2018 Status Report for the Makua and Oahu Implementation Plans

October 2018
Prepared by:
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Army Natural Resource Program - Oahu

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*Cover photo: Philip Taylor, Natural Resource Avian Conservation Specialist, educates Kupu Hawaii Youth Conservation Corps members about endangered Oahu Elepaio during monitoring activities.

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EXECUTIVE SUMMARY

The Army natural resource program on Oahu (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 plant nursery/seed bank crew. Most of these staff are employed via a cooperative agreement funded by the U.S. Army Garrison, Hawaii 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) 2018 were slightly up from FY 2017. For FY 2018, OANRP received a total of $5,872,155 to implement Makua Implementation Plan (MIP) projects and Tier 1 projects from the Oahu Implementation Plan (OIP). 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 2017, for FY 2018, 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 MIP and OIP. The period covered in this report is July 1, 2017 to June 30, 2018. This report covers Year 14 of the MIP and Year 11 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 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 fourteenth year of the MIP Addendum (Addendum completed in 2005, original finalized in 2003) and the eleventh 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 2018, 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 require 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 (BA) 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 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 the fall of 2018 and a BO from the USFWS is anticipated in the summer of 2019. 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 Army's natural resource program beyond ongoing routine maintenance. A shade house to hold taller living collection trees was erected. The program paved the Schofield Barracks greenhouse floor, replacing the gravel covered by weed mat. In addition, other paving projects were completed around the baseyard to improve safety and baseyard function. Lastly, awnings were constructed to protect storage areas.

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 which expires in May 2019.

In July 2011, an MOU was signed between the Army and the State of Hawaii, Department of Land and Natural Resources (DLNR). Currently, the Army holds seven 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, a State Parks Permit and a Protected Wildlife Permit. The Army and the State were working on finalization of a rental agreement for OANRP's use of the NIKE site mid-elevation greenhouse and associated facilities. This process has been delayed due to process changes at the Army Corps of Engineers, Real Estate Division. Natural resource staff may need to look for an alternative plan moving forward.

OANRP continues to provide and receive support from partner agencies including the Oahu Invasive Species Committee, Oahu Plant Extinction Prevention Program (OPEPP), Snail Extinction Prevention Program (SEPP) and the Koolau and Waianae Mountains Watershed Partnerships. The Army is also an official member of the Koolau Mountains Watershed Partnership, the Waianae Mountains Watershed Partnership, the Coordinating Group on Alien Pest Species, the Hawaii Rare Plant Restoration Group and the Pacific Islands Climate Change Cooperative. Highlights of Army natural resource partnership work over the last fiscal year included cooperation in wildfire response, staff exchanges on high priority incipient invasive weed and restoration projects, 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

MU 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 expanded the Palikea MU fence to incorporate the new Palikea North snail enclosure. In addition, supplemental fencing was installed via contract above Waianae Kai and Makaha Valleys to further protect the summit of Kaala. Also, the Makaleha West MU fence was expanded via contract support to encompass more habitat for rare plant taxa being stabilized there. Additionally, the ungulate staff responded to pig ingress at three management units and goat ingress at Ohikilolo. Monitoring intervals are suitable for detecting any ungulates that breach fence boundaries and response is efficient. For more details about OANRP ungulate control see Chapter 1 – Ungulate Control Program.

Ecosystem Restoration Program

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

In this reporting period, OANRP spent 10,399 hours controlling weeds across 528 ha. Incipient Control Area (ICA) efforts accounted for 382 ha (72% of total area controlled). Staff spent 2,645 (25% of total effort) hours on ICA management and conducted 674 visits to 234 ICAs. Of the ICA treatment area, 92% of it was treating 10 priority taxa, and of the treatment effort, 90% was spent treating 11 taxa. Three ICAs were declared eradicated over the reporting period, for a total of 36 eradcations over the last 14 years. However, 19 new ICAs were created. Weed Control Area (WCA) efforts covered 146 ha (28% of total area controlled), which is an increase from last year's area covered. OANRP conducted control in WCAs for a total of 7,753 hours (75% of total effort) over 951 visits at 193 WCAs, an increase in all areas as compared to last year's statistics. Of special note is that access to the Lihue MU and portions of the Makua MU were restricted because of unexploded ordnance safety concerns which limited all weed control work for six months of the reporting period. Access is not yet fully restored as of this writing and will require clearance of unexploded ordnance before resuming all projects in these areas.

OANRP conducted 134 road, landing zone, campsite and weed transect surveys to detect and prevent the spread of any newly introduced invasive species. OANRP submitted 28 non-native plant samples to Bishop Museum. Of these samples, two were new state records, and one was a new island record for Oahu. Highlights are covered in Chapter 3 – Ecosystem Management.

OANRP has completed a total of 22 Ecosystem Restoration Management Unit Plans (ERMUPs) for the highest priority and largest MUs. Four ERMUPs for Manuwai, Opaeula Lower, Kaluaa & Waieli, and Pahole MUs were updated during this reporting period and are included in this year's report (see Appendices 3-1 to 3-4).

Complementary to our other threat control programs, our additive restoration work expanded during this past reporting period. The number of common native outplants was three times greater than last year. In twelve MUs, and across nearly three acres, 7,051common 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 habitat for rare plants. Two MUs received the largest number of common outplants: Kahanahaiki and Palikea. In addition, the use of seeds sows, divisions, and transplants continue to compliment outplanting and weed control efforts. This year numerous seed sows of *Pipturus albidus* and *Bidens torta* were conducted. Common native seed collection efforts also increased to secure seed for planned restoration projects, for seed production sites, and for seed broadcast trials. See Chapter 3 – Ecosystem Management, for more information on habitat restoration efforts.

Rodent Control Program

OANRP directed rat and mouse control in MUs via small and large trapping grids both seasonally and year-round, depending on the resource targeted for protection. Small trapping grids were deployed for localized rodent control around rare plant and animal populations. Large trapping grids were used for rodent control across MUs as part of native habitat restoration efforts and to protect the rare species found there. In addition, OANRP continues to be on the cutting edge of research and development for new rodent control tools to increase efficiency and effectivenss. During this reporting period, OANRP purchased and deployed 910 new A24 traps, tested an auto-lure pump baiting system, deployed rodent bait via an aerial platform, and tested rodent birth control at one of our MUs. The program has contributed extensively to the development of an effective set of rodent control tools which may be applied by others doing conservation projects in the State of Hawaii. See Chapter 8 Rodent Control for details on these projects.

Monitoring Program

The OANRP monitoring program consisted of a number of projects: vegetation community monitoring, rare plant recruitment following *in situ* seed sowing, and bird gut passage treatments.

During this reporting period, OANRP monitored the Kahanahaiki and Kapuna MUs. Included in this report are vegetation monitoring results for the Kahanahaiki, Kapuna and Palikea MU (Appendices 3-8, 3-9, and 3-10, respectively).

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

- Monitored vegetation change associated with an intensive weed control project in Makaha.
- Monitored germination of a seed sow trial of *Cyanea superba* subsp. *superba* and established a second seed sow trial at Palikea with slug control.
- Monitored a seed sow trial for *Tetramolopium filiforme* var. *polyphyllum* to establish new populations in steep terrain and test seed application techniques.
- Monitored vegetation post-construction at the Palikea North snail enclosure.
- Developed monitoring protocols for initial release of ESU-E lab snails as part of Translocation Plan (Appendix 5-1)
- Analyzed temperature and relative humidity from data loggers kept at snail sites through 2017 in Makaha and Ohikilolo, to inform possible snail translocation from Makaha to Ohikilolo.
- Investigated vegetation monitoring methodologies for Pahole MU. Assisted in re-reading the Welton vegetation monitoring plots in Pahole and Kapuna MUs.
- Continued to use Gigapan System to guide management of target weed taxa at various sites including KTA and Keaau.
- Continued developing drone utilization protocols to capture photos documenting change over time.

Fire Management

During this reporting period, two fires occurred at Schofield Barracks that impacted 0.25 acres of Oahu Elepaio critical habitat (Appendix ES-3). In May of 2017, the Army conducted another successful prescribed burn at Schofield Barracks. The burn reduced fuel within the impact area as planned.

Just after the reporting period, in August 2018, a series of fires were started on the west coast of Oahu. These fires occurred past the data cut off for this report but are included to summarize information in a

timely manner. Two fence units in the Keaau Forest Reserve were burned, impacting valuable native dry forest and two endangered plant taxa, *Hibiscus brackenridgei* subsp. *mokuleianus* and *Gouania vitifolia*. The fires are a major setback for Army restoration work at the *Hibiscus* fence. Details regarding this fire are summarized in the Memorandum for Record included as Appendix ES-4. A total of more than 5,000 acres burned between Waianae, Makaha and Keaau Valleys. The Army managed fire response in the northern most portion of the fire contributing critical Army air support to the effort. The Army was mobilized under a mutual aid agreement between the State of Hawaii and the Army and to prevent the fire from burning into Makua Military Reservation from the south. Close coordination with partners was critical during the reponse.

Also in August, two fires started at Kahuku Trainnig Area via training. The forest impacted by the fires consisted primarily of *Eucalyptus* and *Casurina* and very few native species were burned. The fires did impact trees > 15 feet in height during the Hawaiian Hoary Bat pupping season. See Appendix ES-5 for more details.

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 service trips, educational displays at community events, internships, and the production of publications and other media materials.

In 2018, 2,440 military members were trained during the Environmental Compliance Officers course and the Range Safety Officer/Officer-in-charge briefings. These presentations were designed to educate service members in leadership roles about the rules and procedures in place to protect natural resources on training lands and their role in ensuring compliance.

During this reporting period, volunteers contributed 4,168 hours on 69 field work trips and 413 hours volunteering at our baseyard. In addition, the program hosted five summer interns. Many former interns, return to work for OANRP after college graduation. See Chapter 2 – Environmental Outreach for more details.

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, 43 of 100 MIP PUs (43%) and 13 of 31 (42%) 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 1,117 individuals of 14 species of MIP and OIP taxa. In the last year, OANRP made 526 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.

A taller shade house was added on to our Schofield Barracks facility to accommodate living collections of tree taxa up to 16 feet in height, for species such as *Eugenia koolauensis*, *Gardenia mannii* and *Alectryon macrococcus* var. *macrococcus*. In addition, staff replaced the gravel and weed mat floor of the greenhouse with concrete for safety and to improve greenhouse sanitation; it had previously been gravel covered by weed mat. The Kahua seed orchard at Schofield Barracks continues to flourish. Staff have secured seed collections for the Keaau population of *H. brackenridgei* subsp. *mokuleianus* from *ex situ* stock growing at the site. The timing of this achievement comes in the same year that the population and habitat were impacted by a catastrophic wildfire. Lastly, the seed lab staff is continuing to secure valuable stock for many taxa. Currently there are 171 taxa represented in collections and ~9 million total seeds.

The project being conducted by University of Hawaii researchers involving inoculation of *Phyllostegia kaalaensis* with beneficial fungi is still on going. *P. kaalaensis* is overwhelmed by a pathogenic leaf fungus or downy 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 *P. kaalensis* has been inoculated in the lab. Planting of inoculated plants will occur during the 2018 winter planting season. For an update on the status of this research see Appendix ES-6.

Table 1. MIP Plants Executive Summary

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 of 100

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2017	# 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	2	2	0	0	4	53	0%	0%	No	
		Kahanahaiki to Keawapilau	1	0	1	0	2	8	0%	100%	No	
		Makaha	11	11	0	0	29	75	52%	100%	No	
		Makua	4	4	0	0	4	15	33%	100%	No	
		Alectryon macrococcus var. macrococcus Total:	18	17	1	0	39	151				0 of 4
Cenchrus agrimonioides var. agrimonioides	50											
		Central Ekahanui	261	203	58	44	302	20	10%	100%	Yes	
		Kahanahaiki and Pahole	268	195	73	17	276	276	52%	100%	Yes	
		Makaha and Waianae Kai	290	164	126	0	289	12	25%	96%	Yes	
		Cenchrus agrimonioides var. agrimonioides Total:	819	562	257	61	867	308				3 of 3
Cyanea grimesiana subsp. obatae	100											
		Kaluaa	109	97	12	0	141	0	75%	100%	No	
		North branch of South Ekahanui	147	82	65	0	147	5	100%	100%	No	
		Pahole to West Makaleha	103	61	42	0	106	46	45%	100%	No	
		Palikea (South Palawai)	920	914	6	0	921	63	65%	100%	Yes	
		Cyanea grimesiana subsp. obatae Total:	1279	1154	125	0	1315	114				1 of 4
Cyanea longiflora	75											
		Kapuna to West Makaleha	236	89	147	0	257	66	51%	100%	Yes	
		Makaha and Waianae Kai	246	116	130	0	246	4	33%	100%	Yes	
		Pahole	219	58	161	70	74	114	100%	100%	No	
		Cyanea longiflora Total:	701	263	438	70	577	184				2 of 3
Cyanea superba subsp. superba	50											
		Kahanahaiki	371	46	325	4	226	152	100%	100%	No	
		Makaha	180	39	141	175	199	0	N/A	100%	No	
		Manuwai	83	0	83	0	79	0	N/A	100%	No	
		Pahole to Kapuna	166	95	71	4	166	170	N/A	100%	Yes	
		Cyanea superba subsp. superba Total:	800	180	620	183	670	322				1 of 4

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 of 100

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2017	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Cyrtandra dentata	50											
		Kahanahaiki	78	25	53	18	175	97	70%	100%	No	
		Kawaiiki (Koolaus)	21	2	19	1	21	50	0%	0%	No	
		Opaeula (Koolaus)	196	35	161	2	196	26	4%	100%	No	
		Pahole to West Makaleha	814	330	484	97	814	300	100%	100%	Yes	
		Cyrtandra dentata Total:	1109	392	717	118	1206	473				1 of 4
Delissea waianaeensis	100											
		Ekahanui	219	196	23	0	219	58	86%	100%	Yes	
		Kahanahaiki to Keawapilau	146	140	6	1	194	34	88%	100%	Yes	
		Kaluaa	441	425	16	0	538	44	90%	100%	Yes	
		Manuwai	168	132	36	0	168	0	N/A	100%	Yes	
		Delissea waianaeensis Total:	974	893	81	1	1119	136				4 of 4
Dubautia herbstobatae	50											
		Makaha	43	41	2	0	54	0	39%	0%	No	
		Ohikilolo Makai	137	133	4	0	137	700	0%	100%	Yes	
		Ohikilolo Mauka	400	373	27	0	400	1300	0%	100%	Yes	
		Dubautia herbstobatae Total:	580	547	33	0	591	2000				2 of 3
Euphorbia celastroides var. kaenana	25											
		East of Alau	22	20	2	66	22	26	75%	0%	No	
		Kaena	1154	880	274	0	1154	300	100%	0%	Yes	
		Makua	85	85	0	0	85	40	100%	100%	Yes	
		Puaakanoa	142	140	2	0	150	157	62%	0%	Yes	
		Euphorbia celastroides var. kaenana Total:	1403	1125	278	66	1411	523				3 of 4
Euphorbia herbstii	25											
		Kaluaa	90	2	88	0	20	0	N/A	100%	No	
		Kapuna to Pahole	78	33	45	0	97	170	42%	100%	Yes	
		Manuwai	0	0	0	0	0	0	N/A	100%	No	
		Euphorbia herbstii Total:	168	35	133	0	117	170				1 of 3
Flueggea neowawraea	50											
		Kahanahaiki to Kapuna	125	5	120	0	143	32	29%	100%	No	
		Makaha	44	7	37	0	64	4	36%	57%	No	
		Manuwai	16	0	16	0	16	0	N/A	100%	No	
		Ohikilolo	1	1	0	0	1	3	50%	100%	No	
		Flueggea neowawraea Total:	186	13	173	0	224	39				0 of 4

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 of 100

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2017	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Gouania vitifolia	50											
		Keaau	49	47	2	0	51	0	66%	0%	No	
		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:	49	47	2	0	51	0				0 of 3
Hesperomannia oahuensis	75											
		Haleauau	5	1	4	0	5	0	0%	100%	No	
		Makaha	80	11	69	0	45	13	29%	100%	No	
		Pahole NAR	24	3	21	0	24	8	N/A	100%	No	
		Pualii	72	14	58	1	72	0	N/A	100%	No	
		Hesperomannia oahuensis Total:	181	29	152	1	146	21				0 of 4
Hibiscus brackenridgei subsp. mokuleianus	50											
		Haili to Kawaiu	84	82	2	0	122	4	81%	0%	Yes	
		Keaau	86	82	4	0	86	0	60%	100%	Yes	
		Makua	95	95	0	0	144	7	81%	100%	Yes	
		Manuwai	71	70	1	12	110	0	N/A	100%	Yes	
		Hibiscus brackenridgei subsp. mokuleianus Total:	336	329	7	12	462	11				4 of 4
Kadua degeneri subsp. degeneri	50											
		Alaiheihe and Manuwai	147	75	72	0	161	60	65%	96%	Yes	
		Central Makaleha and West Branch of East Makaleha	49	17	32	0	32	47	60%	0%	No	
		Kahanahaiki to Pahole	202	102	100	150	202	161	100%	100%	Yes	
		Kadua degeneri subsp. degeneri Total:	398	194	204	150	395	268				2 of 3
Kadua parvula	50											
		Ekahanui	87	58	29	0	87	0	N/A	100%	Yes	
		Halona	35	31	4	0	35	64	100%	0%	No	
		Ohikilolo	239	90	149	20	230	66	100%	100%	Yes	
		Kadua parvula Total:	361	179	182	20	352	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	581	570	11	0	582	2009	10%	100%	Yes	
		Melanthera tenuifolia Total:	1797	1516	281	274	1798	3139				3 of 3

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 of 100

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2017	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Neraudia angulata	100											
		Kaluakauila	258	258	0	0	124	0	N/A	100%	Yes	
		Makua	49	45	4	0	78	29	40%	100%	No	
		Manuwai	160	97	63	10	161	12	57%	100%	No	
		Waianae Kai Mauka	13	11	2	0	13	46	28%	100%	No	
		Neraudia angulata Total:	480	411	69	10	376	87				1 of 4
Nototrichium humile	25											
		Kaluakauila	178	133	45	0	188	200	0%	100%	Yes	
		Makua (south side)	53	50	3	0	53	138	0%	100%	Yes	
		Manuwai	111	111	0	0	111	0	N/A	100%	Yes	
		Waianae Kai	264	134	130	0	305	200	8%	97%	Yes	
		Nototrichium humile Total:	606	428	178	0	657	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	56	5	51	0	57	33	84%	100%	No	
		Halona	15	6	9	0	15	50	49%	0%	No	
		North Mohiakea	71	28	43	0	51	30	34%	100%	No	
		Ohikilolo	24	24	0	0	50	14	82%	100%	No	
		Plantago princeps var. princeps Total:	166	63	103	0	173	127				0 of 4
Pritchardia kaalae	25											
		Makaleha to Manuwai	134	123	11	0	134	141	0%	2%	Yes	
		Ohikilolo	1687	131	1556	3	1675	473	0%	100%	Yes	
		Ohikilolo East and West Makaleha	295	11	284	0	334	75	N/A	100%	No	
		Pritchardia kaalae Total:	2116	265	1851	3	2143	689				2 of 3
Sanicula mariversa	100											
		Kamaileunu	213	31	182	1	213	26	84%	100%	No	
		Keaau	43	0	43	2	28	141	16%	100%	No	
		Ohikilolo	229	0	229	0	229	162	34%	100%	No	
		Sanicula mariversa Total:	485	31	454	3	470	329				0 of 3

Table 1 (continued).

Makua Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 43 of 100

= Ungulate Threat to Taxon within Population Unit

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

Plant Taxon	Target # Matures	Population Unit Name	Total Current Mat.+Imm.	Total Current Mature	Total Current Immature	Total Current Seedling	# Plants In 2017	# Plant In Original Report	% Completed Genetic Storage Requirement	% of Plants Protected from Ungulates	PU Met Goal?	# PU Met Goal
Schiedea kaalae	50											
		Kaluaa and Waieli	143	141	2	0	168	55	100%	100%	Yes	
		Maakua (Koolaus)	10	10	0	0	10	4	60%	0%	No	
		Pahole	79	40	39	3	84	3	100%	100%	No	
		South Ekahanui	265	170	95	21	268	85	89%	100%	Yes	
		Schiedea kaalae Total:	497	361	136	24	530	147				2 of 4
Schiedea nuttallii	50											
		Kahanahaiki to Pahole	245	141	104	168	123	65	84%	100%	Yes	
		Kapuna-Keawapilau Ridge	100	75	25	45	57	4	100%	100%	Yes	
		Makaha	127	121	6	0	96	0	N/A	100%	Yes	
		Schiedea nuttallii Total:	472	337	135	213	276	69				3 of 3
Schiedea obovata	100											
		Kahanahaiki to Pahole	258	91	167	200	351	90	100%	100%	No	
		Keawapilau to West Makaleha	434	25	409	5	405	36	100%	100%	No	
		Makaha	20	20	0	0	90	0	N/A	100%	No	
		Schiedea obovata Total:	712	136	576	205	846	126				0 of 3
Tetramolopium filiforme	50											
		Kalena	42	26	16	0	117	0	16%	100%	No	
		Ohikilolo	2782	1740	1042	20	3367	2500	12%	100%	Yes	
		Puhawai	0	0	0	0	6	12	80%	0%	No	
		Waianae Kai	20	20	0	0	20	22	0%	0%	No	
		Tetramolopium filiforme Total:	2844	1786	1058	20	3510	2534				1 of 4
Viola chamissoniana subsp. chamissoniana	50											
		Halona	21	16	5	0	21	3	11%	0%	No	
		Makaha	53	29	24	0	79	50	4%	100%	No	
		Ohikilolo	340	107	233	0	243	0	0%	100%	Yes	
		Puu Kumakalii	44	44	0	0	44	20	16%	0%	No	
		Viola chamissoniana subsp. chamissoniana Total:	458	196	262	0	387	73				1 of 4

Table 2. OIP Plants Executive Summary

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 13 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 2017	# 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	153	54	99	30	175	44	23%	100%	Yes	
		Kaawa to Puulu	214	27	187	0	203	124	4%	48%	No	
		Kahanahaiki	74	69	5	0	74	0	100%	100%	Yes	
		Makaha Makai	225	92	133	0	225	100	72%	75%	Yes	
		Abutilon sandwicense Total:	666	242	424	30	677	268				3 of 4
Cyanea acuminata	50											
		Helemano-Punaluu Summit Ridge to North Kaukonahua	158	81	77	0	205	72	26%	0%	Yes	
		Kaluanui and Maakua	249	123	126	50	249	0	0%	0%	Yes	
		Makaleha to Mohiakea	284	195	89	0	284	118	20%	95%	Yes	
		Cyanea acuminata Total:	691	399	292	50	738	190				3 of 3
Cyanea koolauensis	50											
		Kaipapau, Koloa and Kawainui	125	113	12	0	125	76	2%	85%	Yes	
		Opaeula to Helemano	28	21	7	0	28	13	0%	48%	No	
		Poamoho	39	20	19	0	39	12	3%	0%	No	
		Cyanea koolauensis Total:	192	154	38	0	192	101				1 of 3
Eugenia koolauensis	50											
		Kaunala	54	15	39	27	59	141	42%	93%	No	
		Oio	8	6	2	0	8	74	41%	83%	No	
		Pahipahialua	24	18	6	124	28	291	45%	100%	No	
		Eugenia koolauensis Total:	86	39	47	151	95	506				0 of 3
Gardenia mannii	50											
		Haleauau	64	60	4	0	74	2	25%	100%	Yes	
		Helemano and Poamoho	23	23	0	0	23	18	64%	4%	No	
		Lower Peahinaia	39	9	30	0	22	46	42%	56%	No	
		Gardenia mannii Total:	126	92	34	0	119	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	26	24	0%	0%	No	
		Hesperomannia swezeyi Total:	381	200	181	53	381	250				2 of 3

Table 2 (continued).

Oahu Implementation Plan - Executive Summary - Plants

# of Stable IP Population Units: 13 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 2017	# 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	310	275	35	0	343	100	22%	89%	Yes	
		Koloa	22	3	19	0	31	0	N/A	100%	No	
		Labordia cyrtandrae Total:	332	278	54	0	374	100				1 of 2
Phyllostegia hirsuta	100											
		Haleauau to Mohiakea	49	47	2	0	98	18	53%	100%	No	
		Koloa	32	26	6	1	149	0	50%	92%	No	
		Puu Palikea	33	22	11	3	142	0	N/A	100%	No	
		Phyllostegia hirsuta Total:	114	95	19	4	389	18				0 of 3
Phyllostegia mollis	100											
		Ekahanui	1	1	0	0	1	35	100%	100%	No	
		Kaluaa	43	42	1	7	97	49	100%	100%	No	
		Pualii	0	0	0	0	11	0	100%	100%	No	
		Phyllostegia mollis Total:	44	43	1	7	109	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	136	136	0	0	230	1	100%	100%	Yes	
		Kaluaa	26	5	21	0	204	79	100%	100%	No	
		Makaha	8	0	8	0	60	0	N/A	100%	No	
		Stenogyne kanehoana Total:	170	141	29	0	494	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 two new snail enclosures and 6) Translocating snails into snail enclosures. The table below presents the status summary for the Waianae *A. mustelina* in the MIP. This report does not include an 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 ESU. Five 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	258	1	258	230 (Kahanahaiki) 28 (Pahole)	Kahanahaiki/Pahole
B1	Ohikilolo	330	7	330	0	West Makaleha
B2	East Makaleha	484	188	672	0	West Makaleha
C	Lower Kaala NAR & Schofield Barracks West Range	335	10	345	0	Kaala
D1	Central Kaluaa to Schofield Barraks South Range	747	14	761	747(Hapapa)	Hapapa
D2	Makaha	342	10	352	0	No suitable site
D*	South Range to Lihue	0	392	392	0	Kaala and Hapapa
E	Ekahanui	80	21	101	0	Palikea North
F	Puu Palikea	295	9	304	174 (Palikea)	Palikea South

*Snails from this portion of the ESU are not managed for stability in the MIP

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 completed construction on the new Palikea North enclosure which will be the home for Ekahanui (ESU-E) *A. mustelina* in the future. In addition, the West Makaleha exclosure is well underway and contruction is scheduled for completion in September. This new exclosure will be the home for ESU-B snails. OANRP and partners continued to monitor population trends for *A. mustelina* within the Kahanahaiki, Puu Hapapa, and Palikea predator exclosures using timed-count monitoring. A steep decline was observed at the last remaining large population of *A. mustelina* at Palikea (PAK-M). OANRP decided to translocate the remaining snails into the Palikea exclosure before more are lost to *E. rosea* predation. Also, the State

continues to prepare for the replacement of the Pahole snail enclosure which should occur before the next annual report.

Some adjustments to the design of the Palikea North snail exclosure were made, improving the realiability of the barriers and the structure. These changes will be applied to future exclosures and those currently under construction. For more information on rare snail management, see Chapter 5 – *Achatinella mustelina* Management.

Rare Vertebrate Management

Currently, OANRP manages three species of rare vertebrates: the Oahu Elepaio (*Chasiempis ibidis*), the Nene or Hawaiian Goose (*Branta sandvicensis*), and the Opeapea or Hawaiian hoary bat (*Lasiurus cinereus semotus*). Management consists of active predator control for the Oahu Elepaio, monitoring during Nene sightings at Schofield Barracks and Wheeler Army Airfield, and monitoring for Opeapea at Army installations across Oahu. Staff conducts spot monitoring for bat roosting in trees that need to be pruned or removed at Army installations during the bat pupping season.

In 2018, OANRP controlled rats to protect 151 pairs of Oahu Elepaio at four management sites which is double the requirement in the Oahu BO. The dramatic increase from last year's total is a result of the aerial broadcast of rodenticide in the Lihue MU. This control was extremely successful, resulting in <10% rat activity during the nesting season, December 2017 through July 2018. Access to Makua Valley was not available due to unexploded ordnance issues, therefore Oahu Elepaio monitoring was not conducted. The number of managed pairs and reproductive efforts in 2018 are summarized in the table below.

Table 4. Summary of Elepaio Management Table

Year	Managed Pairs	Successful Active Nests	Family Groups	Fledglings	Fledglings/ Managed Pair
2018	151	20	22	50	0.33

The number of documented fledgings per managed pairs this year was very low because of access limitations to Schofield Barracks West Range. Many more pairs were managed via the aerial rodenticide application, but access to monitor nest success was limited.

To more effectively and efficiently protect elepaio from rodents, snap traps were replaced with A24 traps. The overall protection for the Oahu Elepaio during the 2017-2018 nesting season was greater than any year previous due to the combination of aerial application of rodenticide and A24s. For more information, see the Chapter 6 - Rare Vertebrate Management and Chapter 8 – Rodent Management.

Over the past year, Nene were not observed at Army Installations on Oahu. 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 conducted an acoustic monitoring project from 2015-2016 for the Hawaiian hoary bats on Army land, the results are being prepared as a Hawaii Cooperative Studies Unit Technical Report. In addition, initial data are available from a new long-term bat study funded through windfarm mitigation. The results so far suggest bats fly over every part of Oahu and have the highest detection rates at Kahuku and Schofield Barracks. OANRP supported this project with access to Army installations for detector deployment. In early September 2015, an official Garrison policy was signed that formalizes a tree-cutting moratorium during the bat pupping season each year. Unfortunately, tree projects are often funded using year-end monies thus the tree work coincides with summer months which are the bat

pupping season. While the policy reduces the number of tree removal projects happening in the summer, some projects are unavoidable, and OANRP must survey trees slated for removal/pruning for roosting bats. During this performance period, OANRP and a contractor conducted 39 bat surveys over a total of 38 hours (not including travel time). Zero roosting bats were found. For more information, see the Chapter 6 - Rare Vertebrate Management.

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 high this year, likely due to high rainfall. Results of the surveys and management conducted during this reporting period are summarized in Chapter 7 – *Drosophila* Species Management. An additional 32 *Urera glabra* and 10 *U. kaalae* outplanted at the North Kaluaa *Drosophila montgomeryi* site. In addition, *Drosophila* host plants such as *U. glaba* and *Cheirodendron trigynum* have been establishing successfully and growing rapidly, and thus are being incorporated into general habitat restoration where appropriate.

Surveys of suitable hosts continue at training ranges to obtain a thorough picture of endangered *Drosophila* distribution at Army training ranges for use in the upcoming Biological Assessment. Also, surveys for endangered *Hylaeus* bees are ongoing. OANRP continue to monitor and control threats to the *Megalagrion xanthomelas* population at Tripler Army Medical Center. This report does not contain a section covering this taxon as management over the course of this reporting period has been similar to last year. OANRP anticipate new management projects during the 2018-2019 reporting period and will report on these activities next year.

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 protecting rare plants and rare plant habitat, and this year was no exception. OANRP now protects 49 rare species population units from slugs (up from 42). In 2017-2018, OANRP controlled slugs within eleven MUs across an area equal to 12.75 acres, a 14% increase from the previous year. Notably, OANRP is utilizing a new slug control bait product called FerroxxAQ® which is longer lasting than the formerly used product, Sluggo®. This increased bait longevity translates to a reduced revisitation rate and labor savings. Staff have detected native snails that have moved into slug control areas previously free of snails and thus have developed a flow chart to ensure regular resurvey.

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. Besides LFA, the Army surveys and controls, where feasible, populations of other invasive ants in management units or at important points of entry like greenhouses and landing zones.

Research Projects

During this reporting period, OANRP funded a few research projects related to management of MIP and OIP taxa. Our internal research projects included investigations on 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. Deptartment of Agriculture, Wildlife Services, to broadcast a rodenticide via helicopter as a pilot project. Updates on projects supported by the Army are listed below and updates/publications can be found Appendices ES-6 through ES-10.

- **Koko, Jerry, Cameron Egan and Nicole Hynson, 2018.** Project update. Testing the effects of inoculation with arbuscular mycorrhizal fungi and the foliar endophytic mycoparasitic yeast *Moeziomyces aphidis* on the diseas severity from Neoerysiphe galeopsidis in infected *Phyllostegia kaalaensis* plants. (Appendix ES-6)
- **Krushelnycky, P.D., et al., 2017.** Quantifying the effects of an invasive thief ant on the reproductive success of rare Hawaiian picture-wing flies. Biological Conservation 215 (2017) 254-259. (Appendix ES-7)
- **Bialic-Murphy, Lalasia, et al., 2017.** Microhabitat heterogeneity and a non-native avian frugivore drive the population dynamics of an island endemic shrub, *Cyrtandra dentata*. Journal of Applied Ecology 2017 (10.1111/1365-2664.12868). (Appendix ES-8)
- **Case, Samuel, 2018.** Project update. Introduced game birds as seed dispersers in Hawaiian Forests. (Appendix ES-9)
- **MacDonald, et al., 2017.** Poster for the 2017 Hawaii Conservation Conference. Artificially Induced Frugivory by Birds: A Management Tool for Rare Plants? (Appendix ES-10)

In addition, OANRP supported various research projects by providing access or guidance during study plan development. The following are ongoing projects supported by OANRP in some way.

- Obtained collections for Harvard University to study Jackson's chameleon sexual dimorphism.
- Supported via logistics, site selection and access, *Lysimachia* phylogeny project- University of Hawaii, Botany Department.
- Supported via logistics and site selection, various on-going projects funded by the Department of Defense's Strategic Environmental Research and Development Program.
- Supported Pacific Rim Conservation's project surveying for nesting Newell's Shearwaters at Kaala by loaning OANRP acoustic recording equipment.

TABLE OF CONTENTS

**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 2017-2018 reporting year are discussed in the Project Highlights section of this chapter.

Threat control efforts are summarized for each Management Unit (MU) or non-MU land division. In total, about 1,020 meters of fencing was replaced, repaired, or built during the reporting year due to fence expansions, environmental damage, or deliberate vandalism. No large fence replacement projects were required, but three fence expansion projects were initiated. Ungulate control data is presented with minimal discussion.

The Ungulate Fence Check and Construction Inventory Summary table below shows the total amounts of each fence that required maintenance or construction throughout the reporting period. From the left, the first two columns are the code and name of each fence. Columns three and four show the length of fence that needed work expressed as feet and meters. Columns 5-12 show the total amounts of material used such as the number of fence panels. The length of hog wire and smooth wire. The number of t-posts, dead man anchors and duckbill anchors. Finally the length of skirting or fickle fence (deer mesh) in rolls that is applied over the fence to keep animals from crossing.

Table 1. Table showing the summary of fence construction and repair projects during the 2017-2018 reporting period

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Ungulate Fence Check and Construction Inventory Summary

Dates from: July 03, 2017 to June 28, 2018

Fence:		Total FT Distance	Total M Distance	Total Panels	Total Hog Wire	Total Smooth Wire	Total T Posts	Total Dead Man	Total Duck Bill	Total Skirts	Total Fickle
ANU-A	Manuwai Perimeter	1230	374.90	0.00	0		0				12.30
HUL-A	Huliwai	10	3.05	1.50	0		0				
KAH-A	Kahanahaiki MU Perimeter	65	19.81	4.00	0		5			5	
KLO-G	Opaeula/Helemano	20	6.10	6.00	0	10	0				
KTA-D	Kaleleiki	14	4.27	9.00	0		0				
LIH-C	Firebreak Road	20	6.10	0.50	0		0				
MAK-D	Makaha Subunit II (Mauka and Makai)	30	9.14	0.00	0	1	2				
MMR-B	Ohikilolo Section A and B	695	211.84	7.00	0		39			435	
MMR-L	MMR Perimeter (Kahanahaiki-Kaluakauila)	100	30.48	5.50	0		6				
PAH-A	Pahole Section A	159	48.46	0.00	0		48	7			
PAK-A	Palikea Subunit I	1024	312.12	76.00	0		307				
PUA-A	North Pualii	3	0.91	0.00	0	15	1				
		3370	1027.18	109.50	0	26	408	7		440	12.30

PROJECT HIGHLIGHTS

Both of the ungulate management technician positions have been filled. Funding was secured to construct two small fences at Kaala and Makaleha West. Both the Kaala and Makaleha West projects have been started and were completed by August 2018. The Palikea expansion project, which encompasses a new snail enclosure, was completed during this reporting period.

Summary of Fencing Efforts

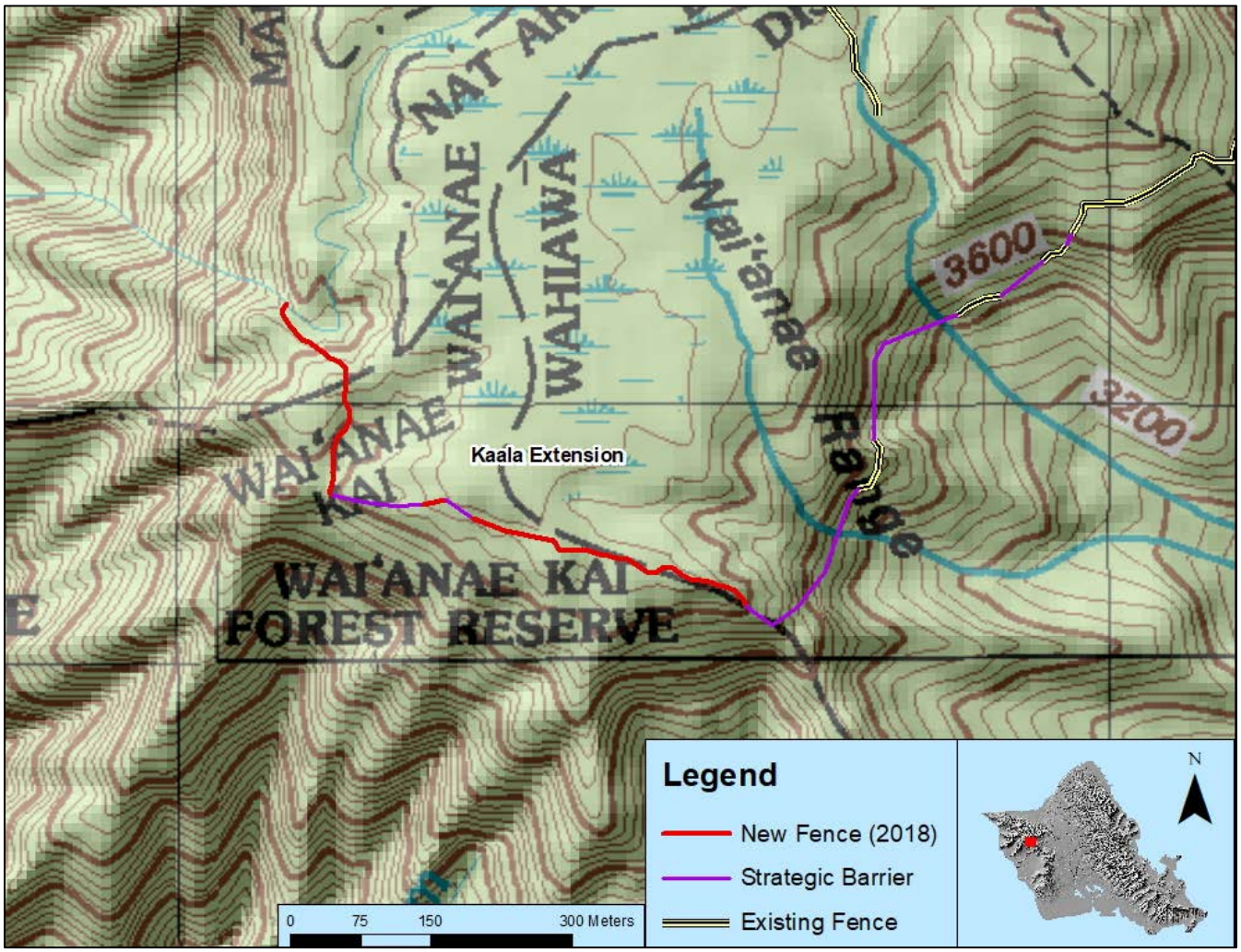

Figure 1. Map of Fence expansion at Kaala

- **The Kaala Fence Expansion Project**: The Army natural resource program on Oahu (OANRP) was able to secure funding to erect a fence on the Waianae Kai side of the summit of Kaala (Figure 1). The Kaala ungulate exclusion project will close off the Western side of the summit to ungulate ingress utilizing a combination of fence panels and strategic fencing. There are series of cliffs around the base of the Kaala bog that are too steep for pigs to traverse. This contract was initiated in mid-May with completion set for the end of August.

