males and the next generation of queens) are produced. After the reproductives leave the colony it typically declines and the workers die off, but in warm climates such as Hawaii they may persist through the winter and grow to an exceptionally large size during a second summer, with tens or hundreds of thousands of workers.

Ten traps baited with heptyl butyrate are monitored monthly at Palikea and Puu Hapapa. Numbers at the two sites are relatively modest compared to upper elevations of Hawaii or Maui. Still, they show a significant number of *Vespula* are usually present at both during the summer, coinciding with the low period of *Drosophila* numbers. It is unclear if there is any causal relationship; *Vespula* numbers in 2016 were high at Palikea but absent at Hapapa, while *Drosophila* were also high and low respectively. This suggests that the benefit to each from weather or other conditions outweighs the negative effect on *Drosophila* from *Vespula* predation. Almost no *Vespula* have been seen so far in 2017, but the spike occurs in the late summer and fall.

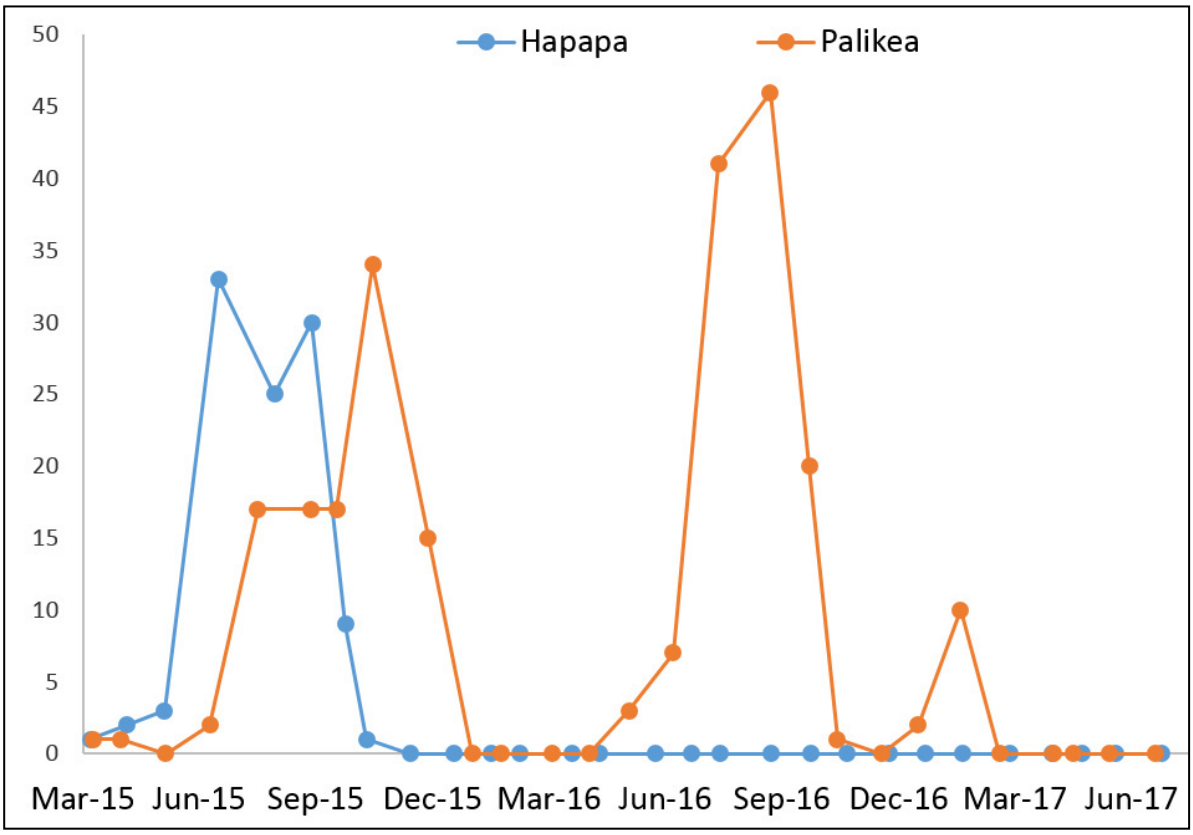


Figure 8. *Vespula pensylvanica* numbers at Palikea and Puu Hapapa (monthly total across 10 traps at each site).

We plan to continue monitoring at Palikea and Hapapa, since the current regime of maintaining 10 traps at each site can be done in conjunction with the monthly fly monitoring without significant additional effort. No other sites have both significant *Drosophila* populations and relatively open canopy suited to

Vespula monitoring. At present, there are no plans to conduct control of *Vespula*, but this may be considered if populations increase in the future.

7.4 *DROSOPHILA MONTGOMERYI* MANAGEMENT PLAN UPDATE

MIP Year 14-17, OIP Year 11-13; July 2017 – June 2020

Management Goals

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

Accomplishments

The previous three-year management plan outlined in the 2014 YER called for managing three population units for *Drosophila montgomeryi* – Palikea, Pualii, and Kaluaa, the last with three subunits (Central, North, and Puu Hapapa). Actions scheduled for each included weed control, monthly (Kaluaa, Palikea) or quarterly (Pualii) monitoring, threat evaluation and control, and outplanting of hosts *Urera glabra* and *U. kaalae* at all sites (*U. kaalae* plantings are now done primarily by OPEPP).

These have largely been accomplished. Weeds, primarily *Rubus rosifolius* at all sites and *Ipomoea cairica* at Kaluaa, occasionally become an issue but periodic sweeps have kept them to a manageable level. Monitoring at Kaluaa and Palikea has been consistent, though it was stopped at Pualii after July 2016 following the loss of most mature *Urera* trees there. Outplantings have been done largely as planned and as scheduled; Central Kaluaa was done early and with more *U. glabra* and fewer *U. kaalae*, while no plantings have been done at Hapapa yet since it is a lower priority, as a large number of both species are already present. Nearly all of the outplants are thriving, with only a few mortalities from

Urera* Outplantings for *Drosophila montgomeryi			
Population Unit	winter 2014–15	winter 2015–16	winter 2016–17
Palikea	• goal: 50 Uregla • planted: 55 Uregla	• goal: 50 Urekaa • planted: 80 Urekaa	• planted: 50 Urekaa • planted: 48 Uregla
Pualii	• goal: 50 Uregla • planted: 50 Uregla	• goal: 50 Urekaa • planted: 98 Urekaa	
Kaluaa			
Central Kaluaa	• planted: 35 Uregla	• goal: 50 Uregla • planted: 61 Uregla • planted: 29 Urekaa	• goal: 50 Urekaa
North Kaluaa	• goal: 50 Uregla • planted: 52 Uregla	• goal: 50 Urekaa • planted: 50 Urekaa	
Hapapa			• goal: 50 Urekaa

treefalls, notably at Palikea and North Kaluaa; however, the *U. glabra* at Pualii and North Kaluaa are in shaded areas and not growing as fast as elsewhere. *Urera glabra* is also being used for general habitat restoration, and plantings in other locations may become future *D. montgomeryi* reintroduction sites.

Threat management is still in progress. Western yellowjackets (*Vespula pensylvanica*) are monitored at Palikea and Hapapa but are in relatively low numbers (sometimes nearly absent) and do not seem to be a major threat; rather, there are more *Drosophila* in years when there are more *Vespula*, suggesting both fluctuate in response to general trends. Recent research has shown that *Solenopsis papuana*, a ubiquitous but cryptic ant, has a significant impact on *Drosophila* reproductive success (see Appendix ES-10). In addition, *Pheidole megacephala*, the big-headed ant, was found at one of the outplanting areas at Pualii that is viewed as a potential reintroduction site if the *D. montgomeryi* population there has been extirpated. Control at this site is being attempted in the summer of 2017.

Population Status

The populations at Kaluaa are persisting, though at extremely low levels in Central and North for the past two years. Hapapa has been relatively stable, often with more *D. montgomeryi* than the "common" species also found there. No *D. montgomeryi* have been seen at Pualii since May 2014 or at Palikea since March 2015. These populations may be extirpated. However, while Pualii is quite isolated, none had been seen at Palikea in over a year of regular monitoring prior to the first detection there, suggesting they may also occur at, and potentially disperse from, the inaccessible *Urera* patches on the cliffs nearby.

In unmanaged areas, the SBW site at South Haleauau has not been surveyed since 2014 due to difficult access. In Waianae Valley, the largest population at Kumaipo Gulch subgulch 4 has suffered severe reduction due to repeated rockfalls and subsequent boring beetle attacks and weed invasion. With this site threatened and difficult to protect, and the Pualii and Palikea populations possibly no longer extant, other sites in Waianae may need to be considered as management areas.

Future Actions

A significant area has been weeded at Pualii below the *D. montgomeryi* site, and is a prime spot for outplanting and restoration if ant control can be successful. At North Kaluaa, a large treefall has opened up a large light gap in a previously densely shaded, heavily native area that is likewise an excellent opportunity to put in *Urera*. These are the sites where the current plantings have been least successful due to heavy shade (mostly from native trees), so this should allow for much better growth. In addition, a number of *Urera* and other outplants were killed or damaged by treefalls at the Palikea banyan restoration site over the past two years (primarily from invasive trees that had been killed and left standing), allowing weeds to move in. Planting more at this site where the surviving plants have grown quickly should fill in the site and lead to better habitat quality. While Hapapa has the most mature plants, there has been significant mortality of *U. kaalae* there over the past two years, so additional plants will be put in there. *Pipturus albidus* (mamaki) is generally considered a highly beneficial native restoration tree, but at Hapapa it supports unusually high densities of leafhoppers which results in a thick layer of sooty mold on all plants below them, suppressing photosyntesis. Replacement with other canopy or subcanopy species should be considered to promote the growth of future outplants.

Other actions will remain largely the same as in the previous plan. Fly monitoring and weed control will be ongoing, and threats from invasive invertebrates (ants, yellowjackets) will be monitored and control undertaken if warranted. In particular, surveys will be conducted for *Solenopsis papauana* to determine if control would be beneficial. Since the impact seems to be mainly on larvae, only relatively small areas of control around breeding hosts may be necessary, similar to rat control around elepaio nests.

Three Year Action Plan for *Drosophila montgomeryi*					
Population Unit	Occd. Area (ha)	Addl. Area (ha)	OIP YEAR 11 July 2017 – June 2018	OIP YEAR 12 July 2018 – June 2019	OIP YEAR 13 July 2019 – June 2020
Palikea	—	4.7	• plant 50 Uregla • weed control • threat evaluation • monitor monthly	• plant 50 Urekaa • weed control • threat evaluation • monitor monthly	• weed control • threat evaluation • monitor monthly
Pualii	—	2.3	• plant 50 Uregla • weed control • ant control	• plant 50 Urekaa • weed control • threat evaluation	• plant 50 Uregla • weed control • threat evaluation
Kaluaa					
Central Kaluaa	0.7	1.8	• weed control • threat evaluation • monitor monthly	• weed control • threat evaluation • monitor monthly	• weed control • threat evaluation • monitor monthly
North Kaluaa	0.2	1.5	• plant 50 Uregla • weed control • threat evaluation • monitor monthly	• plant 50 Urekaa • weed control • threat evaluation • monitor monthly	• weed control • threat evaluation • monitor monthly
Hapapa	0.2	0.5	• weed control • threat evaluation • monitor monthly	• plant 50 Urekaa • weed control • threat evaluation • monitor monthly	• weed control • threat evaluation • monitor monthly

7.5 *DROSOPHILA SUBSTENOPTERA* MANAGEMENT PLAN UPDATE

MIP Year 14-17, OIP Year 11-13; July 2017 – June 2020

Management Goals

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

Accomplishments

The previous three-year management plan outlined in the 2014 YER called for managing three population units for *Drosophila substenoptera* – Palikea, Kaala, and Lower Opaeula. Active management for this species is more limited than for *D. montgomeryi* because the factors causing its rarity are uncertain. The

plan has been largely followed as outlined, with fly monitoring, weed control, and threat monitoring and evaluation. Weed control specifically around *Drosophila* areas has been primarily done at Palikea, where the threat is greatest and where it overlaps with *D. montgomeryi* and several rare plant sites. At Lower Opaeula, the site where *D. substenoptera* is known from has relatively few weeds, but weeding elsewhere has opened up new areas that may be suitable habitat as native trees move in. Kaala has relatively low levels of weeds, with aggressive invaders such as sphagnum moss and kahili ginger controlled across the area.

Population Status

As noted above, no flies have been detected at Kaala or Lower Opaeula since May 2015, but it is rare at these sites (the latter has only been visited once per year since 2015, as trips have been reduced there in general). The Palikea population is somewhat below its numbers in previous years, but still occurs in similar proportion to the other species found there. In addition to the generally poor weather, it may be due in part to the more open, drier conditions at the restoration site where one of the monitoring sites is. There has been a noticeable shift in *D. substenoptera* sightings from this site to others where they had formerly been rarely seen. As native canopy replaces the former christmasberry (*Schinus terebinthifolius*) cover over the next several years, we expect this area to become cooler and wetter, becoming more hospitable to *Drosophila*.

Future Actions

Actions will remain largely the same as in the previous plan. Fly monitoring and weed control will be ongoing, and threats from invasive invertebrates (ants, yellowjackets) will be monitored and control undertaken if warranted. In particular, surveys will be conducted for *Solenopsis papauana* to determine if control would be beneficial. Additional outplanting of common native species (including *Urera glabra*, as part of *D. montgomeryi* conservation efforts) will take place at Palikea to improve the microclimate.

Three Year Action Plan for *Drosophila substenoptera*

Population Unit	Area (ha)	OIP YEAR 11 July 2017 – June 2018	OIP YEAR 12 July 2018 – June 2019	OIP YEAR 13 July 2019 – June 2020
Palikea	5.0	• weed control • threat evaluation • monitor monthly	• weed control • threat control • monitor monthly • plant cover trees	• weed control • threat control • monitor monthly
Kaala	~85	• weed control • threat evaluation • monitor quarterly	• weed control • threat control • monitor quarterly	• weed control • threat control • monitor quarterly
Lower Opaeula	2.0	• weed control • threat evaluation • monitor as possible	• weed control • threat control • monitor as possible	• weed control • threat control • monitor as possible

CHAPTER 8: RODENT MANAGEMENT

OANRP has managed MIP and OIP species that are subject to rodent predation with various strategies since 1997. This chapter discusses rodent control methods utilized over the past reporting year and highlights recent changes. Specifically, this chapter has five main sections: Section 8.1 provides an overview of the current rodent control program and discusses recent changes; Section 8.2 introduces tracking tunnel results from large scale grids; Section 8.3 describes transition to A24 traps; Section 8.4 discusses a trial to be conducted with ContraPest; and Section 8.5 lays out future plans for rat control.

8.1 OANRP RODENT CONTROL PROGRAM SUMMARY

OANRP manages rats seasonally or year-round, depending on rare taxa protection needs. For example, *Chasiempis ibidis* (Oahu Elepaio) are only protected during the nesting season, while *Achatinella mustelina* are protected from predation year-round. Other grids are 'rapid response' to address threats to endangered plant resources. The methods of rodent control that OANRP currently utilizes include: kill-traps (Victor snap traps, Woodstream Corporation, Lititz, PA; Ka Mate Ltd. traps, Nelson, New Zealand; and Goodnature Ltd. A24 traps, Wellington, New Zealand), Diphacinone bait used for trials, ContraPest birth control used for trials and predator-proof fences. OANRP has 31 rat control areas (Table 1).

Rat control in 2017 consisted of deploying small Victor snap traps and Goodnature A24 trap grids around select resources, installing and maintaining large-scale trapping grids consisting of Victor, Ka Mate, and/or Goodnature A24 traps in some management units.

In October 2015, a new predator control contract was awarded to Pono Pacific for a five year period. At this time, we are not going to exercise the next year's option of the contract. Each year we can decide if we are going to fund it in the following year. We are discontinuing the contract because we are transitioning to all A24 traps at all elepaio sites and will conduct the control with OANRP labor as labor inputs should significantly decrease with the use of these self-resetting traps. As funds become available we will continue to transition to A24s at non-elepaio sites.

Table 1. Rat control strategies in 2016-2017.

MU/Area	Primary Spp. Protected	Description	Deployment	Check Interval	Trap Type	# Traps
East Makaleha	*A. mustelina*	Two small grids	Year-round	6 weeks	Victors	40
					A24s	20
Ekahanui	*A. mustelina*	Many small grids	Year-round	2 weeks	Victors	47
					A24s	30
Ekahanui	*C. ibidis*	Large-scale grid	In Season: Dec-June	2 weeks	Victors	674
Ekahanui	*A. mustelina, Cyanea grimesiana, Schiedea kaalae, Delissea waianaeensis*	Large-scale grid	Off Season: July-Nov	2 weeks	Victors	200
Kaala	*Labordia cyrtandrae*	One small grid	Rapid Response	6 per year	Victors	35
					Kamates	35
Kahanahaiki	*A. mustelina, Cyanea superba*	Large-scale grid	Year-round	4 weeks	A24s	120
				6 per year	Victors	37

MU/Area	Primary Spp. Protected	Description	Deployment	Check Interval	Trap Type	# Traps
Kaluaa	*D. waianaeensis, C. grimesiana*	One small grid	Rapid Response		Kamates	38
Kamaohanui	*A. mustelina*	One small grid	Year-round	6 weeks	Ka Mates	47
					A24s	10
Kapuna/ Keawapilau	*Hesperomannia oahuensis*	One small grid	Rapid Response	6 per year	Victors	23
					A24s	5
Kapuna/ Keawapilau	*Schiedea nuttallii*	One small grid	Rapid Response	6 per year	Victors	13
					A24s	4
Makaha Unit I	*A. mustelina, H. oahuensis, C. superba*	Large-scale grid	Year-round	4 weeks	A24s	111
Makaha Unit I	*H. oahuensis*	One small grid	Rapid Response	6 per year	Victors	14
					A24s	6
Makaha Unit II	*C. grimesiana, Cyanea longiflora, H. oahuensis, S. nuttallii*	Many small grids	Year-round	6 weeks	A24s	47
Makaha Unit II	*C. grimesiana*	One small grid	Rapid Response	6 per year	Victors	12
Makaha Unit II	*H. oahuensis*	One small grid	Rapid Response	6 per year	Victors	12
Manuwai	*D. waianaeensis*	One small grid	Rapid Response	6 per year	Victors	14
					Ka Mate	12
					A24s	8
Moanalua	*C. ibidis*	Many small grids*	Annual: Dec-June	2 weeks	Victors	180
Ohikilolo	*A. mustelina, Pritchardia kaalae*	Many small grids	Year-round	6 weeks	Victors	133
					A24s	53
Opaeula Lower	*Cyrtandra dentata*	One small grid	Year-round	6 weeks	Victors	24
Palehua	*C. ibidis*	Large-scale grid	Annual: Dec-June	2 weeks	Victors	200
Palikea	*A. mustelina*	Large-scale grid	Year-round	2 weeks	Ka Mate	250
Pualii	*H. oahuensis*	One small grid	Rapid Response	6 per year	Victors	24
					A24s	4
Lihue (Banana)	*C. ibidis*	Many small grids*	Annual: Dec-June	4 weeks†	Victors	111
Lihue (Haleauau)	*C. ibidis*	Many small grids*	Annual: Dec-June	4 weeks†	Victors	166
Lihue (Haleauau)	*A. mustelina*	Two small grids	Year-round	6 weeks	Victors	24
Lihue (Haleauau)	*H. oahuensis*	One small grid	Rapid Response	6 per year	Victors	12
					A24s	3

MU/Area	Primary Spp. Protected	Description	Deployment	Check Interval	Trap Type	# Traps
Lihue (Mohiakea)	*C. ibidis*	Many small grids*	Annual: Dec-June	4 weeks†	Victors	165
Lihue (Mohiakea)	*D. waianaeensis*	One small grid	Rapid Response	6 per year	Victors	7
Makaleha West	*C. grimesiana*	One small grid	Year-round	6 weeks	Victors	29
Kaluaa and Waieli	*A. mustelina*	One small grid	Year-round	6 weeks	Victors	25
Kahanahaiki	*A. mustelina*	Predator-proof fence	Constructed 1998			
Waieli-Hapapa	*A. mustelina*	Predator-proof fence	Constructed 2011			
Palikea	*A. mustelina*	Predator-proof fence	Constructed 2012			

* *Each managed Elepaio (C. ibidis) territory has 12-15 traps installed ~12 m apart.*

† *Due to limited range access traps are baited twice during one week once a month.*

8.2 TRACKING TUNNEL RESULTS FROM LARGE-SCALE GRIDS

For this report and future reports, a graph of tracking tunnel results will be provided for all of our large-scale grids (Kahanahaiki, Ekahanui, Makaha, Ohikilolo, and Palikea) (see Figures 1-5). In general, these graphs should be used to look at the differences between years or between control and treatment sites. Small changes of ~20% or less between or within grids cannot be assessed accurately. At Kahanahaiki, there is an associated control site at Kapuna MU where no rodent control is being conducted. At other grids we collected control data for one year after the grid was installed. At Makaha MU there are monitoring tunnels within the A24 grid and we compare these to tunnels that are outside of the trapping grid. The goal of OANRP rat control is to keep tracking levels at 10% or less though out the year. This number is based on goals developed in New Zealand.

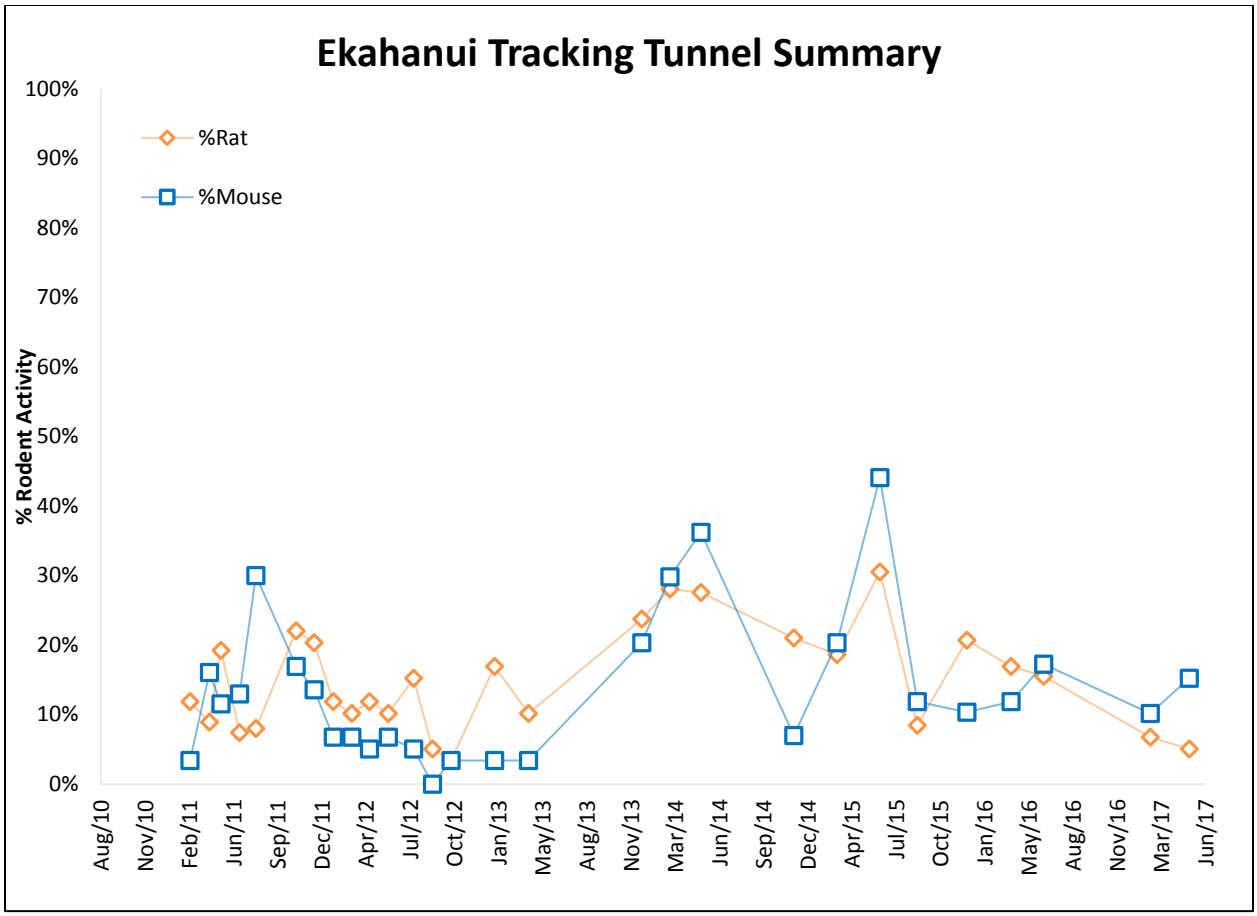


Figure 1. Percent of rodent activity at Ekahanui.

The Ekahanui grid is predominantly Victors with a few A24s installed around snail areas. Tracking has a relatively stable trend with a high of 30% in June of 2015. Most tracking events show rates around the 10% goal (Figure 1). OANRP look forward to seeing the effect of the installation of the full A24 grid in fall 2017.

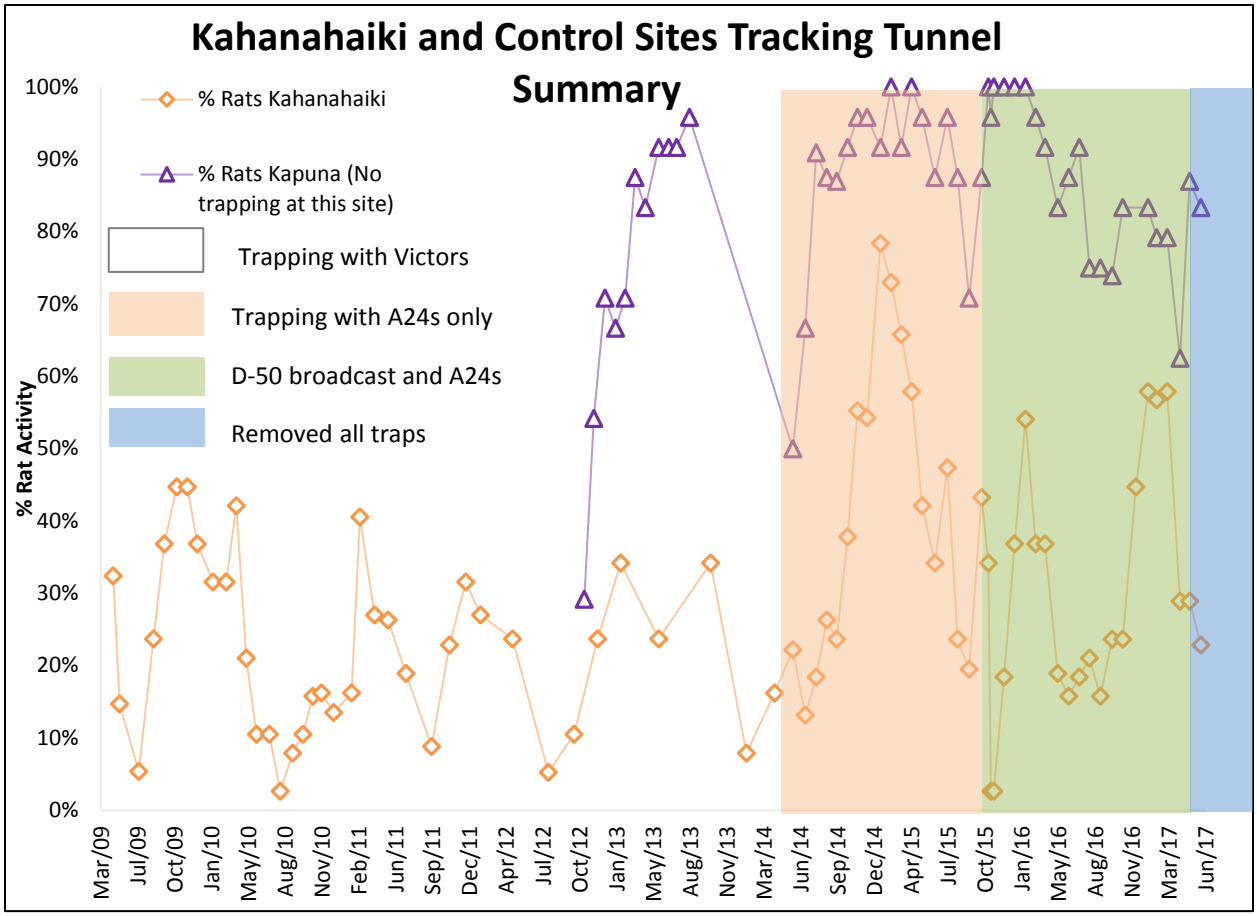


Figure 2. Percent of rat activity at Kahanahaiki and Kapuna.

Kahanahaiki has been one of the most difficult areas to maintain low tracking rates. Over the years OANRP has employed various methods (Figure 2). Lowest rates of tracking were seen in 2015 following the hand broadcast (OANRP 2016). Currently there are no traps deployed as we are experimenting with Contra-pest birth control. Results will be reported next year. Mouse tracking data is omitted for simplicity.