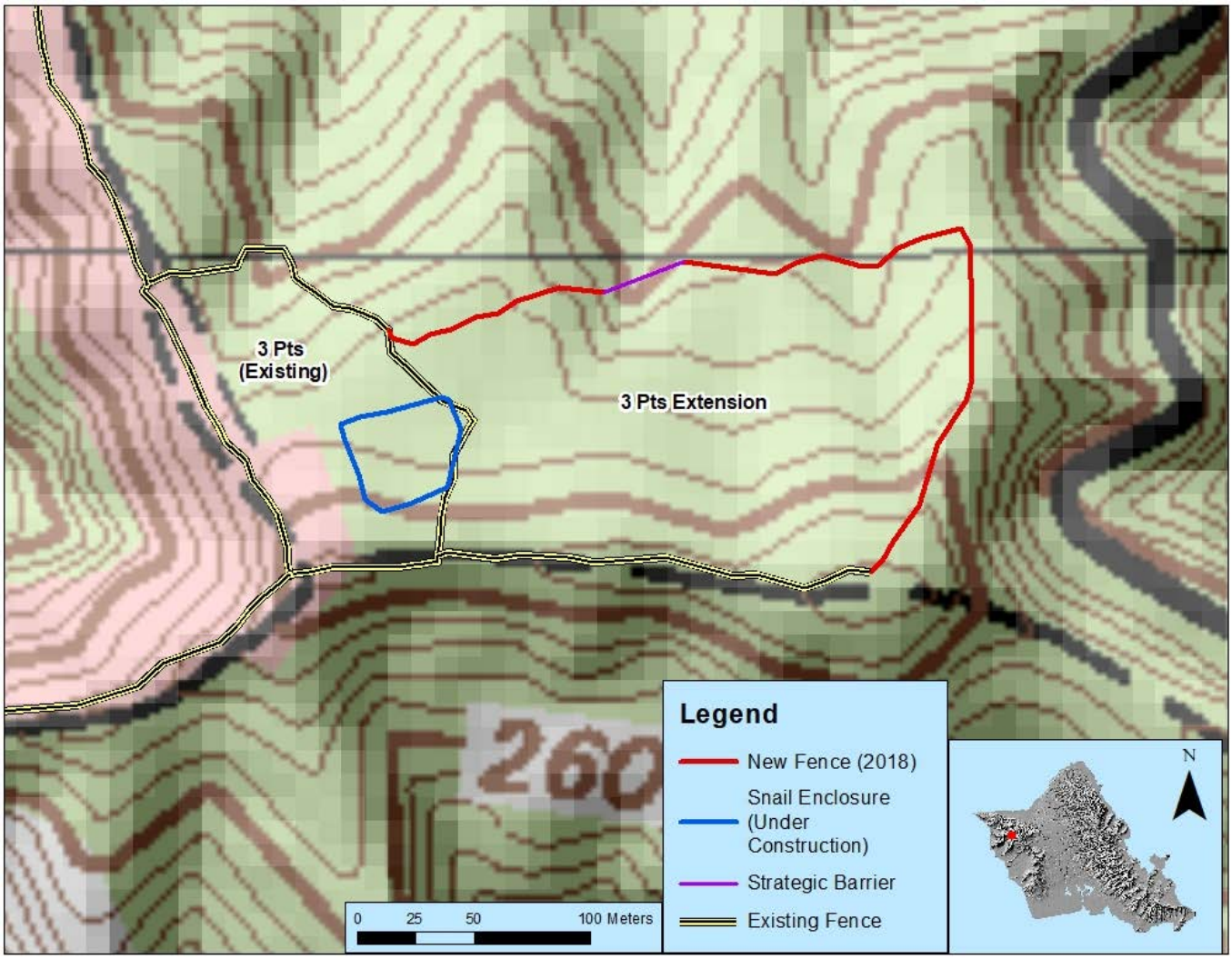

Figure 2. Map of Fence expansion at 3-Points

- **Makaleha West**: OANRP was able to secure funding to expand the existing fence in West Makaleha (Figure 2). The Makaleha West project will enclose the new snail enclosure that is currently being constructed as well as a larger area of suitable habitat for management of endangered plants. The Makaleha West project will close off this plateau area to ungulate ingress utilizing a combination of fence panels, hog wire and strategic fencing. There is a tall waterfall that is too steep for pigs to traverse. This contract was initiated in mid-May with completion set for the end of July.

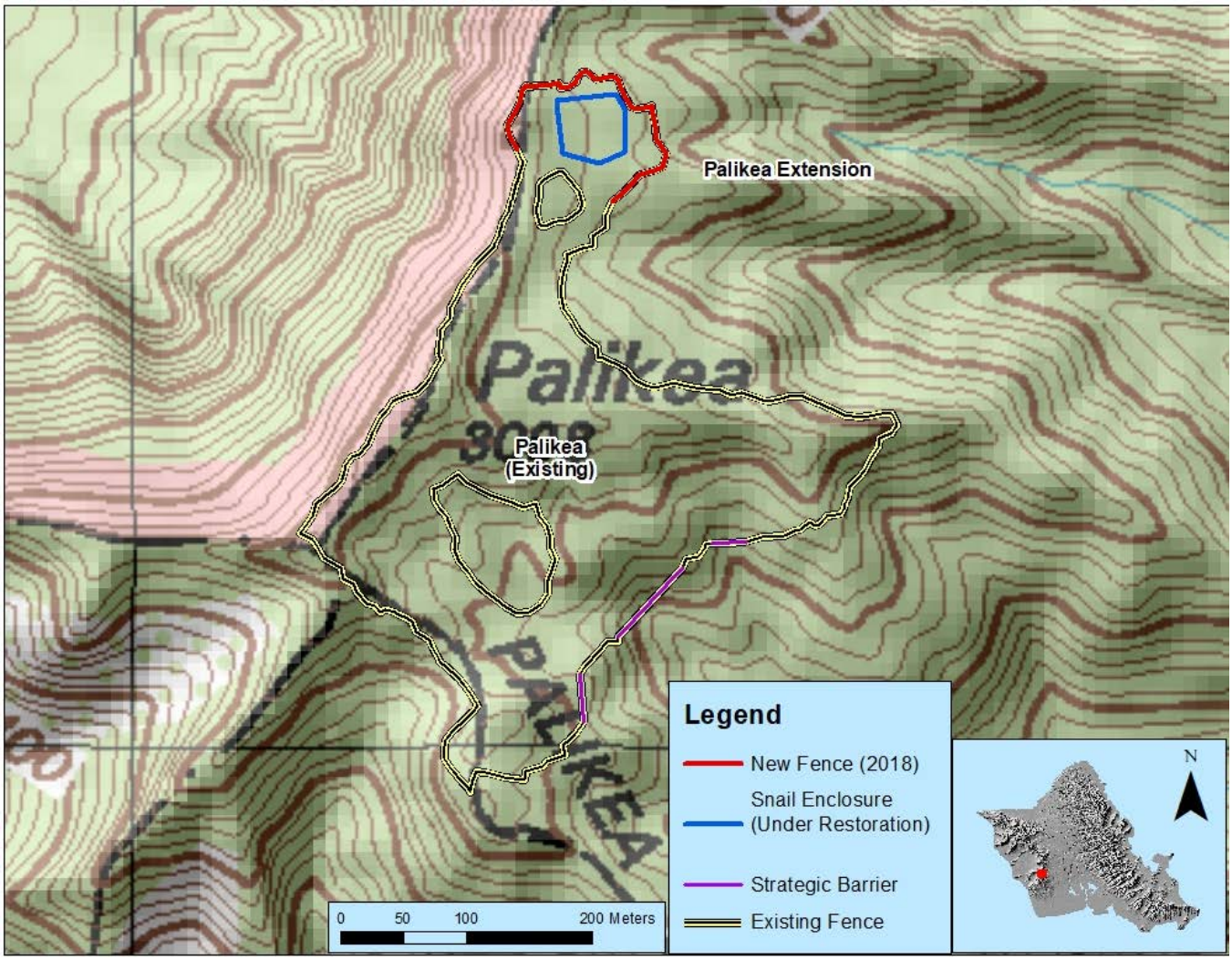

Figure 3. Map of Fence expansion at Palikea

- **Palikea Fence Expansion Project**: With the completion of the second snail enclosure at Palikea MU (Figure 3), OANRP needed to expand the existing MU fence to enclose this new structure. OANRP staff completed the fence which increased the size of the MU by nearly 0.81 hectares.

Summary of Ungulate Removal Efforts

- **Manuwai MU**: In August 2017, it appeared that one small pig was able to squeeze through the fence at Manuwai Subunit II. The amount of pig sign such as rooting, tracks and scat indicated that there was only one animal. OANRP conducted snaring/trapping operations and removed one young male. Staff applied skirting and wire mesh over the fence in the areas with the highest pig traffic to reduce the threat of future incursions.

- **Kapuna Upper MU**: In September 2017, pig sign was observed in Kapuna Upper Subunit IV. Fence checks showed that the fence had been deliberately vandalized and propped open. At least, two animals were observed on game cameras that were installed in response to the incursion. Snaring and trapping operations were initiated. Hawaii Department of Land and Natural Resources (DLNR) and OANRP staff agreed to split the unit in half so that each group could

manage a smaller area within the unit. One sow was removed by OANRP staff and no new sign has been observed since in our area. DLNR staff have continued to observe sign in their area so control operations continue there.

- **Makaha Subunit II MU**: In June 2018, one small pig was able to squeeze through the fence into the upper unit of Makaha Subunit II. A portion of the fickle fence that had been applied over the panels failed, rusted away so a small pig was able to enter into the unit. A newer, more durable product is being purchased to reapply over the fence. OANRP contract staff are not allowed to manage a volunteer hunter program so ungulate management has to be achieved through the use of snares. In Makaha, all snares must be removed when staff exit the MUs. One snaring trip was completed before the end of the reporting period and was unsuccessful at catching the pig. Staff will continue trips each week.

- **Kaluaa and Waieli MU**: Towards the end of June 2018, pig sign was observed in Kaluaa Subunit III. By the amount of sign observed it appears one small pig was able to squeeze through the fence. OANRP staff have scheduled trips to conduct snaring operations as soon as possible.

- **Lihue MU**: A total of 547 pigs have been removed, to date. Only three animals were caught this year, after hunters had vandalized the fence and propped it open along the firebreak road. Pig sign throughout the MU and the number of catches per year has declined dramatically but sign is still visible in a few areas. Due to Unexploded Ordnance (UXO) policy changes, staff are prohibited from entering into a large area of the MU until the UXO can be removed (detonated). This policy change has effectively halted any hopes of pig eradication until all areas are open to be entered or some form of aerial dispensed toxicant, such as Sodium nitrite,

- **Ohikilolo MU**: Occasionally, goats are able to breach the ridge fence on Ohikilolo and OANRP staff are not certain how they are entering the unit. One goat was removed from the Ohikilolo MU fence area over the past reporting period.

- **Makua Military Reservation (MMR)**: OANRP initiated an eradication effort for MMR in 2015. Snares are employed since hunting with dogs is not allowed. Staff would like to install live traps and baiting/shooting stations to try some alternative methods at removal. To date, 180 pigs have been removed. Due to UXO policy changes, staff are prohibited from entering into a large area of MMR until the UXO can be removed (detonated).

OIP/MIP Management Unit Fence Status

The MU status tables below show the current status of all completed fence units, organized by MU. Shaded boxes identify where ungulate management or compliance documentations and authorizations are needed. The tables identify whether or not the fence is complete, whether it is ungulate free, identifies how many acres are actually protected versus acreage proposed in the Implementation Plan and lists the year the fence was completed or is expected to be completed. 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 Population Units (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 2. MIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete	# 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						Fence is complete and ungulate free	None
Kaluakauila	Kaluakauila	Yes	Yes	104/104	2002	5					Complete. Fence is in need of some minor repair but still pig-free.	None
Opaeula Lower	Opaeula Lower	Yes	Yes	26/26	2011	1		1	1		Fence is complete and ungulate free.	None
Ohikilolo	Ohikilolo	Yes	No	4000/574	2002 2016	14	1				The Northern Makua rim section is complete, ungulate eradication has been initiated. There are six PU fences within the larger unit which are ungulate free. Since July 2006, 25 goats have been able to breach the fence; a couple may still be inside MMR but OANRP staff have not observed them since they were originally seen. 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	6	1	2		1	Completed by the Nature Conservancy of Hawaii (TNCH).	Pigs
	Ekahanui II	Yes	Yes	165/159	2009						Complete and ungulate free	None
Haili to Kealia	Haili to Kealia	No	-	-	-	1					As per DLNR Division of Forestry and Wildlife staff 'no fence needed'	None
Kaena	Kaena	Partial	-	-	-	1					There is a predator proof fence installed by State but it only protects a few of the EupCelKae plants	None
Kaluaa/Waieli	Kaluaa/Waieli I	Yes	Yes	110/99	1999	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						Completed by TNCH. The completed fence is 7% larger than the original proposed MU fence.	None
	Kaluaa/Waieli III	Yes	Yes	43/11	2010						Complete and ungulate free. The completed fence is 3% larger than the original proposed MU fence	None
Keaau	Keaau II	Yes	Yes	8/33	2014	2					Complete and ungulate free. DLNR requested OANRP reduce the size of original proposed MU fence.	None

Table 2 (continued).

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete	#MFS Pus					Notes	Current Threats
						MIP		OIP				
						P	I	P	I	V		
	Keaau III	Yes	Yes	4/33	2015						Fence was built by the Oahu Plant Extinction Prevention Program (OPEPP) with assistance from the Waianae Mountain Watershed Partnership and OANRP	None
Keaau/Makaha	Keaau/Makaha	Yes	Yes	1/3	2009	1					Complete and ungulate free.	None
Manuwai	Manuwai I	Yes	Yes	166/166	2011	3	1		1		Complete and ungulate free.	None
Napepeiaoolelo	Napepeiaoolelo	Yes	Yes	1/1	2009	0					Complete and ungulate free	None
Pahole	Pahole	Yes	Yes	215/215	1998	14	1				Complete and ungulate free	None
Palikea	Palikea I	Yes	Yes	23/21	2008	1	1	1	2		Complete and ungulate free. Extension to fence was completed to enclose new snail enclosure	None
Kapuna Upper	Kapuna I/II	Yes	Yes	32/182	2007	13	1				Complete and ungulate free.	None
	Kapuna III	Yes	Yes	56/182	2007						Complete and ungulate free.	None
	Kapuna IV	Yes	Yes	342/224	2007						Complete and ungulate free	None
Waianae Kai	Slot Gulch	Yes	Yes	9/9	2010	1					Complete and ungulate free.	None
	Gouvit	Yes	Yes	1/1	2008	1					Complete and ungulate free	None
	NerAng Mauka	No	No	1/1	2011						Complete. All management actions have been transferred to Kamaili unit due to the continuous rock fall damage and threat to personnel. Fence not being maintained.	Pigs/Goats
Makaleha West	Makaleha West	Yes	Yes	7/11	2001 2016	5					The *Schiedea bovata* and *Cyanea grimesiana* subsp. *obatae* PU fences are complete and pig free. Staff 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	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.	None
	Makaha II	Yes	Yes	66/66	2013	5		1			Complete. A pig breached the fence and is currently being pursued	None

Table 3. OIP Management Unit Status

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete	# 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			4	1		Strategic fences complete. Three pigs were caught in 2014, the first since 2010 and no sign since. Fence is slated to be completed in August 2018.	Pig
Kaunala	Kaunala	Yes	Yes	5/5	2006			1			Complete and ungulate free.	None
Lihue	Lihue	Yes	No	1800/980	2012	3	1	6			Completed. Encompasses six PU fences and the original three proposed units. A total of 537 pigs have been removed, to date. There are very few pigs left in unit.	Pig
Oio	Oio	Yes	Yes	4/4	2006			1			Complete and ungulate free.	None
Opaeula / Helemano	Opaeula / Helemano	Yes	Yes	273/273	2001/ 2007			1			Complete and ungulate free.	None
Opaeula Lower												
Pahipahialua	Pahipahialua	Yes	Yes	2/2	2006			1			Complete and ungulate free.	None
South Kaukonahua	South Kaukonahua I	No	No	0/95	TBD			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			1			Complete and ungulate free.	None
Ekahanui	Ekahanui III	Yes	Yes	8/8	2010			1			Complete and ungulate free.	None
Manuwai	Manuwai II	Yes	Yes	138/138	2011	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			1			Site is included within the larger Poamoho NAR fence. Fence is completed.	Pig
Poamoho	Poamoho Lower II	Yes	Yes	5/5	2014			1			Site is included within the larger Poamoho NAR fence.	Pig
	Poamoho Pond	Yes	Yes	18/18	2014						Site is included in the larger Poamoho NAR fence	Pig
Waimano	Waimano	Yes	Yes	4/4	2011						Complete and ungulate free. Transferred management of fence over to OPEPP.	None
North Pualii	North Pualii	Yes	Yes	20/20	2006	1		1	1		Completed by TNCH and ungulate free.	None
	BOARD OF WATER SUPPLY											
Kamaili	Kamaili	Yes	Yes	9/7	2014	1		1			Complete and ungulate free.	None
	HAWAII RESERVES INC.											
Koloa	Koloa	Yes	Yes	177/160	2012			4			Complete and ungulate free.	None

Table 3 (continued).

Management Unit	Management Unit Fence	Fenced	Ung Free	Acreage Current/ Proposed	Year Complete	#MFS Pus					Notes	Current Threats
						MIP		OIP				
						P	I	P	I	V		
	KAMEHAMEHA SCHOOLS											
Waiawa	Waiawa I	No	No	0/136	Cancelled						Army training does not impact these tier 1, 2 and 3 taxa. To be constructed by DLNR Division of Forestry and Wildlife Native Ecosystems Protection and Management (NEPM) and the Koolau Mountain Watershed Partnership (KMWP).	Pig
	Waiawa II	No	No	0/136	Cancelled						Army training does not impact these tier 1, 2 and 3 taxa. To be constructed by NEPM and KMWP.	Pig
STATE OF HAWAII DEPARTMENT OF TRANSPORTATION												
North Halawa	North Halawa	Yes	Yes	.5/4	2010						Completed a small PU sized fence. Transferred management of fence over to OPEP.	Pig
KUALOA RANCH INC.												
Kahana	Kahana	Yes	No	1/23	2010						Small PU fences were built around individual *Schiedea kaalae* plants in gulch. Larger unit will not be built until the Army trains in a way that may impact Tier 2 and 3 taxa.	None
U. S. FISH AND WILDLIFE SERVICE												
Kipapa	Kipapa	Yes	Yes	120/4	2015						U.S. Fish and Wildlife Service constructed a 120 acre unit.	None

CHAPTER 2: ENVIRONMENTAL OUTREACH

The Army natural resource program on Oahu (OANRP) is tasked with:

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

Updates to each of these actions are provided in detail within the following sections of this chapter.

Volunteer Program

Outreach staff maintained a volunteer database of 2,243 individuals and communicated regularly with active volunteers.

Most volunteer outings consist of individual members of the general public. In addition, specific community groups (e.g, schools, hiking clubs) and other members of the community with no affiliation volunteered with the program throughout the reporting year. The following specific community groups volunteered with OANRP in 2018:

- Hoala School Camp Kokua
- U.S. Dept. of Agriculture Ag Discovery Summer Program
- Malama Loko Ea Foundation
- AmeriCorps Vista
- Hawaii Vertebrate Introductions and Novel Ecosystems (VINE) Project
- Waialua High School Staff
- Directorate of Public Works Environmental Division Staff
- Hawaii Audubon Society
- Mililani High School AP Environmental Science Class
- Mililani High School Biology Class
- Waialua High School Eco Club
- MeetUp Hawaii Hiking Group
- North Shore Outdoor Circle
- Nanakuli High School Aalii Hui
- State of Hawaii Office of Hawaiian Education Staff
- Le Jardin Academy High School Environmental Science Class

Figure 1. Mililani High School biology class students participated in weed control and transect monitoring activities at Kahanahaiki with OANRP in 2018.

The table below (Table 1) compares volunteer participation for 2018 with that of previous years, distinguishing between volunteer efforts spent in the field and around the baseyards.

Table 1. OANRP volunteer participation from 2010 to 2018

Report Year	Total Volunteer Hours for Field Days*	Total Volunteer Hours at Work Site**	Total Volunteer Hours at Baseyard ***
2018	**4,168**	**1,356**	**413**
2017	3397.5	905.75	489
2016	3,575.5	974.5	537.75
2015+	3,013.5	824	333.25
2014	4,421.5	1,133.75	490.75
2013	3,767.5	957	569.5
2012	4,302.5	1,261.5	602.5
2011	4,194	1,231	618
2010	3,415	1,299	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 spent a total of 104 days in the field this reporting year. Outreach staff led a total of 69 volunteer trips and facilitated 35 additional opportunities for volunteers to assist natural resource staff with miscellaneous field projects. These supplemental projects varied depending on volunteer abilities and program needs.

Volunteer weed control efforts focused mainly within Kaala, Palikea, and Kahanahiki Management Units (MUs) during the 2018 reporting year. While Kaala and Kahanahaiki have consistently occupied a large portion of weeding efforts, additional volunteer projects at Palikea were established in support of the Palikea North snail enclosure, leading to a greater number of hours in the field and on volunteer projects during this reporting year.

In addition to weeding, outreach staff coordinated revegetation projects in consultation with the ecosystem restoration program. These efforts, which include fruit collection, seed sows and outplanting activities, supported habitat diversity in previously weeded areas within various Weed Control Areas (WCAs).

Two volunteers regularly supported activities at the OANRP baseyard, including seed lab activities, nursery work and maintenance of the native Hawaiian interpretive garden.

The following table (Table 2) summarizes volunteer work by project type and location.

Table 2. Volunteer actions for reporting year 2018

Work Area	Type of Project	Number of Actions
Haili to Kealia	Revegetation projects	1
Helemano	Fence monitoring/maintenance	1
	Weed survey	1
Kaala Army and Kaala NAR	Weed control in *Sphagnum palustre* Incipient Control Areas (ICAs)	1
	Incipient weed control in other ICAs	20
	Habitat weed control in WCAs	7
Kaena	Rare plant monitoring	1
Kaena East of Alau	Rare plant monitoring	1
Kahanahaiki	Habitat weed control in WCAs	16
	Revegetation projects	7
Kahuku Training Area	Incipient weed control	1
Kaluaa and Waieli	Habitat weed control in WCAs	6
	Snail enclosure projects	4
	Revegetation projects	1
Kamaileunu	Rare plant monitoring	1
Kapuna Upper	Rare plant monitoring	3
	Non-native predator control	1
Makaha	Habitat weed control in WCAs	6
	Monitor/Maintenance/Collect	1
	Non-native predator control	2
Makaleha West	Habitat weed control in WCAs	6
Ohikilolo	Monitoring	1
	Habitat weed control in WCAs	1
Palikea	Incipient weed control	3
	Habitat weed control in WCAs	15
	Snail enclosure projects	15
Pualii North	Habitat weed control in WCAs	2
Tripler	Stream cleanup	1

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.

- *Summer Internships*

  Outreach staff scored 45 applicants, interviewed 12 applicants, and awarded five individuals with paid summer internships with natural resource field and horticultural crews. The summer internships began in June 2018 and ranged from eight to twenty weeks. One of the interns was also a participant with the University of Hawaii's Pacific Internship Programs for Exploring Science (PIPES) program. Outreach staff and field crews planned and implemented a four-day orientation session for the summer interns, consisting of new hire training modules and hands-on field activities at various management units.

  During this reporting year, two former interns, Deann Nishimura-Thornton (Summer 2017) and Keith Adams (Summer 2016) joined the program as full-time natural resource management technicians.

- *Hawaii Youth Conservation Corps (HYCC)*
  Hosted three teams of HYCC members (totaling 20 youth for the three weeks combined) during the month of June. Each HYCC team spent one week working with a natural resource program field crew.

- *2018 Science Fairs*
  Staff mentored Oahu students at numerous events this year, providing feedback and guidance by judging projects at Sunset Beach Elementary School Science Fair, Mililani High School Science Fair and the 61st Hawaii State Science and Engineering Fair.

Educational Materials

Outreach staff developed educational materials on natural resource issues specific to Makua and and Oahu Implementation Plan species and their habitats. Materials ranged from large scale exhibits to live broadcasts from the field in order to reach a broad spectrum of the community.

Exhibits

- 2018 American Malacological Society Meeting Exhibit
  Provided an overview of the Army's rare snail program and highlights the *Achatinella mustelina* enclosure approach to managing endangered Hawaiian tree snails.

- 2017 Hawaii Conservation Conference Exhibit
  Provided an overview of the Army's rare plant program while making a connection to the conference theme, "He waa he moku, he moku he waa" (The canoe is an island, and the island is a canoe).

Figure 2. The OANRP exhibit at the 2017 Hawaii Conservation Conference provided a glimpse into endangered plant management on Oahu.

Presentations

- Wahiawa Hawaiian Civic Club Presentation
  New presentation highlighting OANRP management and native plants that thrive in the Wahiawa central plateau and upland areas.

Publications

- Ecosystem Management Program Bulletin 2018
  An annual newsletter highlighting achievements made by the Army Environmental Division's Conservation Branch on Oahu and Hawaii islands, posted online at http://manoa.hawaii.edu/hpicesu/dpw_emb.htm and at www.issuu.com/oanrp.

- Elepaio Flyer

  Designed a two-sided, half-sheet flyer to provide information on the Oahu Elepaio (*Chasiempis ibidis*) including: natural history, endangered status, current threats, cultural significance, OANRP management actions for elepaio protection and suggestions for community involvement in protecting remaining Oahu Elepaio populations.

Figure 3. Front and back of Oahu Elepaio flyer

Other Educational Materials

- Periscope Broadcast/Virtual Field Trip

  Produced and recorded a live broadcast using a social media platform (Periscope) to connect to students from Daniel K. Inouye Elementary School; enabled students to interact with OANRP staff during a common native outplanting day at the Kahanahaiki MU. See Table 5 for a link to the live broadcast overview.

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 and figure below (Table 3 and Figure 4). The total number of outreach activities was 18 for this reporting year.

- Total number of people served (approximated): 5,599

Table 3. Outreach activities for 2018

Event	Format	Attendance	Audience
Hawaii Trail and Mountain Club Trail Clearing Support	community service	20	community group/general public
Hawaiian Civic Club of Wahiawa Meeting	presentation	19	
Kolekole Tour (Waianae Wellness and Place-Based Learning Alliance)	tour	33	
Makua Military Reservation Visit and Natural Resource Overview (Waianae Military Community Advisory Counsel)	tour	25	
Schofield Barracks Interpretive Garden, Seed Conservation Lab and Nursery Visit (community members)	tour	2	
Schofield Barracks Interpretive Garden, Seed Conservation Lab and Nursery Visit (Waianae Military Community Advisory Counsel)	tour	15	
Schofield Barracks Interpretive Garden, Seed Conservation Lab and Nursery Visit (Waianae Neighborhood Board)	tour	2	
Schofield Barracks Interpretive Garden, Seed Conservation Lab and Nursery Visit (Waianae Wellness and Place-Based Learning Alliance)	tour	33	
Wahiawa Rotary Club Meeting	presentation	15	
Waianae Neighborhood Board Meeting	presentation	50	
Kaena Volunteer Outing with Department of Land and Natural Resources	community service	10	
Koolau Mountain Watershed Partnership Ala Mahamole Community Garden Workday	community service	20	
Palikea Presidential Service Awardees Interpretive Hike	tour	6	
University of Hawaii at Manoa Natural Resource and Environmental Management Internship Course	presentation	50	higher education
Ewa Makai Middle School Career Day	presentation	45	K-12 schools
Ewa Makai Middle School Mock Interviews	community service	12	
Hawai'i Agriculture and Environmental Awareness Day	presentation	125	
Hawaii State Science and Engineering Fair	community service	15	
Le Jardin Academy Global International Networking Conference (middle and high school)	presentation	60	
Mililani High School Science Fair	community service	15	
Mililani Middle School Career Day	presentation	53	
Punahou G-Term Conservation Class	presentation	21	
Punahou School Elementary Career Day	presentation	50	
Sunset Beach Elementary School Science Fair	community service	14	
Wahiawa Elementary School Career Day	presentation	30	
Army Earth Day at Kalakaua Community Center	exhibit	350	military
Environmental Compliance Officer (ECO) Trainings (6 presentations)	presentation	149	

Table 3 (continued).

Event	Format	Attendance	Audience
Environmental Quality Control Committee Meeting	tour/exhibitor	25	
Makua Military Reservation Briefings (7 presentations)	presentation	304	
Range Safety Officer/Officer-in-Charge Briefings (RSO/OIC) (3x monthly)	presentation	2,281	
Schofield Fun Fest 2018	exhibit	1000	
Daniel K. Inouye Elementary Educational Visit to Schofield Barracks Baseyard	tour/exhibitor	125	military/K-12 schools
Daniel K. Inouye Elementary Periscope Broadcast from Kahanahaiki for Public Lands Day	presentation	125	
2017 Hawaii Conservation Conference	exhibit	300	natural resource professionals
American Malacological Society Conference	exhibit	170	
Interpretive Garden and Seed Conservation Lab Visit (City and County Botanical Gardens staff)	tour	23	
La'au Hawai'i/The Hawaiian Fern Project Palikea Visit	tour	5	
Schofield Barracks Interpretive Garden, Seed Conservation Lab and Nursery Visit (Cincinnati Zoo and Botanic Garden)	tour	2	
Total Number in Attendance:	**5,599**		

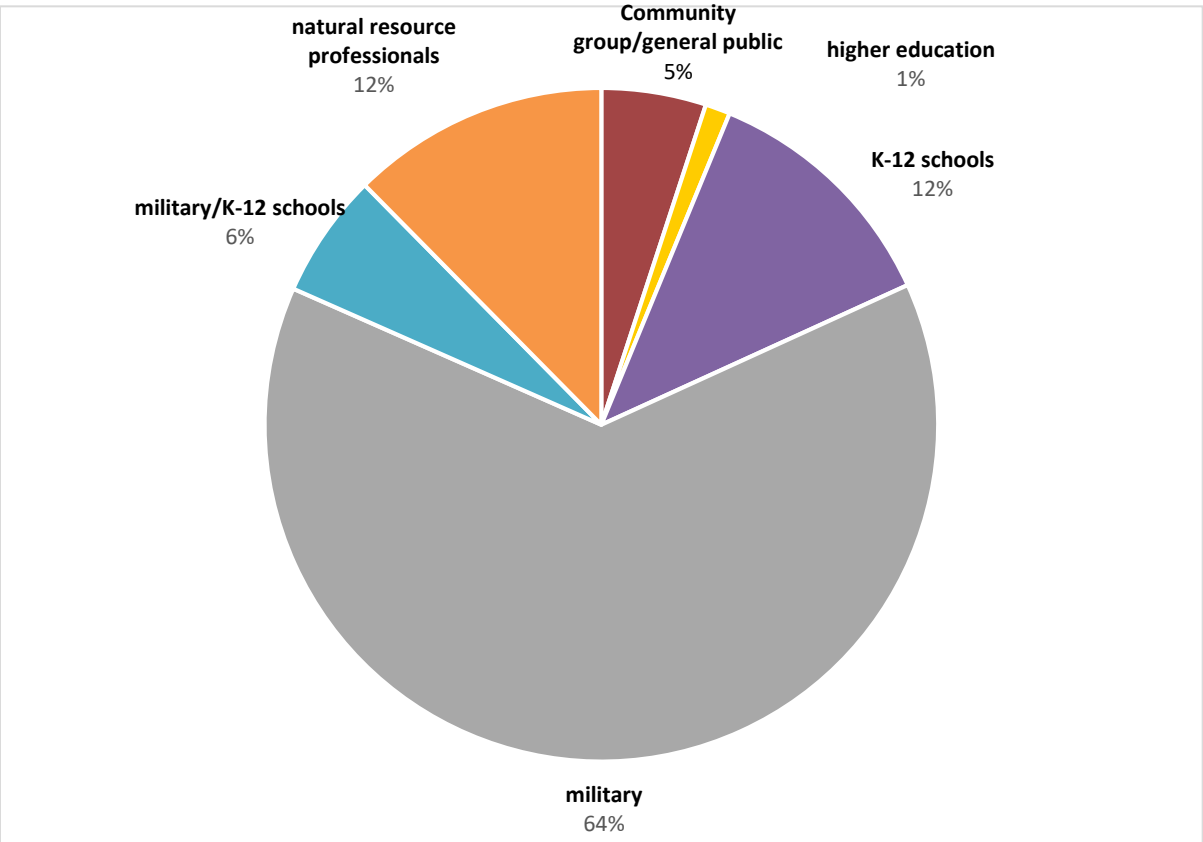

Figure 4. Target audience at 2018 outreach events

Contributions to Conferences and Workshops

OANRP staff contributed to outreach by presenting research findings at various academic conferences and workshops. The table below (Table 4) summarizes contributions to conferences and workshops in the 2018 reporting year.

Table 4. Contributions to Conferences and Workshops

Presentation Title	Format	Venue	Date	Author
Development of a Rodent Bait with Slug-repellant Propterties	Poster presentation	Hawaii Conservation Conference 2017	2017-07-19	Stephanie Joe, Tyler Bogardus, Aaron Sheils
Assessment of a Hand-Broadcast Rodenticide Bait Trial to Control Rats in the Waianae Mountains, Oahu	Oral presentation	Hawaii Conservation Conference 2017	2017-07-20	Tyler Bogardus
Native Plant Restoration as Weed Suppression	Oral presentation	Hawaii Weed Workshop 2018	2018-03-22	Taylor Marsh
Effects of Loss of Fruit Dispersers for Rare Lobelioids on Oahu: Assessment of Seed Viability in Undispersed Fruits	Oral presentation	Hawaii Native Seed Conference 2018	2018-05-16	Michelle E. Akamine; Timothy Chambers; Makanani Akiona; and Lauren A. Weisenberger*
Perspectives in Seed Conservation: A Journey from Plant Propagation to Regional Seed Networks	Keynote Presentation	Hawaii Native Seed Conference 2018	2018-05-16	Timothy Chambers
Optimal Harvest Times and Seed Collection Methods	Lecture	Hawaii Native Seed Conference 2018	2018-05-16	Timothy Chambers
Optimal Harvest Times and Seed Collection Methods	Workshop	Hawaii Native Seed Conference 2018	2018-05-16	Timothy Chambers
Farming Native Seed: Native Plant Material Development for Seed-based Restoration	Oral presentation	Hawaii Native Seed Conference 2018	2018-05-16	Julia Lee and Timothy Chambers
Post-Harvest Handling and Processing	Lecture	Hawaii Native Seed Conference 2018	2018-05-17	Makanani Akiona
Post-Harvest Handling and Processing	Workshop	Hawaii Native Seed Conference 2018	2018-05-18	Makanani Akiona
Management of Oahu tree snails using predator-proof enclosures	Poster presentation	84th American Malacological Society Annual Meeting	2018-06-20	Vince Costello, Deena Gary and Stephanie Joe

Public Relations and Publications

OANRP was regularly featured in articles, press releases, bulletins and scholarly journal articles this reporting year. Staff authored and coordinated published media with local, state, regional and national media and agencies. Staff escorted media staff into the field for coverage of natural resource news. See Table 5 for summary of all media and publications relating to OANRP management in reporting year 2018.

Table 5. Media coverage and publications in 2018

Title	Author	Publication	Date	Format
Oahu's elepaio are struggling for survival	Gutierrez, Stefanie	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2017/08/09/oahus-elepaio-are-struggling-for-survival)	2017-08-09	online and printed news article
Help the Army help the elepaio	Office of Hawiian Affairs	Ka Wai Ola (https://issuu.com/kawaiola/docs/kwo0917_web)	2017-09-17	online and printed news article
Volunteers lend a hand to the forest on Public Lands Day	Hanley, Celeste	Hawaii Army Weekly http://www.hawaiiarmyweekly.com/2017/10/11/volunteers-lend-a-hand-to-the-forest-on-public-lands-day/)	2017-10-11	online and printed news article
Endangered species benefit from evolving technologies	Gutierrez, Stefanie	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2017/10/31/endangered-species-benefit-from-evolving-technologies)	2017-10-31 (online) & 2017-11-03 (print)	online and printed news article
Army to install hundreds of rat traps in Waianae, Koolau mountains	Mendoza, Jim	Hawaii News Now (http://www.hawaiinewsnow.com/story/36722907/army-uses-re-setting-rat-traps-to-protect-endangered-species)	2017-10-30	online article, news broadcast
Volunteers Atop Mt. Kaala	Seyler, Linda	North Shore News	2017-10-25	printed news article
Multi-kill rat traps deployed	Else, Jessica	The Garden Isle	2017-11-1	online article
Microbiome transplants provide disease resistance in critically-endangered Hawaiian plant	University of Hawaii at Manoa	Phys Org (http://www.hawaiiarmyweekly.com/2017/10/31/endangered-species-benefit-from-evolving-technologies/)	2017-11-14	online news article
Students take virtual field trip with Army Nature team	Hawaii State Department of Education	Hawaii DOE Media Room Website (http://www.hawaiipublicschools.org/ConnectWithUs/MediaRoom/PressReleases/Pages/Students-take-virtual-field-trip-into-the-Waianae-Mountains-with-Army-Nature-team.aspx)	2017-11-15	online article & video
Army Natural Resources team gives keiki a virtual field trip	Colte, Michelle	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2017/11/24/army-natural-resources-team-takes-students-on-a-virtual-field-trip/)	2017-11-24	online and printed news article
Endangered native plant gets a boost to disease resistance	Tsai, Michael	Star Advertiser (http://www.staradvertiser.com/2017/11/26/hawaii-news/endangered-native-plant-gets-boost-to-disease-resistance/)	2017-11-26	online and printed news article

Table 5 (continued).

Title	Author	Publication	Date	Format
USAG-HI wraps year with many deeds	Brum, Aiko	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2017/12/21/usag-hi-wraps-year-with-many-deeds/)	2017-12-22	online and printed news article
Roadtrip Nation Setting Course in Hawaii: Know Where Home Is (Episode Three)	Public Broadcasting Service	PBS (https://roadtripnation.com/roadtrip/hawaii)	2018-01-17	televised documentary
Ho'okele i ka huliau navigating change	Pacific Islands Climate Change Cooperative	Pacific Islands Climate Change Cooperative (https://www.youtube.com/watch?v=lk1Q13fFRz8)	2018-01-30	online video (case study series)
Over 500 elementary students got hands-on with agriculture and the environment	Worely, Tesia	KITV (http://www.kitv.com/story/37473315/over-500-elementary-students-got-hands-on-with-agriculture-and-the-environment#)	2018-02-09	online news article, video and evening news
State recognizes Army for its efforts	Gutierrez, Stefanie	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2018/02/22/state-recognizes-army-for-its-efforts/)	2018-02-22	online news article
Tracking Invasive Chameleons Using Dogs	Vandercook, Chris and Catherine Cruz	Hawaii Public Radio's The Conversation	2018-02-28	radio broadcast
Seed Lab News Coverage	Scarbrough, Avijah	KITV Island News	2018-03-28	evening news
Army supports native forests	Iwamoto, Karen	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/storage/2018/01/040618HAW_WEB.pdf)	2018-04-06	online news article
WMCAC Visits Army's Natural Resources Program and Rare Seed Lab and Greenhouse	Overton, Kayla and Don Arakaki	Westside Stories	2018-April	printed news article
IMCOM Commander Lt. Gen. Kenneth Dahl reviews USAG-Hawaii bio-fuel plant, other areas	U.S. Army Garrison Public Affairs	Hawaii Army Weekly (http://www.hawaiiarmyweekly.com/2018/04/20/imcom-commander-lt-gen-kenneth-dahl-reviews-usag-hawaii-bio-fuel-plant-other-areas/)	2018-04-20	online newspaper article
In the field	Teruya, Erin	Punahou Bulletin (https://bulletin.punahou.edu/article/~board/bulletin-articles/post/jane-beachy-97?issue_id=42&issue_id=42)	2018-Spring	Quartely Bulletin
Army's efforts recognized during Invasive Species Awareness Month	Gutierrez, Stefanie	Public Works Digest, Vol. XXX, No.2, p. 32	2018-April/May/June	online and printed news article

Table 5 (continued).

Title	Author	Publication	Date	Format
Seeds in the bank safeguard plant populations	Chambers, Tim	Public Works Digest, Vol. XXX, No.2, p. 36	2018-April/May/June	online and printed news article

Volunteer Recognition

Each year, outreach staff nominate eligible volunteers for the President's Volunteer Service Award. Nominations for this reporting year included volunteer service from 01 July 2017 - 30 June 2018. A total of nine individuals listed below in Table 6 volunteered over 100 hours with OANRP within the past 12 months. These volunteers will be honored with certificates signed by the President of the United States and commerative pins.

Table 6. 2018 President's Volunteer Service Awardees

Award Level	Name	Hours of Service in 2017-2018
Silver	Elaine Mahoney	438.75
Silver	Roy Kikuta	412.50
Silver	David Danzeiser	392
Silver	Kathleen Altz	253
Bronze	Sean Rivera	153
Bronze	William (Joe) Hall	145
Bronze	Matthew Liang	106
Bronze	Serene Smalley	104
Bronze	Catherine Upton	102

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 $6,470.52 from the 2017 National Public Lands Day Department of Defense Legacy Grant to support volunteer efforts to control invasive weeds, plant common natives and collect seeds for restoration within the Kahanahaiki MU at Makua Military Reservation.

The funds were used to purchase volunteer tools (gloves, telescoping pruners, shovels, handsaws, dry bags for carrying tools and boot brushes) and broadcasting equipment (video camera, microphone, and bonding device). Volunteers utilized this gear during the two National Public Lands Day events scheduled in 2017:

- September 30 – weed control and outplanting preparation
- November 14 – outplanting, seed collection, and live broadcast

Outreach staff broadcasted live from the field to Daniel K. Inouye Elementary School during the second event on November 14, providing an overview of volunteer activities in the field and sharing about the endangered species the efforts support.

CHAPTER 3: ECOSYSTEM MANAGEMENT

Notable projects from the 2017-2018 reporting year are discussed in the Project Highlights section of this chapter.

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 planned for the five years immediately following its finalization. The ERMUPs are working documents; the Army natural resource program on Oahu (OANRP) modifies them as needed and can provide the most current versions on request. This year, the Pahole, Manuwai, Opaeula Lower, and Kaluaa & Waieli, ERMUPs were revised; they are included as Appendices 3-1 to 3-4.

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 ERMUPs for each MU detail specific goals and monitoring expectations for each MU.

Figure 1. Staff working in a restoration site at Palikea

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 10,398.5 hours controlling weeds across 528.2 hectares (ha). These figures include both incipient and ecosystem control efforts by staff and volunteers but do not include survey efforts or travel time. Table 1 lists efforts for previous 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)
2017-2018	10,398.5	528.2
2016-2017	9,309	593.9
2015-2016	8,447	539.5
2014-2015 (9 months)	4,654	325.9
2013-2014	7,600	286.5
2012-2013	6,967.6	267.7
2011-2012	5,860	275.7
2010-2011	5,778	259

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

Figure 2. Treated invasive trees (brown/gray) at Kahanahaiki

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 *Schizachyrium condensatum* in SBE or *Chromolaena odorata* in KTA, 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. In certain cases, at ICAs where no mature plants were ever seen and total plant numbers were very low, this may be shortened to five years. OANRP currently controls 54 taxa in 281 ICAs.

Of the total 528.2 ha swept, ICA efforts covered 381.9 ha. This year, staff spent 2,645 hours on ICA management, conducted 674 visits to 45 taxa in 234 ICAs, achieved eradication at 3 ICAs, and created 19 new ICAs. This is the greatest effort spent for incipient weeds in a reporting period to date; see Table 2. Also, this is the greatest number of ICA sites visited in one year. Total ICA area treated dropped, returning to 2015-2016 report year levels. ICA work accounted for 72% of the total area weeded and 25% 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)
2017-2018	234	674	2,645	381.9
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 control, 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 *Juncus effusus* and *Crocosmia* x *crocosmiiflora* along the boardwalk at Kaala. 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, often in steep terrain, while maintaining pressure on the less immediate boardwalk ICA taxa threats.

The number of ICAs managed has increased steadily over the years. Part of this is due to 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. Occasionally, if a species or site is determined to no longer be eradicable, the ICA is made inactive and/or addressed only during regular habitat weeding efforts. 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 three ICAs, for a total of 36 eradications ever. These include one *E. stipoides* site (Kaluaa and Waieli), one *Rubus argutus* site (Ohikilolo), and one *Senecio madagascariensis* site (SBE). Unfortunately, 19 new ICAs were also created, see Table 3. Note that OANRP assisted with efforts at the Waimalu *C. setaceus* infestation as part of an interagency project; primary management of this site is conducted by the Oahu Invasive Species Committee (OISC) and Koolau Mountains Watershed Partnership (KMWP). The suspected vector for each ICA is listed in the table. Almost half (eight) of the new ICAs are likely the result of military spread, either via training or maintenance activities, although it is impossible to rule out illegal recreational users as vectors in KTA. One of these is likely the result of a historical landscaping effort by military. It is likely that another six ICAs were introduced via staff, volunteers, researchers, and/or management activities. This emphasizes the need for proper sanitation and decontamination practices, and the importance of monitoring management sites for incipient weed ingress.

Table 3. New ICAs Found in 2018

Taxon	MU	ICA Code	Vector Comments
Angiopteris evecta	Pahole	Pahole-AngEve-06	Natural dispersal
Cenchrus setaceus	SBE	SBE-CenSet-03	Military
Cenchrus setaceus	Waimalu No MU	WaimaluNoMU-CenSet-01	Unknown
Chromolaena odorata	Kaluaa No MU	KaluaaNoMU-ChrOdo-01	Staff
Chromolaena odorata	KTA No MU	KTA-ChrOdo-30	Military/Recreation
Chromolaena odorata	KTA No MU	KTA-ChrOdo-31	Military/Recreation
Chromolaena odorata	KTA No MU	KTA-ChrOdo-32	Military/Recreation
Chromolaena odorata	KTA No MU	KTA-ChrOdo-33	Military/Recreation
Chromolaena odorata	SBW No MU	SBWNoMU-ChrOdo-05	Military
Ehrharta stipoides	Kahanahaiki	MMR-EhrSti-10	Staff
Ehrharta stipoides	Makaleha West	WestMakaleha-EhrSti-01	Staff
Erythrina poepiggiana	Lihue	SBW-EryPoe-04	Historical (military landscaping)
Pterolepis glomerata	Palikea	Palikea-PteGlo-02	Staff
Rhodomyrtus tomentosa	Kaiwikoele to Elehaha No MU	KLOA-RhoTom-01	Unknown/Recreation
Schizachyrium condensatum	Manuwai	Manuwai-SchCon-01	Staff
Schizachyrium condensatum	SBW No MU	SBWNoMU-SchCon-01	Military
Setaria palmifolia	Kahanahaiki	MMR-SetPal-02	Staff, researchers, or volunteers
Solanum capsicoides	Lihue	SBW-SolCap-01	Unknown
Sphaeropteris cooperi	Kapuna Upper	UpperKapuna-SphCoo-01	Natural dispersal

This year, there was noteworthy decline in total ICA area treated. In all, 114 ICAs showed an increase in area treated, 9 had no change, and 118 had a decrease. Of the ICAs which showed a decrease in treatment area, 21 of these had a decrease of more than 1 ha, including 7 which had decreases greater than 6 ha. Most of the decline is the result of skipping treatment of several *Acacia mangium* sites in KTA this year, in preference for increased effort on *C. odorata*. ICAs eradicated last year account for just 1.47 ha of the total decline in area treated. Of the ICAs which showed an increase in treatment area, 19 of these had an increase of more than 1 ha. However, the largest increases occurred in just a handful of ICAs, including one *S. condensatum* site (SBE), one *C. setaceus* site (Keaau No MU), one *C. odorata* site (KTA) and one

Alstonia macrophylla site (SBE). These ICAs were prioritized this past year, with the exception of *A. macrophylla*, which was treated incidentally during other work in SBE. The new ICAs discovered this year account only for only 0.95 ha of treatment area. Of the 381.92 ha treated for ICAs this year, the majority of this, 352.22 ha or 92%, was for just ten taxa: *C. odorata, S. condensatum, R. tomentosa, C. setaceus, A. evecta, Melochia umbellata, A. mearnsii, E. poepiggiana, Miscanthus floridulus,* and *A. macrophylla*.

There was a small increase in total effort this report year. In all, 25 taxa had increases in effort and 20 had decreases in effort. The greatest increases in effort (> 20 hours) were seen for *Sphagnum palustre, S. condensatum,* and *C.* x *crocosmiiflora*, with more modest increases (> 10 hours) seen for *C. odorata, Acacia mearnsii,* and *A. macrophylla*. The greatest decreases in effort (> 20 hours) were seen for *C. setaceus, A. evecta, J. effusus,* and *P. glomerata*. These are discussed in Table 4. Of the 2,645 hours spent on ICA treatment this year, the majority, 2,387 or 90%, were for just eleven taxa: *C. odorata, S. condensatum, S. palustre, C.* x *crocosmiiflora, R. tomentosa, J. effusus, P. glomerata, C. setaceus, A. evecta, M. umbellata,* and *E. stipoides*. 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.

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.

Figure 3. New *Schizachyrium condensatum* infestation at SBW No MU, in the BAX; plants circled in red.

The table below highlights the eleven taxa which required the most control effort in the past year. Effort from report year 2017 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 (3.6) for more detailed discussion of *C. odorata*.

Table 4. 2018 ICA Effort by Select Target Taxa

Taxa	2018 Control	2017 Control	Comments
Chromolaena odorata	1,147.50 hrs 135.98 ha 155 visits	1,128.75 hrs 161.28 ha 146 visits	*Chromolaena* continues to be OANRP's top ICA priority. Staff efforts include treatments of hotspots, large sweeps, and aerial spraying; see discussion Sections 3.6. OANRP continued to contract OISC to conduct work across half of the KTA infestation; see Appendices 3-5 and 3-6 for OISC's progress report. OISC efforts are not included in the totals in this table.
Schizachyrium condensatum	284.50 hrs 92.63 ha 40 visits	227.65 hrs 53.78 ha 36 visits	*Schizachyrium* was discovered in two new locations this year: SBW No MU, and Manuwai. The SBW infestation was discovered during annual road surveys, in the Battle Area Complex (BAX) along an unimproved road leading to a target. As staff do not manage this area, the likely vector is military, probably maintenance personnel. Managing this site is challenging, as it is located within the Radiologically Controlled Area (RCA, special procedures required), and within the live fire training area (UXO present). Currently, under SOP staff cannot access this area due to UXO. Aerial sprays may be used to treat this small infestation if ground access cannot be obtained. The risk of further spread across SBW (via mowing) is great. The Manuwai infestation was found in June 2018, and was likely introduced to the area via staff. Delimiting and treating this infestation will be a priority in the coming year. The majority of *S. condensatum* control occurs at SBE (7 ICAs). No new ICAs were found at SBE this year. An aggressive treatment strategy, including more consistent visits to hotspots, regular use of the power sprayer (provides best coverage of target plants), inclusion of Polaris (strong grass suppressant herbicide), and large annual sweeps has led to some progress at SBE. No plants were found at one ICA, while numbers declined dramatically at four ICAs. In the largest ICA, focused hotspot work led to some decline in numbers of plants at some hotspots, but overall plant numbers remained high. The increase in treatment area is due to thorough sweeps at this ICA. Staff likely need to continue aggressive treatment for several years in order to bring SBE *S. condensatum* infestations under control.
Sphagnum palustre	227.00 hrs 2.66 ha 23 visits	101.85 hrs 1.43 ha 18 visits	Control efforts have been very successful in removing the majority of the *S. palustre* infestation on the Army side of the Kaala boardwalk. While effort more than doubled this year, the majority of the increase is due to buffer surveys, which are conducted every 3 years, including this report year. No new ICAs were found this year, but buffer surveys slightly expanded the infestation area. More telling is the reduction of moss-killer used over the years. In the first year of control (2012-2013), 2,260 L were used. This quantity has steadily dropped, with 256 L used last report year, and only 213 L used this report year.
Crocosmia x *crocosmiiflora*	215.00 hrs 1.92 ha 30 visits	165.28 hrs 1.49 ha 27 visits	Volunteers conduct the majority of *C.* x *crocosmiiflora* control at both Kaala and Palikea, removing the corms by hand, a labor intensive process. Last year there was a reduction in effort, but this year, effort increased back to 2015-2016 report year levels. The increase is primarily due to additional volunteer effort at the boardwalk trailhead at Kaala. The majority of effort was spent at Kaala (81%), where there are 7 ICAs, all of which are located either on the road or directly around the FAA enclosure. This year, staff monitored an informal foliar spray trial based on a mix used in New Zealand; see Appendix 3-7. The trial was successful in reducing leaf biomass dramatically, but one of the herbicides is not labeled for use in forested areas and can only be used adjacent to roads and buildings. In the coming year, both digging and sprays will be used at Kaala. Hopefully, this will increase efficiency, allow for expanded control, and improve efficacy. Unfortunately, the mix cannot currently be used at Palikea. There are 3 ICAs in Palikea, and 2 more just outside. Numbers continue to decline, but full eradication may be difficult without herbicide. Alternate treatments will be investigated for this MU.

Table 4 (continued).

Taxa	2018 Control	2017 Control	Comments
Rhodomyrtus tomentosa	98.75 hrs 46.60 ha 15 visits	98.00 hrs 56.93 ha 16 visits	*Rhodomyrtus*, a small tree with bird-dispersed fruit, is locally common on windward Oahu but uncommon elsewhere. Staff manage it at SBE, Pahole, and KLOA. The largest infestation managed is at SBE, where 99% of total *R. tomentosa* effort was spent. The *R. tomentosa* and *S. condensatum* infestations overlap, and include large fields which are regularly mowed to facilitate training. This makes both taxa difficult to spot; mowed *R. tomentosa* can flower when they are less than a meter tall. Fortunately, staff can sweep for both taxa at the same time. Unfortunately, numbers of plants found have remained relatively constant. Staff fear that mowed *R. tomentosa* may be more resilient to standard treatment, and will experiment with manual control (digging out the extensive root system) in the coming year. 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 KLOA site was first discovered during this year's survey of Drum Road. All plants were found on one eroded peak, but delimiting surveys are pending. Given the low level of military training in the area, it seems likely *R. tomentosa* was introduced to the area via recreational users.
Juncus effusus	86.63 hrs 1.00 ha 22 visits	137.50 hrs 0.78 ha 26 visits	This rush thrives in wet environments and has very long-lived seeds. OANRP manages infestations at Kaala and Makaleha East. There are nine ICAs at Kaala, all of which were checked in the last year. No plants were found at the five smallest ICAs, and numbers of plants continue to decline at the remaining four. Volunteers conduct the majority of control on this species. The decline in effort this year is due to less work occurring in the two largest ICAs at Kaala, in part because of the decrease in total plants. As numbers continue to decline, this project will no longer be appropriate for volunteers, and will be transitioned to a field team. However, there is a large population of *J. effusus* on the State side of the boardwalk which is currently not a high priority for NEPM management; this likely will act as a seed source for spread in the region. There is one ICA at Makaleha East, and only a handful of plants have ever been found at this site. Preventing further spread of this weed is a priority.
Pterolepis glomerata	83.50 hrs 1.79 ha 82 visits	108.30 hrs 1.34 ha 79 visits	This taxon is only a target in the Waianae Mountains, where it is a control priority at Kaala, Kahanahaiki, Makaha, Makaleha, Manuwai, Ohikilolo, Pahole, and Palikea. This year, one new site was found, in contrast to five last year. The new site is located at Palikea in the heavily trafficked North Palikea Snail Enclosure; *P. glomerata* likely was spread to the area via management work. Fortunately, only two plants were found, and the site will be easy to check during the course of other field work. The decrease in total *P. glomerata* control effort seen this year in part is due to past effective control at the smallest ICAs, and in part due to a decrease in effort at the largest Manuwai ICA. Of the 19 ICAs checked this year, no plants were found at eight, and declines in plant numbers were seen at six. In general, control efforts have been most successful on the smallest, newest ICAs, while older and/or larger ICAs have been much more difficult to manage. The oldest ICA in Manuwai, for example, continues to grow in size, despite regular checks. Improved delimiting surveys, increased control of obscuring vegetation, and use of pre-emergent herbicide may assist in improving control, until an effective biocontrol is released.
Cenchrus setaceus	74.24hrs 28.35 ha	163.76 hrs 33.60 ha	This fire-prone grass is a high priority for control across Training Ranges and in MUs. Previous studies by the OANRP seed lab suggest seeds do not persist in the soil for longer than a year and half. An ICA is deemed

Table 4 (continued).

Taxa	2018 Control	2017 Control	Comments
	27 visits	34 visits	eradicated after 3 years of regular checks with no plants found. Last year, three ICAs were successfully extirpated, including two at SBE and one at KTA. This year, no plants were found at five ICAs (KTA, MMR, Kahanahaiki), a promising trend. One new ICA was discovered at SBE, with just two plants found; military activity is the most likely vector. Another new *C. setaceus* site was discovered near the 'Kawiwi SanMar' fence; this find was reported to the State and OISC. The majority of *C. setaceus* control effort was spent on the largest infestation, at Ohikilolo Lower. However, due to UXO access limitations, staff were not able to visit the entirety of this ICA starting in February 2018; this accounts for most of the drop in total *C. setaceus* control effort. Once access is restored, control will be a priority. Another ICA runs along Ohikilolo ridge and into Keaau; most of it is located on private land and is managed by OISC. Staff surveyed the ridge portion of the ICA and found plants at higher elevations than ever before. OANRP will continue to control ridgeline plants in this ICA and support OISC efforts as much as possible. In the coming year, OANRP plan to test the efficacy of BurnOut in controlling *C. setaceus*. If effective, this non-EPA regulated organic herbicide will be a useful tool for use on the privately owned portions of the ICA, as the landowner has not approved the use of conventional herbicide. Last year, valley-wide surveys for *C. setaceus* were conducted in MMR. These are planned every 3-5 years, and also account for some of the decline in total effort and area treated this year. OANRP assisted partner agencies with aerial sprays of *C. setaceus* infestations at both Waianae Kai and Waimalu/Aiea, providing the aerial spray rig and staff expertise; OANRP will continue to assist partners with these sites, until they build their own aerial rig.
Angiopteris evecta	73.55 hrs 12.73 ha 24 visits	126.25 hrs 12.13 ha 28 visits	This long-lived, 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 no mature plants were found, suggesting the current strategy of annual maintenance checks is sufficient to suppress recruitment. Staff continue to find large numbers of seedlings and immatures at many sites; it is unclear how long gametophytes and spores survive. Since *A. evecta* takes many years to mature, next year staff may begin monitoring ICAs once every two years. Effort at all ICAs decreased this year, particularly at Kapuna Upper, which accounts for 71% of all *A. evecta* control. Despite this, area treated remained constant, suggesting increased efficiency. In all, 18 *A. evecta* ICAs were treated this year. Seven of these were in Kapuna Upper, six at Pahole - including one new ICA, two at Kahanahaiki, two at Kaluaa & Waieli, and one at Kaala. No plants were found at the seven smallest ICAs. The new ICA at Pahole was discovered in a previously un-surveyed area in the back of Gulch 2, where a single immature plant was found.
Melochia umbellata	54.00 hrs 10.29 ha 11 visits	45.00 hrs 35.56 ha 15 visits	This species, incipient to KTA, has been controlled by OANRP since 2002. It likely forms a persistent seed bank. Of the seven 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 all but one of these have steeply declined over the last 5 years. The largest ICA, running along Kaunala gulch, had a spike in the number of immature plants controlled this year, but no mature plants were found. Last year, staff used aerial surveys to guide control efforts in Kaunala, but no surveys were conducted this year; this accounts for the decline in total area managed.
Ehrharta stipoides	42.45 hrs 3.26 ha 59 visits	50.55 hrs 2.97 ha 63 visits	This year, eradication was achieved at one ICA, located in Kaluaa & Waieli adjacent to the snail enclosure. Although *E. stipoides* can be quite cryptic and is easily spread, staff have had some success in achieving eradication at select ICAs in the past couple years. In part, this is because past trials have shown that *E. stipoides*

Table 4 (continued).

Taxa	2018 Control	2017 Control	Comments
			seeds do not persist longer than one year in soil. Of the 18 other *E. stipoides* ICAs monitored this year, two are primarily monitored by NEPM, no plants were found at three, declining numbers of plants were seen at seven, low but constant numbers were seen at four, and two new sites were found. Both new sites are in heavily managed areas: a restoration site at Kahanahaiki, and the Three-Points exclosure in Makaleha West. While this shows that sanitation continues to be an issue, the encouraging trends at the remaining ICAs suggest the increased focus on regular quarterly visits is having a positive impact.

The thirteen MUs where the most ICA effort was spent this report year are highlighted in Table 5; they include all MUs with greater than 15 hours of ICA effort. MUs are listed in order of effort. Last year, both Kaluaa & Waieli and Kaleleiki MUs were included on this list. Effort declined greatly at both MUs, as all ICAs at the MUs have entered the maintenance phase, with few or no plants found on most visits.

Table 5. 2018 ICA Effort in Select 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*	123	922.60	35% of all ICA effort was spent at KTA this 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 *C. odorata* in the State. For part of the year, access to KTA was limited as UXO concerns were addressed. This accounts for some of the 90 hour decline in effort from last year. *C. odorata* control accounts for 92% of time spent at KTA. Hours recorded here do not include hours spent by OISC, which are included in Appendices 3-5 and 3-6, or hours spent surveying trails in un-infested portions of KTA. See Section 3.6 for more discussion of *C. odorata* control. While all other ICA taxa require comparatively less effort, both *M. umbellata* and *A. mangium* infest large areas (37.7 ha and 83.7 ha, respectively) and have long-lived seeds. The strategy for both taxa is to survey/treat each ICA annually, with twice a year checks at *M. umbellata* hotspots. However, this year one *M. umbellata* and several *A. mangium* ICAs were missed, as teams chose to prioritize *C. odorata* work. Most of the *A. mangium* work conducted this year occurred at a site where it overlaps with *C. odorata*; several mature, fruiting trees were controlled at this location. The *M. floridulus* ICA is large and encompasses part of Pahipahialua gulch. Regular checks of the most accessible portions of the ICA have paid off, with declining numbers of plants seen. However, part of the infestation is located in a steep gulch, and work needs to expand in this region. Control efforts at both the *S. madagascariensis* and *C. setaceus* ICAs have been successful, with no plants found at either site this year.

Table 5 (continued).

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
SBE No MU	9	*Alstonia macrophylla* *Cenchrus setaceus* *Chromolaena odorata* *Heterotheca grandiflora* *Rhodomyrtus tomentosa* *Schizachyrium condensatum* *Senecio madagascariensis* *Smilax bona-nox* *Vitex trifolia*	68	411.45	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, 16% of all ICA effort was spent at SBE. Of this, 68% was spent on *S. condensatum* and 24% was spent on *R. tomentosa*; both taxa are discussed in Table 3. There was a 20% increase in total effort at SBE, due primarily to increased effort on *S. condensatum*. One new *C. setaceus* ICA was found this year, along Centerline road. Only two plants were found and none have been seen since. This likely was introduced via military training. Happily, no plants have been seen at the *C. odorata* ICA since 2015, suggesting the infestation was removed before creating a seed bank. No *H. grandiflora* have been seen at any of the 3 ICAs since 2014; staff will monitor these sites annually until 2024. The single *S. madagascariensis* ICA was eradicated this year; no plants were seen since 2008. The *S. bona-nox* ICA continues to persist, with little decline in numbers of plants found this year. The plants appear to spread clonally and may be resistant to traditional herbicide control techniques. Alternative options, like digging or using Milestone, will be tried in the coming year. The two *V. trifolia* ICAs continue to be low priority, with few plants found. Similarly, *A. macrophylla* is also a low priority, and staff will continue to control it opportunistically during other field work.
Kaala Army	8	*Angiopteris evecta* *Anthoxanthum odoratum* *Crocosmia* x *crocosmiiflora* *Diplazium esculentum* *Festuca arundinacea* *Juncus effusus* *Pterolepis glomerata* *Sphagnum palustre*	64	305.57	There was about a 25% increase in total effort spent at Kaala Army this year. This is primarily due to increased control of *S. palustre*. *Sphagnum* control made up 63% of ICA effort and was mostly conducted by OANRP staff. *Juncus* control was 20% of total effort, and *C.* x *crocosmiiflora* control was 11%; both were conducted primarily by volunteers. There are two *P. glomerata* ICAs at Kaala Army; no plants have been seen at either since 2014 and 2015, which is very encouraging. For more discussion of *S. palustre*, *J. effusus*, *C.* x *crocosmiiflora*, and *P. glomerata*, see Table 3. No plants have been seen at the single *A. evecta* ICA since 2013, or at the single *A. odoratum* ICA since 2016. This year, declining numbers of plants were found at the *D. esculentum* ICA. The single *S. palmifolia* ICA was skipped this year; only one more check is needed before this site is considered eradicated. One of the most difficult species to detect is *F. arundinaceae* (4 ICAs). While declining numbers were seen at two ICAs, and no plants were found at two ICAs, this cryptic grass may be well-established within the FAA fence; further surveys and discussion is needed to determine if eradication is feasible.
Kaala NAR	5	*Crocosmia* x *crocosmiifolia* *Diplazium esculentum*	29	202.08	There was also about a 25% increase in ICA effort at Kaala NAR this year. This is mostly due to increased control of *S. palustre* by staff and *C.* x *crocosmiiflora* by volunteers. The majority of effort (69%) was spent on the three *C.* x *crocosmiiflora* ICAs. Staff and volunteers focused on plants along the forest edge, and saw a decline in numbers of plants found within the boardwalk fence. Experimental sprays were conducted at the third ICA, as described in Table 3. *Sphagnum*

Table 5 (continued).

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Juncus effusus			efforts accounted for 17% of total effort. They focused along the boardwalk corridor, to reduce the likelihood of spread by staff and hikers, and also along the radio tower road. Efforts on the three *J. effusus* ICAs declined this year, in part because efforts have been successful at two of the ICAs. No plants were found this year at both the radio tower road and USGS marker sites. Numbers haven't declined significantly at the boardwalk site, the largest of the ICAs, but given that this species is known to form a persistent seed bank, this is expected. Volunteers continue to conduct most *J. effusus* control. No plants were found at the roadside *D. esculentum* ICA; but regular checks are still needed as this fern is cryptic when it is small. Small numbers of plants continue to be found at the *P. glomerata* ICA at the Kaala Shelter; this site remains a high priority
		Pterolepis glomerata			
		Sphagnum palustre			
SBW No MU	3	*Chromolaena odorata*	41	182.25	ICA effort increased at SBW this year by 23%. Most of this is due to increased effort on *C. odorata*, which accounts for 87% of ICA efforts at SBW. One new site was found this year, in the Kolekole Range portion of Schofield. See Section 3.6 for further discussion. There are two *E. poepiggiana* ICAs at SBW, an outlier, and a more established patch along Trimble road. No plants have been seen at the outlier site since 2016. Staff completed delimiting surveys at the Trimble site, and control is on-going. Large trees continue to be difficult to kill with conventional herbicide methods. As discussed in Table 3, a new taxon was found at SBW, *S. condensatum*. Located in a grassy field in the RCA portion of the live-fire range, this ICA is a priority for control once UXO issues are resolved.
		Erythrina poepiggiana			
		Schizachyrium condensatum			
Manuwai	4	*Chromolaena odorata*	32	160.70	ICA effort doubled at Manuwai this year. This is entirely due to time spent surveying buffers for the *C. odorata* discovered last year. Fortunately, no additional sites were found. See Section 3.6 for further discussion. One ICA was not checked this year, *C. decapetala*, as the site was off-limits due to UXO for part of the year. No plants have been seen at this site since 2013. The single *D. iridioides* ICA was checked regularly and plant numbers again declined, however staff still found between 50-300 plants on any given visit. Staff will experiment with herbicide sprays to see if any result in greater suppression. *Pterolepis* continues to present the greatest management challenge at Manuwai. While control at the two smallest ICAs has been effective, with no plants seen at the West fenceline site since 2015, and major declines seen at the Kamaohanui site, plant numbers increased at the East fence line site, and the Manuwai/Alaiheihe ridge site continued to increase in size. Alternate strategies must be considered for the Manuwai/Alaiheihe site. Unfortunately, as discussed in Table 3, a new taxon was found at Manuwai this year, *S. condensatum*. Delimiting surveys will be conducted in the coming year.
		Dietes iridioides			
		Pterolepis glomerata			
		Schizachyrium condensatum			
Kahanahaiki	9	*Acacia mearnsii*	56	56.32	Total effort at Kahanahaiki dropped by almost half this year. In part, this is due to four ICAs being eradicated and the completion of *C. setaceus* buffer surveys last year, actions not conducted this year. The majority of time (38%) was spent controlling *A. mearnsii*. Unfortunately, mature trees were found at one of the two ICAs. Most plants found were immature, recruits from a persistent seed bank. Annual surveys will be prioritized to prevent plants from maturing in the
		Angiopteris evecta			

Table 5 (continued).

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Casuarina glauca *Cenchrus setaceus* *Ehrharta stipoides* *Elephantopus mollis* *Pterolepis glomerata* *Setaria palmifolia* *Sphaeropteris cooperi*			future. The *A. evecta* and *S. cooperi* ICAs overlap, and both are centered on the gulch bottom. No mature plants were found of either species, but immatures continue to recruit throughout the gulch. No plants have been seen at the Ethan's outlier *A. evecta* ICA since 2015. There is one *C. glauca* ICA on the edge of Maile Flats. It has been a low priority, as it is not spreading quickly, and therefore has not received regular control. The entire walkable portion of the ICA was swept this year and about 300 plants treated. Part of the ICA is on a cliff and will be controlled on rappel in the coming year. No plants have been seen at the single *C. setaceus* ICA since 2016. This site is approaching eradication. Previously, staff identified a new, potential *C. setaceus* site on a cliff just west of Kahanahaiki. After surveying the site with binoculars, a drone, and via helicopter, staff determined that the plant was a native grass, kawelu, and not *C. setaceus*. Staff continued to make *E. stipoides* treatment a high priority. Although one new ICA was found in the Shire restoration site, regular checks were conducted at all six ICAs, and total plant numbers were low. No plants were seen at either *E. mollis* site this year. Since one of the sites only ever had 1 immature (2015), the criteria for eradication was halved to five years with no plants seen (2020). There are two *P. glomerata* ICAs. No plants have been seen at the Chipper Site ICA since 2012. More surprising, no plants were found at the Kahanahaiki II ridge site either, suggesting past aggressive control was successful in suppressing germination. Last year, a *S. palmifolia* ICA was discovered in Maile Flats. While no plants were found at it this year, a new ICA site was found elsewhere in Maile Flats. This species likely was introduced to the area via staff or volunteers.
Palikea	4	*Crocosmia* x *crocosmiiflora* *Dicliptera chinensis* *Pterolepis glomerata* *Setaria palmifolia*	36	52.40	Effort spent at this MU did not change from last year. The majority of time (74%) was spent on *C.* x *crocosmiiflora* control and utilized volunteer labor. However, volunteer efforts have been so successful that many of the remaining plants are located in areas too steep for future volunteer trips. OANRP field staff will take over the largest, steepest ICA in the coming year. Although plant numbers declined dramatically since control began, they have plateaued in recent years. This reflects the difficulty of removing each corm by hand. Foliar sprays may help push this taxon closer to eradication, as discussed in Table 3. About 15% of MU effort was spent on four *S. palmifolia* ICAs. No plants have been seen at one since 2013, another since 2014, and a third since 2016. A small spike in immature plants was seen early in the year at the fourth, but overall, this species appears well managed. No plants were seen at either of the *D. chinensis* ICAs. Last year, one new *P. glomerata* site was discovered on the summit fence trail, but no plants have been seen since. This year a new site was discovered in the Palikea North Snail Enclosure. However, all plants found were immature, suggesting a seed bank may not have formed.
Kapuna Upper	4	*Angiopteris evecta*	15	46.85	ICA effort at Kapuna Upper halved this year, falling back to 2015-2016 levels. This is entirely due to reduced effort at all seven *A. evecta* ICAs. *Angiopteris* effort declined in part because of increased efficiency at some ICAs, and decreased coverage at two of the largest ICAs.

Table 5 (continued).

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Ehrharta stipoides *Rubus argutus* *Sphaeropteris cooperi*			*Angiopteris* accounts for 88% of MU effort. The annual check strategy is effective, with no mature plants found anywhere, and no plants seen at two ICAs; ICAs may be checked every other year in future. No plants have been seen at either of the *R. argutus* ICAs since 2010, suggesting these sites are approaching eradication. However, staff did find a new *R. argutus* location during belt plot monitoring. As the site is distant from OANRP-managed resources, the location is being managed by NEPM. One new *S. cooperi* ICA was found this year, for a total of three ICAs. There is a large infestation to the west of the Kapuna fence, which may be the source for these plants. All *S. cooperi* locations will be shared with NEPM. As two of the ICAs are distant from OANRP resources, they are a low priority for control. NEPM leads control efforts on the *E. stipoides* ICAs. This year, staff controlled plants found in the trailside ICA during the course of other fieldwork, and monitored another ICA on a side ridge (no plants found).
Ohikilolo Lower	1	*Cenchrus setaceus*	5	45.50	Total effort dropped significantly from 120.16 hrs last year. As discussed in Table 3 above, much of this decline is due to access limitations, and periodic valley-wide surveys conducted last year. Staff were able to treat the *C. setaceus* infestation in the first half of the year. Unfortunately, no aerial sprays were conducted this year, due to personnel limitations. This has been rectified and aerial sprays will resume in fall/winter 2018.
Pahole	9	*Angiopteris evecta* *Axonopus compressus* *Dicliptera chinensis* *Ehrharta stipoides* *Elephantopus mollis* *Pterolepis glomerata* *Rhodomyrtus tomentosa* *Setaria palmifolia* *Tecoma capensis*	37	41.86	ICA effort almost doubled from last year, primarily due to do an increase in effort for *A. evecta* and *P. glomerata*. Work on *A. evecta* ICAs accounts for 55% of ICA effort at Pahole. One new *A. evecta* ICA was found, for a total of 6 ICAs. All were checked this year, and no plants were found at two. While no matures were found anywhere, immature plants continue to recruit, and annual maintenance checks will be required for years. The single *P. glomerata* ICA is located along the well-used Kahanahaiki-Pahole trail, and has been managed since 2007. The ICA was somewhat overgrown the last couple of years, hampering detection. General habitat weed control is planned in this area, which should assist in future ICA efforts. Control effort increased at the *T. capensis* site, with plants found for the first time since 2013. This vine is challenging to spot due to thick surrounding vegetation, and appears to grow from bits of root left in the soil. If numbers do not decline, Milestone may be used to improve efficacy. Regular checks at the *A. compressus* ICA resulted in a decline in number of plants found this year. Only one *E. stipoides* ICA remains in Pahole, in/around the State Snail Enclosure. No plants were found here for the first year ever, and hopefully the site can be declared eradicated next year. Both the *D. chinensis* and *R. tomentosa* ICAs are on the path to eradication, with no plants seen since 2013. Similarly, no plants have been found at the *S. palmifolia* or *E. mollis* ICAs since 2016. Most encouraging, no new ICAs were found along the well-traveled Pahole-Kahanahaiki fenceline, in contrast to the past couple years.
Ohikilolo	4	*Cirsium vulgare*	34	34.35	Effort at Ohikilolo remained relatively constant from last year to this year, and no new ICAs were found. The majority of ICA time at Ohikilolo (45%) was spent on *E. stipoides* control. Regular

Table 5 (continued).

MU	# of Taxa	Taxa List	# of Visits	Effort (hrs)	Comments
		Ehrharta stipoides			checks at *E. stipoides* sites are finally paying off, with declining numbers of plants seen at the largest and oldest ICA. No plants were seen at the single *C. vulgare* ICA; it is challenging to check due to its large size and dense vegetation. No plants were seen at either *P. glomerata* ICA, which is very encouraging, particularly as one ICA is located on the high-traffic main LZ. Staff doubled the effort spent on *R. argutus* control. One ICA was eradicated, with no plants found for more than ten years. Declines were seen at the two other *R. argutus* ICAs, in part due to a new control technique (foliar spray of 5% Milestone in water). This technique appears much more effective than Garlon 4 Ultra control, likely because Milestone translocates into the spreading root/rhizome system of the *R. argutus*, rather than acting as a chemical girdle.
		Pterolepis glomerata			
		Rubus argutus			
Ekahanui	2	*Acacia mearnsii*	11	17.05	ICA effort increased from last year, due entirely to an increase in time spent controlling *A. mearnsii*. The *A. mearnsii* ICA is large and requires better delimitation to guide control efforts. Since this tree takes several years to mature, annual surveys are sufficient. Effort at *E. stipoides* ICAs remained constant this year. While declines in plant numbers were seen, the infestation at one ICA spread downslope. This ICA is difficult to check due to very steep terrain and the cryptic habit of *E. stipoides*. Quarterly checks will be continued.
		Ehrharta stipoides			

Figure 4. Examples of incipient taxa. Left: *P. glomerata* in the North Palikea Snail Enclosure. Center: Cryptic immature *E. stipoides* at Kahanahaiki. Right: *C. setaceus* near Kawiwi.

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 an 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 *S. 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 6. Summary Statistics for WCAs

Report Year	Visits	Effort (hours)	Area (ha)
2017-2018	951	7,753	146.3
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	*

*Data not comparable

This year, WCA efforts covered 146.3 ha. Staff spent 7,753 hours over 951 visits at 193 WCAs. WCA work accounted for 28% of the total area controlled and 75% 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. Table 6 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.