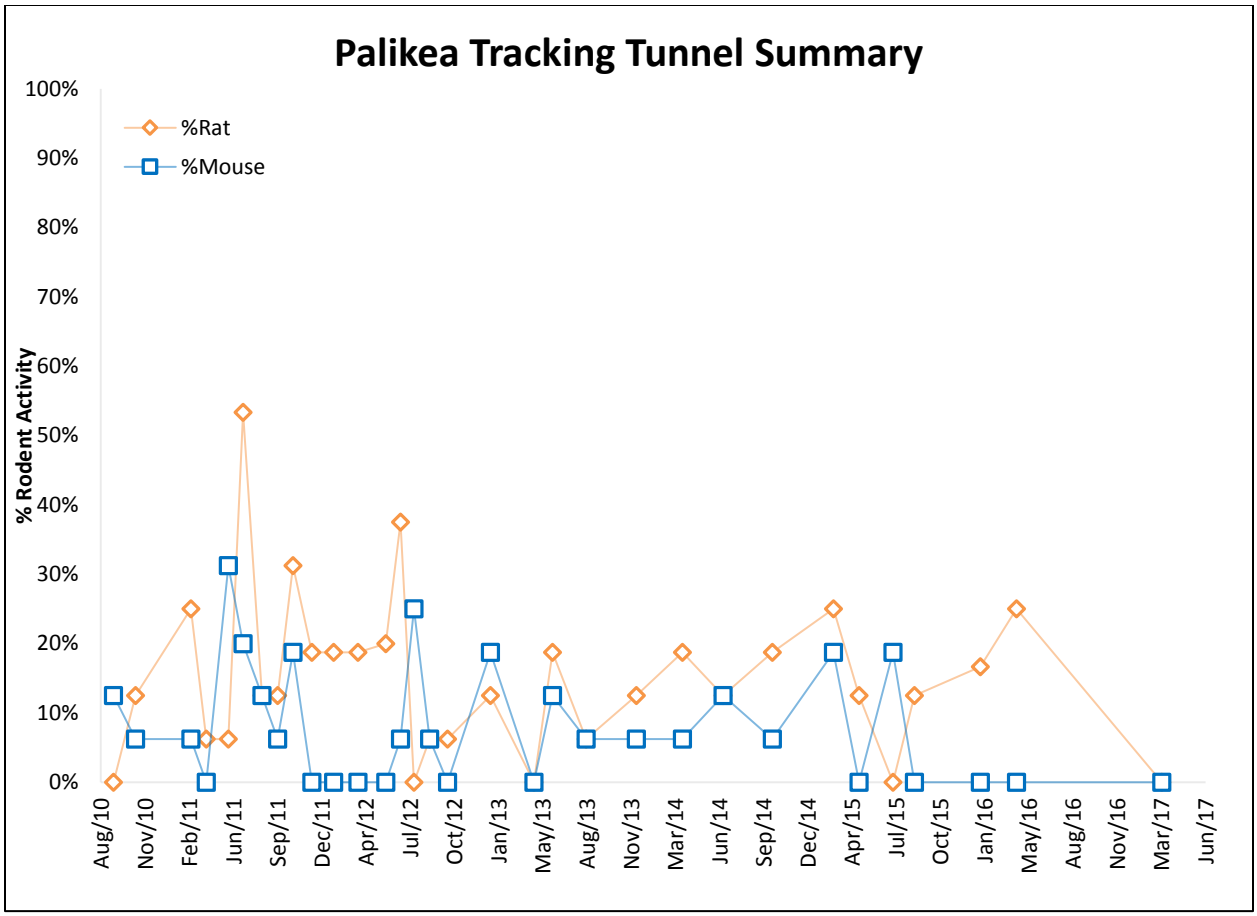


Figure 3. Percent of rodent activity at Palikea.

The Palikea grid is Ka Mate traps. Tracking has a relatively stable trend with a high of 53% in June of 2011. Most tracking events show rates around the 10-20% level (Figure 3). OANRP look forward to seeing the effect of the installation of the full A24 grid in fall 2017.

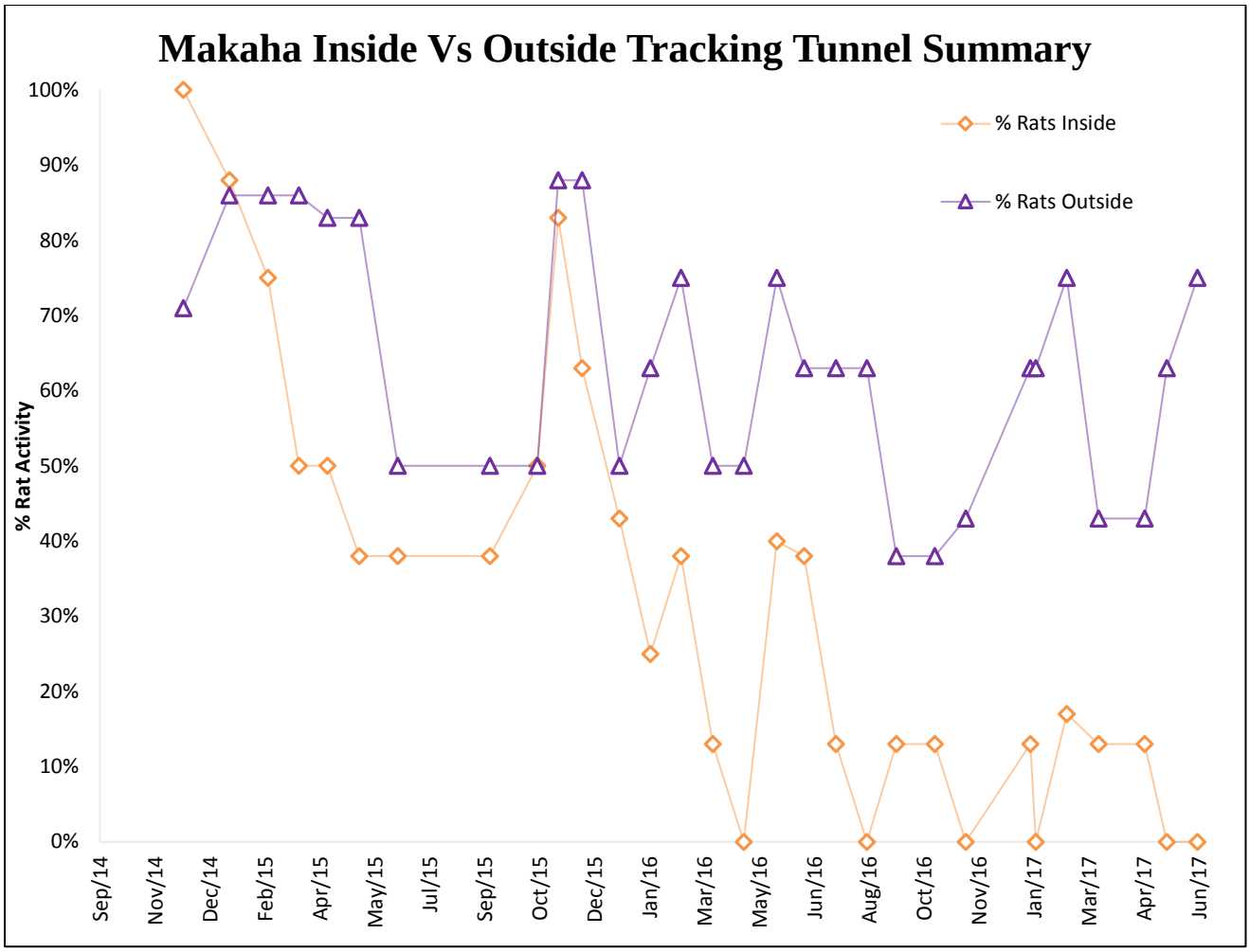


Figure 4. Percent of rodent activity at Makaha inside and outside of the A24 grid.

The Makaha grid is all A24s with auto lure pumps (ALPs). Tracking is very impressive with six 0% tracking events in 2016 and all other events close to the 10% goal (Figure 4). These results have motivated the transitions of the other grids to A24 with ALPs.

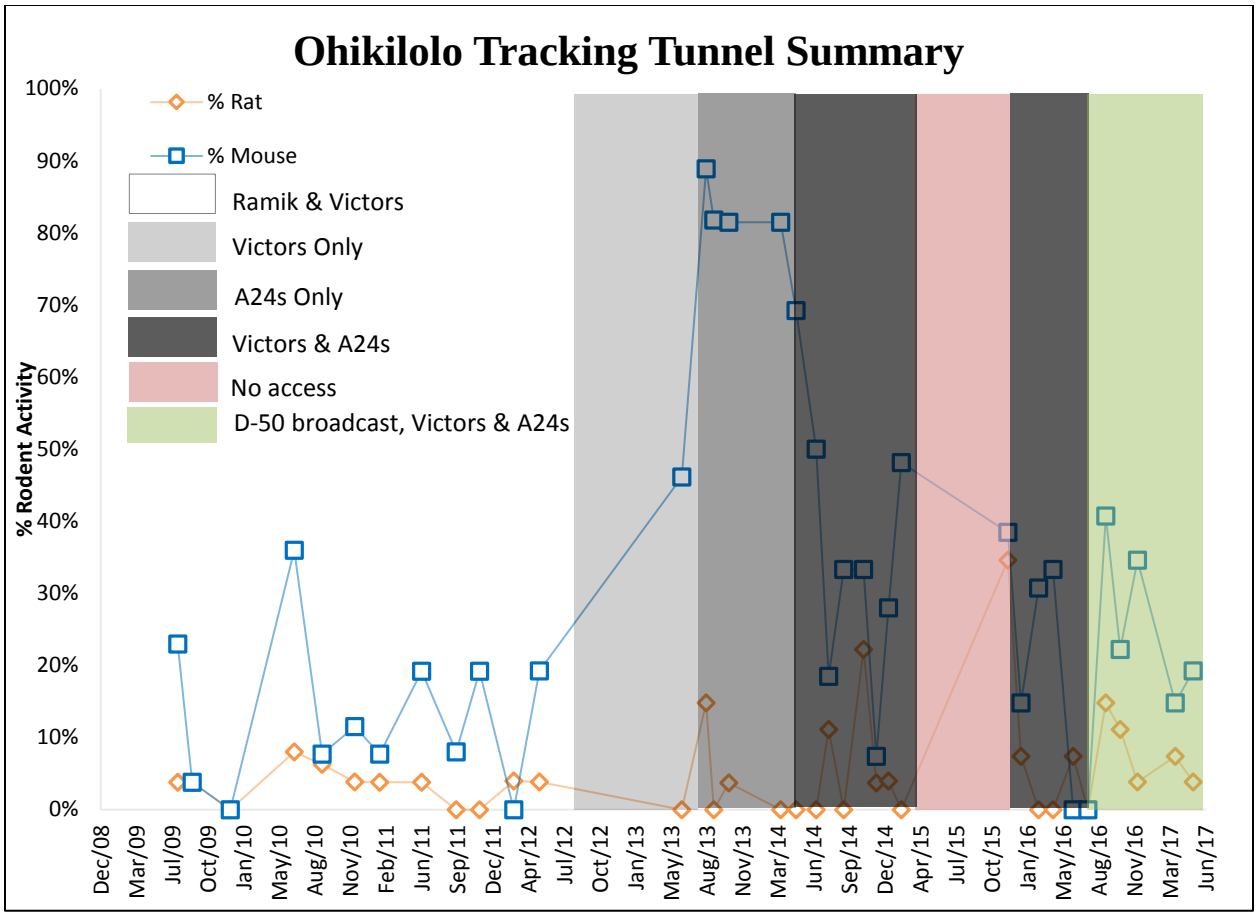


Figure 5. Percent of rodent activity at Ohikilolo.

The Ohikilolo grid is A24s with ALPs and Victors. The tracking trends looks good over the past year with all events under 10% (Figure 5).

8.3 TRANSITION TO A24S

Our program has been using A24s since 2013 at several MUs and has conducted numerous trials of the traps and bait. There have been some mechanical issues involving leaking seals and gaskets that have reduced the efficacy of these traps. GoodNature has addressed these malfunctions and now produces a trap that has very few issues.

Bait longevity and attractiveness are also key to trapping success. Several reasons for decreased longevity/attractiveness include mold, ants, and slugs. It is not uncommon to see slugs remove all of the bait within weeks of placement (see Figure 6). The old bait system used a “static” lure that would only last from one to four weeks at our MUs. We have also been working to optimize trap spacing. Currently we are deploying at 100x50m grids but will continue to investigate this factor.

Figure 6. Static lure being consumed by a slug.

Goodnature has now developed a new bait delivery system called the Automatic Lure Pump (ALP) (see Figure 7). This system is designed to deliver a constant supply of bait to the opening of the unit therefore increasing attractiveness. We have trialed several hundred ALPs and find that they generally last around 4 months at most of our MUs. Because of the constant flow we find that very little mold develops on the bait. Slugs are the biggest consumer of bait and still can access this system. We have demonstrated that by adding 5% citric acid to the Goodnature rat lure we can decrease consumption by slugs (Section 9.3). Plans are to trial this addition in the ALPs to stop slug consumption.

Figure 7. ALP on left fully consumed by slug. ALP on right is an example of an ALP in good working order.

Because of the advances in trap design as well as the introduction of the ALP, we are confident that the A24 will be more effective and less labor intensive than current and past methods. This method has the added benefit of being more humane than other traps and rodenticides. Beginning in the fall of 2017 we will be transitioning all Oahu Elepaio Victor snap trap grids to A24s. We plan on using one A24 for every two victor traps and these will be checked every four months, year around. If the addition of citric acid prolongs the bait longevity to 6 months we will change our checking interval accordingly. We will continue to monitor the tracking tunnels at MUs on a quarterly basis to determine the effectiveness of this approach on tracking rates. Hopefully we will be able to maintain tracking to the 10% target level.

8.4 CONTRAPEST TRIAL

We will be entering into a cooperative agreement with SenesTech inc. to conduct a trial with their rodent birth control product ContraPest. Tracking tunnel monitoring data at several sites has shown that rodent activity typically spikes in Dec-Feb despite the use of mechanical traps. In an attempt to reduce seasonal spikes and maintain low-levels of rodent activity year-round, we have received an Experimental Use Permit (EUP) to trial ContraPest in a forest environment at Kahanahaiki MU. The treatment site will be a 4 ha area within the gulch and an associated 4 ha reference site in the Maile Flats (Appendix 8-1). We have removed all traps from the MU and will run this trial without any traps. We may install localized control around certain plant populations in the MU that do not fall within the trial grids.

8.5 FUTURE PLANS

We will continue to work with the A24 trap and bait to maximize its full potential. Now that the checking interval is every 4-6 months we may be able to expand protection to more areas for less cost. It would be worth evaluating if MU grids should be installed at some sites that have isolated or territory based grids.

We may investigate an alternative to our current monitoring methods using tracking tunnels. It is becoming difficult to purchase the tracking cards that are designed for our environment and the current method requires two consecutive days of labor. Motion triggered game cameras may be an option that could cut labor in half. Camera locations would be baited and the cameras would be set to take pictures for one day. We would not return to retrieve the pictures until the next monitoring period thus saving labor. The only downside would be the loss of real time data as we would be seeing the activity three months after it was collected. A trial would need to be conducted to see how results from cameras compares to results from tracking tunnels. Finding a cheap reliable game camera may also be key, as equipment costs could be high for this type of project.

CHAPTER 9: ALIEN INVERTEBRATE CONTROL PROGRAM

Summary

This chapter describes the status and outcome of actions carried out to control alien invertebrates such as slugs, ants and incipient threats such as *Oryctes rhinoceros*, the coconut rhinoceros beetle (CRB). Also included here are results from experiments to create a rat bait that repels slugs.

As in previous years, we have expanded the area of slug control to include more plant populations (Fig. 1). Plant populations were prioritized for slug control by former staff in 2015. Among the aspects considered for prioritization at that time were the following: 1. Species is known to be impacted by slugs 2. Species represents the only extant population of that taxon within a particular management unit (MU) 3. Slugs are abundant locally and no rare snails are present that could be adversely impacted by molluscicide.

We now control slugs at all high priority rare plant sites identified in 2015 with the exception of 8 where the presence of rare snails preclude molluscicide application. As there has been staff turnover and additional outplantings, we plan on revising the list this year to ensure vulnerable plants are protected.

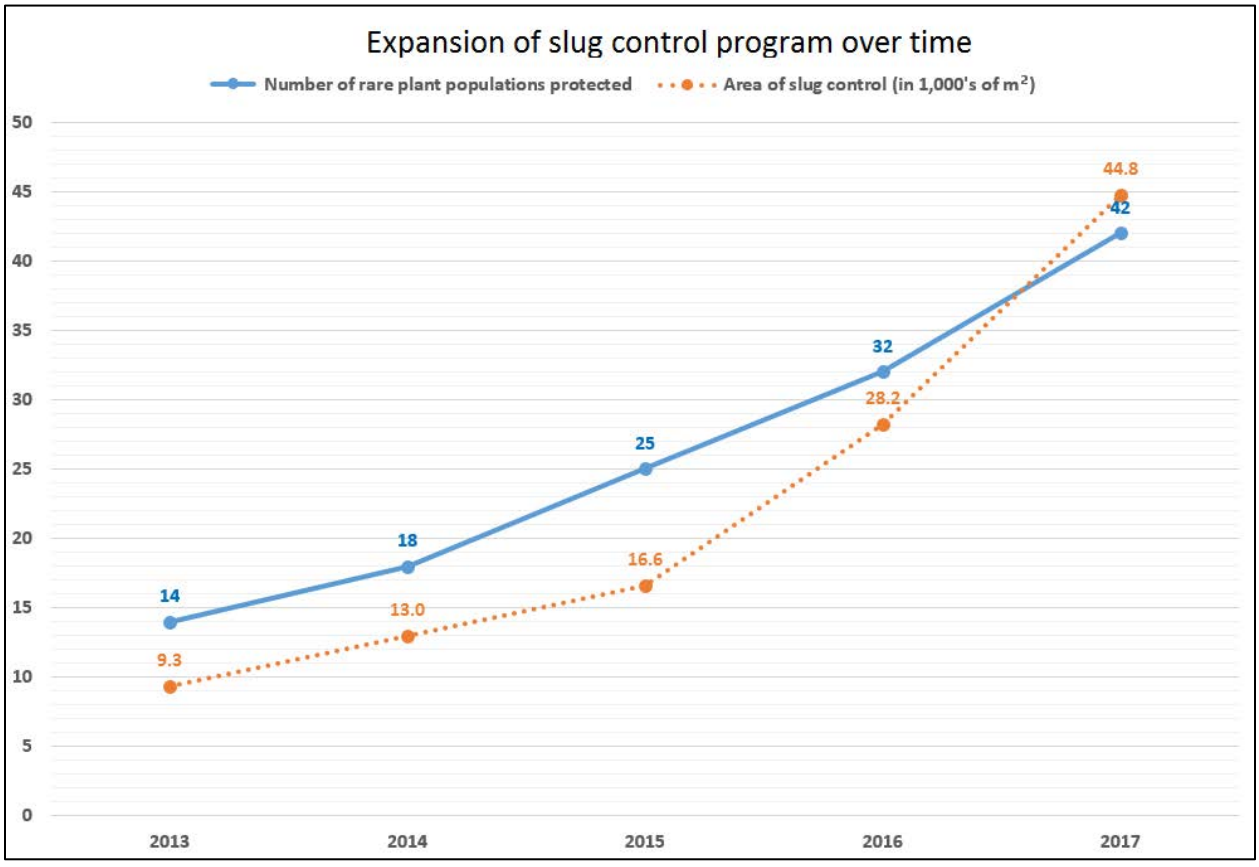


Figure 1. Plant populations (PU's) protected from slugs over time by number of populations and area.

This year we carried out research testing the efficacy of a new slug control product: FerroxxAQ® (EPA Reg No. 67702-49) against LeafLife Sluggo® (EPA Reg. No. 67702-3-34704). Sluggo is the product

used by OANRP since 2010 to protect rare plants from slug damage. Based on results from our efficacy study outlined in section 9.2 we have largely transitioned to FerroxxAQ. Makaha I is the only MU where Sluggo continues to be applied as OANRP is awaiting approval of FerroxxAQ by the Board of Water Supply. Currently, 42 rare plant populations, spanning a 4.8 ha area (11.9 acres), receive slug control. Of these, 93% of plant populations and 95% of the slug control area receive FerroxxAQ. Details on which species are protected and their locations are outlined in section 9.1.

This year we continued research to develop a rat bait with slug-repellent properties. Previous research confirmed that 5% citric acid (CA) added to Goodnature® peanut butter flavored rat lure significantly deterred slug feeding over a control bait (OANRP 2016). Here we tested the efficacy of lower levels of citric acid (CA) mixed with different types of bait. The most repellent test baits were 5% CA added to Goodnature rat lure while some of the least repellent were 5% CA added to peanut butter and 0.5% CA added to Goodnature rat lure. We discuss our findings in section 9.3. Parts of this research were presented as a digital poster at the 24th annual Hawaii Conservation Conference July 2017. This poster may be viewed on-line at: https://hca.ipostersessions.com/Default.aspx?s=gallery.

We continue to survey for the Naio thrip (*Klambothrips myopori*) which has not yet been discovered on Oahu but is well established on the Big Island. Annual surveys of Naio (*Myoporum sandwicense*, the host plant) on Schofield and at Kaena Point MU confirm thrips are not present. We also assist in surveys for, and control of, incipient invertebrate pests already on Oahu but are not yet widespread: the Coconut Rhinoceros Beetle (CRB) (*Oryctes rhinoceros*), the Little Fire Ant (*Wasmannia auropunctata*), and inspect high risk areas for problematic invasive ants (Hymenoptera, Formicidae). None were detected in the areas surveyed (Schofield Barracks and surrounding environs) in 2016-2017. The status of ant sampling efforts and CRB surveys remain unchanged since 2015-2016 and are discussed briefly in section 9.4.

9.1 Summary of Slug Control Actions July 1, 2016-June 30, 2017

Background: Slugs can cause dramatic declines in the survival of rare native Hawaiian plants (Joe & Daehler 2008). Slug control with molluscicide (Sluggo) was shown to encourage seedling germination and recruitment for certain rare plant species (Kawelo *et al*. 2012) in particular those within the Campanulaceae. In 2015, the Special Local Needs (SLN) permit for Sluggo allowing for its use in forests was renewed through October 2020. Soon after this renewal, a new product, FerroxxAQ was introduced to control slugs in forests but we remained unaware of this product until May 2016 when a representative from Neudorff (the company which manufactures Sluggo) sent us a sample. Tests concluded in early 2017 (see section 9.2) show FerroxxAQ to be an improvement over Sluggo because its waterproof coating allows it to persist and suppress slugs for a longer period of time.

Between July 1, 2016 and May 1, 2017 Sluggo was applied monthly in and around the plant populations listed in the Table 1. Figures 2 and 3 show slug treatment area by Management Unit (MU) and by plant populations, respectively. From May 2 to the present all plants (except for those in Makaha) received FerroxxAQ every 6 weeks. A map of treatment sites is shown in Figure 4.

Table 1. List of rare plant species undergoing slug control. Bold underlined text indicates additions since the prior year (2015-2016). An Asterisk (*) marks remote plant populations which, due to the difficulty of access, receive slug control at a reduced rate.

MU	Plant species treated (Population Reference Code)	Treatment area (m^2) 2016-2017	Product used/rate of application
Ekahanui	*Cyanea grimesiana* subsp. *obatae* (EKA-C) , *Delissea waianaeensis* (EKA-D), *Schiedea kaalae* (EKA-D)	2,950	FerroxxAQ/6 weeks
Kahanahaiki	*Cyanea superba* (MMR-E & MMR-H), *S. nuttallii* (MMR-E), *S. obovata* (MMR-C & MMR-G)	1,650	FerroxxAQ/6 weeks
Kaluaa & Waieli	*Delissea waianaeensis* (KAL-C), *S. kaalae* (KAL-B)	3,500	FerroxxAQ/6 weeks
Makaha	*Cyanea longiflora* (MAK-B), *C. grimesiana* subsp. *obatae* (MAK-B), *S. obovata* (MAK-A), *S. nuttallii* (MAK-B)	2,450	Sluggo/4 weeks
Opaeula Lower	*Cyrtandra dentata* (OPA-F)	1,000	FerroxxAQ/12 weeks*
Pahole	*Schiedea nuttallii* (**PAH-A,** PAH-D, PAH-E,), ***S. obovata* (PAH-E)**, *C. grimesiana* subsp. *obatae* (PAH-D), *S. kaalae* (PAH-C & **PAH-A**), *Euphorbia herbstii* (PAH-G, PAH-R & PAH-S), *C. longiflora* (PAH-A & PAH-I),	17,930	FerroxxAQ/6 weeks
Palikea	*Cyanea grimesiana* subsp. *obatae* (PAK-A & PAK-B), *C. superba* (PAK-A), *Phyllostegia hirsuta* (PAK-A)	5,097	FerroxxAQ/6 weeks
Upper Kapuna	*Schiedea kaalae* (KAP-A), ***Cyanea longiflora* (PIL-B, PIL-C, PIL-E, PIL-F), *Schiedea kaalae* (KAP-A), *S. nuttallii* (PIL-B)**	3,427	FerroxxAQ/6 weeks
West Makaleha	*Cyanea longiflora* (LEH-B), *S. obovata* (LEH-A, LEH-C & LEH-B)	2,461	FerroxxAQ/6 weeks
Manuwai	***Delissea waianaeensis* (ANU-A)**	1,441	FerroxxAQ/12 weeks*

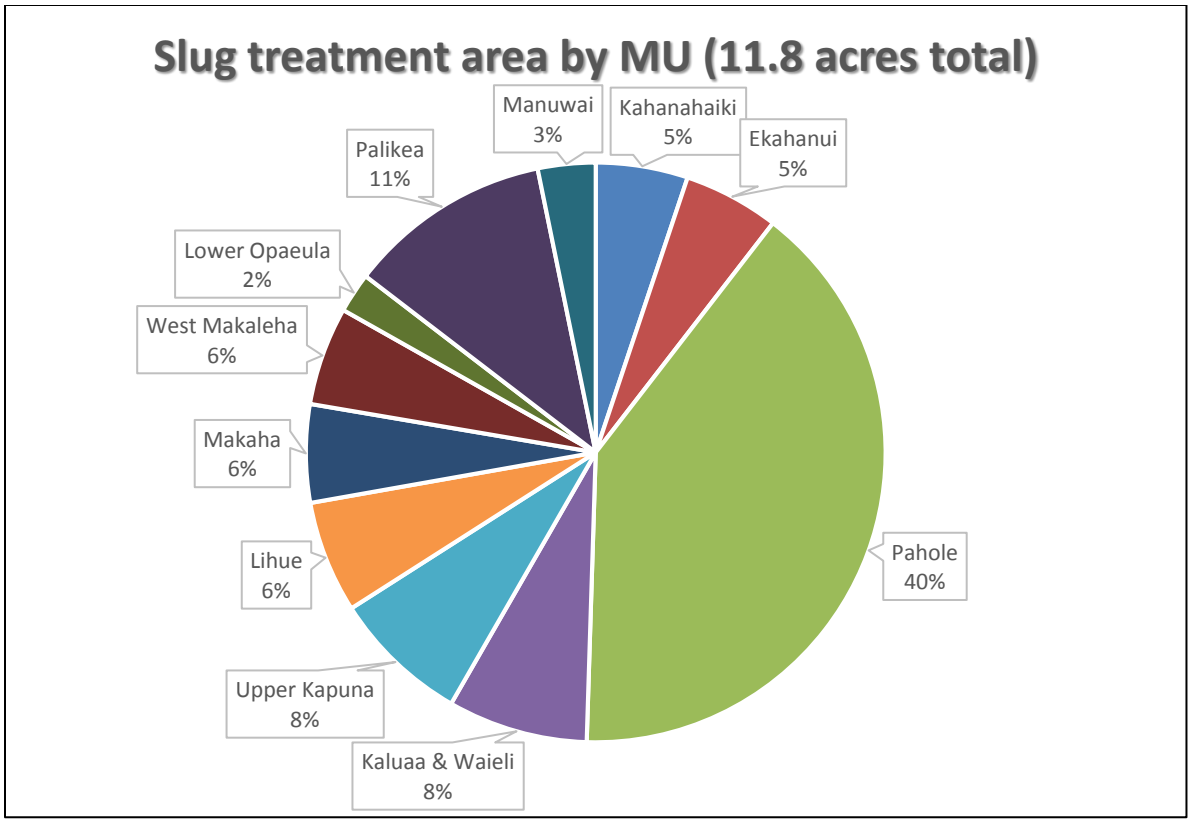


Figure 2. Pie chart showing proportion of area controlled for slugs by Management Unit (MU). It can be seen that Pahole is an area of particular focus.