Overall area weeded increased from last year. Looking at a finer scale, area weeded increased at 34 MUs and decreased at 21 MUs. Changes of 2 ha or more are summarized in Table 7. Only a handful of MUs had noteworthy declines in area treated. At both Kaala Army and Kaluaa & Waieli, the decrease is due to reductions in targeted canopy or single species sweeps. At Kaala Army, sweeps targeting *H. gardnerianum* in the bog flats ideally are conducted every 3-5 years; the bulk of these were conducted last year, with much less area requiring treatment this year. At Kaluaa & Waieli, targeted sweeps for select canopy weeds were conducted both last year and this year, but efforts this year focused on smaller, steeper areas in the mauka portion of the MU. Last year, staff cleared rat management trails at Lihue to facilitate rodent management and experimental trials. These trails were not re-cleared this year. The

decline at Haili to Kealia No MU is due to a lack of treatment of *S. cooperi* on the Kuaokala road. As this area is distant from MUs, it is a low priority for OANRP. Many more MUs showed noteworthy increases in area treated, and of those listed in Table 7, increases were seen in the majority of WCAs rather than just a select few. In part, this is the result of increased team staffing and increased focus on weed actions this year. Targeted canopy and single-species sweeps account for portions of the increase at Kahanahaiki (*Grevillea robusta* searches), Kaluakauila (*A. mearnsii* along the fence), Kaluanui No MU (*Psidium cattleianum* sweeps), Manuwai (canopy weed sweeps), Ohikilolo (canopy sweeps in valley WCAs and *Clidemia hirta* sweeps in ridge WCAs), Opaeula (*P. cattleianum* sweeps), Palawai No MU (*S. cooperi* sweeps adjacent to the north end of the Palikea fence), and Pahole (*Montanoa hibiscifolia* sweeps). Targeted grass control increased at a handful of MUs, including Kahanahaiki, Kaluakauila, and Ohikilolo. Heavy spring rains contributed to high grass cover this year, and staff prioritized grass treatment. Several MUs had a large increase fencelines and trails maintained, including Kahanahaiki, Kapuna Upper, Makaha I, Ohikilolo, Palikea, and Pahole. Work around rare taxa sites, including both new and old reintroduction sites, expanded at Ohikilolo, Palikea, and Pahole. Work on restoration sites expanded at Kahanahaiki, Kaluakauila, Makaha I, and Palikea. Lastly, staff assisted partner agencies at with general weed control at Kapuna Upper (NEPM) and Kaluanui No MU (KMWP).

Table 7. Changes in Area Weeded between Report Year 2018 and 2017

IP Management Unit	Increase in Area (ha)	IP Management Unit	Decrease in Area (ha)
Kapuna Upper	+8.63	Kaala Army	-10.95
Pahole	+7.63	Kaluaa and Waieli	-6.41
Kahanahaiki	+5.26	Lihue	-5.29
Kaluanui No MU	+5.16	Haili to Kealia No MU	-2.50
Opaeula	+4.96		
Kaluakauila	+3.31		
Palikea	+3.00		
Manuwai	+2.99		
Makaha I	+2.67		
Ohikilolo	+2.38		
Palawai No MU	+2.22		

Table 8. Changes in Weeding Effort between Report Year 2018 and 2017

IP Management Unit	Increase in Effort (hrs)	IP Management Unit	Decrease in Effort (hrs)
Palikea	+349.6	Kaala Army	-161.6
Kahanahaiki	+339.6	Lihue	-112.3
Oahu South Central No MU	+152.0	Ohikilolo Lower	-78.0
Makaleha West	+142.0	Makaha II	-76.7
Kapuna Upper	+130.5	Kaluaa and Waieli	-45.5
Pahole	+114.9	Manuwai	-40.2
Opaeula	+89.0	Pualii North	-25.9
Kaluanui No MU	+83.0		
Haili to Kealia I	+73.5		
Waimea No MU	+73.0		
SBW No MU	+56.5		
Opaeula Lower	+51.0		
Ekahanui	+38.95		
Koloa	+27.0		
Keaau Hibiscus	+26.0		
Ohikilolo	+24.3		
Keaau No MU	+20.0		

Total effort spent weeding again increased this year. Effort increased at 31 MUs, but decreased at 24. Changes of 20 person hours or more are summarized in Table 8. Of the MUs which saw declines, access issues affected both Lihue and Ohikilolo Lower. Perhaps because of this, fence/trail maintenance and rare taxa site weeding also declined at Lihue. Volunteer effort is responsible for much of the decline at Pualii North; this is not a concern, as volunteer time was shifted to other, higher priority projects. Team staffing issues likely contributed to declines at Makaha II and Kalua & Waieli, as effort dropped at most WCAs in these MUs. The declines at both Kaala and Manuwai are due to changes in single-species or canopy weed sweeps; while these projects continued, they shifted to different, smaller WCAs and required less effort. For the MUs which saw increases, a variety of factors are responsible. The Greenhouse staff greatly stepped up maintenance of all living collections this year; this includes sites at Waimea No MU (Waimea Valley), Oahu South Central No MU (Koko Crater, Kapolei), and SBW No MU (Kahua). Management of trails and fences increased greatly at Ekahanui, Kahanahaiki, Kapuna Upper, Keaau Hibiscus, Keaau No MU, Opaeula Lower, Pahole, and Palikea. Weed control at rare taxa sites, both wild and reintroduced, increased at select sites in Ekahanui, Haili to Kealia, Kahanahaiki, Kapuna Upper, Keaau Hibiscus, Opaeula Lower, Pahole, and Palikea. Restoration projects accounted for some of the increase at Kahanahaiki and Palikea. Targeted single-species/canopy sweeps account for some of the increase at Kahanahaiki, and all of the increase at Koloa, Opaeula, and Kaluanui No MU; the latter two were swept in conjunction with KMWP. Lastly, preparation for the new snail enclosure at Makaleha West accounts for much of the increase at this MU.

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.

The 20 MUs where the most effort was spent this reporting year are summarized in Table 9. 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, Pahole, Kaala Army, Makaha I, Kaluaa and Waieli, Kapuna Upper, Ohikilolo, Ekahanui, Manuwai, and Lihue. One exception is Opaeula, which is difficult to access due to its location in the northern Koolaus, and which primarily hosts Tier 3 OIP species, making it a low priority for control efforts. Several of other MUs in the table are significantly smaller, but support several IP taxa and include patches of native forest; these include Makaleha West, Opaeula Lower, Makaha II, Kaluakauila, and Pualii North. Three MUs on the list are located in severely degraded habitat and host one or two IP taxa; these include Ohikilolo Lower, Keaau Hibisucs, and Haili to Kealia. 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 no large fuel breaks are maintained here, reducing fuel cover close to the rare taxa requires regular maintenance. Lastly, Haili to Kealia is located along the public Kealia trail, passes through some remnant native forest patches, and is dominated by steep grassy cliffs. Efforts focus on improving habitat and reducing fuel loads directly around rare taxa.

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, but not always, implemented by the EcoRest team). These three factors are included in Table 9, and provide some insight into the levels of effort spent at various MUs. Team weeding efforts at Kahanahaiki, for

example, are bolstered by targeted sweeps for priority weeds, volunteer work at two different sites, and five 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. Note that only restoration projects associated with proactive weed control which occurred this year were included in the table.

Table 9. Top Twenty MUs with Highest WCA Control Effort

IP Management Unit	Hours	Visits	Area Weeded (ha)	Targeted Canopy or Single Taxa Sweeps Conducted?	Volunteer Projects Present?	Restoration Project On-going?
Kahanahaiki	1,571.70	168	11.61	Yes (*Grevillea robusta*, invasive grasses)	Yes	Yes
Palikea	1,345.25	157	5.86	Yes (invasive grasses)	Yes	Yes
Pahole	459.65	78	12.43	Yes (*Montanoa hibiscifolia, Spathodea camplanulata, Toona ciliata, Triumfetta semitriloba*)	No	No
Kaala Army	453.28	46	9.77	Yes (*Hedychium gardnerianum, Odontonema cuspidatum, Psidium cattleianum*)	Yes	No
Makaha I	447.25	42	3.92	No	Yes	Yes
Kaluaa and Waieli	331.00	33	6.67	Yes (*Grevillea robusta, Toona ciliata*)	Yes	No
Makaleha West	328.25	25	0.82	No	Yes	Yes
Kapuna Upper	288.00	32	9.86	No	No	No
Ohikilolo	268.25	41	6.77	Yes (*Clidemia hirta, Grevillea robusta, Lantana camara, Psidium cattleianum, Schinus terebinthifolius, Syzigium cumini, Toona ciliata*, invasive grasses)	No	No
Ekahanui	262.20	27	3.61	No	No	No
Ohikilolo Lower	249.50	22	3.44	Yes (*Leucaena leucocephala*)	No	Yes
Manuwai	144.81	24	16.42	Yes (*Acacia confusa, Aleurites moluccana, Grevillea robusta, Schinus terebinthifolius, Spathodea campanulata, Syzigium cumini, Toona ciliata, Trema orientalis*)	No	No
Opaeula Lower	118.75	18	1.24	No	No	No
Lihue	118.25	17	5.21	No	No	No
Makaha II	113.00	11	0.23	No	No	No
Haili to Kealia I	96.00	9	0.30	No	No	Yes
Opaeula	95.00	4	4.97	Yes (*Psidium cattleianum)*	No	No
Kaluakauila	92.00	18	5.32	No	No	Yes
Pualii North	91.80	19	1.91	No	Yes	No
Keaau Hibiscus	87.00	10	0.69	No	No	Yes

Control efforts for all MU are summarized in Table 10. The table lists all MUs where WCA control was conducted in the past year. This year, new WCAs were drawn to specifically track weed control along fencelines and trails. For these visits, the intent is simply to maintain infrastructure, as opposed to improve habitat. These new WCAs generally encompass an entire MU, overlapping other WCAs, and explain why the total WCA area is double the MU area. These infrastructure maintenance WCAs have not yet been created at all MUs. Data from the 2017 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 10. MU WCA Weed Control Summary, Report Years 2018 and 2017.

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Alaiheihe No MU	N/A	11.35	**1.97**	**1**	**10.00**	3.72	2	6.00	This area includes the Lower Kaala NAR access road. Staff sprayed roadside weeds, focusing on *Urochloa maxima* and other weedy grasses. The road beyond Manuwai remains impassable.
Ekahanui	87.5	91.65	**3.61**	**27**	**262.20**	4.77	35	223.25	Efforts in this large, highly degraded MU are centered on select, small rare taxa locations. While efforts did not increase at all WCAs, additional effort was spent at the *Abutilon sandwicensis* site, as well as on fenceline maintenance. Staff continued to maintain trails for the rodent control grid; this accounts for 29% of all effort.
Ekahanui No MU	N/A	15.27	**0.07** ***(655 m²)***	**2**	**0.50**	0.01 *(133 m²)*	1	1.15	Staff sprayed grasses along part of the Honouliuli contour trail, and controlled an outlier site of the invasive herb *Achyranthes aspera* on the primary Ekahanui access trail.
Haili to Kealia I	7.91	1.03	**0.30**	**9**	**96.00**	0.10	4	22.50	Weed control targeted woody weeds and grasses around the *Hibiscus brackenridgii* subsp *mokuleianus* reintroduction and associated common native outplants along the Kealia trail.
Haili to Kealia No MU	N/A	3.37	**0**	**0**	**0**	2.50	2	11.00	This area encompasses the Kuaokala access road. No control was conducted either along the road or the *S. cooperii* hotspot.
Helemano	60.63	61.86	**0**	**0**	**0**	0.37	7	12.50	Helemano is a low priority MU due to the small number of Tier 1 taxa, and is challenging to access due to weather. Last year staff monitored the fenceline for *S. palmifolia*, but no management was conducted this year.
Honolulu East No MU	N/A	1.85	**1.85**	**15**	**150.00**	0.90	1	9.00	Weed control was conducted around rare plant living collections at Koko Crater Botanical Garden. OANRP Greenhouse staff weeded this site more consistently and aggressively this year.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Huliwai	0.12	0.20	**0.15**	**3**	**4.00**	0.12	3	6.00	This small MU is centered at an *A. sandwicensis* population. Weed control was targeted directly around the rare plants and along the fenceline.
Huliwai No MU	N/A	9.53	**0.24**	**2**	**6.25**	0.08 *(801 m²)*	1	3.00	Staff conducted weed control around a *Cenchrus agrimonioides* var. *agrimonioides* site during a monitoring trip, and also sprayed grass on the ridgeline leading up to the site.
Kaala Army	49.02	51.63	**9.77**	**46**	**453.28**	20.73	51	614.85	*Hedychium gardnerianum* continues to be the primary weed target at Kaala, along with *P. cattleianum*. This year, staff wrapped up sweeps at the largest WCA, Kaala-01, and began treatment at neighboring Kaala-02. Remaining weed effort occurred at rare taxa sites, the *Odontonema stricta* site, and along trails.
Kaala NAR	20.03	22.14	**0.71**	**6**	**10.00**	0.01 *(69 m²)*	1	0.50	Effort focused on *H. gardnerianum* treatment along the State side of the boardwalk and adjacent to the radio tower road at a *Labordia cyrtandrae* site. Staff continued to maintain the area around the shelter/campsite as well.
Kaena	10.06	3.28	**0.19**	**1**	**10.00**	0.02 *(190 m²)*	3	11.50	The vegetation matrix at Kaena appears to be relatively stable and requires little effort to maintain. This year, efforts focused the far western and central *Euphorbia celastroides* var. *kaenana* patches.
Kaena East of Alau	14.51	1.11	**0.70**	**2**	**14.00**	0.17	4	23.75	Weed control focused around the small *E. celastroides* var. *kaenana* site, as well as along the access trail. Both grasses and invasive trees were controlled to reduce fuels.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kahanahaiki	37.7	82.58	**11.61**	**168**	**1571.70**	6.35	124	1232.13	Effort spent weeding again increased at this MU. In part, this is due to continued emphasis on restoration sites; one new site was added near Ethan's, the Schweppes site was expanded, and a full-staff weeding day was held at the Maile Flats Chipper Site. In addition, control expanded at select rare taxa sties, a concerted effort was made to conduct grass control across Maile Flats, and Kahanahaiki I was swept to treat any *G. robusta* missed during 2015-2016 surveys. Volunteers continue to contribute greatly to weed control and habitat restoration at this MU.
Kaleleiki	0.12	0.80	**0**	**0**	**0**	0.14	1	9.00	This *Eugenia. koolauensis* population has been heavily impacted by the *Austropuccinia* rust. Staff did not conduct weed control at this enclosure this year, as weed control is a low priority until new options for *E. koolauensis* management are discovered.
Kaluaa and Waieli	80.97	83.00	**6.67**	**33**	**331.00**	13.10	48	376.50	Control efforts declined at almost every WCA in this MU this year. In part, this is because of team staffing challenges. Control efforts continue to focus on rare taxa sites and targeted canopy weed sweeps. These canopy sweeps account for most of the area treated this year.
Kaluaa No MU	N/A	14.23	**0**	**0**	**0**	0.32	5	12.50	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 infrastructure maintenance work was required.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Kaluakauila	42.73	11.70	**5.32**	**18**	**92.00**	2.01	16	76.00	For the second year in a row, weed control effort expanded at Kaluakauila. This increase occurred at all three WCAs. Efforts focused on rare taxa sites, restoration outplanting areas, grass control across rare plant and restoration areas, fenceline maintenance, and treatment of *A. mearnsii* along the northeastern fence.
Kaluanui No MU	N/A	209.57	**5.16**	**3**	**83.00**	0	0	0	Staff assisted KMWP in sweeps for *P. cattleianum* and *A. evecta* in the State Kaluanui enclosure.
Kamaileunu No MU	N/A	0.96	**0.04** ***(375 m²)***	**3**	**10.00**	0.04 *(428 m²)*	1	7.00	All control was conducted at the LZ and campsite. The LZ requires regular maintenance as it quickly becomes overgrown.
Kamaili	2.57	3.92	**0.68**	**6**	**42.5**	0.85	4	38.00	This MU is divided into mauka and makai fences. Potential restoration sites 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	177.57	**9.86**	**32**	**288.00**	1.23	19	157.50	The large increase in effort this year can be attributed to expanded efforts around select rare taxa sites, a joint weeding effort with NEPM in the lama band, regular maintenance of the fenceline, and improved team staffing.
Kaunala	1.98	2.24	**0**	**0**	**0**	0	0	0	Until effective techniques to combat *Austropuccinia* rust in the field are found, OANRP is hesitant to commit resources to habitat restoration at any *E. koolauensis* sites, including all three MUs in KTA: Kaunala, Oio, and Pahipahialua (not listed again in this table).
Keaau and Makaha	1.19	0.18	**0.09** ***(869 m²)***	**1**	**3**	0	0	0	This small enclosure protects a *Sanicula mariversa* population. Invasive grasses, shrubs, and woody weeds were carefully handpulled around this sensitive rare taxon.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Keaau Hibiscus	3.64	3.67	**0.69**	**10**	**87.00**	0.21	6	61.00	All weeding effort focused around wild and reintroduced *H. brackenridgei* subsp. *mokuleianus*, common native outplantings, and along the fenceline. Both herbaceous weeds and grasses were controlled as a priority.
Keaau No MU	N/A	0.46	**0.46**	**4**	**20**	0	0	0	The trail leading to the Keaau Hibiscus enclosure was maintained for easy access. All grasses, especially *U. maxima*, were cut and sprayed.
Koloa	71.54	72.95	**1.20**	**8**	**86.50**	2.15	5	59.50	Located at the summit of the Koolau Mountains, weather poses a major challenge to conducting effective weed control. One camp trip occurred this year. Staff conducted several sweeps targeting *P. cattleianum*, which accounts for the majority of effort and area, and also weeded a rare plant reintroduction site.
Lihue	711.92	714.91	**5.21**	**17**	**118.25**	10.50	32	230.55	Access issues have plagued Lihue this year, and account for much of the reduction in area and effort. In addition, no rodent grid trail maintenance occurred this year, unlike last year. 2018 efforts were split between control at rare taxa sites and fenceline maintenance.
Makaha I	34.20	71.20	**3.92**	**42**	**447.25**	1.25	38	451.50	Effort stayed constant at Makaha I this year. The majority of effort was spent on restoration projects on Camp Ridge, 49%. These sites responded well to *P.cattleianum* removal, and are actively being restored with outplants, transplants and seedsows. The rodent control grid was expanded this year, and fence/trail maintenance accounts for 27% of MU effort. Volunteer efforts on Flag City Ridge account for 16% of weed effort. Only 8% of effort was spent on rare taxa sites, in part because of team staffing challenges.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Makaha II	26.69	6.85	**0.23**	**11**	**113.00**	0.59	18	189.70	Weed control efforts dropped this year, in part due to team staffing challenges. While efforts continued to focus on rare taxa reintroduction sites and fenceline maintenance, time and area declined for both.
Makaleha East	111.99	3.59	**0**	**0**	**0**	0.01 (133 *m²)*	1	0.60	Last year, staff opportunistically controlled high priority weeds while monitoring rare taxa. No similar effort occurred this year.
Makaleha East West Branch	1.14	1.23	**0**	**0**	**0**	0.00 (28 *m²)*	1	1.00	Last year, staff controlled weeds around the *Kadua degneri* var. *degneri* site during a regular monitoring trip, but as no rare plant monitoring trip was scheduled this year, no weed control was performed either.
Makaleha West	38.04	1.50	**0.82**	**25**	**328.25**	0.64	16	186.25	This MU has two widely separated WCAs. Most effort took place at the 3-Points WCA. About 30% of all effort was spent clearing the new snail enclosure. The remaining staff effort focused around rare taxa locations and on grass control, while volunteer effort focused on the fenceline and in a patch of *P. cattleianum*. For the first time since 2015, weed control was conducted at the northern WCA. This small enclosure protects a *Schiedea obovata* site, and requires more weed management.
Makaleha West No MU	N/A	0.52	**0**	**0**	**0**	0.11	2	7.00	Staff maintain the access trail as needed. No control was required this year.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Manuwai	122.49	127.44	**16.42**	**24**	**144.81**	13.43	24	185.00	Effort at Manuwai was split between large landscape sweeps for canopy weeds, control around discrete rare taxa sites, fenceline maintenance, grass control, and habitat weed control. While landscape sweeps account for the majority (83%) of area treated, they account for just 41% of effort. Rare taxa habitat weed control accounts for 49% of MU effort, but less than 10% of area. This year, staff conducted one trip weeding a native forest patch, and hope to expand this effort in future. Maintenance of grass cover on the northern end of the MU is important for fuels reduction, and options to expand this will be investigated in future.
Manuwai No MU	N/A	4.17	**4.17**	**6**	**19.00**	3.90	5	25.00	Staff cleared vegetation, primarily *U. maxima*, other grasses, and shrubs, along both access roads and the western access trail.
MMR No MU	N/A	20.24	**1.24**	**9**	**46.50**	1.03	4	35.00	The majority of time was spent maintaining grasses along the Makua-Kuaokala fenceline. Weeds were also controlled along the C-Ridge and Puaakanoa-Farrington Highway fences.
Moanalua No MU	N/A	86.33	**0**	**0**	**0**	0.37	1	15.00	Last year, staff cleared trails in Moanalua to facilitate rodent control and Elepaio monitoring. No similar effort was needed this year.
Nanakuli No MU	N/A	6.01	**1.57**	**1**	**17.50**	2.16	2	32.00	This leeward facing bowl stretches between the Palikea and Palikea IV MUs. Staff swept it for *S. cooperi*, to reduce ingress into neighboring MUs.
Napepeiaoolelo	0.75	0.48	**0.07 *(651 m²)***	**1**	**2**	0.13	2	5.00	The *Hesperomannia oahuensis* protected by this fence has been dead since 2013. Staff continue to monitor and maintain the fenceline.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Oahu South Central No MU	N/A	10.46	**0.67**	**1**	**11.00**	0	0	0	There is a living collection of *H. brackenridgii* subsp *mokuleianus* in Kapolei. OANRP Greenhouse staff controlled grasses and weedy shrubs once. Staff have not decided whether this site will be maintained as a living collection.
Ohikilolo	232.79	139.17	**6.77**	**41**	**268.25**	4.39	24	244.00	In the Lower Makua portion of the MU (11% of effort), effort was divided equally between rare taxa sites and sweeps of native-forest dominated ridges. In the Ohikilolo Ridge portion of the MU (89% of effort), efforts increased greatly over last year. In part, this is due to increases at select rare taxa sites, more grass control, and large sweeps targeting *C. hirta* (per MU belt transect monitoring recommendation).
Ohikilolo Lower	28.75	4.54	**3.44**	**22**	**249.50**	3.84	35	327.50	Work at this MU is focused in 3 WCAs centered on rare taxa. The goal of weed control is to reduce fuels while increasing native vegetation cover. Effort was hampered by a range closure, which is still not fully resolved. Despite this, staff were able to sweep all WCAs in their entirety several times. Restoration plantings are surviving and hopefully will reduce weed control effort required in future.
Opaeula	50.93	50.42	**4.97**	**4**	**95.00**	0.01 *(61 m²)*	1	6	This MU hosts primarily Tier 2 taxa, and thus is a low priority for weed control. KMWP and OANRP staff conducted one camp trip to the area, focusing on landscape sweeps of *P. cattleianum*.
Opaeula Lower	10.15	13.96	**1.24**	**18**	**118.75**	0.50	10	67.75	Effort increased this year, in part due to improved team staffing. Control focused around wild and reintroduced rare taxa sites, native forest patches, and fenceline maintenance.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Pahole	88.02	193.61	**12.43**	**78**	**459.65**	4.79	40	344.75	This is the second year in a row where effort and area treated has increased at Pahole. This improvement cannot be attributed to one specific project, but represents an across the board increase at most WCAs. Efforts continue to focus on rare taxa sites and surrounding habitat, and along the Kahanahaiki-Pahole access trail.
Pahole No MU	N/A	14.92	**8.58**	**12**	**53.00**	8.05	7	47.00	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	5.97	**2.24**	**1**	**13.50**	0.02 *(187 m²)*	2	4.25	This area immediately abuts the Palikea MU. Staff swept it for *S. cooperi* to reduce ingress of this highly invasive fern into the enclosure. No maintenance of the LZ was conducted this year.
Palikea	9.95	22.14	**5.86**	**157**	**1345.25**	2.85	83	995.65	Last year, clearing for the Palikea North Snail Enclosure accounted for 45% of 2017 effort. Despite the completion of this project, weed control effort again increased this year. Effort increased at most WCAs, in part due to the expansion of existing - and creation of new - restoration sites across the MU. In particular, efforts increased dramatically at the 'Fern Gully' restoration site (222.75 hrs). In addition, weed management around rare taxa sites expanded, fence and trail maintenance increased, and volunteer efforts were maintained. Though relatively small, this MU is a high priority due to the density of high quality native forest patches, presence of priority IP species, and accessibility.
Palikea V	1.40	0.02	**0.02 *(176 m²)***	**1**	**6**	0	0	0	Staff cleared a new landing zone in this MU to facilitate access for gear-heavy rare plant rappelling trips.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Poamoho North	257.77	202.77	**0**	**0**	**0**	3.99	3	192	This MU is of moderate priority, as it contains few MFS IP taxa and is actively managed by two other agencies. Last year, OANRP assisted NEPM and KMWP on one weed control camp trip targeting *A. evecta*. OANRP will continue to participate in joint trips in future, as time permits
Puaakanoa	10.7	1.56	**0.48**	**4**	**10.00**	0.21	3	17.00	Efforts focused on grass and herbaceous weed control around *C. celastroides* sites. Weed control efforts were again hampered by the closure of MMR due to UXO issues.
Pualii North	7.99	10.98	**1.91**	**19**	**91.80**	1.53	14	117.75	This year, staff weeded at wild and reintroduced rare taxa sites (including potential *Drosophila* sites), around native forest patches, and along the fenceline. Most of the decline in effort from last year is due to a reduction in volunteer work in the lower part of the gulch.
SBE No MU	N/A	4.16	**0.15**	**5**	**10.00**	0.06 *(602 m²)*	2	5.00	Weeds were maintained at East Base to reduce the potential for staff and volunteers to act as vectors. In addition, the sediment disposal site was sprayed to keep it open. In the coming year this site will be abandoned in favor of a more secure location on the old Schofield landfill.
SBW No MU	N/A	2.61	**1.68**	**27**	**71.00**	1.33	10	14.50	This year, staff continued controlling weeds at the Kahua Living Collection site; this accounts for the increase in effort. Staff also continued to regularly maintain weeds at West Base to reduce the potential for staff to act as vectors.
Waianae Kai	3.66	1.14	**0.11**	**3**	**7**	0.06 *(580 m²)*	2	2.50	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	**0.51**	**4**	**3.25**	0.98	2	2.50	This area encompasses the Palikea access trail. Staff controlled alien grasses along the trail to reduce the potential for weed spread, and treated some woody weeds at the Meadow site.

Table 10 (continued).

Management Unit	MU area (ha)	Total WCA area (ha)	2018 Report Year			2017 Report Year			Comments
			Area weeded (ha)	**# Visits**	**Effort (person hours)**	Area weeded (ha)	# Visits	Effort (person hours)	
Waimea No MU	N/A	0.27	**0.27**	**18**	**73.00**	0	0	0	The rare plant living collections at Waimea Valley were maintained throughout the year. Increased effort and attention were given to all living collections this year.
TOTAL	N/A	3028.04	**146.30**	**951**	**7,753.44**	126.64	727	6,735.9	Total effort, visits, and area increased this year. These increases can be attributed to expansion of restoration sites, increased focus on weeding around many rare taxa sites, continued single-species and canopy weed control sweeps, and increased maintenance around infrastructure and living collections.

Figure 5. Fruiting *Acacia mangium* at KTA

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. Similarly, much remains to be learned about restoration techniques. Collaboration is critical in achieving progress. OANRP supports, and is supported by, a variety of partner agencies in addressing weed control and restoration issues. In alphabetical order, they include, but are not limited to:

- Bishop Museum. Plant samples were submitted to and identified by the Bishop Museum Herbarium staff. Noteworthy finds are discussed in Section 3.5.
- Board of Water Supply (BWS). BWS reviews OANRP weed control actions in Makaha Valley.
- Coordinating Group on Alien Pest Species (CGAPS). The Federal Biologist participates in the CGAPs working groups on mosquitoes and coconut rhinoceros beetle.
- Hawaii Agricultural Research Center (HARC). This year, OANRP began assisting HARC with their project to develop fungus-resistant *Acacia koa* stock for the Waianae Mountains. Staff received an overview of the *A. koa* project and collections needs, shared *A. koa* seeds from previously banked collections, and collected from new locations. Once fungus-resistant stock is developed, OANRP will be able to use it in restoration projects.
- Hawaii Department of Agriculture (HDOA). OANRP maintains positive working relationships with HDOA staff.
- Hawaiian Electric Company (HECO). OANRP shared invasive weed location information with HECO. HECO is currently working on sanitation/weed decontamination protocols for themselves and their contractors, and the invasive weed information will assist them in this effort.
- Hawaii Army National Guard (HIARNG). OANRP shared invasive plant information with the HIARNG Conservation Manager, in support of her efforts to better educate National Guard soldiers on invasive species issues.
- 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. This year, due to scheduling issues, staff assisted with weed control sweeps at Kaluanui and Opaeula instead of Poamoho.
- NAVFAC Marianas. OANRP staff met with NAVFAC biosecurity program staff to discuss weed control and biosecurity issues.
- Oahu Invasive Species Committee (OISC). OANRP serves on the OISC steering committee and attends all OISC meetings. In June 2018, the OANRP Ecosystem Restoration Program Manager completed two years as the OISC Chair. In the past year, joint projects and collaborations included:
    - OANRP reported finds of OISC target species: *Nassella tenuissima* (private residence in Whitmore Village), *C. setaceus* (Puu Kawiwi/Waianae Kai), and *C. odorata* sites off of Army Training lands (Climbworks Keana Farms, Kaluaa, Pupukea-Paumalu State Park Reserve, and Kamaili).
    - OANRP assisted with aerial ball sprayer treatments of *C. setaceus* at Aiea/Waimalu and *Tibouchina herbacea* on the windward slopes of the Koolau Mountains near Poamoho. Planned aerial sprays of *C. setaceus* at Waianae Kai and *C. odorata* at Kahana were cancelled due to weather and scheduling issues.

  - OANRP shared aerial ball sprayer rig specifications with OISC, in support of OISC pursuing construction of their own rig.
  - OANRP continues to collaborate with OISC on a variety of *C. odorata* issues, including contracting OISC to conduct control on KTA, collaborating on overall management strategy, and pursuing a biocontrol.
  - OANRP also collaborates with OISC on *C. setaceus* management on the Waianae coast, particularly in the Ohikilolo Ridge and Waianae Kai regions.

- State of Hawaii: Dept. of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW), Natural Area Reserve System (NARS), Forest Reserves (FS), Native Ecosystems Protection and Management (NEPM), and State Parks. Several OANRP MUs are located on State land. In the past year, collaborations with State staff included the following:
  - OANRP and NEPM staff shared discoveries of new invasive weed locations and discussed new and existing weed control/restoration projects. OANRP continues to assist with NEPM *S. palustre* control efforts at Kaala by treating both sides of the boardwalk corridor. Following an incident where OANRP staff mistakenly conducted weed control at one of the State release sites for *Tectococcus ovatus* (the *P. cattleianum* biocontrol), NEPM staff shared GIS locations of all the release sites with OANRP; all OANRP staff were directed to avoid these areas.
  - OANRP continues to assist NEPM with 80 person hours of weed control effort per year, as part of a work swap agreement. This year, staff fulfilled the hours via assisting with sweeps of a high-quality *Diospyros* spp. patch in Kapuna Upper.
  - OANRP shared aerial ball sprayer rig specifications with NEPM, in support of NEPM pursuing construction of their own rig.
  - OANRP reported the discovery of *C. setaceus* on Forest Reserve land at Puu Kawiwi in Waianae Kai.
  - OANRP provided a letter of support to DOFAW for the release of *Syphraea uberabensis*, a biocontrol which targets *T. herbacea* and *P. glomeratus*.
- Dr. Cliff Morden, University of Hawaii. OANRP is collaborating with Dr. Morden and OISC on genetic testing of *C. odorata*; see Section 3.6 for details.
- College of Tropical Agriculture and Human Resources (CTAHR), University of Hawaii. 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 monitored two IPA trials on *Citharexylum caudatum* and *Psidium cattleianum* var. *lucidum*. These trials are designed to run for two years, and results will be discussed when they are complete. In addition, staff assisted Dr. Leary's efforts in obtaining a Special Local Needs label for Fusilade DX use in natural areas. The SLN was issued this year; this greatly assists OANRP, as it allows staff to use a grass-specific product and thus reduce non-target impacts during alien grass control efforts.
- Waianae Mountains Watershed Partnership (WMWP). OANRP is a member of the partnership.
- Waimea Valley. OANRP manages two rare taxa living collection sites at Waimea.

This year, OANRP participated in two conferences related to weed control and restoration issues. The Fifth Annual Oahu Natural Areas Restoration and Weed Management Forum was held on March 22, 2018 at Aloha Stadium. The interagency hui Priority Oahu Native Ecosystems (Priority ONE) organizes and

hosts this annual workshop. The Forum is a valuable way to share information, data, and control techniques among local agencies conducting active weed control management and habitat restoration work, and is structured to encourage discussion. The first two-thirds of the Forum consisted of short talks, each of which was followed by ample time for questions. The last third of the Forum was dedicated to group discussions on native plant restoration and vegetation monitoring. OANRP continues to be an active participant in this event. Jane Beachy served on the organizing committee, provided a short update on the 'Weed Control by Species' reference document maintained by Priority ONE, and assisted in facilitating group discussions. Taylor Marsh presented a talk entitled 'Native Ecosystem Restoration as Weed Control.'

Figure 6. The 5th Annual Oahu Natural Areas Restoration and Weed Management Forum scored big!

The second Hawaii Native Seed Conference was held May 16-18, 2018 at the University of Hawai'i at Mānoa. The conference began with a full day of short presentations related to the conservation of seed, the use of seeds in ecological restorations, social aspects of seed conservation, and seed ecology, followed by two days of paired lecture/workshops focusing on four areas central to seed conservation; germination and breaking seed dormancy, optimal harvest time and seed collection methods, post-harvest handling and processing, and seed storage and longevity. Eighty-five people attended the conference including delegates from the Millennium Seed Bank Partnership, Royal Botanic Gardens, Kew, the Cincinnati Zoo and Botanical Garden, the New Zealand Indigenous Biosecurity Network, and the Southwest Seed Partnership. OANRP staff were significantly involved in this year's conference. Tim Chambers served on the conference's organizing committee, while Michelle Akamine, Makanani Akiona, Julia Gustine Lee, and Tim Chambers presented at the conference.

3.3 VEGETATION MONITORING

This year, vegetation belt transect monitoring was conducted and analyzed for the Kahanahaiki and Kapuna Upper MUs, and analysis was completed for last year's monitoring of Palikea MU (Appendices 3-8 to 3-10). The results of these studies will be used to modify weed control plans at these MUs. Vegetation monitoring options for Pahole MU were researched and discussed with the State. Belt transect monitoring will be installed at Pahole in 2020. Staff aided NEPM and a researcher in re-reading the Welton plots in Pahole and Kapuna gulches; unfortunately, the original methodology cannot be replicated. Point-intercept vegetation monitoring was conducted at the Makaha 'Giant Ohia' Restoration Area and North Palikea Snail Enclosure, Gigapan imagery was taken at Keaau Hibiscus, and drone utilization protocols for capturing vegetation change over time were developed; results of these efforts are not presented this year, but will be compiled and presented at a later date. Gigapan imagery was taken of cliff-side portions of the *C. odorata* infestation; since these images were used to guide OISC control efforts, no formal analysis was conducted.

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 the Range Division, Directorate of Public Works (DPW), and contractors to increase the Army's awareness of alien weed threats and improve sanitation-related protocols, practices, and policies. Highlights are summarized here.

Soldier Training

- OANRP regularly participates in conducting Officer in Charge/Range Safety Officer (OIC/RSO) briefs, which are held about three times a month. 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. This year, OANRP staff split briefing duties with DPW Cultural Resources staff, with each office presenting a joint natural/cultural resources message in alternate months. In addition, OANRP staff continued to update the briefing slides to keep them current.
- Prior to any training at MMR, units receive a joint brief from Range Control, DPW Cultural Resources, and DPW Natural Resources. In the Natural Resources portion of the brief, staff emphasize prevention of invasive species spread and washrack use. This year, briefings were held a handful of times, including once to a unit from the Air Force.
- The Federal Natural Resource Manager and Biologist regularly attend and present at quarterly USARHAW Environmental Quality Control Committee (EQCC) meetings. These meetings are the primary way environmental concerns, from clean water to natural resources to hazardous waste, are conveyed to unit commanders. This year, EQCC meetings incorporated hands-on elements. At one meeting, attendees toured the OANRP baseyard to learn about natural resources issues. At another, attendees viewed a Humvee cleaned as a demonstration; DPW staff pointed out problem areas and showed how the Humvee did not meet inspection standards. Unit leaders saw firsthand how detailed washing needs to be in order to pass inspection. An informational video was created by the Garrison for soldiers to watch before using the Central Vehicle Wash Facility (CVWF), and was publicized at the EQCC; https://vimeo.com/117847345.

Figure 7. Still from the CVWF video, showing soldiers cleaning a stryker with water cannons during the pre-wash bath.

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

- Last year, staff noted a number of uncommon weeds growing out of a sediment pile on Wheeler Army Airfield. After discussing the location with other DPW divisions, DPW decided to rehabilitate this area to better meet clean water requirements. Once work is complete the area will function as a safe stockpile for construction debris and street sweeper sediment. It is monitored during annual road surveys.
- Federal staff conducted an informational brief to Center for Environmental Management of Military Lands (CEMML) contractors, highlighting invasive species concerns, sanitation and wash rack use, and fire prevention. CEMML contractors work under the Range Division and conduct much of the vegetation maintenance on range. CEMML requested photos of priority invasive weeds for their staff; OANRP produced posters for their baseyard (completed in July 2018, outside of this report year).

Wash Rack Status

- The 2014 Wash Rack Utilization Policy to Control Invasive Species is still in effect. Federal staff proposed updates to the policy in 2017, but the new policy has not yet been signed.
- Last year, Federal Staff worked with the DPW Engineering Department on signs reminding personnel to use the wash racks, to be posted on all exit gates at KTA, SBE, SBS, and SBW. The signs were fabricated, but had not been installed by the end of this report year. They were installed in August 2018.

Figure 8. Sign reminding all personnel to use the wash rack, posted on the SBE Centerline road gate.

- This year, the Federal Natural Resource Manager officially became part of the management chain for the wash facilities. This means OANRP has greater insight into the challenges with maintenance contracts, facility scheduling, and soldier requirements. This has greatly assisted OANRP in both monitoring when the wash facilities are functional, and improving systems to encourage and require regular use. For example, all units use the RFMSS site to reserve trainings areas. The RFMSS site opens first to an announcement page; a notice detailing the hours of

operation and a contact number for the wash facilities is included on this page, making it easy for units to find more information. However, major challenges remain, such as ensuring all units are aware of SOPs regarding wash rack use and have completed required risk assessments.

- This year, the 3rd Infantry Brigade deployed to the Joint Readiness Training Center in Fort Polk, Louisiana. All equipment was shipped through Port Arthur, Texas, where it failed agricultural inspection. Soil, seedlings, twigs, and black twig borers were found by inspectors. The Brigade incurred over one million dollars in costs, including port and boat fees, as well as cleaning fees. This incident highlights the importance of cleaning all equipment and vehicles before they leave the state. Unfortunately, such rigorous USDA inspections are not conducted for shipments within the State or returning to Hawaii from the continental U.S., only when arriving in other States from Hawaii.
- The CVWF, SBE Wash Rack, and KTA Wash Rack were all at least partially operational for most of the year. The CVWF is the only facility capable of handling large, tracked vehicles, and also has the greatest capacity for washing highly soiled vehicles; the 84th Engineers were diverted from the SBE Wash Rack to the CVWF due to the enormous amount of mud on their machinery.
- The KTA Wash Rack was plagued by equipment problems throughout the year. While parts of the facility were always operational, the facility as a whole could not accommodate large units. The large-volume fire hoses were broken and many of the pressure washer hoses and spray guns leaked copiously. There was also a large leak in the equipment building. On occasion, staff were unable to use the KTA Wash Rack at all. In part, these issues were difficult to resolve as the contract for maintenance of the KTA facility ended, and a new contract has yet to be put in place. DPW is managing the maintenance of washrack facilities in the meantime.