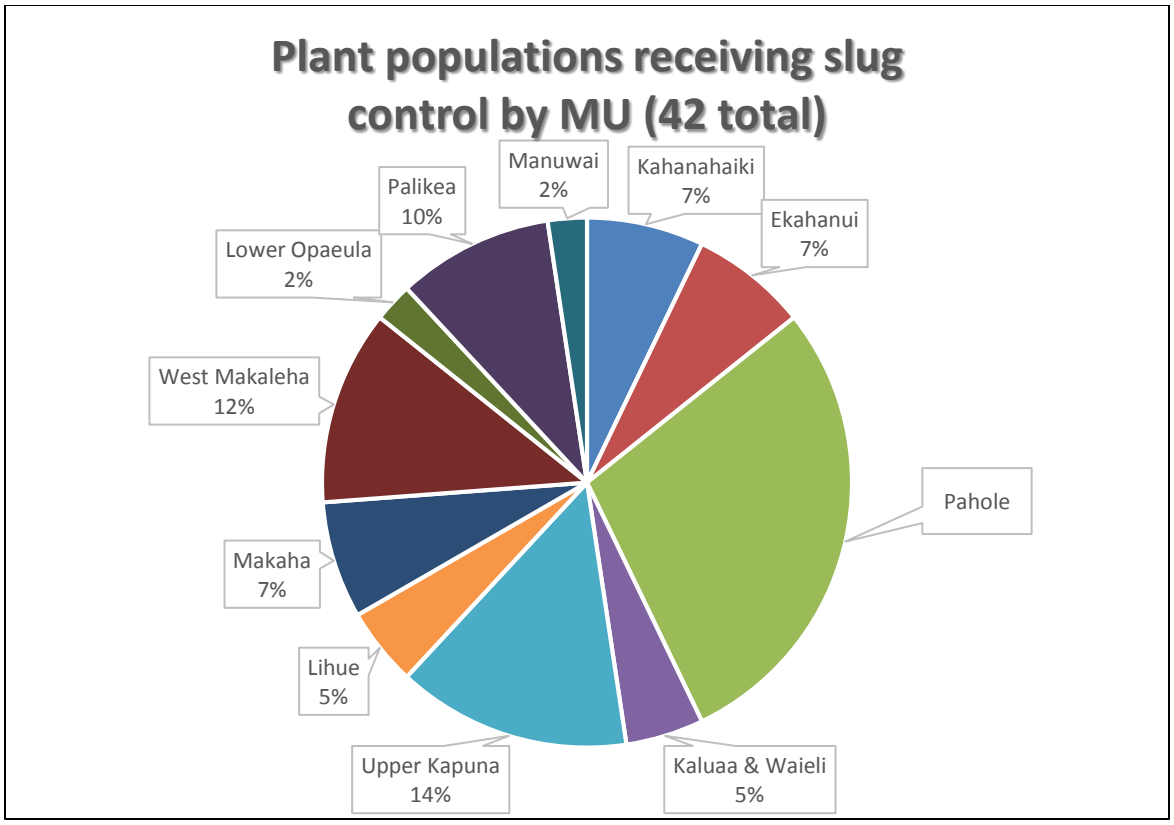


Figure 3. Pie chart showing being treated and the most plant populations. proportion of vulnerable plant populations undergoing treatment by MU. As expected, Pahole MU has both the largest area

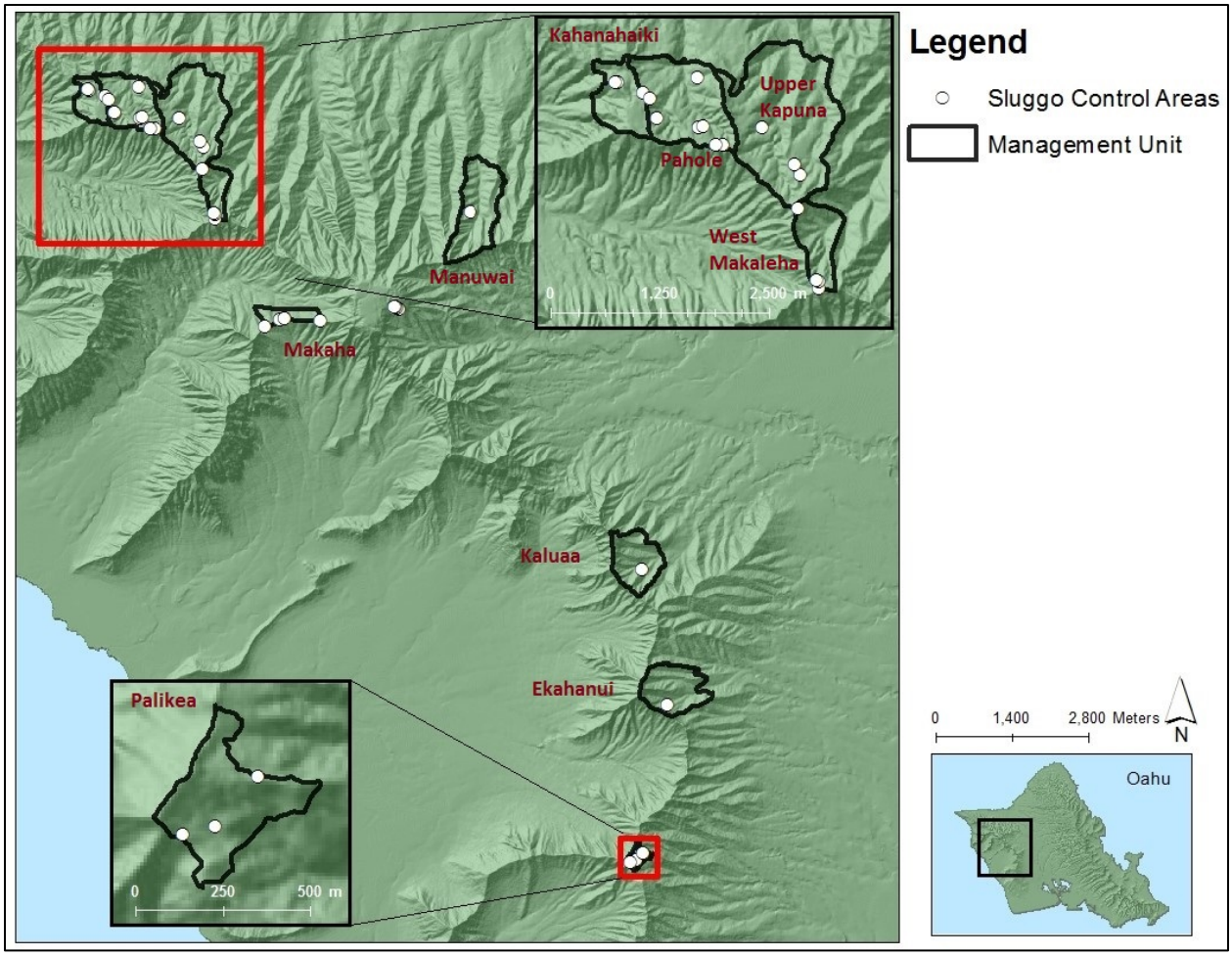


Figure 4. Map showing locations of rare plant species within MUs undergoing slug control in the Waianae Mountains. A single slug control site in the Koolau Mountains (Opaeula Lower) is not shown.

9.2 IMPROVED EFFICACY OF FERROXXAQ COMPARED TO SLUGGO IN A FIELD SETTING

Introduction: Neudorff, the company that manufactures Sluggo, registered a new slug control product: FerroxxAQ in December 2015. Unlike Sluggo, FerroxxAQ does not require a Special Local Needs (SLN) label for use in forests. The FerroxxAQ label already includes "Pastures, Rangeland, Forests, Parks and Campgrounds" as areas of application. Both Sluggo and FerroxxAQ products contain the same active ingredient (a.i.); iron phosphate, and have the same mode of action (slugs must consume the bait in order to be affected). They differ in at least two ways: 1). FerroxxAQ contains 3% of the a.i. compared to 1% in Sluggo and therefore must be applied in lesser amounts. Its highest application rate is equal to 2/3 the lowest effective rate of Sluggo. Thus, less product needs to be purchased and there is less labor associated with carrying it to the field sites. 2). FerroxxAQ has a water proof coating on the pellets making them more water resistant. Neudorff representatives felt that FerroxxAQ was preferable to Sluggo as it would persist longer in wet environments and less of the bait needs to be consumed by slugs to cause death. We felt further testing was needed before transitioning to the new bait. We had spent 3 years testing, followed by 10 years using Sluggo and felt confident that it was attractive to, and controlled slugs in the forest. With FerroxxAQ it was possible it would not be as attractive (maybe because of the coating) or, that the reduced application may result in slugs missing the bait altogether.

Purpose: To test whether slug abundance over time is similarily suppressed by FerroxxAQ compared to Sluggo and to establish whether both out-perform a control site where no molluscicide is applied.

Methods: In late 2016 to early 2017 we established test plots at Ekahanui, Kahanahaiki and Palikea MUs. At each site, and at two sites in Palikea (referred to as Gulch and Ridge), we established three 400 m^2 circular plots (4 sites total). The size of the plots is based on prior research on slug incursion which showed that slugs could recolonize a 400m^2 plot in one month after treatment with Sluggo (OANRP 2012). Each plot was at least 10 meters from the next closest plot, while the distance between the Palikea Ridge and Gulch sites was approximately 75 meters.

One of the three plots at each site randomly received one of the following treatments: 1. 10 ounces of FerroxxAQ (0.3 ounces of a.i.) 2. 20 ounces of Sluggo (0.2 ounces of a.i.) 3. No treatment (control). The FerroxxAQ rate was of Slug abundance was measured before and after treatment using baited pitfall traps (McCoy 1999) consisting of 10 12-oz. plastic cups per plot, placed in holes so that their openings were level with the soil surface and baited with six oz. of beer (Pabst Blue Ribbon). Traps were oriented at the center of each plot, within a grid measuring 5 square meters so as to be a maximum distance from the edge of the treated area. These traps were rebaited at 15 day intervals and all slugs identified and counted at that time (Nov. 2016-Feb. 2017).

Analysis: Using summed counts of slugs from each plot at each site over time, we compared differences between the two treatments and the control on day 0, and every 15 days thereafter while controlling for differences in slug abundance due to site (N=12). We accomplished this using a Generalized Linear Model GLM (Poisson distribution, fit with over dispersion parameter when appropriate) with post-hoc contrasts between treatment groups using JMP® Statistical Software (© SAS Institute Inc.). This model provided us with information on the overall effecacy of the treatment across all sites. Differences in treatments by site were analyzed using a one-way ANOVA followed by a Tukey's HSD for post-hoc comparisons between groups. This latter analysis used the number of slugs per trap as replicate (N=30) and was performed using Minitab® 14 (© Minitab Inc.). P-values of <0.05 were considered significant.

Results: Analysis of the data pre-treatment showed significant differences between (P<0.0001), but not within sites (P=0.53146) in slug abundance (Table 2). Though site was included as a factor in the model investigating treatment effects, we did not have enough replicates to contrast differences between each site by treatment by time combination. For example, we were unable to evaluate whether FerroxxAQ at Ekahanui was better than Sluggo at Kahanahaiki on a given day.

Table 2. Slug abundance by site prior to treatment

Location	Slugs/trap (N=30)	Standard dev.	Max # of slugs in a trap	Min # of slugs in a trap
Palikea Gulch Site	8.5	3.6	18	3
Kahanahaiki	4	2.0	8	1
Palikea Ridge Site	3.3	1.9	9	1
Ekahanui	1.5	0.68	3	1

No pre-existing differences in slug abundance was evident between treatments on the day of treatment (Day 0, Fig. 4). Both Sluggo and FerroxxAQ significantly reduced slugs compared to the control group on day 15 (Fig. 4, Table 3), but by one month, slugs recovered sufficiently in the Sluggo treatment as to be indistinguishable statistically from either the control or FerroxxAQ group (Day 30, Fig. 5). This remained the case through day 45. Finally, two months from the initial treatment date, slugs in both

treatments (Sluggo and FerroxxAQ) recovered to a point where they did not differ significantly from the control group.

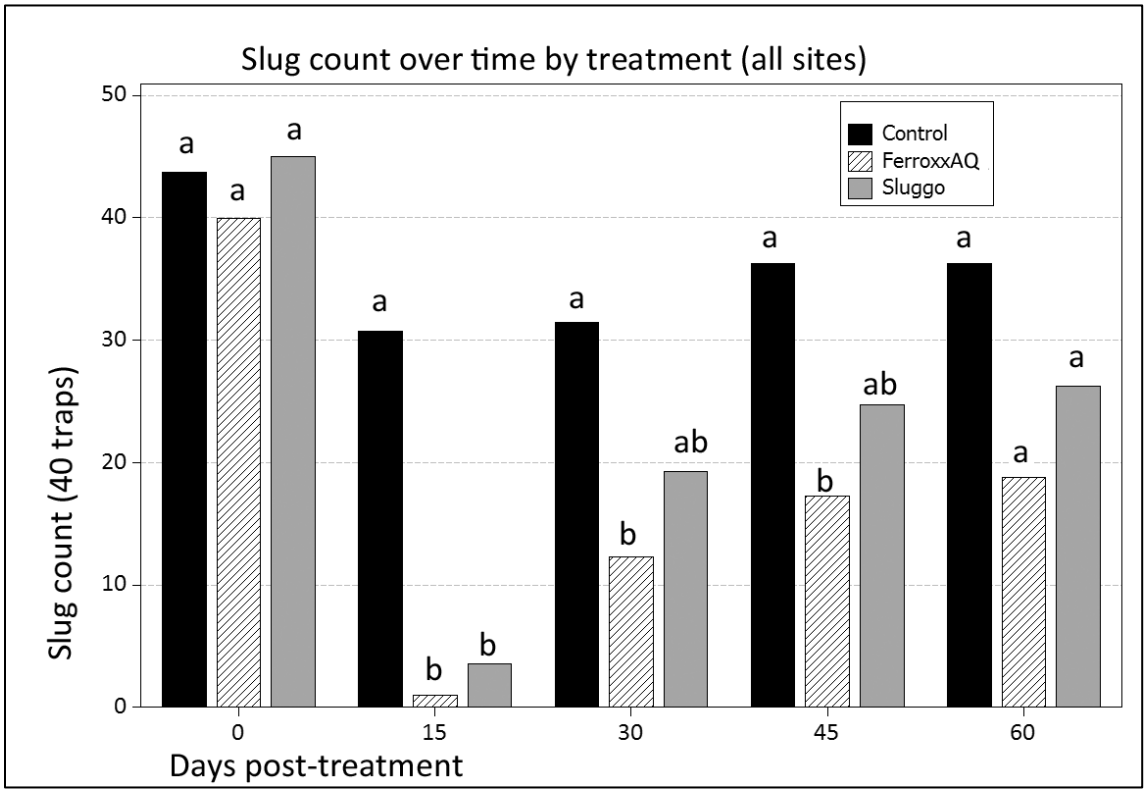


Figure 5. Graph of slug counts (all sites grouped) over time showing recovery of slugs in the treated sites by day 60. Letters denote which groups differ significantly from one another according to the GLM.

Table 3. Table of P values for all GLM contrasts between treatments over time. An asterisk denotes significance.

Trial Day	Groups compared	P value	Author comment
0	All treatments (Sluggo vs. FerroxxAQ vs. Control)	0.53146	There were no significant differences in slug number due to treatment
15	Sluggo vs. Control	<0.0000*	There were fewer slugs in the plots treated with Sluggo
15	FerroxxAQ vs. Control	<0.0000*	There were fewer slugs in the plots treated with FerroxxAQ
15	FerroxxAQ vs Sluggo	0.06	There were no significant differences in slug counts between groups, but it was approaching significance
30	Sluggo vs. Control	0.14	There were no significant differences in slug counts between groups

30	FerroxxAQ vs. Control	0.013*	There were fewer slugs in the plots treated with FerroxxAQ
30	FerroxxAQ vs Sluggo	0.294	There were no significant differences in slug counts between groups
45	Sluggo vs. Control	0.08	There were no significant differences in slug counts between groups
45	FerroxxAQ vs. Control	0.002*	There were fewer slugs in the plots treated with FerroxxAQ
45	FerroxxAQ vs Sluggo	0.174	There were no significant differences in slug counts between groups
60	All treatments (Sluggo vs. FerroxxAQ vs. control)	0.3169	There were no significant differences due to treatment

Though the GLM demonstrated that FerroxxAQ performed best across sites overall, when sites were analyzed separately using a one-way ANOVA followed by a Tukey's HSD, treatment efficacy varied. Figures 6-9 show slug abundance over time by site. Letters indicate differences between groups as identified by a P value <0.05 according to the Tukey's HSD (within each time period). The dotted line indicates the threshold at which our program would begin slug control. This threshold is reached when the average number of slugs per trap exceeds one.

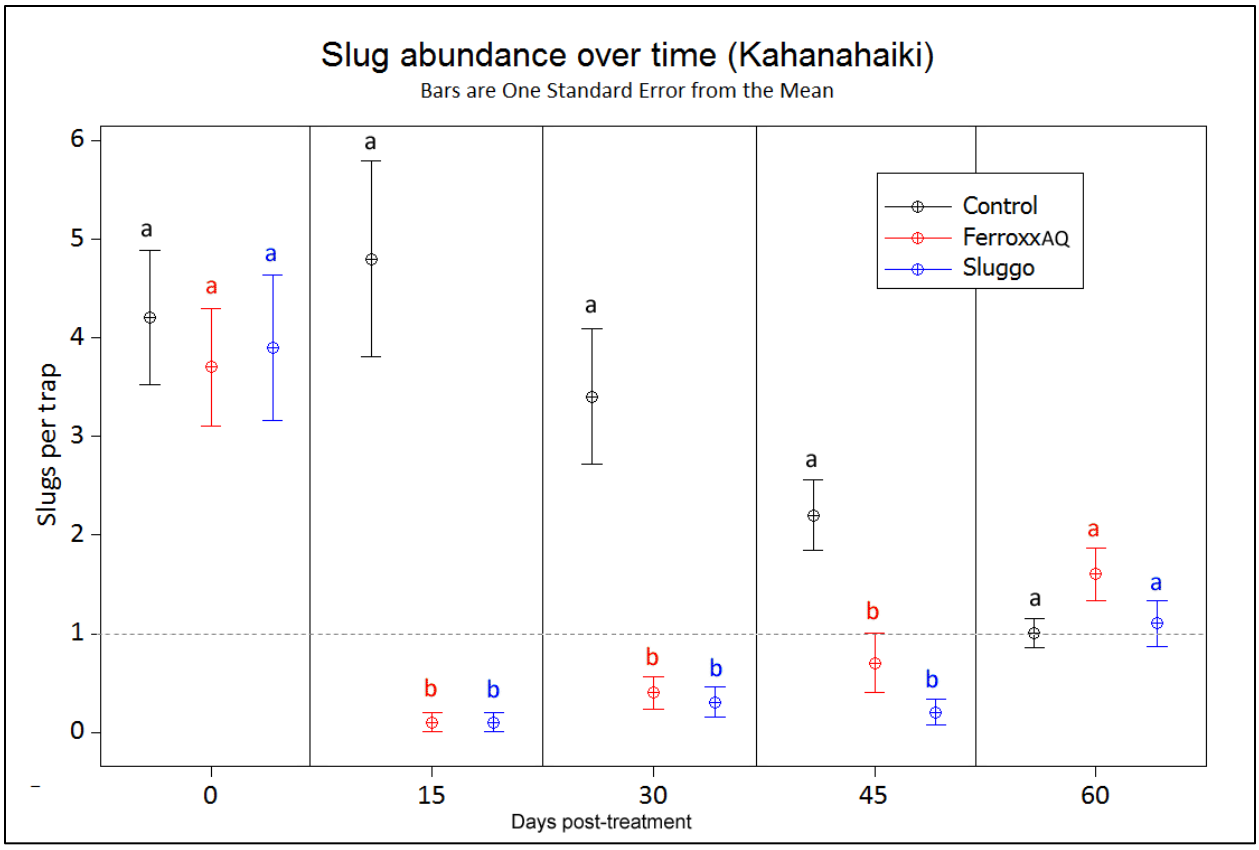


Figure 6. Both Sluggo and FerroxxAQ significantly reduced slugs compared to the control through day 45 at Kahanahaiki. On Day 60, slug abundance barely passed the threshold requiring treatment.

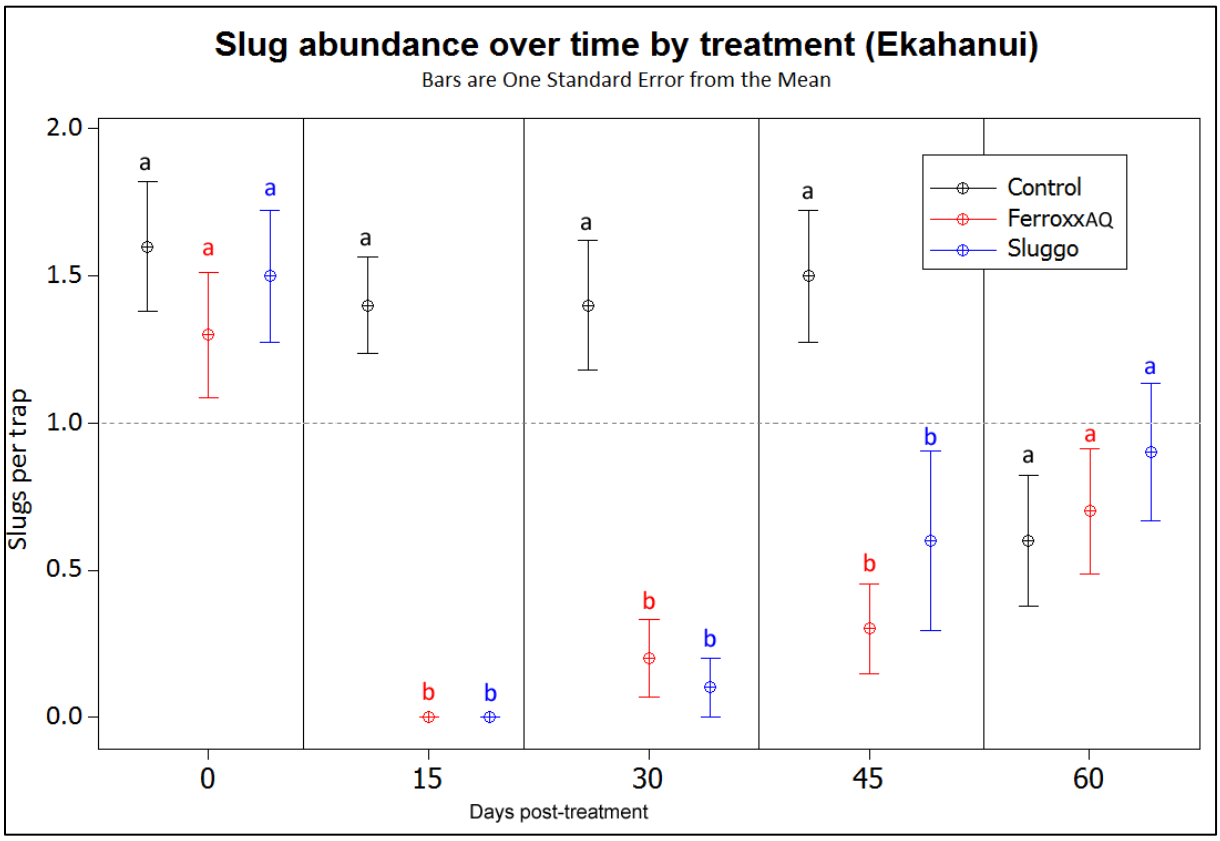


Figure 7. Both Sluggo and FerroxxAQ significantly reduced slugs compared to the control through day 45 in Ekahanui. On Day 60 slug numbers remained low enough in all groups that we would not consider treatment necessary.

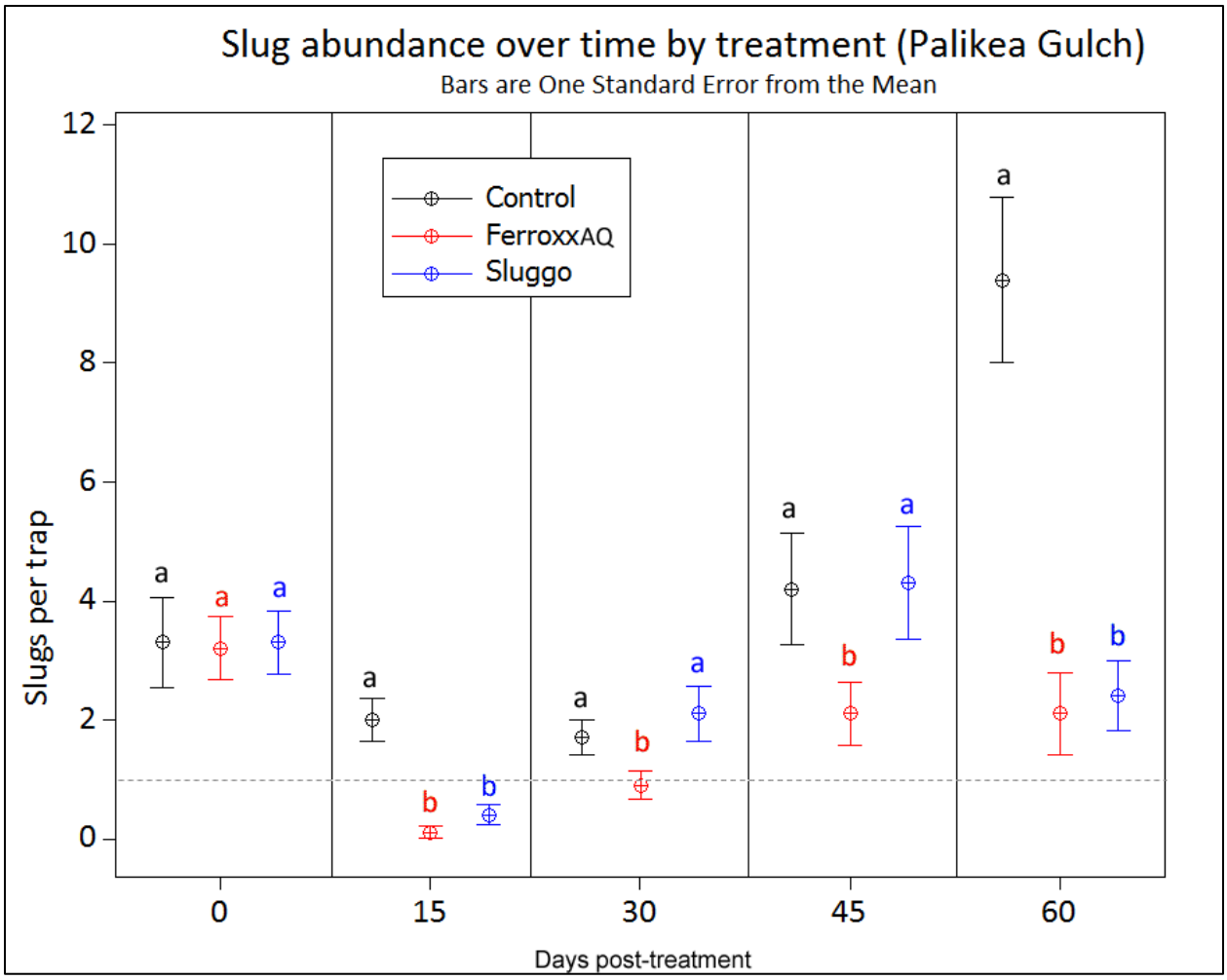


Figure 8. FerroxxAQ continued to sigficantly reduce slug abundance 60 days after treatment; however, the acceptable threshold of abundance was exceeded in all plots by day 45 at Palikea Gulch.