Figure 9. Left: this hose reel is detached from its mount and now sits on the ground, the reel is rusted through, and water leaks from all connecting points. Right: while still on its mount, this hose reel leaks prolifically.

Figure 10. Leaking and broken pressure hoses.

Wash Rack Sediment Disposal

- For the first time ever, the sediment basins at the CVWF were cleaned out this year. A secure site for the sediment was identified at the landfill off Area X. The sediment was dumped at the site in June 2018. The Army is required to maintain a vegetated cap over the landfill, so once it had dried, the sediment was spread in a thin layer over approximately 0.35 acres, and sprayed with rye grass hydromulch. Unexpectedly, staff found a fair amount of trash in the sediment. This was removed prior to hydromulching. The site was then marked with cones and rope, to prevent contractors from mowing it during regular landfill maintenance. Staff will monitor the site throughout the year for germination of priority invasive weeds.

Figure 11. Sediment spread out at the landfill site.

Figure 12. Sediment disposal site, marked by cones, after hydromulch application.

KTA

- Four new *C. odorata* sites were discovered at KTA this year. Three are located adjacent to the highly trafficked Kane's LZ, and one is at an abandoned building site on Mt. Kawela. It is unclear if these new sites were spread via military training or trespassing recreational motocross riders, but all were found along trails or roads, and highlight the importance of cleaning gear and vehicles before leaving KTA.
- Range Division contacted the Natural Resources office in April 2017 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 found no *C. odorata*. Staff surveyed the area again in August 2017 before the second stage of work; one immature *C. odorata* was found and removed from one section of trail.
- Last year, OANRP reported finding a zipline tower and observing unauthorized ATV activity in the Delta 1 and 2 training ranges. The zipline tower belongs to Climbworks at Keana Farms, a business which runs zipline and ATV tours. The ITAM office investigated the zipline towers, but staff have not heard from the Department of Emergency Services about what, if any, action was taken. The entire area, both on KTA and on Keana Farms, is infested with *C. odorata*. OISC surveyed part of the Keana Farms area last year and began treatment. There is huge potential for *C. odorata* to spread from this area to other locations on the island.
- This year, there were major staffing challenges at KTA Range Control. This often had a negative impact on staff productivity, as there were numerous delays in getting keys to enter the range and use the wash rack. On a couple occasions, Range Control was unable to open the wash rack for staff, due to the keys being misplaced or mistakenly checked out to a unit for multiple days. While OANRP has since been issued a set of keys for KTA, staffing challenges at KTA need to be resolved to ensure units and other range users are able to use the washrack.

MMR

- OANRP and Federal staff reviewed a proposal for a training event called 'Spur Ride.' Staff emphasized the importance of cleaning gear prior to entering MMR, and investigated options for conducting outreach to the participants on the unique natural resources found in Makua Valley.

SBE

- Staff discovered *C. setaceus*, a high priority incipient invasive weed, along Centerline Road in August 2017. All other *C. setaceus* sites at SBE were eradicated in 2016, and no plants have been seen at the KTA infestation since 2015, making these unlikely sources for this new infestation. Since this area is heavily used for training, and *C. setaceus* is widespread at Pohakuloa Training Area (PTA) on the Big Island, the most likely vector for this introduction is soldiers or vehicles from PTA. Oahu staff continue to highlight the importance of cleaning gear between islands.
- Staff continue to monitor and maintain cones, rope, and signs around select *S. condensatum* hotpsots to prevent accidental mowing of this highly invasive grass by maintenance crews.

SBW

- High priority incipient invasive weeds were found at two new sites on SBW this year. In November 2017 staff found one mature *C. odorata* in the Kolekole Range area, and in January 2018 staff found a small infestation of *S. condensatum* in the BAX. This is the first time *C. odorata* was found outside of the McCarthy Flats area on SBW, and the first time *S. condensatum* was discovered outside of SBE. Both of these sites are in areas where vegetation was either mowed or cleared in the last year, and this seems like the most likely vector. Federal staff briefed Range Maintenance staff about the importance of segregating equipment used on different ranges.
- In May 2018, staff noted a stand of Eucalyptus adjacent to Area X and the McCarthy Flats access road was cut down. This area is part of the active SBW *C. odorata* infestation. When the site was surveyed, *C. odorata* plants were found in and around the cleared area. Staff sprayed the area with pre-emergent herbicide to minimize seedling recruitment, and discussed the issue with ITAM. A week later, ITAM requested OANRP survey an area adjacent to OP X-Ray prior to more vegetation clearing. One large plant was found, and staff were able to show it to both ITAM and CEMML contractors. Staff hope to maintain open lines of communication with ITAM and CEMML in the coming year, and avoid the need for retroactive surveys.
- A private contractor was again hired to spray herbicide across much of the area within the firebreak road at SBW this year, prior to the prescribed burn in May. 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.

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. All surveys where drivable roads may vary year to year are tracked and stored in Geographic Information Systems (GIS).

LZ surveys were conducted for the first time at Ekahanui North LZ (LZ-HON-136), and MelTen Puu LZ in Manuwai (LZ-Manuwai-209). Staff survey effort was elevated as an all-time high number of LZ surveys were conducted this year.

Staff also surveyed locations of potential introductions such as OANRP camp sites, Baseyards, Army washrack sediment disposal and storage sites, and MU access trails. Two Kaluakauila weed transect surveys were updated this year in order to survey along more of the access trails. A survey was conducted for the first time this year around the OANRP East Baseyard and will continue annually. Staff conduct a survey on land leased from Dole Food Company at Basilon DZ when Army training has taken place there during the year. This year the survey was overlooked during the report year period, but was completed in the first quarter of the new report year, and will be done so again during the regularly scheduled period (quarter 2 of the report year).

Table 11. 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 several were not on the schedule.	17 road surveys
LZ Survey	Actively used Army LZs are surveyed once per year. OANRP LZs were surveyed if used within a quarter.	91 surveys on 45 LZs
Transect Survey	Surveys are conducted annually along high use access trails to OANRP MUs, selected MU fencelines, and transects inside MUs.	12 weed transect surveys
Camp/Other Survey	Surveys are conducted at OANRP campsites and other potential locations of introduction such as washrack sediment disposal sites, the baseyard, and other staging locations. Survey frequency varies based on location and use.	14 surveys at 7 sites

Locations of LZ and camp/other survey sites surveyed this year are depicted below as points in Figure 13. Incidental observations, or those made by staff during the course of regular work or on personal time are identified on the map as stars. Surveys along roads and transects are portrayed as lines.

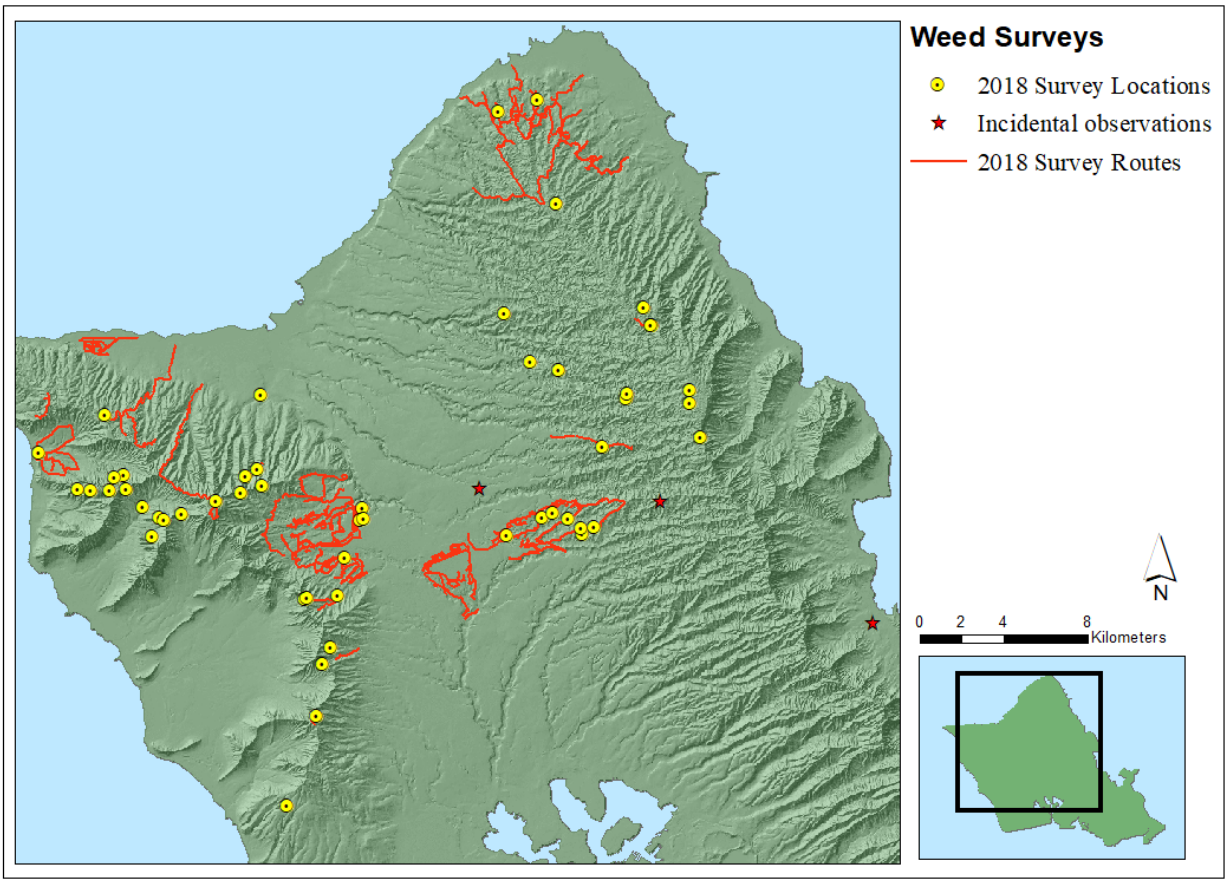

Figure 13. Map of conducted in 2018

Survey data are tracked in the OANRP database and each year the list of new finds on each of those surveys is reviewed. Noteworthy species are discussed in Table 12 below. Many new species this year were found, on LZs in particular. While most of these species are not considered to be ecosystem altering, they often favor disturbed habitats and have the ability to spread along fencelines and trails. In order to prevent introduction of these species into managed areas, this year, management of vegetation on LZs and drop zones will be a priority. This will include controlling select invasive weeds, as well as a push to make sites less diverse and more sterile, to reduce the potential of helicopters and gear to spread seeds.

Unusual and notable plants found during the course of other field work are referenced as "incidental" in the table. OANRP contracted the Bishop Museum to identify unknown species. This year a total of 28 alien taxa submissions were sent to Bishop Museum for identification or to document new locales for select taxa. For *Digitaria radicosa*, a grass from Kahuku Training Area, Bishop Museum updated its status as naturalizing. Another species collected opportunistically by staff, a fern, was identified only to genus, *Aglaomorpha*, however it was a new State record for that genus. The grass, *Eragrostis parviflora*, found at Dillingham Military Reservation was also a new island record for Oahu.

Table 12. Summary of Alien Taxa on Surveys

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Road	**RS-DMR-01**	*Eragrostis parviflora*	This grass is a new island record for Oahu; previously documented only from Kauai. No control is planned.
Road	**RS-KAALA-01** Kaala road	*Richardia brasiliensis*	Quite a bit of this species showing up on LZs as well. Not known from Kaala summit transect surveys. It is locally widespread in certain valleys of windward Koolaus. Not widespread elsewhere. No control is planned.
Road	**RS-KLOA-08** Drum road	*Rhodomyrtus tomentosa*	Significant Koolau weed and is currently only known from and controlled at Schofield East Range. New ICA created at this site to prevent spread along the road and to additional training areas.
Road	**RS-KTA-08** Kahuku Training Area	*Filicium decipiens*	This ornamental species is known to naturalize, however much of Kahuku is alien dominated vegetation. No control will be conducted.
		Digitaria radicosa	Bishop Museum notes that this species was suspected of naturalizing, and this record confirms its naturalized status. Not a priority for control at Kahuku Training Area.
Road	**RS-KTA-09** Kahuku Training Area	*Toona ciliata*	It is unclear how many monotypic stands of this species exist in the Koolaus compared with in the Waianae Mts; it may be too wet to establish in the same way. It is, however, known from all other KTA road surveys. While it is a good invader, it presents little concern on the training range and no control is planned.
Road	**RS-PAHOLE-01**	*Trema orientalis*	Not unusual to find this species along the road, but will be targeted during weed control sweeps if seen in nearby managed areas.
Road	**RS-SBE-01**	*Albizia adianthifolia*	There is uncertainty about the validity of the identification of this taxa from this road survey. This species was likely planted as an ornamental tree on Schofield Barracks and has been since removed as it has been documented as naturalizing on the training range in the BAX of SBW. This year staff will look for this potentially invasive species on this road survey. Any new individuals identified will be controlled.
Road	**RS-SBS-01** Training range roads across Northern SBS	*Ficus religiosa*	*Ficus religiosa* naturalizes readily across Schofield Barracks and staff will be vigilant for spread along the road and closer to Management Units. No control is planned.
Road	**RS-SBS-02** Training range roads across Northern SBS	*Petrorhagia velutina*	This tiny plant was first observed as a new island record in 2010 on a West Range road survey, and now occurs on an adjacent training range. Not ecosystem altering; no control is planned.
Road	**RS-SBW-04** Training range roads across SBW	*Cinnamomum burmannii*	This weed is invasive in the Waianaes. There is a good chance it already occurs in the forested areas of Lihue, however staff will monitor movement across the range and along roads and towards high-value areas. No control is planned.
		Schizachyrium condensatum	This invasive grass is currently targeted at several ICAs across SBE. It is suspected to disperse readily on grass cutting equipment which is discouraged by roping off most known ICAs. It is designated as an ICA at this new site, however control will be a challenge due to access issues. This location is in the BAX area of the range that is currently off limits due to UXO issues. More discussion of this issue can be found in Section 3.1.

Table 12 (Continued).

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
LZ	**LZ-HON-106** Ekahanui Crestline	*Drymaria cordata var. pacifica*	This groundcover has been difficult to control at other known locations, such as the Hapapa snail enclosure. It has sticky seeds and is easily transported along trails by humans and animals. It should be targeted for control on LZs and staff access trails to prevent further spread.
LZ	**LZ-HON-151** Hapapa-Waieli Ridge	*Acanthospermum australe*	Known from elsewhere in this region, this groundcover favors open disturbed habitats and has bur-like seeds which could be transported accidentally via staff/gear. It will be targeted for control on this landing zone.
LZ	**LZ-HON-215** Palikea weatherport	*Ehrharta stipoides*	This species is widespread across the southern Waianes and Palikea MU. It is targeted regularly along trails and managed areas around rare resources. There is a zero tolerance for it on LZs and it will be controlled until no more is found here. It is a priority target for eradication in several other MUs in the northern Waianaes.
LZ	**LZ-Kaluaa-214** Kaluaa Trailhead LZ and parking area	*Pimenta dioica*	These two tree species are not new to the area, but further spread via staff should be avoided. Gear is staged in specified open dirt areas, and the landing zone is kept clear of weeds.
		Schefflera actinophylla	
LZ	**LZ-KLOA-190** Poamoho connex	*Nephrolepis brownii*	As mentioned elsewhere in this table, this species continues to show up on landing zones. Less of this species is observed in Koolau MUs, however staff will note any new locations during the course of field work inside MUs.
		Sisyrinchium exile	This tiny species continues to show up at a number of landing zones. While not habitat altering, staff will continue to pay attention to new locations of this alien species.
		Triumfetta semitriloba	This species moves around easily on humans and animals and is very invasive in the right environment. Although the Koolaus may not be preferred habitat, it would be prudent to keep this off the LZ and parking area. Many partner organizations use this LZ. OANRP will work with DOFAW staff to delineate a weed-free area at this landing zone to prevent spread of alien species to other locations.
LZ	**LZ-Koloa-169** Koloa Middle Ridge	*Melaleuca quinquenervia*	This species should be controlled whenever found in Koloa MU as it is an invader elsewhere in the Koolaus.
		Rhynchospora caduca	This species is widespread in lower elevations, however now occurs on nearly every Koolau LZ. Observations could be due to staff confidence in identification, but more likely are due to the fact that it has tiny seeds and is a successful disperser. Staff can say with confidence that it is being moved between the Koolau LZs by humans including: by staff, helicopters, and military training. The spread here seen on LZs in Koloa follows the trend seen across KLOA military LZs, and Opaeula and Opaeula Lower. Although invasive, it is only noted to occur in disturbed habitats, and no impact has yet been seen in intact forest areas. No control is planned.
LZ	**LZ-MMR-188** Makua Valley	*Themeda villosa*	An unusual find for this location, however there are no known occurrences in the adjacent forest, and an invasion is unlikely. Control on LZ.
LZ	**LZ-MOKFR-189** Nike Upper LZ	*Erigeron karvinskianus*	This invasive weed occurs in Ohikilolo MU. It is known to invade native forests and thrives particularly well on steep, cliffy habitat. Flights to that MU begin from this LZ. This species should be controlled on this LZ to prevent further spread.

Table 12 (Continued).

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
LZ	**LZ-SBE-172** Lower 36 LZ	*Pittosporum undulatum*	This ornamental plant has a somewhat high Weed Risk Assessment of 10, but has not been noted naturalizing elsewhere. Staff will monitor for spread.
LZ	**LZ-SBE-17** Upper 36 LZ	*Sphaeropteris cooperi*	Staff only have record of one other location of this species on East Range, however it is definitely known to be widespread across the Koolaus. Staff should control when observed.
Transect	**WT-Ekahanui-01** Ekahanui access trail	*Drymaria cordata var. pacifica*	Also documented from an Ekahanui LZ this year, staff will be vigilant for this weed and control where observed along trails and locations where it can be transported in gear and on staff.
		Nephrolepis brownii	This species is a priority to control around rare resources in Ekahanui MU.
Transect	**WT-Kaala-01** Kaala boardwalk	*Ageratina riparia*	This species is present in disturbed habitat at the beginning of the boardwalk and is controlled during regular weeding at that location. Spread along the boardwalk should however be minimized, and all plants seen will be controlled.
Transect	**WT-Kaluaa-01** Kaluaa access trail	*Falcataria moluccana*	This invasive tree is widespread across Schofield Training Ranges, and its spread into Kaluaa and Waieli MU would be a significant threat. It will be controlled whenever seen inside the MU.
Transect	**WT-Kaluakauila-01** Kaluakauila access trail	*Acacia mearnsii*	This tree is well established along the Kuaokala road, however is targeted for control in or near the Kaluakauila MU to prevent establishment or further spread inside the enclosure.
		Pinus luchuensis	Staff anecdotally note an increases in density of this species along the access ridge over the years. This species may pose a fire risk to the MU. Options to replace it on the eroded ridgeline will be considered.
Transect	**WT-Kaluakauila-02** Kaluakauila access trail to lower patch	*Acanthospermum australe*	This groundcover species could create dense mats in open disturbed areas within Kaluakauila MU. Any significant patches in the MU will be controlled.
		Pinus luchensis	See WT-Kaluakauila-01 comments
		Toona ciliata	This species is abundant nearby along the Kuaokala road, however is not often found within the enclosure. All occurrences within the MU will be controlled.
Transect	**WT-Kapuna-01** Mokuleia trail	*Rivina humilis*	This species is widespread across the Waianaes, however does not yet occur with high frequency in the MUs within Pahole NAR. It is noteworthy due to its shade-tolerance and ability to thrive in low-light conditions where other weeds do not. This species will be controlled during weed control efforts within high-value areas in the adjacent MUs.
Transect	**WT-Koloa-01** Koloa summit trail	*Angiopteris evecta*	This species is controlled in the Koloa MU as an important target. It is widespread in the Koolaus; recruits are common.
		Hedychium coronarium	One small immature was seen along the weed transect. *Hedychium coronarium* is controlled in a single ICA from the old 'Kahuku Cabin' and along the trail north (along the fence). No matures have been observed since 2014.
Transect	**WT-Pahole-01** Pahole gulch trail	*Commelina diffusa*	This species can grow prolifically and once established is most effectively controlled with an herbicide spray, but if around rare plants, this tool can become risky. Staff will control if seen approaching rare plant areas.
		Montanoa hibiscifolia	This species is a target in the Management Unit and single species sweeps are conducted for it.
		Sigesbeckia orientalis	*Sigesbeckia orientalis* is a target in this area by the State. No OANRP control is planned.

Table 12 (Continued).

Survey Type	Survey Code/ Description	Significant Alien Taxa Seen	Discussion
Transect	**WT-Palikea-01**	*Spathodea campanulata*	There is not currently much of this weedy tree in the Management Unit, however it occurs widely across Honouliuli. The seeds are wind dispersed, and it appears to colonize light gaps and disturbed areas. It is controlled during regular weed control efforts inside the MU.
Other	**OS-KLOA-01** Koloa campsite	*Angiopteris eveca*	See comments for WT-Koloa-01
Other	**OS-SBE-02** East base	*Cinnamomum burmannii*	These species are highly invasive and staff do not want to transport them in the field. Most of this survey occurs around East Baseyard away from vehicles and gear, however, all of these targets will be controlled when observed.
		Citharexylum caudatum	
		Passiflora suberosa	
Other	**OS-SBW-02** West Base	*Nephrolepis brownii*	Both of these species will be controlled when seen to prevent staff, gear and vehicles from becoming vectors into managed areas.
		Passiflora suberosa	
Multiple surveys	**LZ-HON-106** Ekahanui Crestline **LZ-HON-215** Palikea weatherport **WT-Ehakanui-01** Ekahanui Access Trail	*Nephrolepis brownii*	Staff emphasis on learning to distinguish this invasive fern from its native counterpart may speak to increases in observations of this species on several surveys. It is a problematic understory weed able to create dense thickets, can hybridize with the native *Nephrolopis spp.* and is therefore a priority target for control in forested areas and around valuable resources.
Incidental	Ahuimanu Rd, upper bridge	*Aglaomorpha* sp.	This fern was found by staff as an epiphyte on a *Schefflera actinophylla* on Ahuimanu Rd. This genus was noted by Bishop museum as a new State record.
Incidental	Whitmore Village	*Nassella tenuissima*	Staff observed this Mexican feathergrass on personal time. Bishop Museum has collections from 2 other locations. It has a very high Hawaii Weed Risk Assessment of 24. It was previously an OISC target, and this find was reported to them.
Incidental	Schofield Barracks East Range: Schofield Waikane trail	*Blechnum orientale*	It is unclear how widespread this species is across the Koolaus, but OARNP know of it from two locations: KTA and Ahuimanu. This observation was from a staff on a weekend hike. Control for this taxa at this location is currently a low priority as no training occurs where it is found, and there are no managed taxa nearby.

Figure 14. *Digitaria radicosa* from KTA, naturalizing on Oahu.

Figure 15. *Aglaomorpha* found in Ahuimanu by staff.

3.6 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 43% (1,147.5 hours) of the time spent on ICA work, and 11% 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 again this year, both on and off-range. A new ICA was found at SBW. A new site with a single individual was found at Kaluaa. Off-duty staff discovered an outlier plant along the Ehukai Trail in Pupukea, and a recreational hiker found a mature plant in Makaha. There continues to be no effective way to restrict motocross riders to the official State Motocross Park in Kahuku, and little progress in working with the State to build wash facilities for park users. In better news, no plants were seen at either SBE or Manuwai, and delimiting surveys were completed at Manuwai, with no new sites found. No plants have been found at a handful of small KTA outlier ICAs for several years. Aerial sprays continue to be effective at both KTA and SBW, with the cores of both infestations treated at least once. While control efforts at outlier infestations and designated hotspots are going well, OANRP has not succeeded in stemming the spread of *C. odorata* into adjacent and new areas.

OISC continues to manage infestations off of Army lands at Kahana, Keamanea/Haleiwa, and Aiea/Camp Smith. This year, they also worked at Kahuku/Malaekahana and Makaha; see Appendices 3-5 and 3-6. 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.

In early 2017, as a result of the discovery of *C. odorata* in Manuwai, OANRP invested in gear designated solely for *C. odorata* control. Whenever working in *C. odorata* infested areas, staff use tabis, packs, gloves, and brushes dedicated to *C. odorata* control. Despite this, OANRP discovered *C. odorata* along the Kaluaa access trail this year. It is unclear whether this dispersal event occurred before or after staff began using separate gear for *C. odorata* work. Nevertheless, it is a reminder to all staff to practice rigorous decontamination after working in *C. odorata* infestation areas. Staff are directed to clean their gear either in the field at the infestation site, or at the KTA wash rack, or back at West Base. All sediment from the wash rack is collected in a basin on site; the basin has yet to be emptied, but when it is, OANRP will monitor the sediment. Annual weed surveys are conducted across West Base, and high risk weeks like *C. odorata* area a particular focus of these surveys. All *C. odorata* material collected in the field is disposed of in dedicated bins at West Base and taken to H-Power.

Seed Longevity Trial Update

In 2011, staff installed a five-year trial at KTA to determine how long *C. odorata* seeds persist in soil. Seed was collected and placed into packets of 1,250 seed, which were buried 6-8 inches underground at a site outside of, but adjacent to known *C. odorata* areas. Two bags each were removed from the site every three months for the first year of the trial, then once a year for the remaining years. Staff were unable to find the last two packets at the five year, mark, but they were later recovered at the six year mark. Final results are presented in Figure 16. Note that the fourth year seed could not be used to assess overall seedbank persistence, due to low numbers (7 seeds remaining of 2,500 buried). Unfortunately, initial

viability of the seed batch used was not tested. While germination declined dramatically, a small percentage (13.5) of seeds remained viable at six years.

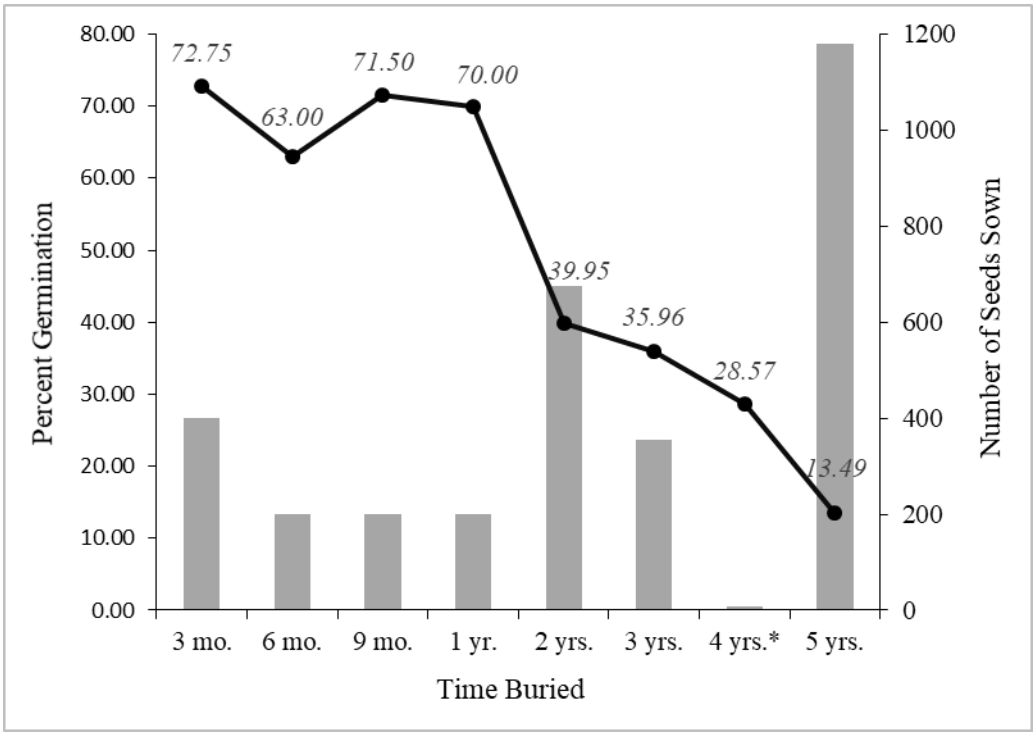

Figure 16. Results of the *C. odorata* buried seed sow trial at KTA. Initial viability was not tested. Percent germination is presented as a line, with actual values listed. The number of seeds sown for each test is presented as a bar. The four-year results (*) are only based off of seven seeds, and should not be given much weight.

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. Initial viability for the seed lot used in this trial was 63.00%. At the two year mark, germination was 41.58%, similar to the two year results for the KTA trial, 39.95%. 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. Currently, it appears that *C. odorata* forms a short-term, persistent seed bank.

Figure 17. *Chromolaena odorata* flowers.

KTA Update

Control efforts at KTA account for 32% 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 3-5 and 3-6 for a summary of OISC's work, including maps of areas treated this year. Figure 18 shows the distribution of ICAs across KTA.

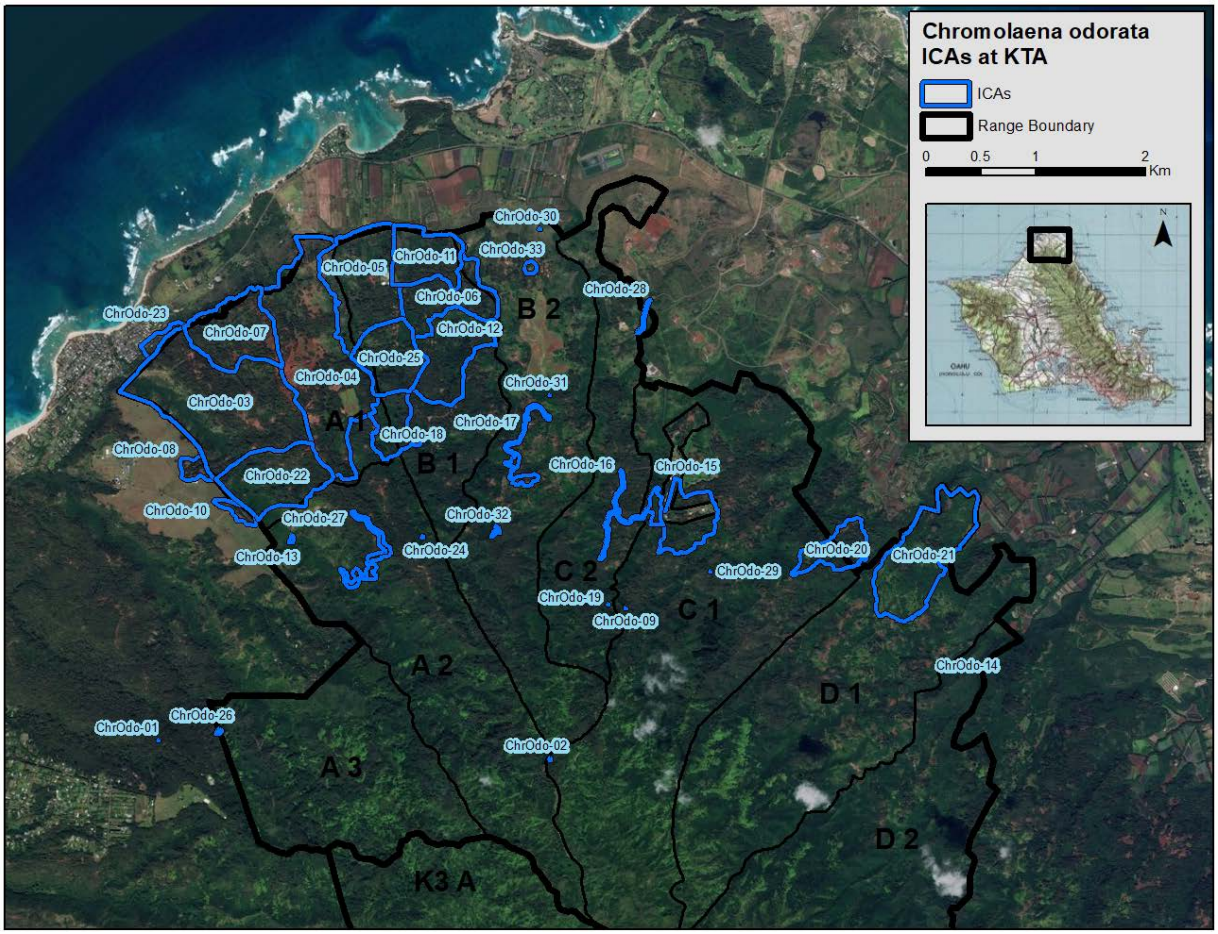

Figure 18. *C. odorata* Incipient Control Areas at KTA.

- New ICAs. Four new ICAs were created this year, numbers 30-33. While this spread is discouraging, only a few plants were seen at each new ICA.
    - ICA-30, North Oio: This year, staff continued to survey trails outside of known ICAs as part of early detection efforts across KTA. During trail surveys across the north end of Bravo 2 training area on November 14, 2017, staff found one immature plant close to the bluffs overlooking Turtle Bay. The ICA is located makai of Kane's LZ, and the habitat is exposed, open, and scrubby. Compared to the western part of KTA, there are few trails in this area, but it is difficult to tell if the trails present are primarily used by motocross riders, soldiers, or pigs. No plants were found at this site on subsequent surveys.
    - ICA-31, Kane's: This site was also discovered during early detection trail surveys in Bravo 2. Staff found one large mature plant on November 14, 2017 on a trail just south of Kane's LZ. The area is densely vegetated, with a tall canopy and thick understory, which is unusual as *C. odorata* generally thrives best in open habitat. Staff swept a 30 meter

buffer around the plant, but no others were found. The area around the plant was sprayed with a cocktail of glyphosate and pre-emergent herbicide. No plants were found at this ICA on subsequent surveys.

- ICA-32, Mt. Kawela: During annual road surveys on February 1, 2018, staff found a single mature plant outside an abandoned building on Mt. Kawela. Although mature fruit were present, staff did not collect them due to the risk of contaminating their clothes and footwear. A month later, staff sprayed the area immediately around the plant with a cocktail of glyphosate and pre-emergent herbicide, and surveyed the open areas to the north of the building; one immature plant was found approximately 80 meters away in a brushy area along the road. Staff monitored the sprayed area in May, and found just one immature plant. *Chromolaena odorata* was likely spread to this area via soldiers or motocross riders. In the coming year, this area will be monitored quarterly, and buffer surveys will be conducted to the south of the known sites.
- ICA-33, Kane's Flats: While hiking to ICA-30 on June 21, 2018, staff found a 1.5 meter tall mature *C. odorata* in an open area crisscrossed with trails. Staff collected and bagged as many of the seed heads as they could for later disposal at H-Power. Staff plan to treat the area with pre-emergent herbicide in the coming year. This ICA is north of Kane's LZ, and may be used by both motocross riders and soldiers. Larger surveys are needed to better map *C. odorata* presence across the area.

- ICA Changes. The boundaries of eight ICAs were expanded this year. Some were expanded to include new patches of *C. odorata* just outside their borders; these include: ICAs 12, 16, and 17. Others were expanded to better include highly trafficked roads and trails adjacent to ICAs which should be regularly monitored to prevent spread; these include ICAs 18, 20, and 27. ICA-23 is located primarily on private land; it was expanded to include the access road to the Alpha ranges and motocross park after staff found a handful of small *C. odorata* along it during the annual road survey. All of these expansions were fairly small, between 0.18 and 2.34 ha. By far the largest expansion, 37.94 ha, occurred at ICA-21. This ICA is contiguous with a *C. odorata* infestation on private land at Climbworks Keana Farms. As a precaution, the boundary of ICA-21 was expanded to the edge of the Delta 1 training area, although the most northern part of the range has not yet been surveyed. If future surveys suggest the ICA should be smaller, it will be trimmed to better reflect the actual infestation area.

Figure 19. Searching for *C. odorata* along Kaunala Road.

Figure 20. *Chromolaena odorata* leaves.

- Control Summary. All control efforts are summarized in Table 13. Area, effort and number of visits are reported for the 2018 and 2017 report years. The dates of the most recently removed mature and immature plants are included. See Tables 15 and 16 for discussion of individual ICAs. The *C. odorata* infestation now covers 646.26 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 13. KTA Control Efforts

ICA Code	ICA Area (ha)	2018 Report Year			2017 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	0.5	1	64 m²	1.0	2	none	2011-04-05	Outlier
KTA-ChrOdo-02	328 m²	112 m²	1.0	1	328 m²	0.5	1	none	2011-08-22	Outlier
KTA-ChrOdo-03	118.44	3.57	94.5	6	7.71	214.0	16	2017-11-22	2018-05-10	OISC Contract + OANRP hotspot
KTA-ChrOdo-04	111.63	5.86	107.0	11	10.40	94.0	10	2018-05-09	2018-05-09	OISC Contract + OANRP hotspot
KTA-ChrOdo-05	57.96	29.61	200.1	16	40.82	258.5	21	2018-06-21	2018-06-21	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-06	32.62	25.30	104.0	5	31.68	103.5	7	2018-05-30	2018-05-30	Sweep + Hotspot
KTA-ChrOdo-07	41.27	1.61	43.0	4	4.18	33.0	6	2018-04-24	2018-04-25	OISC Contract + OANRP hotspot
AimuuNoMU-ChrOdo-08	4.59	0	0	0	0.59	1.0	1	N/A	2016-08-16	Private Land. OISC.
KTA-ChrOdo-09	78 m²	78 m²	0.5	1	78 m²	0.5	1	2013-01-09	2013-09-10	Outlier
AimuuNoMU-ChrOdo-10	3.73	0	0	0	0	0	0	N/A	2016-01-21	Private Land. OISC.
KTA-ChrOdo-11	28.74	4.02	3.0	3	18.64	41.5	5	2016-07-28	2018-02-21	Sweep + Hotspot
KTA-ChrOdo-12	39.79	11.51	55.0	5	4.23	19.0	2	2018-05-09	2018-05-09	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-13	0.23	0	0	0	457 m²	1.0	1	2015-12-23	none	Outlier
KTA-ChrOdo-14	6 m²	6 m²	0.3	1	6 m²	0.5	1	2014-01-07	none	Outlier
KTA-ChrOdo-15	23.51	6.52	2.5	2	3.96	18.5	2	2017-12-12	2017-07-10	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-16	5.75	1.82	8.5	4	1.44	3.5	3	2017-12-12	2018-02-01	Trails + Roads + Hotspots
KTA-ChrOdo-17	4.28	3.42	15.5	2	1.98	4.0	3	2017-11-14	2017-11-14	Trails + Roads + Hotspots
KTA-ChrOdo-18	18.59	2.32	22.5	2	2.34	23.5	2	2014-10-29	2017-11-14	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-19	78 m²	78 m²	2.0	1	78 m²	0.5	1	none	2014-09-24	Outlier

Table 13 (continued).