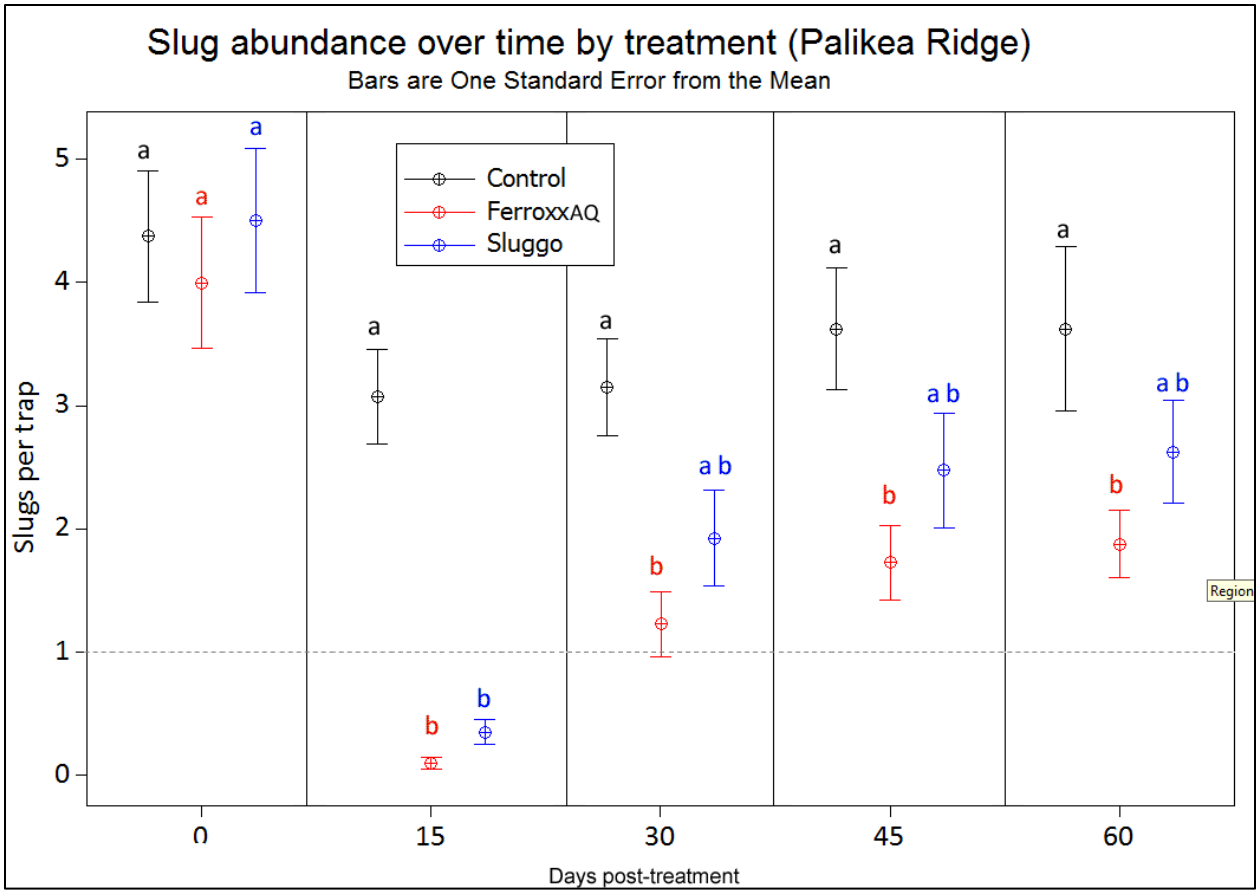


Figure 9. FerroxxAQ continued to sigficantly reduce slug abundance 60 days after treatment, however, the acceptable threshold of abundance was exceeded in all plots by day 30 at Palikea Ridge.

Discussion: The water resistant properties of the FerroxxAQ are likely responsible for the improved performance of the bait compared to Sluggo. Our field trial took place in the rainy season when slugs were most abundant. Currently we apply 10 lbs. of Sluggo monthly to treat a 1,840 m^2 area. With FerroxxAQ we could suppress an equivalent number of slugs by applying 5 lbs. of FerroxxAQ every 1.5 months. This is an enormous savings in staff time and labor and would allow us to focus on other pressing management actions. Slug abundance at Palikea was higher than at Kahanahaiki or Ekahanui and requires monthly treatment even with FerroxxAQ.

Non-target impacts: Though not explicitly stated on the FerroxxAQ label, OANRP commits to following restrictions outlined in the SLN for Sluggo. This means that no molluscicide will be placed in proximity to native snails or "within 20 m of known populations of endemic Hawaiian snail species from the following rare families or subfamilies: *Amastridae*, *Achatinellinae* and *Endodontidae*."

9.3 DEVELOPMENT OF A RAT BAIT WITH SLUG-REPELLENT PROPERTIES

Table 4. Terms & acronyms used in this Section.

Acronym	Description
A24	Goodnature® (Wellington, NZ) self-resetting rodent trap
ALP	Automatic lure pump
CA	Citric acid
Control bait	Bait without citric acid
GNCL	Goodnature® chocolate flavored rat lure
GNPL	Goodnature® peanut butter flavored rat lure
GNRL	Goodnature® rat lure (both flavors)
PB	Skippy® (Hormel Foods, USA) creamy peanut butter
Test bait	bait with citric acid added

Abstract: Since 1995, the OANRP has been controlling rodents in Oahu's forests to protect native plants, invertebrates, and birds. Bait longevity and attractiveness are keys to successful rodent trapping. Our success is impeded when slugs interfere with bait intended for rodents. Slugs can consume all or a portion of the bait, make it less attractive to rodents via their slime, and large slugs can trigger the snap traps (Figs. 10-11). Our goal was to determine whether food grade CA added to bait would repel slugs while remaining attractive to rodents. We conducted several trials including:1) a two-choice food experiment where captive slugs were offered both a test (0.5-5% CA added) and control bait in three types of bait matrices (PB, GNPL, GNCL); 2) a field trial comparing the catch success of rat (*Rattus sp*.) and mouse (*Mus musculus*) snap traps set with either the test (5% CA added to PB) against a control; and 3) a lab trial evaluating whether wild-caught house mice (*M. musculus*) avoided the GNRL with 5% CA. In the lab, we found slugs generally preferred the control bait in the two-choice feeding experiment over any of the 6 combinations of test bait. The most repellent test baits were 5% CA added to GNRL while some of the least repellent were 5% CA added to PB and 0.5% CA added to GNCL. In the field, snap trap success was unaffected by bait type. Finally, mice showed no aversion to the test bait in the lab. This indicates that the addition of CA can improve the longevity and attractiveness of bait thereby aiding rodent control programs.

Figure 10. Photo of a large leopard slug (*Limax maximus*) triggering a Victor rat snap trap.

Figure 11: Leopard slugs (*Limax maximus*) consuming peanut butter flavored bait used in A24 traps.

A detailed description of the field trial of 5% CA mixed with PB as well as the laboratory test of the 5% CA added to GNPL are provided in our 2016 report (OANRP 2016). We discovered that the field trial did not affect trap catch while the laboratory test did succeed in repelling slugs. We used the data from the 5% GNPL so its efficacy could be compared against different baits tested later. Finally, while captive mice showed no aversion to test baits, that work remains under analysis and will not be covered here. Instead we focus on comparing all 6 combinations of test bait with CA including the trial completed in 2016. Differences in methods will be noted where applicable.

Our goal was to determine whether citric acid (CA) added to a bait/lure at varying concentrations (0.5-5.0%) would repel slugs while remaining attractive to rodents. For the purposes of these experiments, we used food grade 100% granular CA. The baits tested included the following: Goodnature Peanut Butter Rat Lure (GNPL), Goodnature Chocolate Rat Lure (GNCL) and Skippy creamy peanut butter (PB).

Methods: To reduce variation in food preference due to species we only used leopard slugs in these trials. All were collected from Waianae Mountains in Oahu. These were kept moist and fed lettuce, carrots, and dry dog food for at least 24 hours (for up to one week) until the start of the trial. Testing took place on different dates but with a different group of slugs in each trial (Table 5). No slugs were used in more than one study. Each trial lasted for 14 days. Any slugs that died during this time or did not consume *any* bait were not used in subsequent analysis as their health was potentially comprised by illness or some unknown factor causing them to behave abnormally.

Table 5. Count of slugs used in each test as well as the timing of laboratory experiments.

Date trial start	Test bait	Number of Slugs
April 2016	5% CA in GNPL	17
February 2017	0.5% CA in GNCL	16
April 2017	5% CA in GNCL	11
April 2017	3% CA in GNCL	11
April 2017	2% CA in GNCL	10
April 2017	5% CA in PB	13

One methodology difference to note is that a scale that weighed to 0.1 gram was used for the trials that took place in April 2016 and February 2017, whereas a scale that can calculate to 0.001 gram was used for the trials thereafter. We therefore have more confidence in our results from April 2017 than from prior dates.

During the two-week experiment, slugs were kept in individual 32 ounce plastic containers and offered 2 g of the test and 2 g of the control bait in marked petri dishes, to prevent confusion between the two baits (Figs. 12 & 13). Every 48 hours, each slug and their baits were weighed, cages cleaned of feces, and observations made on the condition of the bait, such as any evidence of feeding (radula marks) or whether mold was present. Slugs were moistened daily.

Data was analyzed using Minitab 14 software (Minitab Inc. State College, PA). A two-sample T test was used to compare each treatment against its control group at the end of the study. Data used was the change in the weight of each treatment and its control group divided by the weight of the slug.

Figure 12 & 13. Above (Fig. 12) is a photo of a slug in its container. All control baits were marked with a "C," as can be seen on the petri dish above. Below (Fig. 13) is a photo of the same container with its mesh cover to prevent escape.

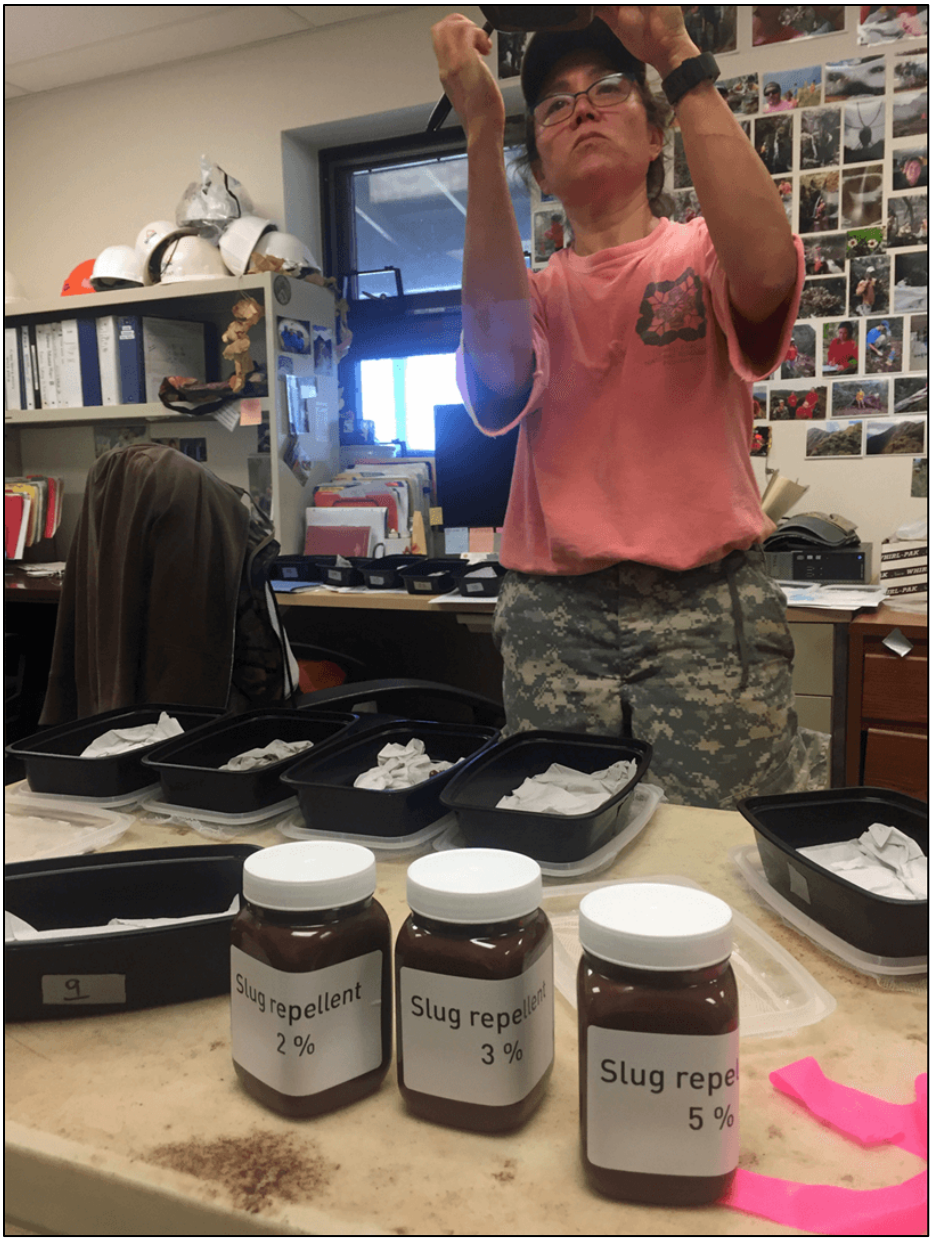


Figure 14. Photo of staff prepping slug cages. In the foreground are containers of GNCL with different levels of added CA.

Results: At the conclusion of the study, all treatments were significantly avoided over their control except for two: 0.5% CA in GNCL had a P value approaching significance (P=0.06) and 5% PB (P=0.285) which proved ineffective. All other groups were significantly different from their control groups (Table 6).

Table 6. Values from a two sample T test comparing each control group with its treatment group. An asterisk marks test baits that were significantly (P<0.05) avoided over the control.

P Value	t (DF)	Discussion
0.369	0.91 (28)	Slugs showed no aversion to 0.5% CA in GNCL vs. GNCL alone.
0.328	1.00 (23)	Slugs showed no aversion to 5% CA in PB vs. PB alone.
0.05*	2.09 (17)	Slugs significantly preferred GNCL alone to 2% CA added to GNCL
0.000*	6.42 (15)	Slugs significantly preferred GNCL alone to 3% CA added to GNCL
0.001*	4.03 (20)	Slugs significantly preferred GNPL alone to 5% CA added to GNCL
0.000*	6.80 (14)	Slugs significantly preferred GNCL alone to 5% CA added to GNCL

To compare effecacy between test groups, we subtracted the amount of treatment bait consumed over 15 days from its corresponding control bait. Therefore if a slug consumed 1 g of test bait and 1 g of control bait the value equalled 0 (both baits were equally attractive). If more control bait was consumed than the test, the result was positive indictaing the slug preferred trhe control. A negative number idicated that more of the test bait was eaten than the control. We then divided this number by the slug weight on Day 14 giving us a value that reflected the amount of control bait consumed relative to the treatment (Fig. 15). These data were normally distributed and we compared groups using a one-way ANOVA followed by a Tukey's HSD.