ICA Code	ICA Area (ha)	2018 Report Year			2017 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-20	17.32	3.99	36.3	4	4.87	42.0	3	2017-12-05	2018-06-27	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-21	59.25	6.62	55.25	5	4.48	35.0	3	2018-06-28	2018-06-28	Trails + Roads + Hotspots + Sweep
KTA-ChrOdo-22	43.8	0.95	4.0	1	0.94	20.5	3	2017-03-21	2017-10-12	Roads + Trails + Hotspots + Sweep
KahukuLaie-ChrOdo-23	3.86	0.21	1.75	2	0.13	1.25	1	2016-04-27	2018-05-10	OANRP Roads + OISC Private Land
KTA-ChrOdo-24	316 m²	316 m²	1.25	3	316 m²	3.0	3	2016-03-02	none	Outlier
KTA-ChrOdo-25	31.27	7.96	70.85	6	5.78	35.0	6	2018-06-21	2018-06-21	Sweep + Hotspot + Aerial spray
KTA-ChrOdo-26	0.18	0.11	7.0	4	0.18	22.00	4	2016-09-08	2018-06-28	Outlier
KTA-ChrOdo-27	5.91	2.60	4.5	2	1.54	3.5	3	2018-01-30	2017-07-11	Trails + Roads + Hotspots
KTA-ChrOdo-28	0.69	0.35	1.3	2	0.35	1.0	1	2017-03-07	2017-03-07	Outlier
KTA-ChrOdo-29	78 m²	78 m²	0.8	2	20 m²	0.5	1	none	2017-03-07	Outlier
KTA-ChrOdo-30	155 m²	152 m²	4.0	3	0	0	0	none	2017-11-14	Outlier
KTA-ChrOdo-31	78 m²	78 m²	6.5	4	0	0	0	2017-11-14	none	Outlier
KTA-ChrOdo-32	0.31	0.30	4.75	3	0	0	0	2018-02-01	2018-05-08	Outlier
KTA-ChrOdo-33	0.99	0.23	1.0	1	0	0	0	2018-06-21	None	Outlier
TOTALS	**646.26**	**118.96**	**859.20**	**107**	**146.36**	**981.75**	**113**			

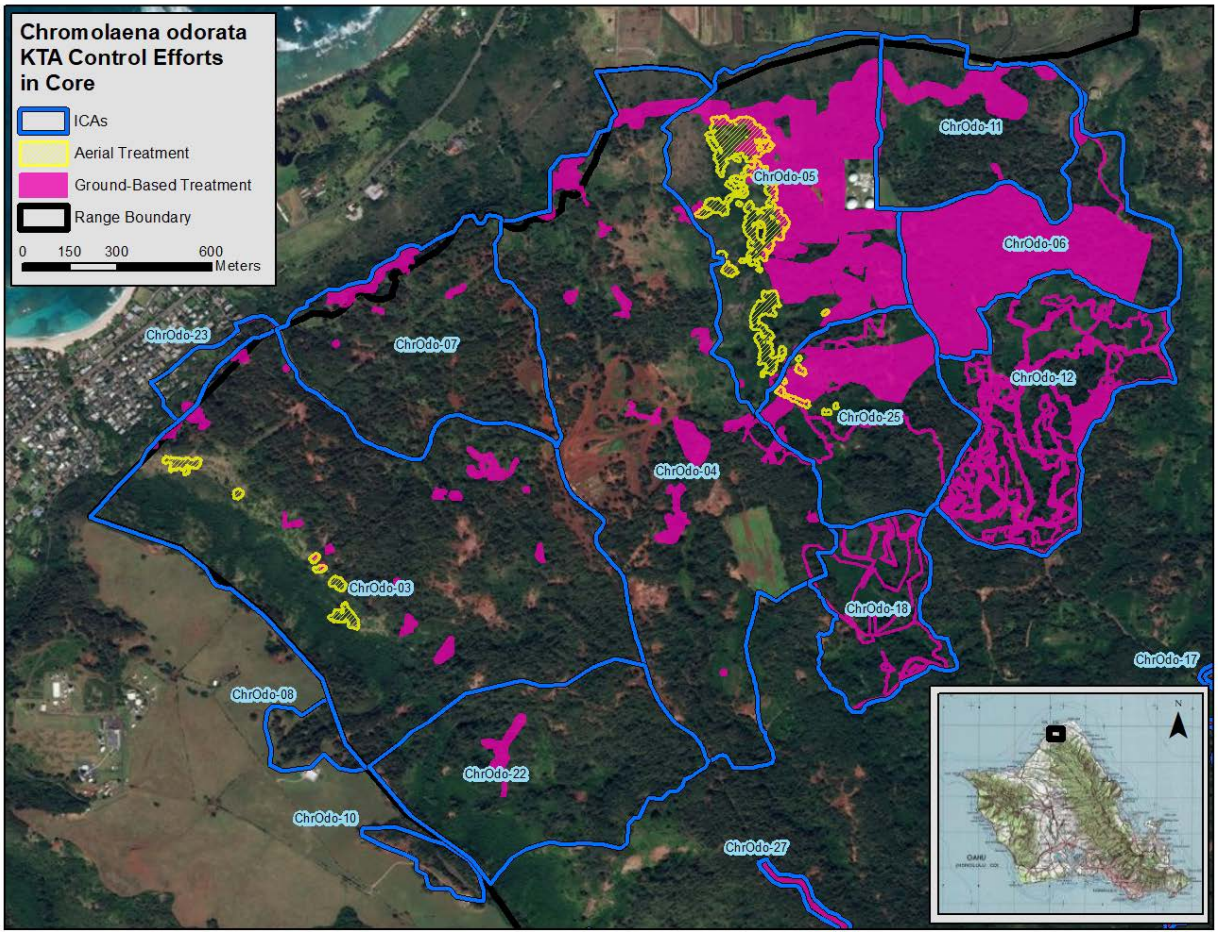

Figure 21. Aerial and Ground Treatment in the KTA Core Infestation

Table 14. KTA Aerial and Ground Treatment Area

Report Year	Total Area Treated (ha)	Aerial Spray Area (ha)	Ground-Based Treatment Area (ha)
2017-2018	118.96	8.13	112.56
2016-2017	146.36	13.36	140.87
2015-2016	98.24	6.36	91.89
2014-2015	71.27	3.98	67.29

- Aerial Sprays. This year, 8.13 ha were sprayed aerially and 112.56 ha were treated on the ground, for a total of 118.96 ha of *C. odorata* controlled (ground and aerial treatments overlapped); see Table 14. Figure 21 shows aerial and ground control efforts across the primary infestation. Aerial sprays were conducted in three different ICAs this year. While efforts focused on ICA-05 (6.64 ha), areas directly adjacent in ICA-25 (0.36 ha) were also sprayed. Last year, a new spray zone encompassing several hotspots was designated in ICA-03. This year, 1.13 ha were sprayed in ICA-03 in this zone. Total aerial spray area declined from last year, for several reasons. Firstly, fewer aerial sprays were conducted this year, in part due to logistical and weather issues. Secondly, while most of this year's sprays were done by an experienced, Big Island-based pilot, some were done by an Oahu-based pilot new to aerial spray work. The new pilot's skill continues to grow, but he is less efficient that the experienced pilot. However, having an Oahu-based pilot for aerial sprays will allow staff greater flexibility in planning spray operations in the coming year. Despite these issues, the majority of the designated aerial spray zones were completely

treated once, and some areas were sprayed twice. Aerial sprays continue to be a valuable tool for *C. odorata* management.

- Outlier ICAs. Control efforts at the outlier ICAs have been successful in reducing plant numbers. Control status is summarized in Table 15; ICAs are listed by the date plants were last observed. All outlier ICAs were monitored at least once this year, with the exception of ICA-13. 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 15. KTA Outlier ICA Status

ICA Code	Plant Type & Total Number	Date Last Observed	Comments
WaimeaNoMU-ChrOdo-01	Immature only (1)	2011 April	None found since initial discovery.
KTA-ChrOdo-02	Immature only (1)	2011 April	None found since initial discovery.
KTA-ChrOdo-09	Mature (1) and immature (1) plants	2013 September	Plants found on separate visits in 2013.
KTA-ChrOdo-14	Mature only (1)	2014 January	None found since initial discovery.
KTA-ChrOdo-19	Immature only (1)	2014 September	None found since initial discovery.
KTA-ChrOdo-13	Mature only (1)	2015 December	None found since initial discovery. However, this ICA has not been monitored consistently since it was discovered in 2015, and more regular checks are needed to determine if *C. odorata* is persistent at it.
KTA-ChrOdo-24	Mature only (1)	2016 March	None found since initial discovery.
KTA-ChrOdo-28	Mature (1) and immature (7) plants	2017 March	None found since initial discovery.
KTA-ChrOdo-29	Immature only (1)	2017 March	None found since initial discovery.
KTA-ChrOdo-30	Immature only (1)	2017 November	New this year. 3 visits made this year, no plants found after initial discovery.
KTA-ChrOdo-31	Mature only (1)	2017 November	New this year. 4 visits made this year, no plants found after initial discovery.
KTA-ChrOdo-32	Mature (1) and immature (2) plants	2018 May	3 visits made this year, 1 plant found on each visit.
KTA-ChrOdo-33	Mature only (1)	2018 June	1 visits made this year, additional surveys needed
KTA-ChrOdo-26	Mature (1) and immature (6) plants	2018 June	Found in 2016. Only immature plants seen this year.

- ICA Discussion. Highlights of ICA management are summarized in Table 16. The ICAs discussed are shown in Figures 18, 21, and 22, and control statistics are detailed in Table 13.

Table 16. KTA ICA Highlights

ICA	Discussion
KTA-ChrOdo-03	ICA-03 is located in Kaunala gulch, and includes all the areas west of the main Alpha road. The more moderately sloped portion of the ICA on the east side of the gulch is located in the motocross park. The western portion of the ICA is dominated by steep terrain, including numerous cliffs, and is densely vegetated with tall alien grasses. This ICA is swept by OISC and OANRP staff conduct follow-up by treating hotspots. Area treated and effort dropped from last year to this year, primarily due to a reduction in aerial surveys of the northern bluffs. Other contributing factors include slightly decreased aerial sprays, a few hotspots becoming inactive, and a shift in strategy for a handful of hotspots on the west slope of Kaunala; as these western hotspots are most easily accessed from private land, it is logistically simpler for OISC to treat them instead of OANRP. This year, OANRP continued to focus treatment on the aerial spray zone, hotspots, and conducted one aerial survey. Six hotspots along a grassy cliff were treated with aerial sprays, and the rest were sprayed or swept on the ground. The largest hotspot (HS-037) required multiple treatments this year. Staff are experimenting with adding imazapyr to the spray mix to achieve longer suppression and increase efficiency.

Table 16 (continued).

ICA	Discussion
KTA-ChrOdo-04	This ICA is located just west of Pahipahialua gulch and the *C. odorata* core, and includes much of the motocross park. The terrain is fairly flat, and much of the area is kept open by motocross users. OISC sweeps the entire ICA and OANRP treats all hotspots. Area swept decreased from last year, due to a reduction in the area aerially surveyed. While one aerial survey was performed this year, it covered a smaller area. This year, OANRP scoped and power sprayed 12 hotspots, five of which were treated twice. In addition, two other hotspots were surveyed, but did not require spraying. A number of hotspots lining the border between ICA-04 and ICA-05 are best treated via aerial sprays; some of these were not treated this year, but are a priority for future aerial operations.
KTA-ChrOdo-05	This ICA includes the core of the *C. odorata* infestation in Pahipahialua gulch. The terrain is difficult; the western slopes are steep and grassy, while the eastern slopes are split by cliffs. The far eastern side of the ICA is comparatively moderately sloped. Both area swept and effort decreased this year. In part, this is due to a reduction in the number of aerial sprays, but most of the decline in area is due to a reduction in aerially surveyed area. Last year's aerial survey covered much more terrain than the survey performed this year. This year, staff swept most of the moderate eastern slopes and sprayed accessible hotspots with the power sprayer. In addition, aerial sprays targeted the lower eastern slopes, part of the gulch bottom, and hotspots on the western slope. Staff will continue aggressive control in the coming year.
KTA-ChrOdo-06	This ICA is directly east of the Opana Radar Tracking facility, and contains four hotspots. This year, most of the ICA was swept, with the exception of the far eastern edge and part of the northern finger. All hotspots were swept, but only the two largest were power sprayed with pre-emergent herbicide. Control efforts continue to be successful; numbers of plants found continue to decline across the ICA, from an estimated 11,600 in in report year 2015 to an estimated 640 this report year. Staff note that this decline is particularly evident within hotspots, but during sweeps, mature plants were found just outside the hotspots; this is a good reminder for staff to avoid limiting themselves to hotspot boundaries. In the coming year, staff will sweep the portions of the ICA missed this year, sweep any area where plants have been found within the last two years, and monitor hotspots at least twice.
KTA-ChrOdo-07	Spanning the Waialee flats between two roads, ICA-07 is in the heart of the motocross park. Most of the terrain is relatively flat, but the northern edge of the ICA includes the top of the bluffs. OISC staff sweep the ICA while OANRP staff treat hotspots. Area swept decreased from last year, due to a reduction in the area aerially surveyed. While an aerial survey was performed this year, it covered a smaller area. This year, staff monitored all six active hotspots at least once. Plant numbers continue to decline at the hotspots on the flats, but large numbers persist on the northern bluffs.
KTA-ChrOdo-11	ICA-11 includes the area northeast of the Opana Radar Tracking facility. The terrain of the southern portion of the ICA is moderate, with flat areas bisected by shallow gullies. The northern half of the ICA is steep, covered with alien grass and shrubs. The entire ICA was surveyed in 2015 and 2016. Since few *C. odorata* have ever been found here, this year staff opted to spend their limited time in the more densely infested ICA-06 instead. The single hotpsot was monitored and only two immatures were found. One aerial survey was conducted over the northern slopes. Next year, OANRP will prioritize this ICA. The southern half will be swept, and the northern half will be surveyed from vantage points.
KTA-ChrOdo-12	This ICA is an interesting case study of *C. odorata* spread and adaptive management, see Figure 22. In 2012, the whole area was surveyed as part of infestation delimiting efforts, with no plants found. Quickly thereafter, a few plants were found along roads, necessitating the creation of the ICA. In response, staff started surveying trails around known plant locations in report year 2014, although the primary focus continued to be along roads. In 2015, all trails in the southern half of the ICA and all roads were surveyed, and one large patch of plants was power sprayed (HS-12d). In 2016, all trails in the ICA were surveyed for the first time, another large patch (HS-12c) was power sprayed, and staff noted that plant numbers across the ICA were increasing. This report year, more extensive management was conducted than ever before; area and effort almost tripled from last year. Staff surveyed all trails in the ICA twice. Five hotspots were finally designated and named, making it easier to track control efforts at each. Four of the hotspots were sprayed with a cocktail of glyphosate and pre-emergent, and the fifth (HS-12c) was thoroughly swept. Due to the large size of the *C. odorata* infestation at KTA, OANRP avoided conducting extensive management at this ICA in early years. Unfortunately, these minimal efforts were not sufficient at halting the spread of *C. odorata* and management had to ramp up in response. At this

Table 16 (continued).

ICA	Discussion
	point, landscape sweeps may be needed to effectively bring plant numbers down at this ICA, but OANRP currently does not have the personnel to do this. In the coming year, staff plan to again sweep all trails and roads twice, and monitor/control all hotspots two to four times. If resources allow, landscape sweeps will be conducted, starting with the northern half of the ICA.
KTA-ChrOdo-15	Located around a portion of the CACTF training facility, this ICA includes heavily used and maintained areas around roads and buildings. Staff surveyed all trails and known *C. odorata* locations once this year and found very low numbers of plants, just 4 mature and 2 immature. One of these mature plants was found within a small Cultural Resources fence. Staff will monitor the entire ICA twice in next year.
KTA-ChrOdo-16	Previously, this ICA was limited to a large clearing and gravel storage area. Last year it was expanded along the Oio road to the north, and this year it was expanded along the same road to the south. This year, staff found more plants than in previous years: 7 matures and 7 immatures. Most of the plants were seen at the new southern Oio road spot, but staff also observed plants for the first time on a gravel pile and next to a small Cultural Resources fence. Both the gravel pile and south Oio road sites were treated with pre-emergent herbicide. The continued spread of *C. odorata* at this ICA is concerning. Staff will monitor the entire ICA twice in the coming year.
KTA-ChrOdo-17	This ICA runs along a portion of the road leading towards Mt. Kawela and includes a few side trails. This year, staff monitored the entire road area twice and the trail area once. Only four plants were found, three of which were located close to the site where a very large mature plant was treated in 2017. This spot has previously been sprayed with pre-emergent, and relatively few plants have been observed since. The last plant was found on a side road, and appeared to have been cut or run over many times. No plants were found in the trail portion of the ICA. This site will continue to be monitored twice a year.
KTA-ChrOdo-18	Located west of the motocross park and north of the ICA-25, *C. odorata* distribution is relatively sparse in this ICA. There is one hotspot, located on the south edge of the ICA above Echo Gate. This year, staff surveyed trails across the ICA and monitored the hotspot. While no mature plants have been seen since 2014, staff note increased numbers of plants on the northern border. Also, immature plants continue to pop up at the hotspot, perhaps because it never was treated with pre-emergent herbicide. In the coming year, staff will survey trails twice, monitor the hotspot two to four times a year and treat it with pre-emergent, and do landscape sweeps across the northern border if resources allow.
KTA-ChrOdo-20	This ICA is located along the border of KTA, in the northwestern corner of the Charlie 1 training range. This year, all trails were surveyed once, and some trails were surveyed twice. Few plants were found, except around one previously identified hotspot and one brand new hotspot. Hundreds of plants were found at the new hotspot, which was treated with pre-emergent herbicide. Larger surveys around this new hotspot are needed, and OANRP will seek permission from the State to do this, as the ICA extends on to State land. This will be a high priority in the coming year, as management strategies may need to be adjusted if large, densely infested areas are found. In the meantime, staff will continue to monitor known *C. odorata* locations and trails.
KTA-ChrOdo-21	ICA-21 is located in the Delta 1 training range on the far western side of KTA. Last year, the ICA was expanded to include newly discovered *C. odorata* patches to the north. This year, staff continued to explore even further north, and discovered yet more *C. odorata*, including patches with hundreds of plants. One complication is that the northern portion of the ICA is not easily accessible by vehicle from KTA. Fortunately, Climbworks Keana Farms granted permission for staff to drive through their land on to KTA, which allowed staff to treat one hotspot with the power sprayer. Further surveys are needed to completely delimit the ICA, identify new hotspots, and revise the management strategy; these surveys are a high priority in the coming year.
KTA-ChrOdo-22	This large ICA is directly south of ICA 03, which is surveyed by OISC. It spans Kaunala gulch and is on the edge of the motocross park. All trails in the ICA were swept in report years 2016 and 2017, and one hotspot was identified and sprayed. This year, the hotspot was monitored, and only 8 immatures were found. In the coming year, all trails will be surveyed twice, and the hotspot will be monitored 2-4 times.
KTA-ChrOdo-25	Last year, ICA-05 was split, and the southern half became ICA-25. This ICA spans Pahipahialua gulch, and includes the southern edges of the *C. odorata* core infestation. Effort this year almost doubled over last year, while area treated increased by a third. Despite this, due to limited time, staff were unable to sweep the entire ICA. Sweeps focused just on the northern portion of the ICA (closest to the core) and some trails. Some hotspots in the northwestern corner of the ICA were sprayed either aerially or with the

Table 16 (continued).

ICA	Discussion
	power sprayer. It appears that *C. odorata* is actively spreading throughout this ICA. This ICA will be a priority for control next year.
KTA-ChrOdo-27	This ICA runs along the Kaunala road, from the gulch bottom up the east side of the gulch to the ridge crest. Only seven plants have ever been found in this ICA, including one mature and one immature removed this year. This is a large area to survey, but is best done on foot, due to the poor condition of the road, and the presence of *Pluchea carolinensis* lining the road.

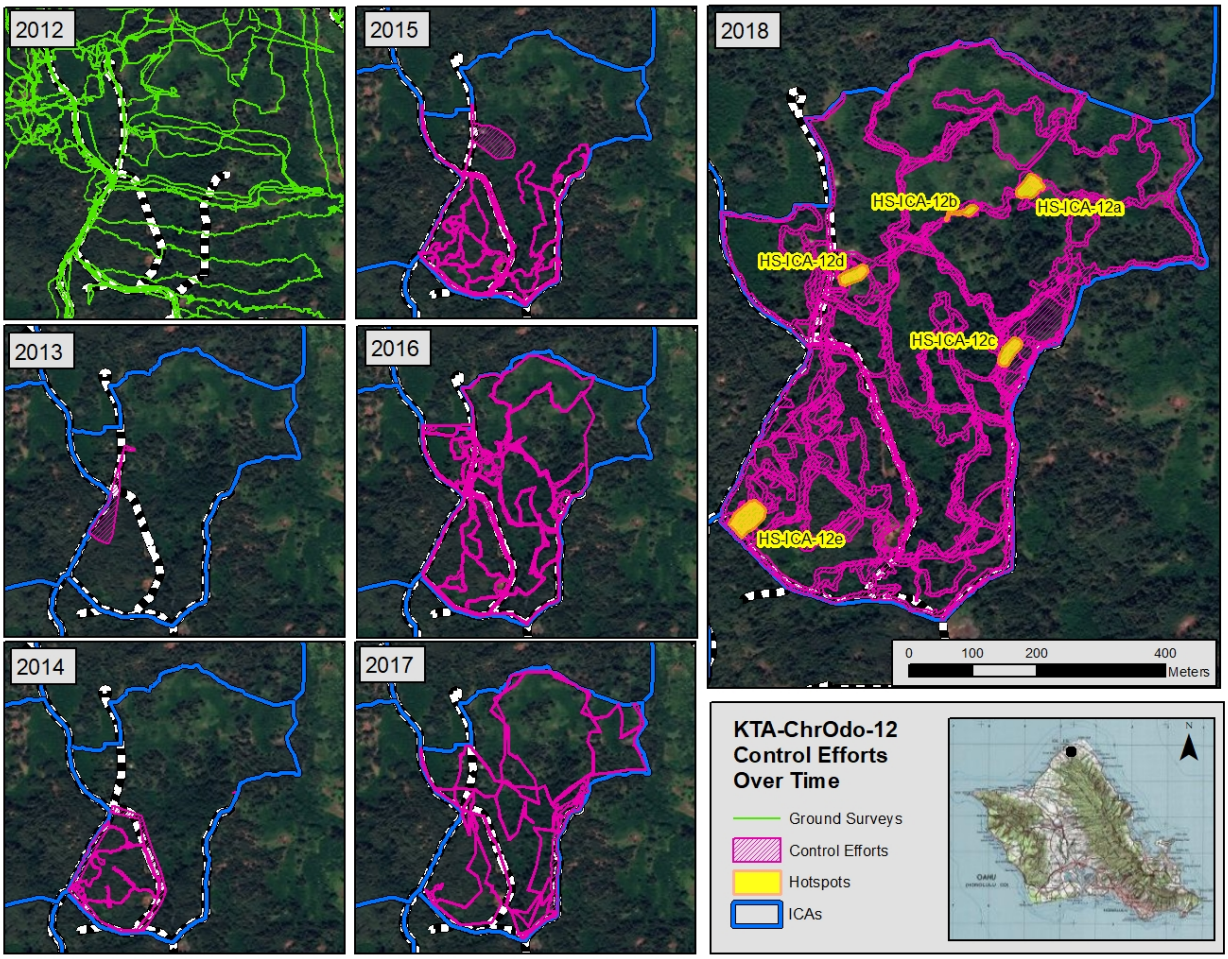

Figure 22. Control efforts at KTA-ChrOdo-12 over time.

- Makai Bluffs and Private Land. The bluffs lining the north edge of KTA are steep, thickly vegetated, and difficult to survey. While portions of them lie within KTA, one section is owned by the State, and the majority is privately owned. OANRP does not have permission to work on private land, and generally defers to OISC when *C. odorata* control is needed in these zones. Even if OANRP could access all the bluffs, the steep terrain and dense vegetation preclude effective *C. odorata* surveys. This year, OANRP conducted one aerial survey over the bluffs, on the west side of KTA between the Alpha and Opana access roads, through ICAs-04, 05, 07, and 11. While *C. odorata* can be difficult to spot from the air, staff have grown more comfortable doing so after many hours directing aerial sprays. A handful of plants were found, included a small patch in ICA-05, and a few plants along the northern edges of ICAs-04 and 07, In coming years, aerial surveys of the bluffs will be conducted annually, and will be expanded to extend to

the Charlie access road to the east. They will serve as an early detection system for the northern edge of the *C. odorata* infestation.

SBW Update

Chromolaena odorata was first discovered at SBW on May 25, 2013 during annual road surveys. SBW contains the second largest *C. odorata* infestation found on Army training lands after KTA. Unlike in KTA, the infestation is mostly confined to a portion of one gulch, Mohiakea, with a small handful of outlier sites. Training activities in SBW are much different than in KTA. As opposed to navigating across large areas, units tend to set up at select locations. While soldiers occasionally venture into the edges of the *C. odorata* infestation, the primary military presence in the infestation is via contractors and civilians conducting range maintenance and vegetation management. OANRP works to maintain positive relationships with these groups, as discussed in Section 3.4 above. Control efforts at SBW are limited by range availability and the need for an UXO escort in all areas off of roads. OANRP has been able to take advantage of regularly scheduled range maintenance 'cold' days, but access to Schofield was limited this year during the UXO stand down. One new *C. odorata* ICA was found on SBW this year, see Figure 23. Staff continue to conduct weed road surveys across SBW and SBS annually.

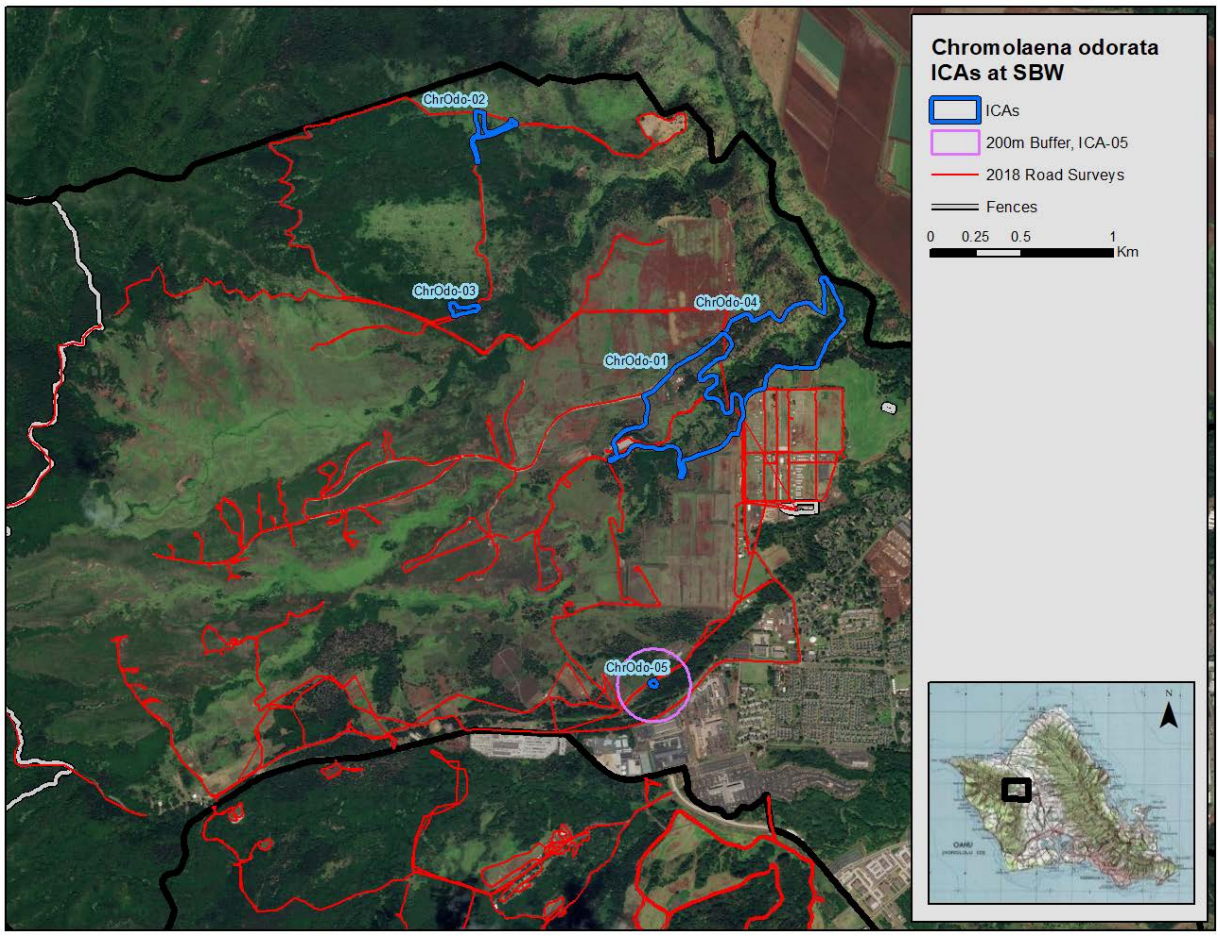

Figure 23. *C. odorata* ICA locations at SBW

Table 17 below summarizes control efforts at SBW this year; control efforts from last report year are included for reference. The Type/Strategy listed for each ICA is defined in the KTA Control Summary discussion above. Due to differences in overall infestation size, terrain, military training, and UXO

presence, fewer management strategies are employed at SBW than at KTA. Three ICAs are designated as outliers, while the largest two require a combination of sweeps/surveys and intensive hotspot control This year, staff conducted quarterly visits, focused on known hotspots, and treated select areas with aerial sprays. Total effort and areas treated increased from last year, primarily due to increases at ICA-04. Each ICA is discussed in more detail below. Control efforts were successful in reducing plant numbers at the outlier ICAs and at hotspots in the core ICAs. Due to the limited Range time available, staff did not conduct landscape surveys across the two core ICAs. After the Range shutdown, some ICAs were overgrown with grass, which limited staff ability to both spot *C. odorata* and walk through the areas safely (due to UXO risk, staff must be able to see the ground whenever working off road). In future, maintaining open vegetation at the ICAs will be a priority.

Table 17. SBW Control Efforts

ICA Code and Type/Strategy	2018 Report Year				2017 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBWNoMU-ChrOdo-01 Sweep + Hotspot + Aerial Spray	22.28	4.69	46.5	9	5.60	56.7	11
SBWNoMU-ChrOdo-02 Outlier	1.10	0.84	5.5	4	0.88	7.0	3
SBWNoMU-ChrOdo-03 Outlier	0.57	0.51	5.0	5	0.46	9.5	3
SBWNoMU-ChrOdo-04 Sweep + Hotspot + Aerial Spray	23.79	10.62	92.0	13	7.79	56.8	9
SBWNoMU-ChrOdo-05 Outlier	0.11	919 m²	9.60	3	0	0	0
TOTAL	**47.86**	**16.76**	**158.6**	**34**	14.72	130.0	26

- 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. Surveys haven't been done since 2016, in part due to access restrictions, and in part because staff opted to focus on hotspot work this year. Geographic hotspots are designated around concentrations of plants to facilitate efficient and thorough coverage; seven are drawn in this large ICA, see Figure 24. This year, staff swept all hotspots at least twice, while many were treated multiple times, and several were treated during aerial sprays. Last year, access to one large hotspot was restricted due the presence of a low-lying electrical cable. This year, Range Division partially addressed this safety hazard, by removing vegetation from a corridor along the cable. This allowed staff to more safely survey and treat plants in the hotspot. Special emphasis was made to treat hotspots aggressively with an herbicide cocktail of glyphosate and a pre-emergent. Of the nine visits made to this ICA, two were aerial sprays, five utilized the power sprayer, one used hand sprayers, and one used only manual control. Although hundreds of plants were found, total numbers declined from last year, a promising trend. In the coming year, staff plan to maintain high pressure on known hotspots, continue aerial sprays, and remotely survey grass-dominated areas.
- Core Buffer Surveys. While buffer surveys were completed around ICA-02 and ICA-03, the full 200 meter buffer around the core of the infestation in ICA-01 and ICA-04 was not completely surveyed. Much of the 200 meter buffer includes active ranges which are regularly mowed and maintained as open fields. Staff monitor these areas during annual road surveys. Some portions of

the buffer include grassy bowls and forest patches, and the eastern portion of the buffer includes steep vegetated slopes leading into Kaukonahua gulch. Staff surveyed Kaukonahua gulch aerially in 2014 and 2016, with no plants found. These aerial surveys will be repeated in the coming year. Completing buffer surveys will be a survey priority in the next two years, and will likely include a combination of ground sweeps, binocular surveys and aerial surveys.

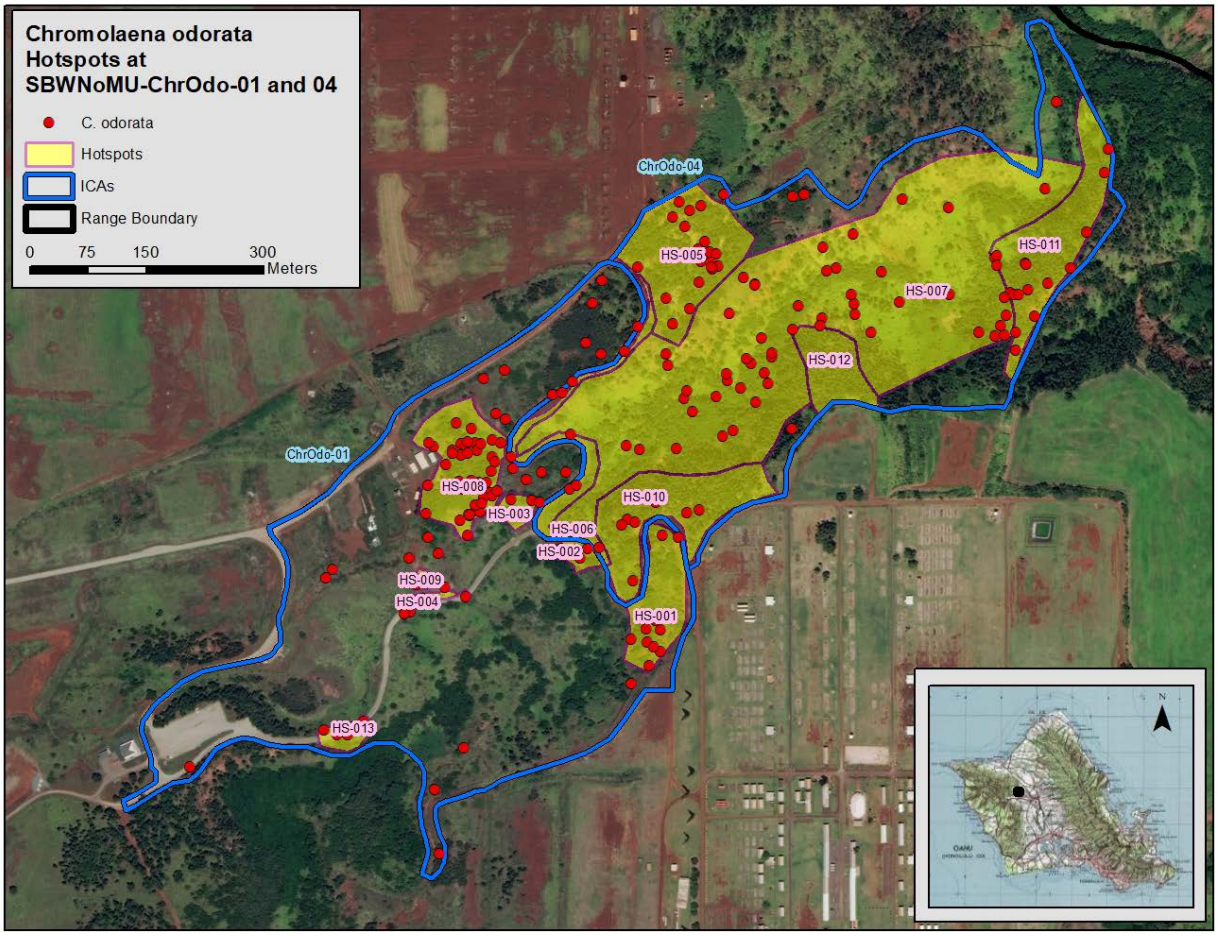

Figure 24. Hotspots in SBW Core ICAs

- SBWNoMU-ChrOdo-02. The most northerly of the ICAs at SBW, this site was first discovered in February of 2014. This site is surrounded by fast-growing, thick *U. maxima*. Staff sprayed the grass on three visits, including one aerial treatment in June. All sprays included a pre-emergent herbicide, which is vital in both suppressing grass cover and minimizing *C. odorata* germination. Thorough checks can only be conducted if the area is open. No *C. odorata* was found at the ICA this year, a milestone. Also, this makes three years with no plants found in the roadside portion of this ICA. The last mature plant was removed from the ICA in April 2016, and the last immature plant was removed in January 2017. In the coming year, staff will work to maintain consistent pressure on this ICA.
- SBWNoMU-ChrOdo-03. Located next to a training target, this ICA was first discovered in July of 2014. The west half of the ICA is dominated by trees and has an open understory, while the east half runs along a bluff above a road and is dominated by *U. maxima*. Previously, control efforts were hampered by the thick grass and presence of one suspected piece of UXO. This year, the UXO was inspected by EOD and determined to be scrap metal only. Staff also sprayed the grassy portion of the ICA twice with pre-emergent herbicide, including once aerially. This

allowed staff to conduct more thorough checks across the ICA. While few mature plants have ever been seen at this ICA, last year a patch of 250 immatures were found tucked in the grass, in a spot which was missed on previous visits. This year, total numbers of plants dropped, with only 1 small mature, 33 immatures, and 20 seedlings found. In the coming year, staff will continue to focus on maintaining low grass cover, and conducting thorough surveys of the entire ICA.

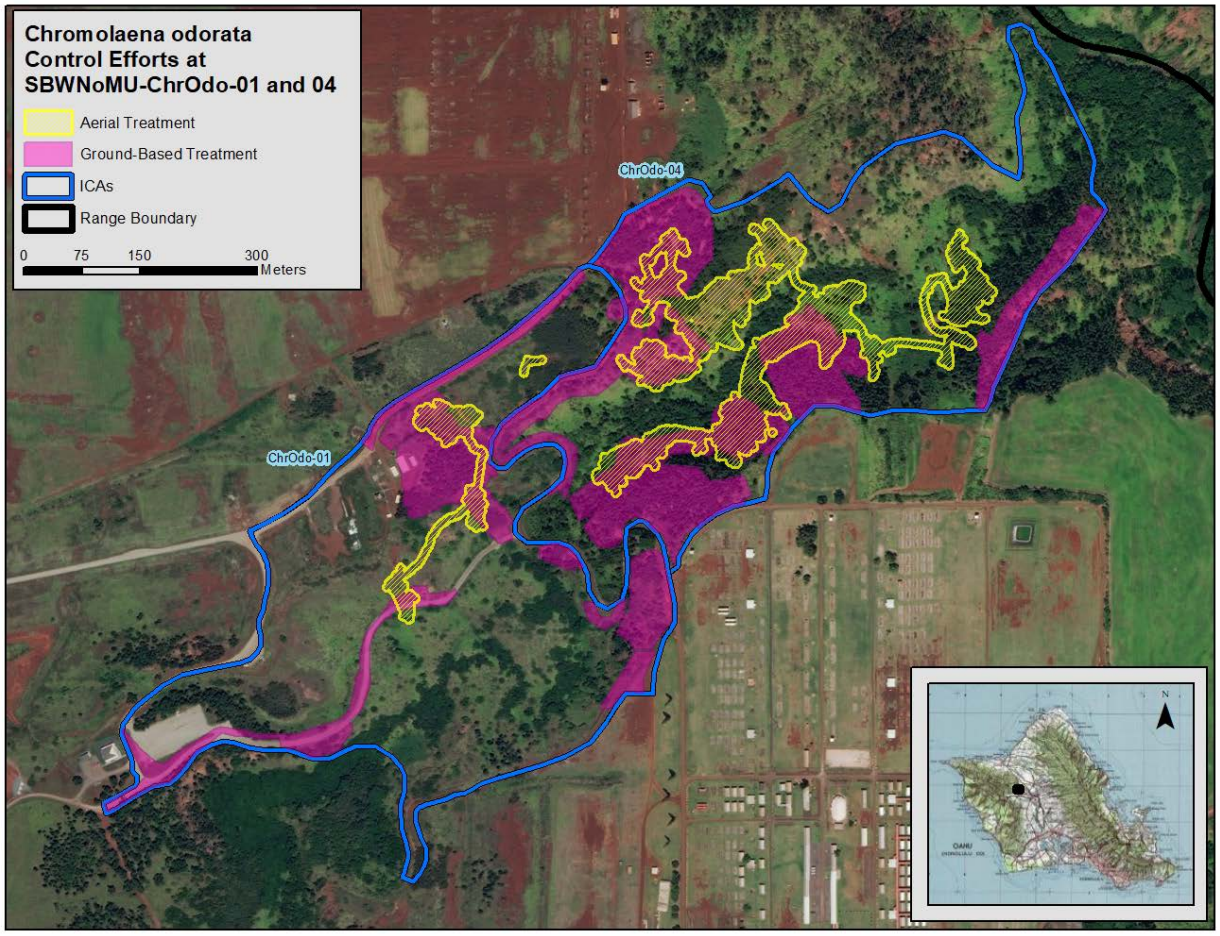

Figure 25. Aerial and Ground Treatment in SBW Core Infestation

- 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 ICA-01, hotspots were drawn around concentrations of plants; there are six hotspots in this ICA. Most of the hotspots are treatable from the ground, but the largest, HS-007 is best treated via aerial sprays. This year, staff maintained aerial spray effort and expanded ground-based control of hotspots, particularly on the southeastern side of the gulch. All hotspots were treated at least twice the year, and most of them received multiple treatments. Of the 13 visits made to the ICA, four were aerial sprays, five utilized the power sprayer, and the remaining four used hand sprayers or manual control. As in ICA-01, all sprays included a pre-emergent. This year, 5.05 ha were aerially sprayed and 7.71 ha were treated on the ground, see Figure 25. In contrast, last year 4.97 ha were aerially sprayed and 5.56 ha treated on the ground. The entire aerial spray zone can now be treated in a day, a testament to the efficacy of past sprays. The total number of plants treated declined somewhat this year, however, as it is difficult to accurately estimate the number of plants controlled in dense patches, this may not yet be a useful measure of

success. In the coming year, staff plan to maintain high pressure on known hotspots, expand ground-based surveys on the northeastern side of the gulch, continue aerial sprays, and remotely survey grass-dominated areas.