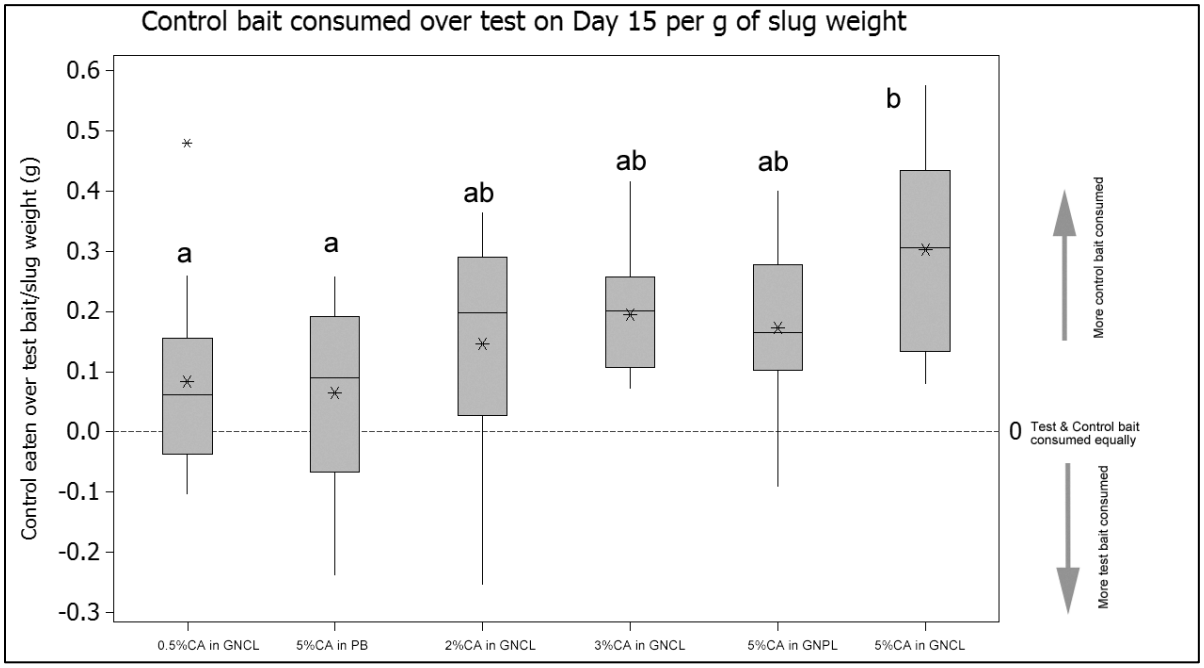


Figure 15. Graph showing effecacy of test baits. A value close to zero indicates the test and control baits were consumed at the same rate. The higher the value above zero, the more repellent the test bait. Letters indicate groups that differed significantly from one another according to a Tukey's HSD.

In figure 15 a value close to 0 indicated the control was eaten as much as the treatment bait. Values below 0 indicate the treatment was preferred to the control while values above 0 indicate the treatment was avoided over the control. The most repellent bait was the GNCL with 5% CA followed by the GNCL 3, 2%, and 5% GNPL, which, while they differed significantly from their control group, were somewhat less repellent. The least repellent baits were the 0.5% with GNCL and 5% mixed with PB.

Table 7. P values for all Tukey's comparisons between treatments. If the pairwise comparison is not listed, there were no significant differences between the two. Note that slugs were only offered one treatment and one control, so the exact pairings listed were not tested.

P Value	Groups compared
0.005	0.5% CA in GNCL was significantly preferred to 5% CA in GNCL
0.003	5% CA in PB was significant preferred to 5% CA in GNCL

Discussion

Citric acid (CA) deters slug feeding, but only at concentrations ≥ 2% and only when added to GNRL. The bait flavor (peanut butter vs. chocolate) did not affect slug feeding (there was no significant difference between 5% GNPL vs. 5% GNCL), however Goodnature has discontinued the peanut butter bait, and only chocolate will be available in the foreseeable future. The higher the CA concentration, the more repellent the bait was to slugs, with 5% CA being the most effective.

We were surprised to find that CA added to PB alone was not a deterrent to slugs, as observed for GNRL. We observed a change in the PB consistency when CA was added. The oil separated out of the mixture and it became more viscous overall. We believe the CA may be reacting to the salt in the PB as the combination of certain salts with acid can create new chemical compounds, such as sodium citrate, that may not be repellent.

As an added benefit, the addition of CA appeared to retard mold formation in humid environments. Among the control baits, mold appeared on Day 2 of the trial but was not seen on the test baits until Day 6. On the final day of the study there was significantly more mold covering the control baits (80%) relative to the test (50%)(P=0.0325, Mann-Whitney U test of medians). It is possible that the addition of CA may improve the longevity of bait in the field..

Evidence from the field trial of traps baited with test or control lures and the laboratory trials with mice demonstrated rodents are not repelled by CA when delivered at amounts up to 5% concentration. The field trial, however was conducted with PB and 5% CA, which we now know does not deter slugs. In the lab, mice were offered GNRL with various concentrations of CA added. Though the data is not yet fully analyzed, the mice appeared to consume all baits equally (A. Sheils, *pers. comm.*).

We remain interested in developing a better method to incorporate CA (or perhaps some other repellent yet to be tested) into PB without compromising its repellent properties. As we continue to replace Victor snap traps (which use PB) with A24 traps (which use GNRL), it is less critical that we develop a new bait. Low-sodium PB may be worth testing with 5% CA for use in Victor traps.

Based on our research to date, we plan to work with Goodnature to produce bait with 5% CA for use in all of our A24 traps as well as injected into ALPs. By preventing non-target, slug take of bait, we can improve trap efficacy, thereby protecting our native forests from the deleterious impacts of rodents.

9.4 SURVEY OF INVASIVE INSECT SPECIES

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

As stated in previous reports (OANRP 2011) OANRP conducts annual surveys of invasive ants in high-risk areas using a standard protocol developed by University of Hawaii entomologists (OANRP 2010). The sampling method involves placing a minimum of 10 vials at set locations baited with SPAM, peanut butter and Karo syrup. Any ants attracted to the bait within one hour are collected. These areas include trailheads, cabins and landing zones, where accidental introductions of ants are more likely to occur as well as in areas where rare resources may prove vulnerable to ant attack (Fig. 16).

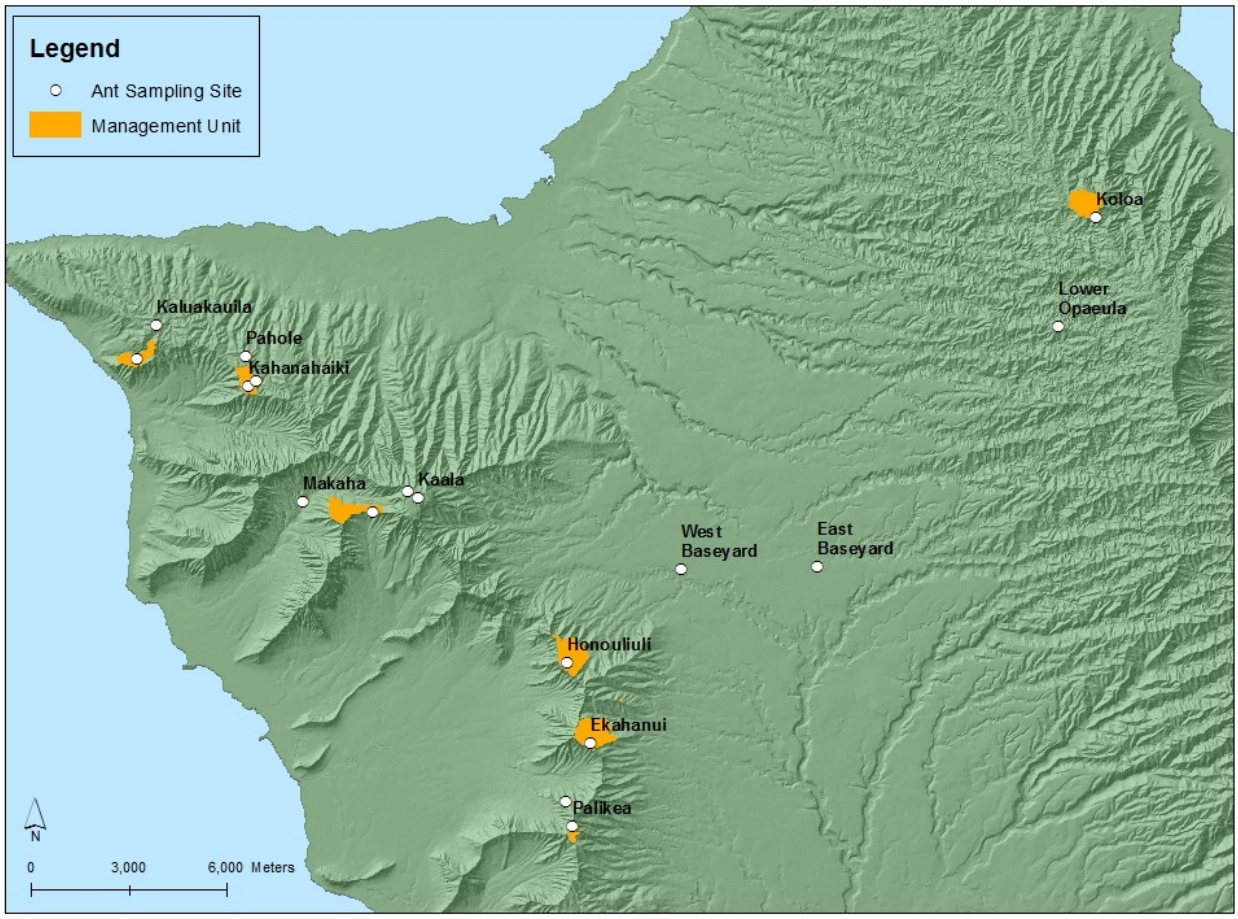


Figure 16. Map showing locations of ant sampling sites.

Ants were sampled in August of 2017 and, therefore are not yet sorted and included in this report. In June 28, 2017 we were made aware of an *Anoplolepis gracilipes* infestation at one of our heavily used landing zones at the Waianae Mountains Watershed Baseyard. Much of our efforts since then have been oriented towards containing that infestation, the results of which will be included in the 2017-2018 report, I have included below a summary of all ants collected within each MU over the past 3 years up to June 2017.

Table 8. List of ants found during annual surveys through June 2017. An asterisk marks species which are new to the area.

Management Unit (MU)	Ants recorded October 2013 - June 2017	Action needed?
East and West OANRP baseyards	*Anoplolepis gracilipes, Brachymyrmex obscurior*, Pheidole Megacephala, Plagiolepis alluaudi, Leptogenys falcigera*	Regular treatment with Amdro, Terro and MaxForce are applied quarterly at our baseyards
Ekahanui	*Solenopsis papuana, Plagiolepis alluaudi, Technomyrmex albipes*	No action needed.
Kaala	No ants found since 2011	Continue annual monitoring of high risk sites
Kahanahaiki	*Anoplolepis gracilipes, Cardiocondyla emeryi, C. venusula, C. wroughtoni, L. falcigera, Ochetellus glaber, Pl. alluaudi, S. geminata, S. papuana, Tc. albipes, Tetramorium simillimum*	*Solenopsis geminata* & *Anoplolepis gracilipes* remain absent since 2011 after repeated treatments. All other species widespread
Kaluakauila	*Anoplolepis gracilipes, C. emeryi, O. glaber, Paratrechina bourbonica, Ph. megacephala, Pl. alluaudi, S. papuana, Tc. albipes*	No action needed. Species detected are too widespread for control. Instead our focus will be to control ants on the LZ when material is moved to high elevations
Kaluaa	*Leptogenys falcigera, Ph. megacephala*	No action needed. *Pheidole megacephala* is too widespread for control
Koloa cabin	No ants found	Continue annual monitoring of high risk sites
Lower Opeaula	No ants found	Continue annual monitoring of high risk sites

Makaha	*Pheidole megacephala, S. papuana, Tc. albipes*	*Pheidole megacephala* is present at low elevation parking lot but too widespread for control. *Solenopsis papuana* detected at outplanting sites
Palikea	*Solenopsis papuana*	No action needed.

Since its first record on Oahu in December 2013, OANRP has been surveying high risk areas on base to prevent *Wasmannia auropunctata* (the Little Fire Ant or LFA) from establishment on Schofield Army Base or at any of our soil and pesticide suppliers. No LFA were detected during any of these surveys

Coconut Rhinoceros Beetle (CRB) trapping

Background: CRB was first detected on Oahu in December 2013. OANRP currently maintains 18 CRB traps spread throughout Wheeler, Schofield and Wahiawa with a single trap at Dillingham (Fig. 17). These are placed near palms and at mulch sites and are checked once every two weeks. Lures are replaced every two months. We have maintained these traps since Feb. 2014. No CRB have been detected at any traps during this period. We mapped and surveyed all coconut palm trees and mulch piles accessible by road on Wheeler Air Force Base. No evidence of CRB feeding was seen on trees. All information is relayed to HDOA and integrated into CRB distribution maps on Oahu.

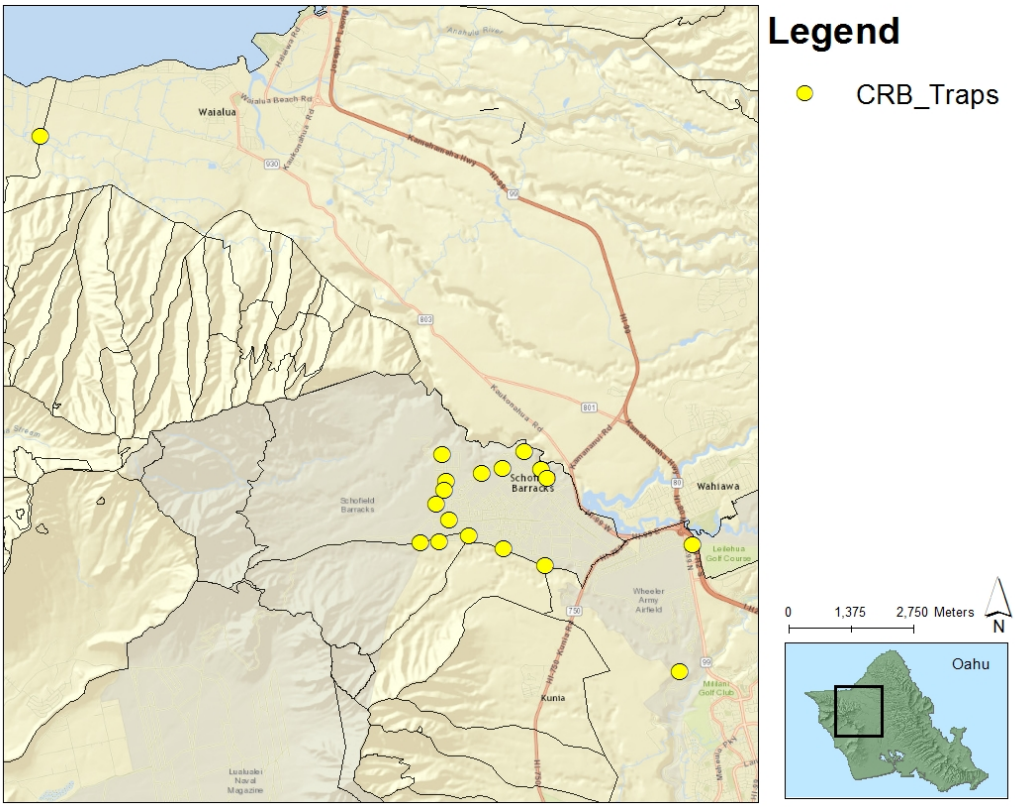


Figure 17. Locations of CRB traps maintained by OANRP.

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