- SBWNoMU-ChrOdo-05. This new ICA was discovered on November 28, 2017 during sweeps for another target weed, *E. poepiggiana*. One mature, flowering plant was found along the main road running through the Kolekole Ranges (KR). Staff previously had noted that a wide band of vegetation was cleared along the road, presumably as part of range maintenance efforts. It is strongly suspected that *C. odorata* was introduced to KR as a result of this clearing work. The infestation area was sprayed with pre-emergence herbicide, and checked quarterly, with no additional plants found. A 200m buffer was drawn around the site. Most of the southern half of the buffer has already been swept, but most of the northern half of the buffer falls within the live fire range and is dominated by thick grass, making it unsafe to survey. Staff will consider other options, such as aerial or drone surveys, to inspect this portion of the buffer.

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. A 200 meter buffer survey around the infestation site was completed in 2014-2015 to delimit the infestation. Although the single mature plant did set seed, staff treated the area with pre-emergent herbicide, and no plants have been found since. This makes almost three and a half years with no plants found, which strongly suggests that no seed bank was formed. Initially, the site was scheduled for quarterly checks, but due to the lack of recruitment, it is now scheduled for twice a year checks. Due the site's close proximity to other work areas in SBE, staff occasionally conduct extra monitoring as well. Control efforts are summarized in Table 18.

Table 18. SBE Control Efforts

ICA Code	2018 Report Year				2017 Report Year		
	ICA Area (ha)	Area Weeded (ha)	Effort (hours)	# Visits	Area Weeded (ha)	Effort (hours)	# Visits
SBE-ChrOdo-01	0.18	0.18	3.00	3	0.18	3.25	3

In the past, staff observed evidence of vegetation spraying around the ICA, possibly because it is adjacent to powerline poles maintained by HECO. These sprays keep the area open and easy to survey. The ICA will be monitored for at least ten years from the date of the last mature plant. 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.

Manuwai Update

Chromolaena odorata was first found at Manuwai on February 23, 2017. 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. Two immatures were later found in March 2017. The ICA was treated once with pre-emergent herbicide, and no plants have been seen since. Control efforts for the year are summarized in Table 19. The ICA will be monitored quarterly in the coming year.

Table 19. Manuwai Control Efforts

ICA Code	2018 Report Year				2017 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	125.70	10	78	13.75	4

Last year, staff determined the dispersal of *C. odorata* to Manuwai likely occurred either in January 2016 or December 2015, during camp trips geared towards treating alien canopy weeds across six different WCAs; these are the 'Potentially Contaminated' purple polygons in Figure 26. This year, staff surveyed all Potentially Contaminated areas, 14.09 ha. No additional *C. odorata* was found. The high effort spent this year is entirely due to these buffer sweeps. Since much of the area within the 200m buffer is marginal habitat for *C. odorata*, full sweeps were not conducted across it. Instead, staff looked for *C. odorata* whenever conducting weed control or other management work in the MU; these areas are noted in green in Figure 26. While these surveys were a major effort, staff had only moderate confidence in detecting isolated *C. odorata* due to the thick vegetation and steep terrain. Therefore, OANRP plans to survey the Potentially Contaminated areas again in five years (2022-2023 report year). In the meantime, staff will continue to look for *C. odorata* in the course of other management work and practice good sanitation.

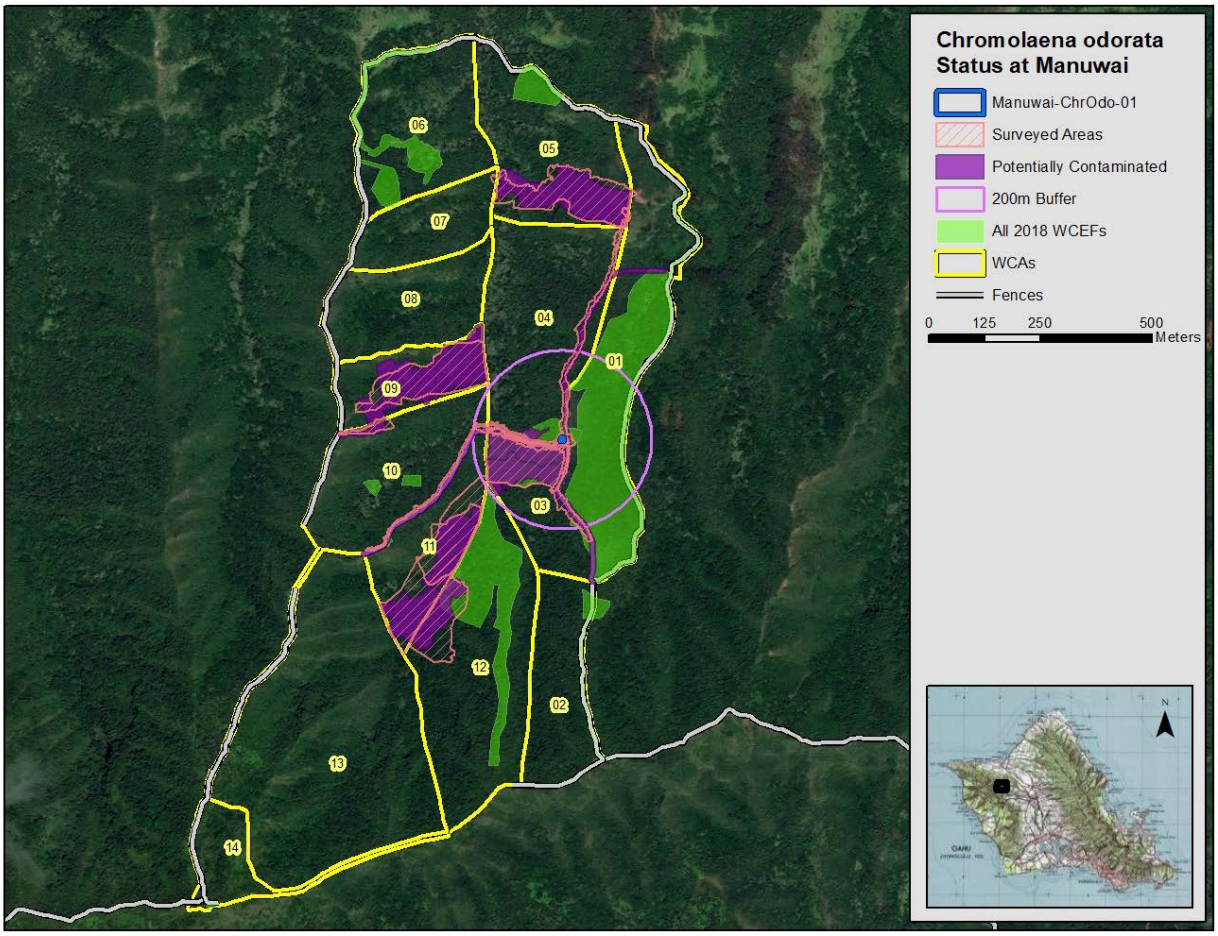

Figure 26. *C. odorata* Status at Manuwai

Makaha Valley Update

In December 2017, a recreational hiker posted a photo of *C. odorata* in Makaha Valley on social media, see Figure 28. OANRP staff conducted a site visit on December 11, 2017 and found two plants. One of the plants was flowering and mature, with a 2" diameter base, while the other was immature. Both were controlled. The plants were found on an unofficial trail on the west side of the valley, see Figure 27. The find was reported to OISC, who conducted extensive surveys in both 200m and 800m buffers around the plant; no other plants were found. The *C. odorata* site is about 900 meters away from the Makaha I MU, and is not visited by OANRP or partner agencies. Makaha is managed by BWS and is not open to public hiking, however, there are numerous trails throughout the valley, and it appears to be a popular local hiking and hunting spot. In the absence of a more likely source, it is assumed that *C. odorata* was introduced to the area via recreational use. OANRP supports OISC and BWS efforts to manage *C. odorata* in Makaha, and will look for it whenever conducting field work in the valley.

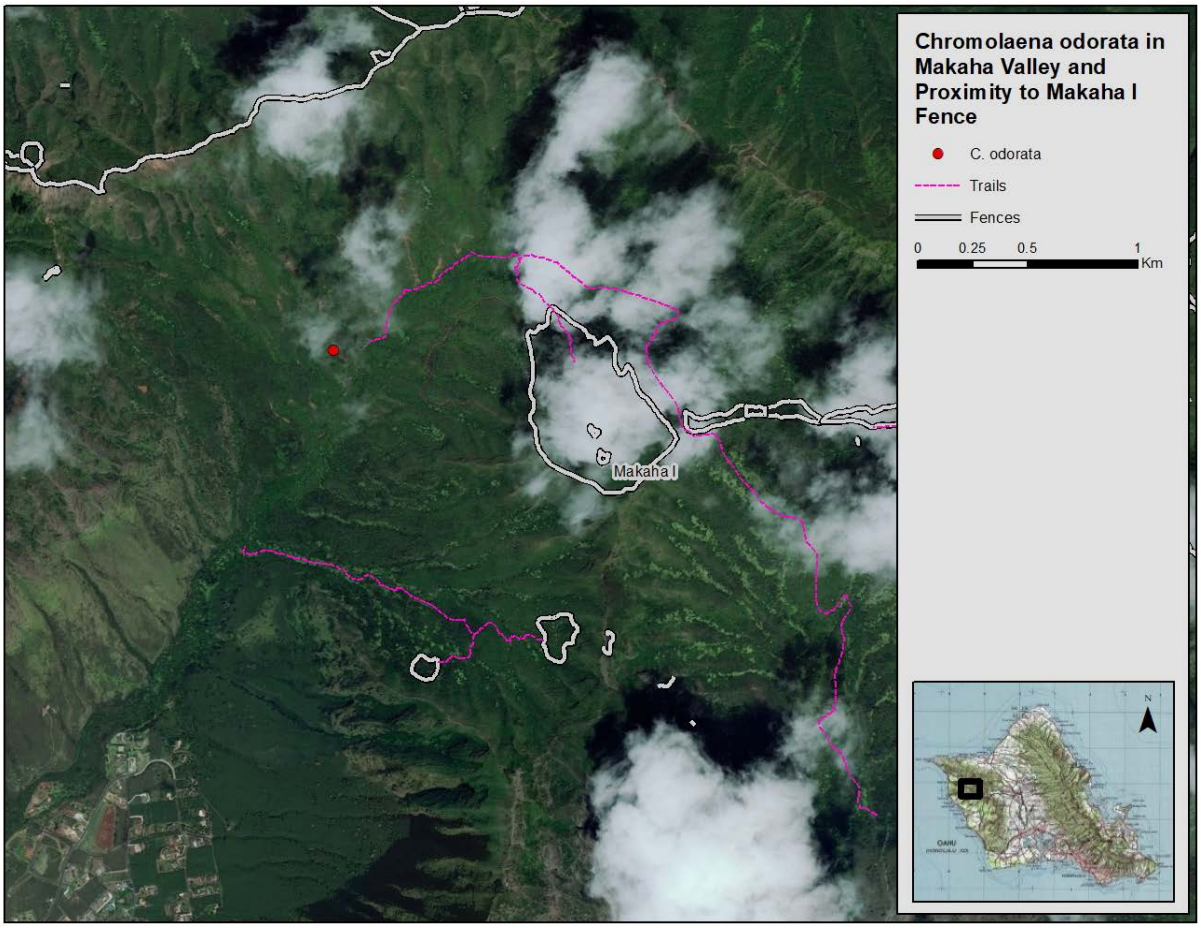

Figure 27. *C. odorata* site found in Makaha Valley, and proximity to Makaha I MU.

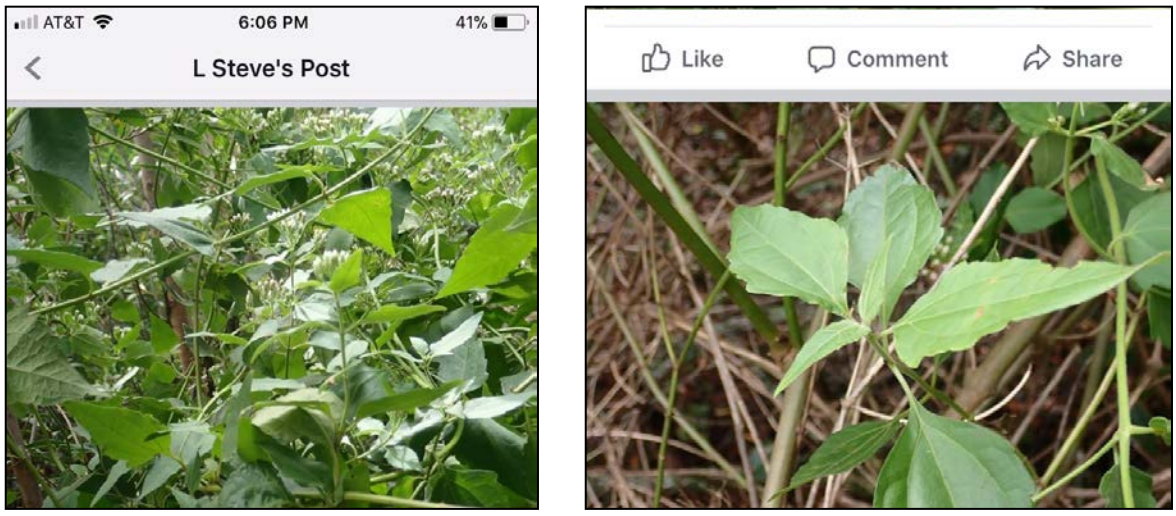

Figure 28. Social media post showing *C. odorata* found by a hiker in Makaha Valley.

Pupukea-Paumalu State Park Reserve Update

During a weekend recreational hike, OANRP staff discovered one mature, meter tall, *C. odorata* along the Ehukai trail above Sunset Elementary School in the Pupukea-Paumalu State Park Reserve; see Figure 29. This popular trail sees heavy recreational use and connects to a network of trails in the Reserve. The new *C. odorata* site is about 2 km from heavily infested areas at KTA to the east, and a little over 2 km from two small ICAs on the edge of the KTA Alpha 3 training area to the southeast. The Reserve trails connect to the State's Kaunala Trail in Alpha 3, and from there to all the roads in KTA. Both the Reserve trails and Kaunala Trail are used by hikers, mountain bikers, and motocross riders; these are the suspected vectors for this find. OANRP reported the find to OISC, and plans to assist OISC's efforts here by obtaining a permit from the State Parks Department and surveying the trails in the Reserve. The North Shore Community Land Trust works with the State Parks Department to manage the area, and according to their website, holds monthly community work days at the Reserve (https://northshoreland.org/the-latest/land-stewarship/pupukea-paumalu-2/). This may be a venue to increase public awareness of *C. odorata* and encourage hikers and other recreational users to clean their boots and gear before entering natural areas. Once trail surveys are complete, OANRP will meet with OISC to discuss management and public outreach options.

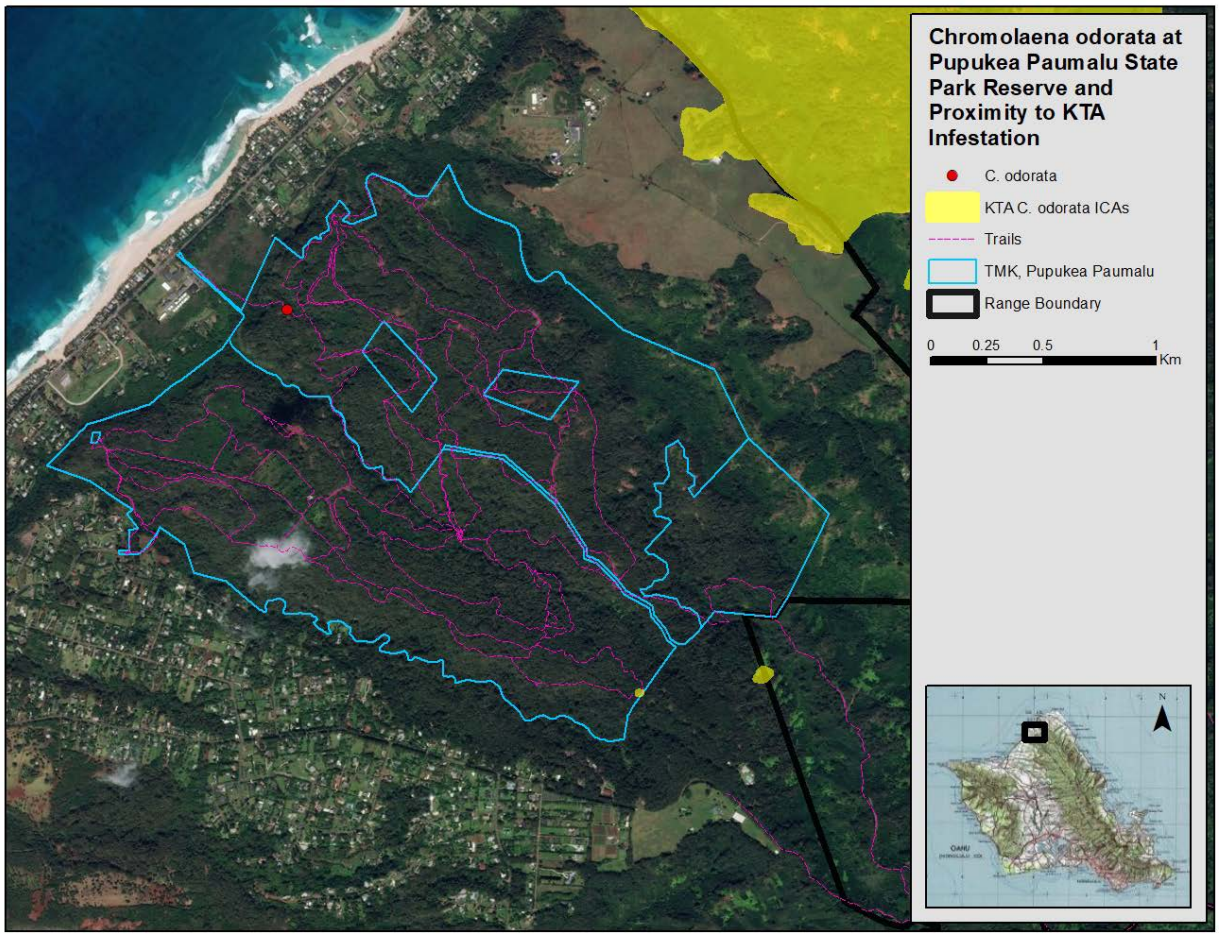

Figure 29. *C. odorata* infestation site at Kaluaa No MU, and proximity to the SBW infestation.

Kaluaa No MU Update

Staff discovered *C. odorata* along a major access trail for the Kaluaa & Waieli MU on May 10, 2018. Two plants were found; one was immature, but the other was large, mature, full of seed, and possibly several years old. The trail is used by staff, and occasionally partner agencies, to access the north end of the MU, including Puu Hapapa; the trail is not easily accessible to the public and is not used by the military. The plants were approximately 10 meters off the trail. The most likely vector for this new infestation site is OANRP. Between early 2018 and 2014, there are numerous occasions where staff worked in KTA controlling *C. odorata*, and within one or two working days visited Kaluaa & Waieli. The new site is unlikely to have dispersed from SBW, as it is approximately 3 km from the closest known *C. odorata* in SBW, and 4 km from the SBW infestation core; see Figure 30. Last report year, OANRP began using gear dedicated to *C. odorata* during all control efforts. Given the size of the mature plant, it is possible dispersal to Kaluaa occurred prior to the use of this dedicated gear, but this find serves as a reminder of the importance of always practicing good sanitation.

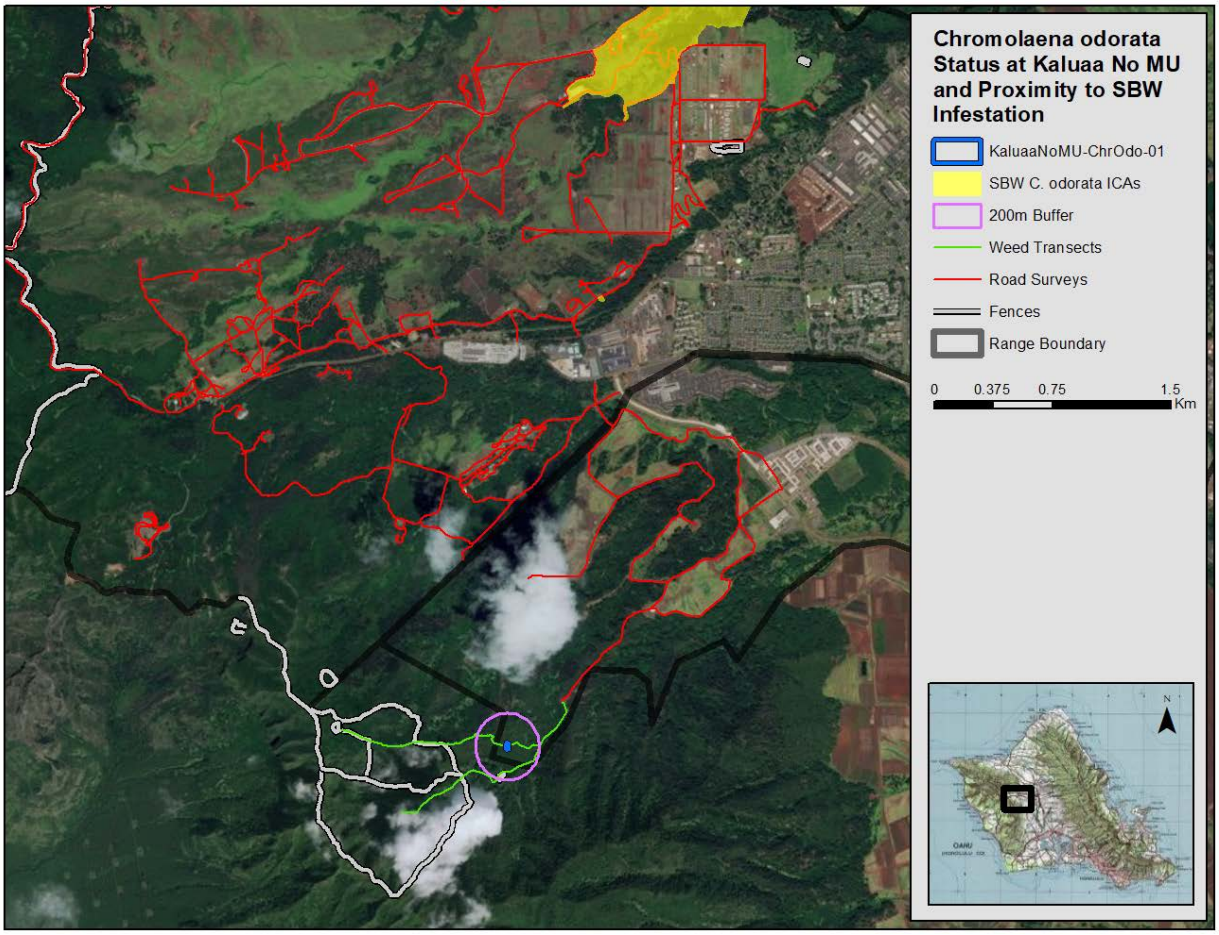

Figure 30. *C. odorata* infestation site at Kaluaa No MU, and proximity to the SBW infestation.

The Kaluaa site is located within the SBS installation boundary, but is less than 100 meters from the Honouliuli Forest Reserve. Control efforts are summarized in Table 20. In the coming year, staff will delimit the infestation by surveying a 200 meter buffer around the known plants and monitoring the whole access trail. Staff already monitor Weed Transects along the entire access trail. The transects are generally read in the first quarter of the year; this year, an additional reading is scheduled for fall of 2018. The road leading to the Kaluaa trail head is monitored during regular annual road surveys, as are all roads

within SBS. Fortunately, the area around the known plants is heavily forested, and not the open, scrubby habitat *C. odorata* appears to thrive in best. The ICA was treated once with a pre-emergent herbicide to reduce on-site recruitment, and will be monitored quarterly in the coming year.

Table 20. Kaluaa No MU Control Efforts

ICA Code	2018 Report Year				2017 Report Year		
	ICA Area (m^2)	Area Weeded (m^2)	Effort (hours)	# Visits	Area Weeded (m^2)	Effort (hours)	# Visits
KaluaaNoMU-ChrOdo-01	812	812	1.0	1	n/a	n/a	n/a

Biocontrol Update

Despite the considerable resources and time invested into *C. odorata* management by OANRP and OISC, efforts appear to be insufficient at stopping the spread of this pest to new locations. Resources are inadequate to conduct planned treatment at all known infestations, much less survey potentially infested lands. More aggressive tools are needed. Biocontrol agents have successfully been used to manage *C. odorata* in other parts of the world. This year, OANRP continued to talk with partner agencies about how to pursue development of a biocontrol for release here in Hawaii. The most promising biocontrol is *Cecidochares connexa*, a gall-forming fly. The International Organization for Biological Control of Noxious Animals and Plants (IOBC) Working Group on Chromolaena endorses this agent: "*C. connexa* is the best biocontrol agent for chromolaena available at present, in terms of host range, efficacy and east of establishment." Galls develop on the stems of plants affected by *C. connexa*, and act as resource sinks; heavily galled plants are reported to have little flower/seed set. In addition, *C. connexa* is easy to rear and establish in the field, and disperses widely; see Appendix 3-11.

One complicating factor for this agent is that there are two different biotypes of *C. odorata*: the Asian/West African (AWA) and South African (SA). These names do not refer to the origin of the biotype, but to the area infested by it. The IOBC defines describes the morphological differences between the biotypes on their website; see Appendix 3-12. The AWA biotype is thought to be more widespread; as its nickname suggests, it is the type found at infestations across Asia and the Pacific. The IOBC states, "due to (*C. connexa's*) narrow host range, it cannot develop on the SA biotype of chromolaena."

While plants found on Oahu morphologically appear most similar to the AWA biotype, this needs to be confirmed before pursuing *C. connexa* further. OANRP is currently working with Dr. Cliff Morden (University of Hawaii) and OISC to answer this question. OANRP and OISC collected samples of *C. odorata* from different infestations around the island, including Aiea/Camp Smith, Kahana, Makaha, SBW, and both the eastern and western sides of KTA. Dr. Morden's lab will conduct genetic analysis of the samples and compare them to published results as well as a fresh sample from Guam; a permit to import vegetative *C. odorata* material was obtained from HDOA. OANRP provided funding for a student hire for Dr. Morden's lab to conduct this work. Once complete, Dr. Morden plans to publish the results of the genetic analysis. Included in the paper will be a discussion of the distribution of *C. odorata* on Oahu, the history of management efforts, and the current status of the infestation. Partners at DOFAW recommended that such a paper would be useful in justifying the threat of *C. odorata* to Hawaii and support later efforts to pursue a biocontrol for it.

Assuming the *C. odorata* in Hawaii does genetically match the AWA biotype, OANRP will continue to pursue *C. connexa* biocontrol testing.

3.7 RESTORATION ACTIONS UPDATE

3.7.1. Management Unit Summaries

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. In general, the most common restoration approach entails conducting seed sows with fast-growing native species, and/or outplanting plants that are also expected to establish either understory or canopy cover quickly. Some more nuanced approaches are taken for species where host specificity and/or habitat specificity is critical such as for *Drosophila* and *Achatinella* spp.

Restoration actions are tracked within WCAs, 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. 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). Reporting of numbers of outplants and restoration area began in 2016, and total number of outplants, and area totals for outplants and SDT efforts to date are displayed in Figure 31 and 32 below. Total number of outplants in each MU since 2016 is displayed in Figure 33.

More detailed restoration information is presented, organized by MU, with a map showing locations of restoration activities and the specific WCAs in which those occurred, followed by a table summarizing restoration actions for each MU, for the last report year. Total number of plants and outplant and SDT area for 2018 is also presented in Table 32 at the end of all the summaries.

This year, over three times more common native outplants were planted than last year. Outplants continued to account for the largest restoration action effort. Additionally, nearly 1500 *Bidens torta* were grown at OANRP nurseries and planted at Kahua to establish a Seed Production Plot for that taxa. See Seed Production Plots Update later in this section for details on those efforts. Hand broadcast seed sows were conducted at restoration sites that were cleared of large swaths of alien vegetation to establish quick cover. Sows were mostly conducted with *B. torta* and *Pipturus albidus* but a few other species were opportunistically broadcast as well; no formal follow-up on those has been conducted. However, this year staff aim to collect enough seed from these species as well as others to be able to conduct seed sow trials. While these trials are not formally designed yet, staff would like to pin down best practices for broadcast sows for a variety of species, as well as to determine how both processed and stored seed perform and compare to each other.

Restoration efforts commenced at the Palikea North snail enclosure this year. Four outplanting events occurred from December through June. Numbers of snail enclosure outplants are reported separately from WCA outplants in the Palikea summary in Table 31.

Individual outplant survival is not monitored. Outplants are re-visited post-planting as needed for supplemental water and to take general observations about overall outplant health. Vegetation monitoring occurs at a subset of restoration sites. Those thought to warrant the effort associated with monitoring include but are not limited to: sites where significant amounts of alien canopy has been removed (all of the Ecosystem Restoration team sites), sites like those in Makaha on

Board of Water supply land where data can be presented to the land owner about native vegetation response after weed control with herbicide, or sites like snail enclosures where monitoring can help assess appropriate habitat for snails. Monitoring techniques vary at each restoration site including: vegetation plot monitoring, point-intercept vegetation monitoring, photopoints, and Gigapan Imagery analysis. The MU belt plot monitoring that looks at overall success of management across the MU as a whole now includes analysis of restoration effort impacts. The Kahanahaiki and Palikea MU vegetation monitoring reports, Appendices 3-8 and 3-10 both address restoration impacts for each of those MU.

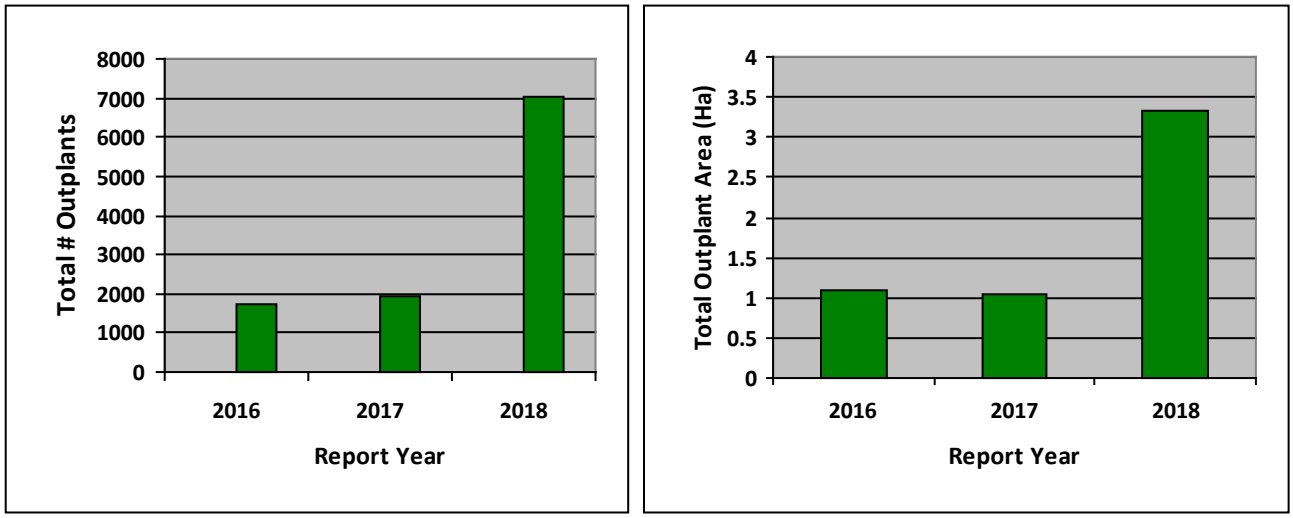

Figure 31. Number of outplants (left) and total area of outplants (right) each year since 2016

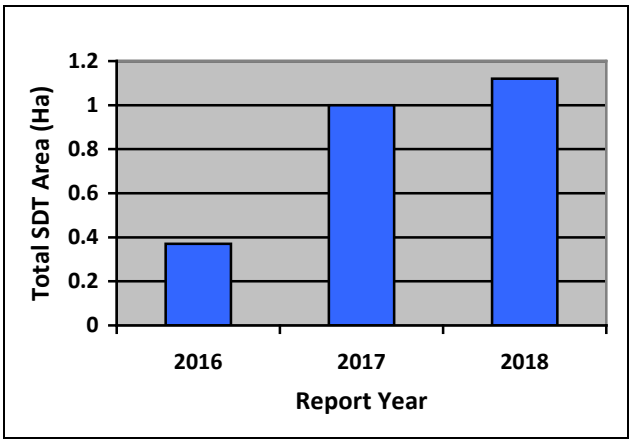

Figure 32. Total SDT area each year since 2016.

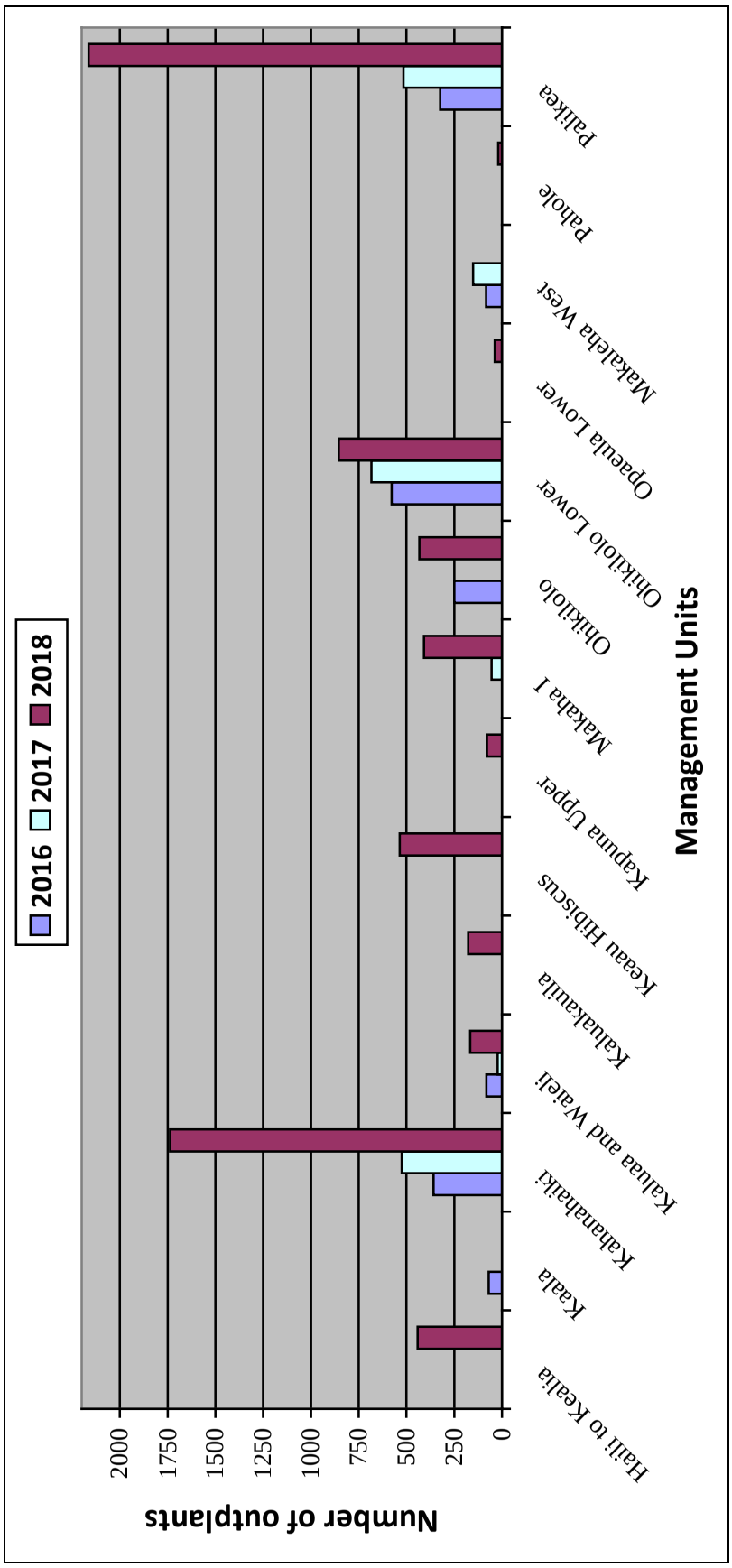

Figure 33. Number of outplants in each MU since 2016

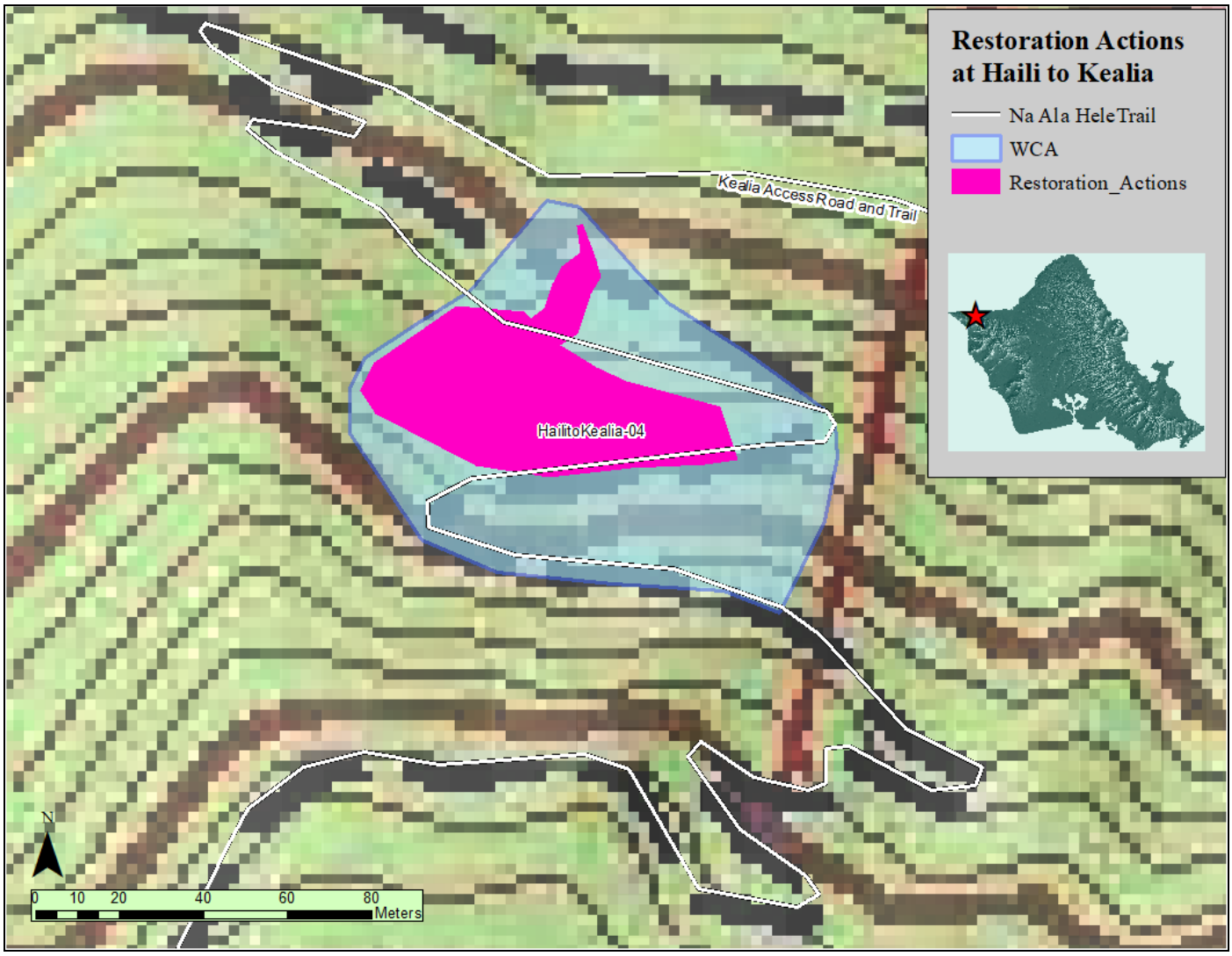

Figure 34. Map of Restoration site in respective WCA in Haili to Kealia.

Table 21. Summary of Restoration Actions in Haili to Kealia

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Haili to Kealia	Outplanting	441	2412	*Plumbago zeylanica*, *Erythrina sandwicensis*, *Chenopodium oahuensis*	Outplants were focused around the *Hibiscus brackenridgei* subsp. *mokuleianus* reintroduction in an effort to increase native cover and reduce alien grass levels. Future outplantings with *Dodonaea viscosa* are planned.

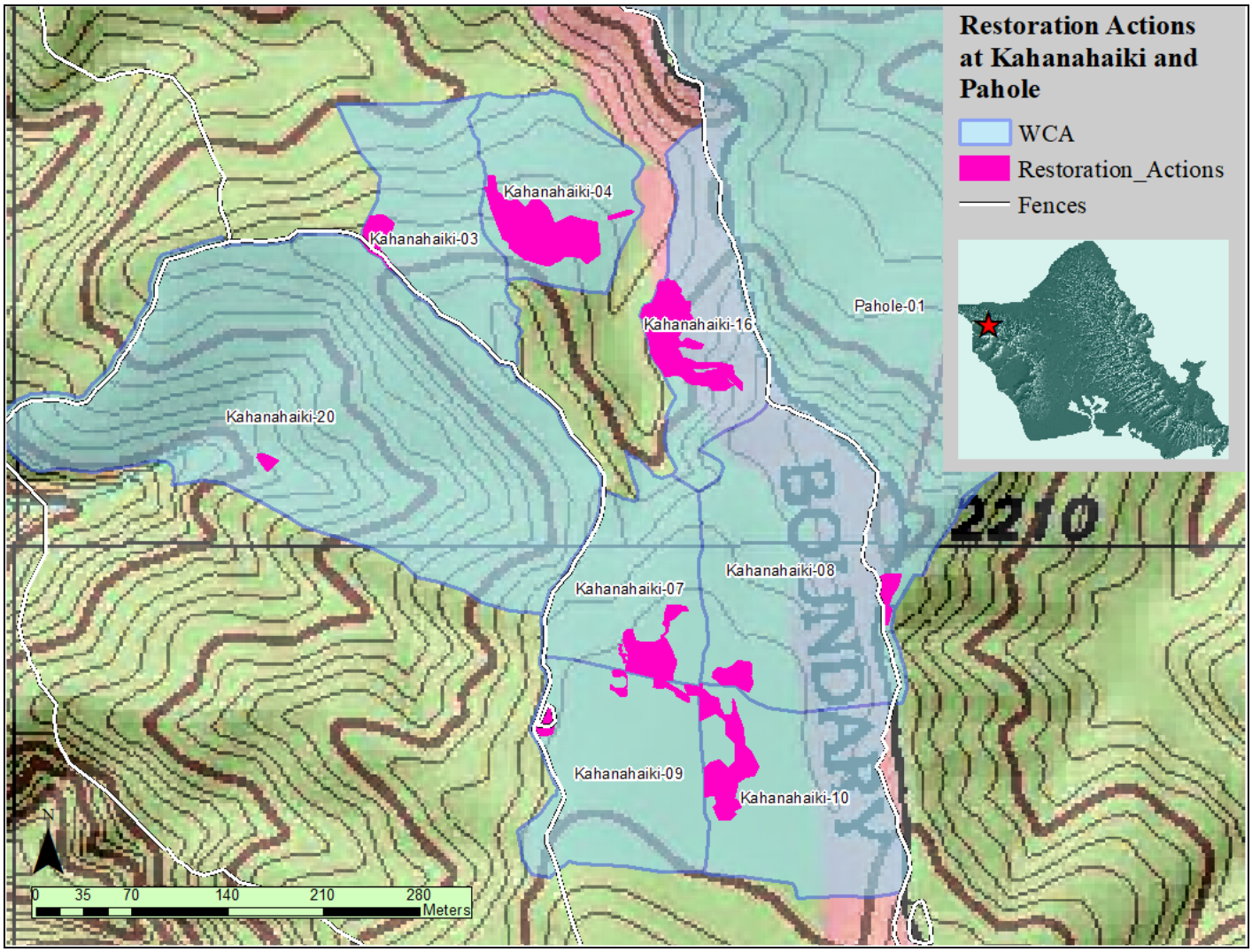

Figure 35. Map of Restoration sites in respective WCAs in Kahanahaiki and Pahole.

Table 22. Summary of Restoration Actions in Kahanahaiki and Pahole

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Kahanahaiki	Outplanting	1737	8817	*Acacia koa, Alyxia stellata, Bidens torta, Canavalia galeata, Carex wahuensis, Dodonaea viscosa, Hibiscus arnottianus* subsp. *arnottianus, Kadua affinis, Myrsine lessertiana, Pisonia* spp.	This year outplanting efforts continued at the 'Shire' site in Kahanahaiki-04, and at the largely expanded 'Schweppes' site in Kahanahaiki-16. A significant amount of *A. koa* and other common native species were planted across the 'Chipper' site in Kahanahaiki 07-10 with volunteer support. Smaller plantings were also conducted in Kahanahaiki-20 and 03 around *Flueggea neowawraea* and *Schiedea obovata* reintroductions respectively.

Table 22 (Continued).

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
	SDT	N/A	4574	*A. stellata, B. torta, Carex wahuensis, Dianella sandwicensis, Pipturus albidus*	Seed sows were conducted on several occasions in the Ecosystem Restoration team's sites in Kahanahaiki-04 and 16. Here *A. stellata* was sown opportunistically; no follow-up has been conducted to identify what if any germinates resulted from these sows.
Pahole	Outplanting	20	365	*A. koa, M. lessertiana, K. affinis*	These species were planted on a small puu around a *Cenchrus agrimonioides* var. *agrimonioides* reintroduction after aggressive removal of a persistent patch of *Melinis minutiflora* grass.

Figure 36. Photos of 'Schweppes Extension' site. Left: photo taken May, 2017 post initial clearing. Right: photo taken February, 2018 highlighting recruitment from seed sows.

Figure 37. Photos of original 'Schweppes' site where thickets of *C. hirta* and stands of *P. cattleianum* are now replaced with *Pisonia* outplants, and *P. albidus* seed sow recruits. Left: photo taken July, 2014. Right: photo taken April, 2018.

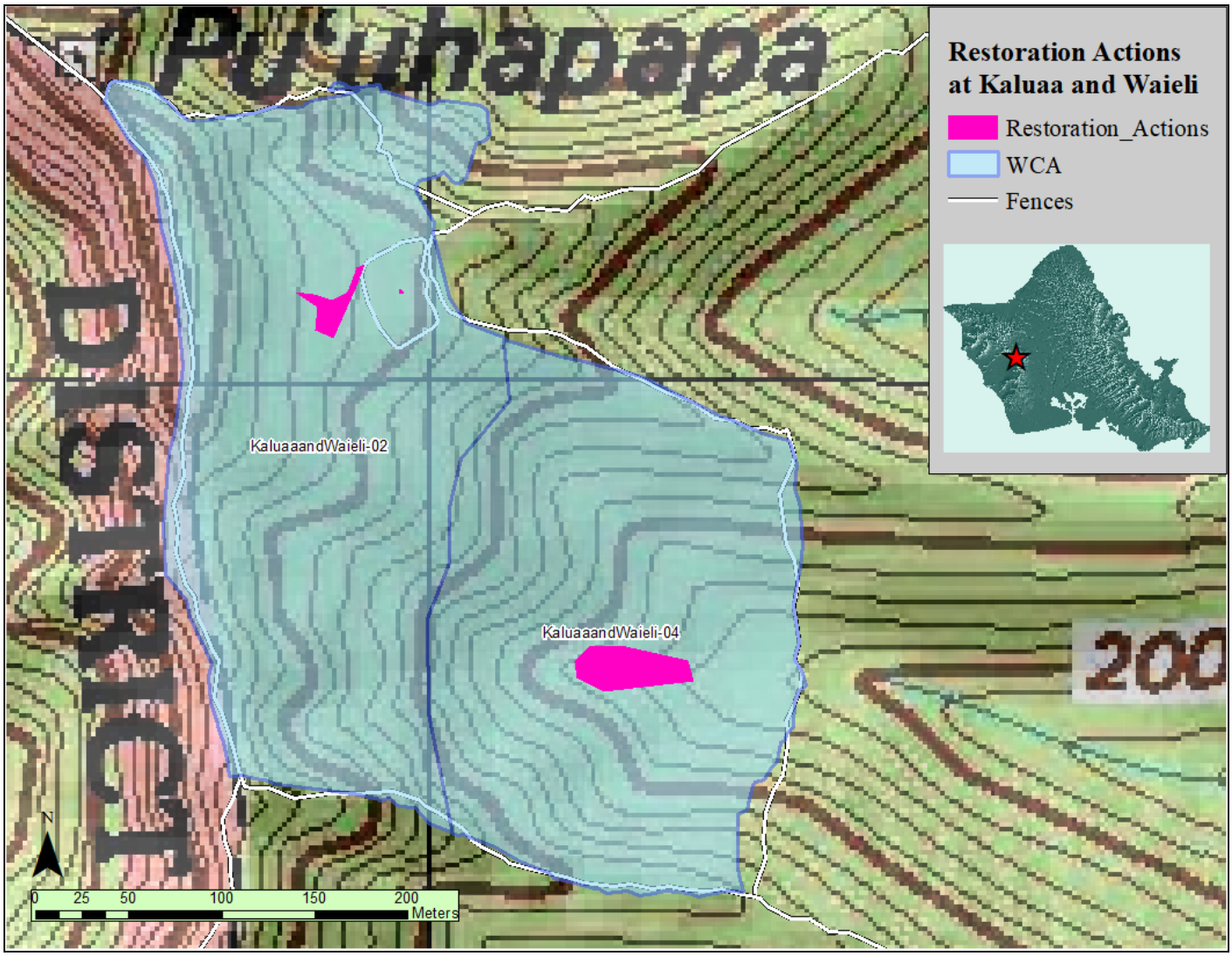

Figure 38. Map of Restoration sites in respective WCAs in Kaluaa and Waieli

Table 23. Summary of Restoration Actions in Kaluaa and Waieli

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Kaluaa and Waieli	Outplanting	166	1551	*Labordia kaalae, Urera glabra, Urera kaalae,*	Two reintroduction events were conducted in Kaluaa and Waieli MU, both in support of *Drosophila montgomeryi* management with outplantings of host species *Urera* spp.

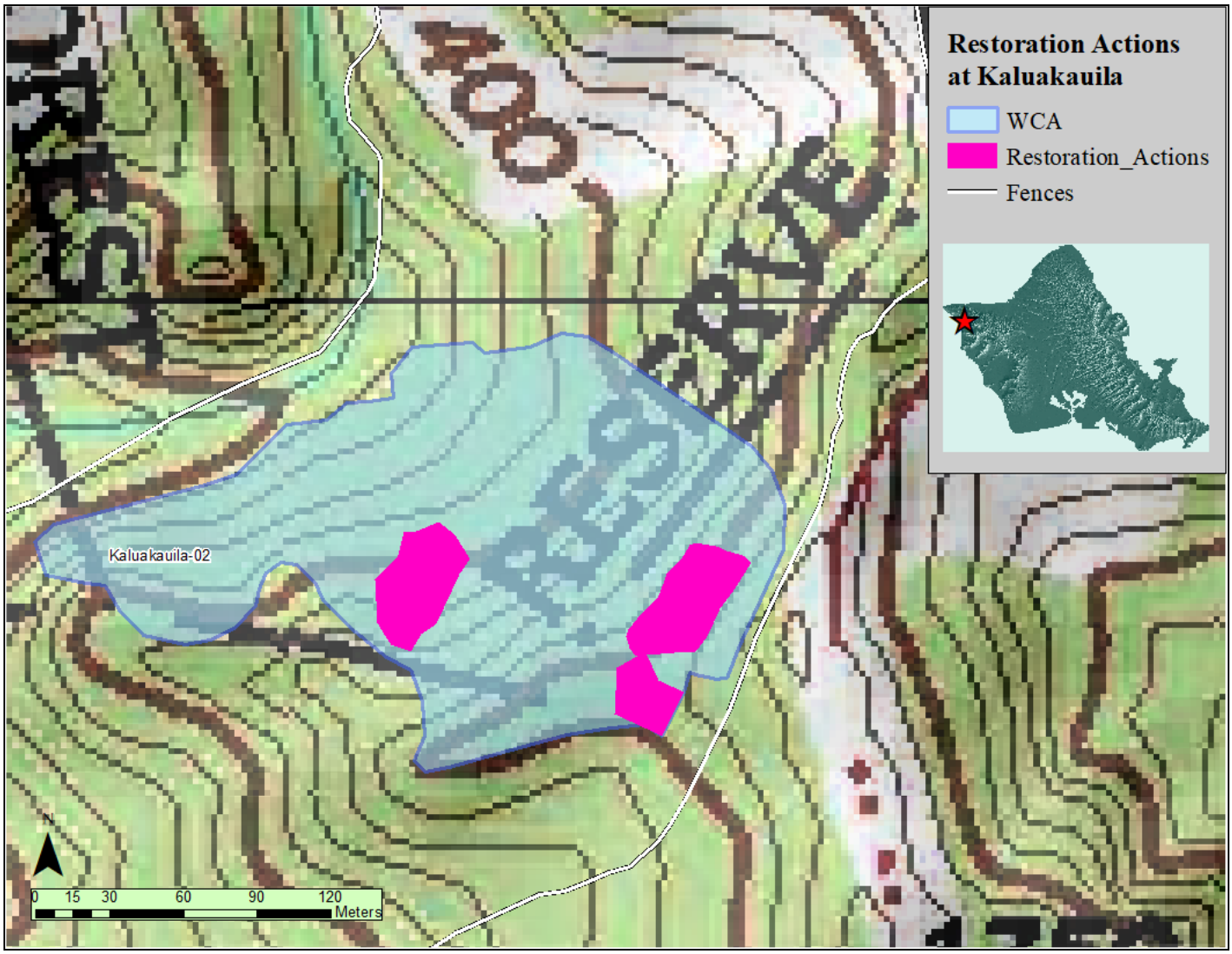

Figure 39. Map of Restoration sites in respective WCAs in Kaluakauila

Table 24. Summary of Restoration Actions in Kaluakauila

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Kaluakauila	Outplanting	177	3066	*Dodonaea viscosa, E. sandwicensis, Myoporum sandwicense*	A single reintroduction effort was made at the 'Upper Patch' of Kaluakauila MU where *Neraudia angulata* and *Nototrichium humile* are managed. In the forested areas, outplants were planted in locations where native canopy was sparse. Some *D. viscosa* was planted in full sun on bare soil in order to prevent erosion and establish more cover adjacent to the forested area near the ridge crest. More understory outplants are planned for the future.

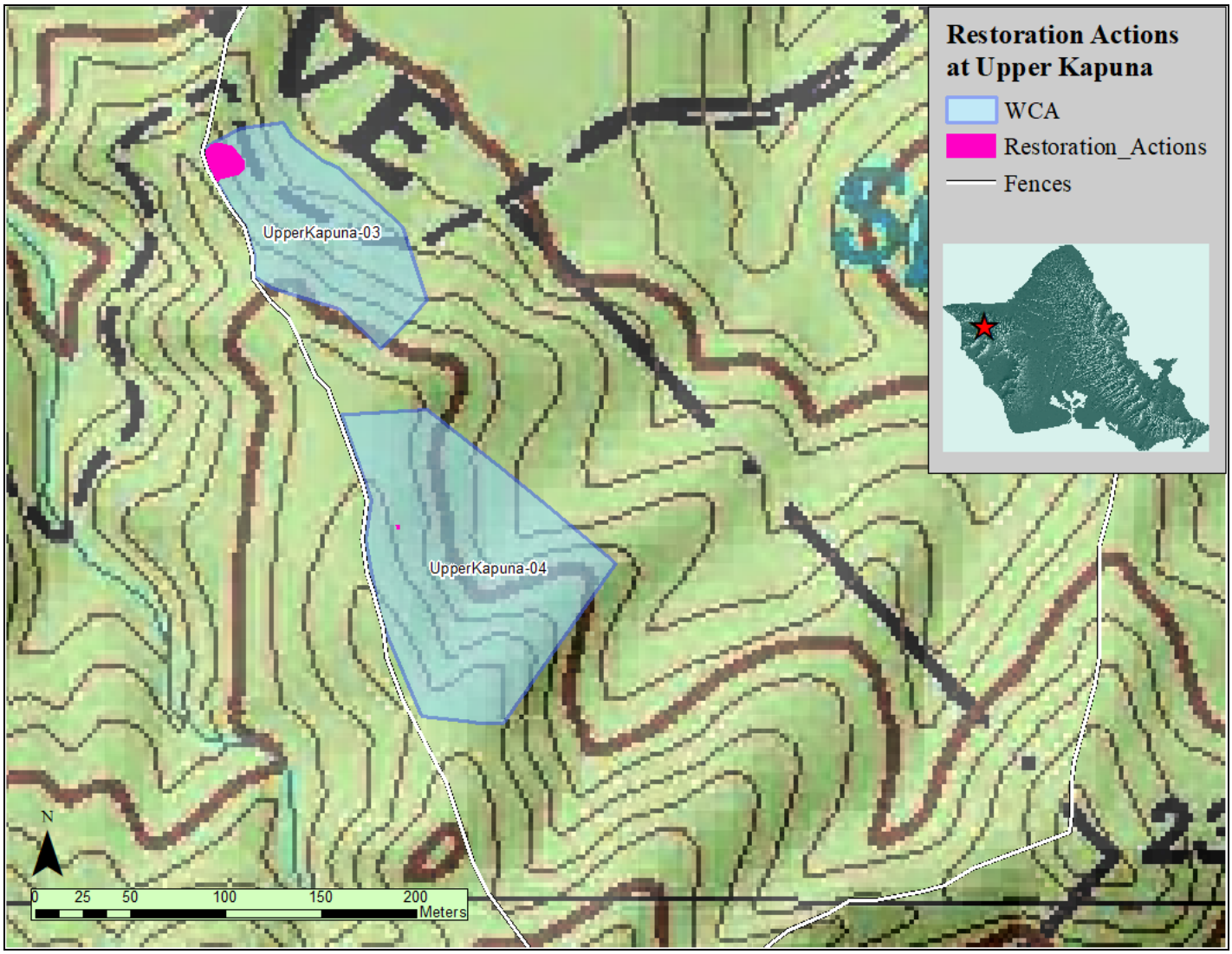

Figure 40. Map of Restoration sites in respective WCAs in Kapuna Upper

Table 25. Summary of Restoration Actions in Kapuna Upper

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Kapuna Upper	Outplanting	78	401	*A. koa*	Reintroductions of *A. koa* were planted along upper slopes of 'K/K' ridge to increase native cover around populations of *Schiedea nuttalii* and *Cyanea longiflora.*

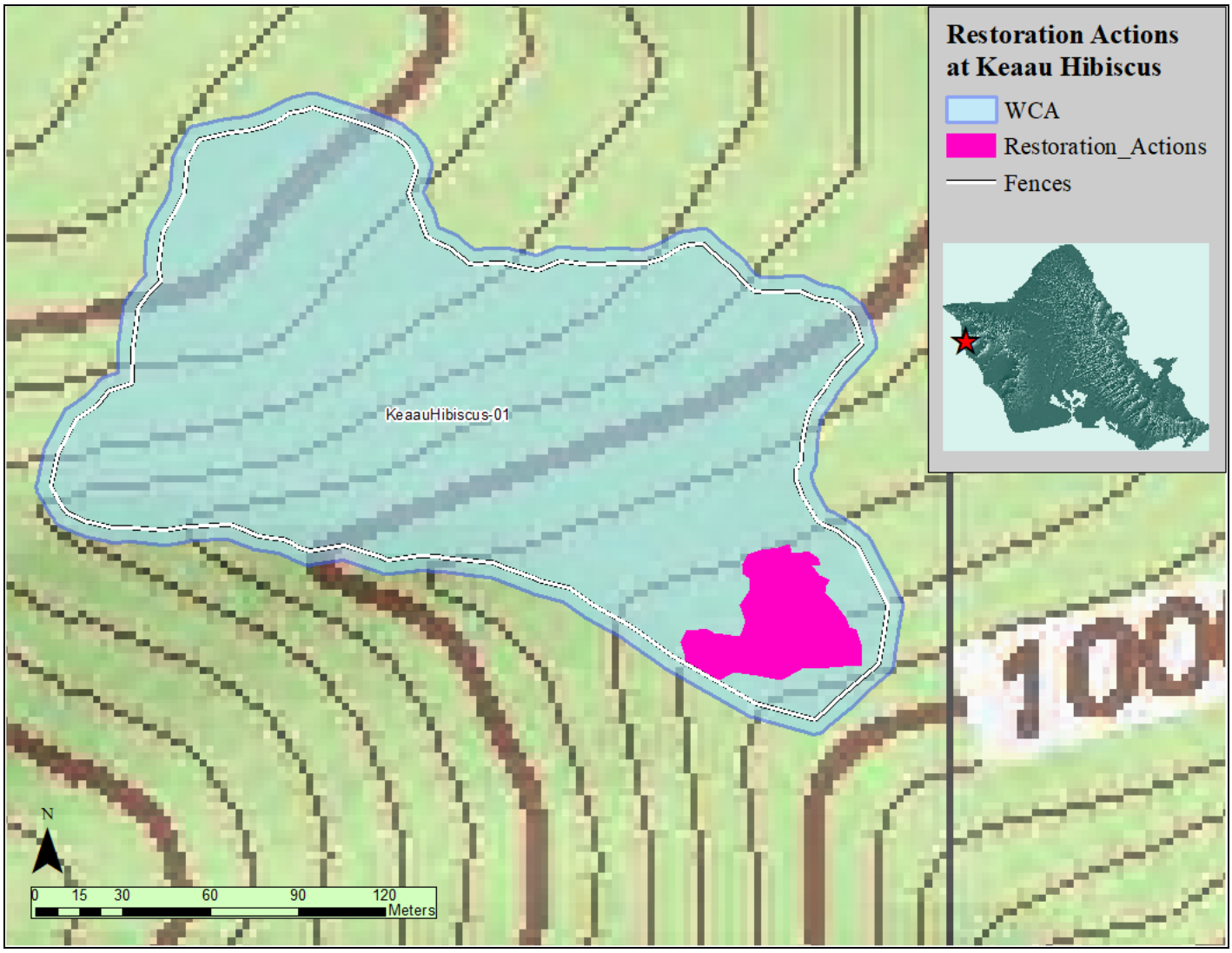

Figure 41. Map of Restoration site in respective WCA in Keaau Hibiscus

Table 26. Summary of Restoration Actions in Keaau Hibiscus

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Keaau Hibiscus	Outplanting	536	1667	*D. viscosa, E. sandwicensis, M. sanwicense*	Restoration activities in Keaau *Hibiscus* began around the *Hibiscus brackenridgei* reintroductions where alien grasses and woody species are controlled. Staff aimed to minimize grasses and *Leucaena leucocephala* around the *Hibiscus* with the addition of common native plants. Continued reintroduction efforts are planned for this coming year, however at the time of writing this report, a fire swept through the fenced area and burned most of the surrounding habitat. While some of the reintroductions were spared, future restoration work needs to be discussed.

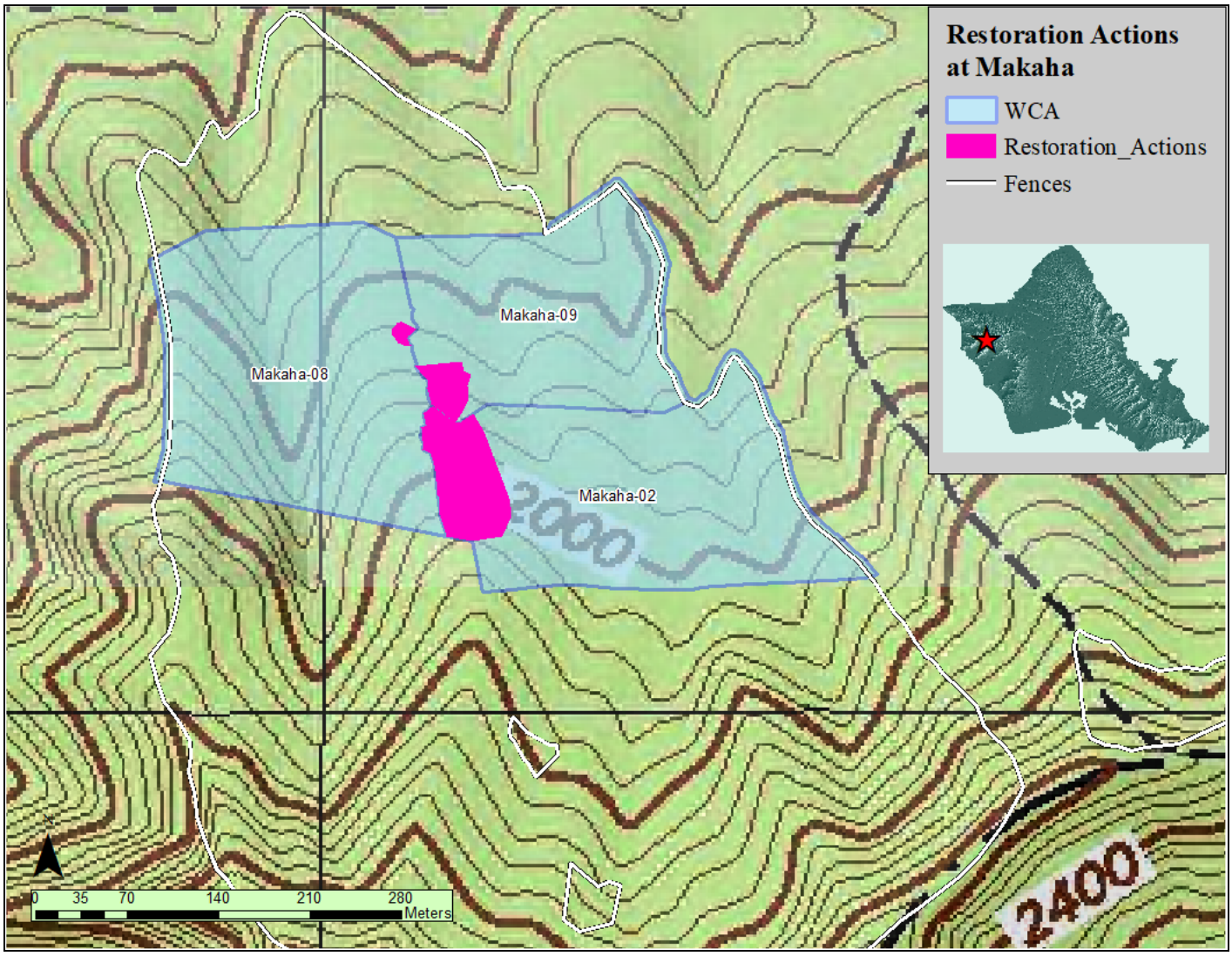

Figure 42. Map of Restoration sites in respective WCAs in Makaha

Table 27. Summary of Restoration Actions in Makaha

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Makaha	Outplanting	408	4917	*C. wahuensis, D. viscosa, H. arnottianus, K. affinis, Microlepia strigosa*	This year staff focused on seed sows and reintroductions at restoration sites on 'camp ridge.' Staff observed relatively little weed incursion in the Makaha-09 restoration site, major *A. koa* recruitment at both Makaha-09 and Makaha-02, and positive response of existing native canopy species uncovered by restoration efforts (i.e., flushing seen in Figures 43 and 44.) at both sites, suggesting that this ridge is resilient. Thus far, less weed follow-up and fewer restoration actions have been needed here than at some other MUs. Staff plan to expand efforts along this ridge in coming year.
	SDT	N/A	4683	*B. torta*	Seed sows were conducted on one occasion at Makaha-02, the newest cleared area where clearing resulted in much more open ground than the site in Makaha-09.

Figure 43. Photos taken at the Makaha-02 site on August, 2016. Right: photo taken May, 2018.

Figure 44. Photos taken at the Makaha-02 site on Camp Ridge. Existing individuals of native fern *Microlepia strigosa*, have also flushed out over the last two years. Left: photo taken in Aug, 2016. Right: photo taken May, 2018.

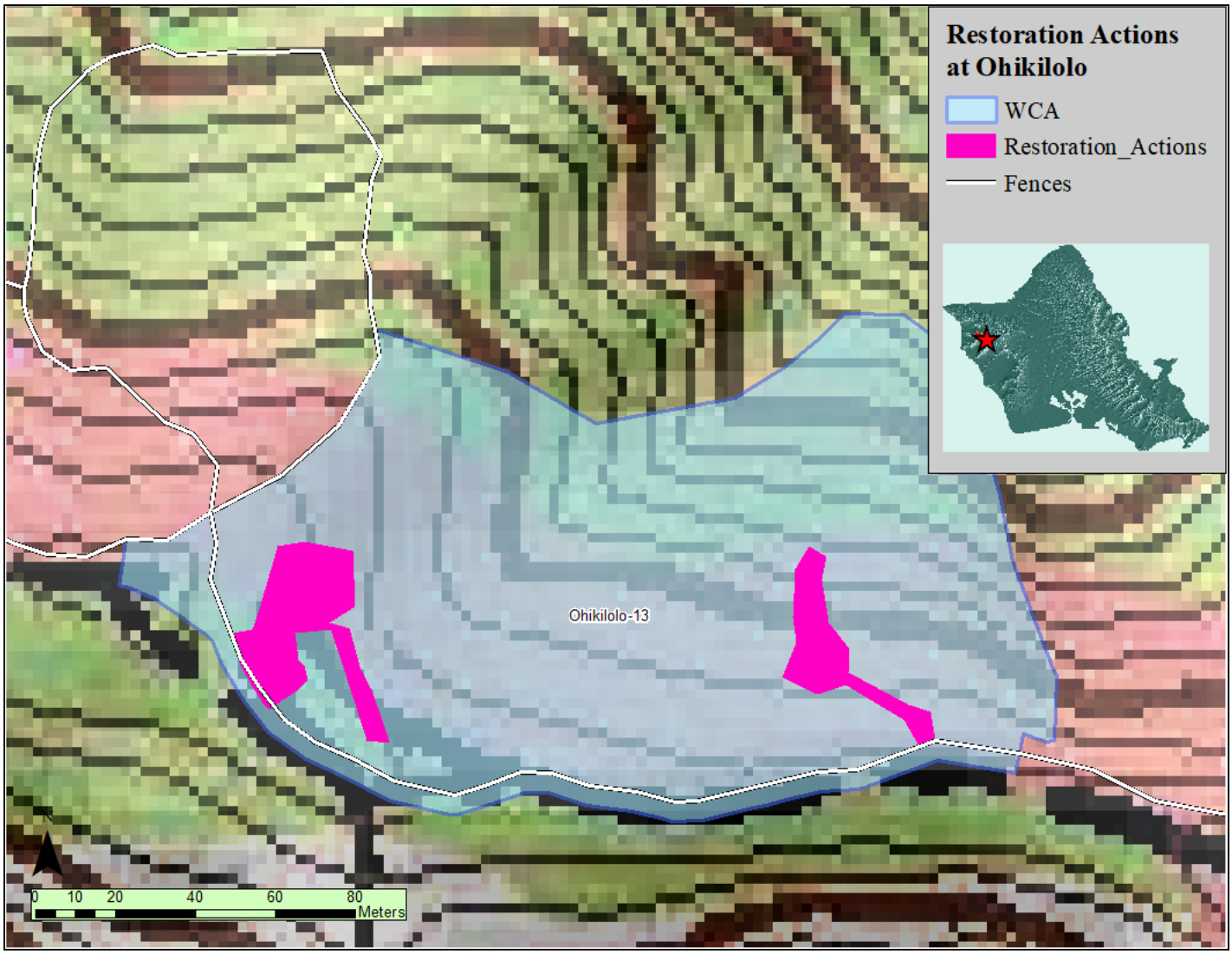

Figure 45. Map of Restoration site in respective WCA in Ohikilolo

Table 28. Summary of Restoration Actions in Ohikilolo

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Ohikilolo	Outplanting	432	1385	*A. koa, D. viscosa, Metrosideros polymorpha, Myoporum sandwicense, Sophora chrysophylla*	This year plantings were added at the restoration site around the cabin on the west end of the WCA to fill in locations where aggressive weeding took place over the last couple of years. Staff aim to connect the patchy native forest in this area to existing native cover in the WCA. On the east side of the WCA, *A. koa* were planted along ridges and in persistently grassy patches. Plans this year aim to aggressively remove the remaining *Schinus terebinthifolius* and continue replacement with *A. koa. D. viscosa* will also be planted to assist with exclusion of grasses on the slopes and to rehabilitate steep eroded areas.

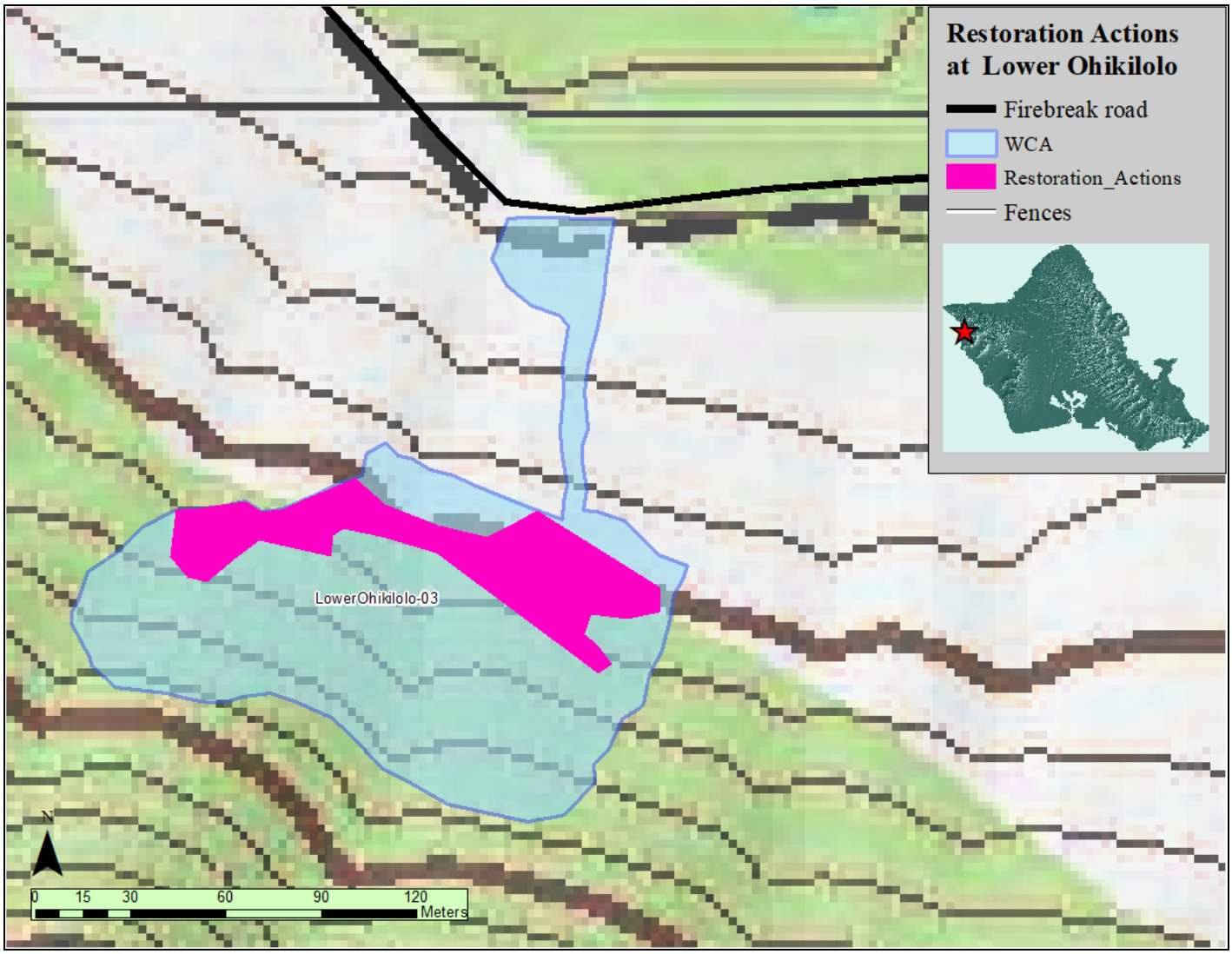

Figure 46. Map of Restoration site in respective WCA in Ohikilolo Lower.

Table 29. Summary of Restoration Actions in Ohikilolo Lower

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Ohikilolo Lower	Outplanting	855	2872	*D. viscosa, E. sandwicensis, M. sandwicense*	Efforts in the past had been concentrated in the 'Upper Akoko Patch', however, this year all outplants were planted around the *Hibiscus brackenridgei* reintroductions. Reductions of grass cover and the need for grass sprays are anticipated following reintroducing native species. While *E. sandwicensis* may take a long time to establish a canopy, staff are enthusiastic about the *M. sandwicensis* which grew and filled out quickly after the reintroduction here this year. This coming year more outplants are expected with an emphasis on *M. sandwicense* and with some new species as well. Hand broadcasts of common shrubby species may also take place.

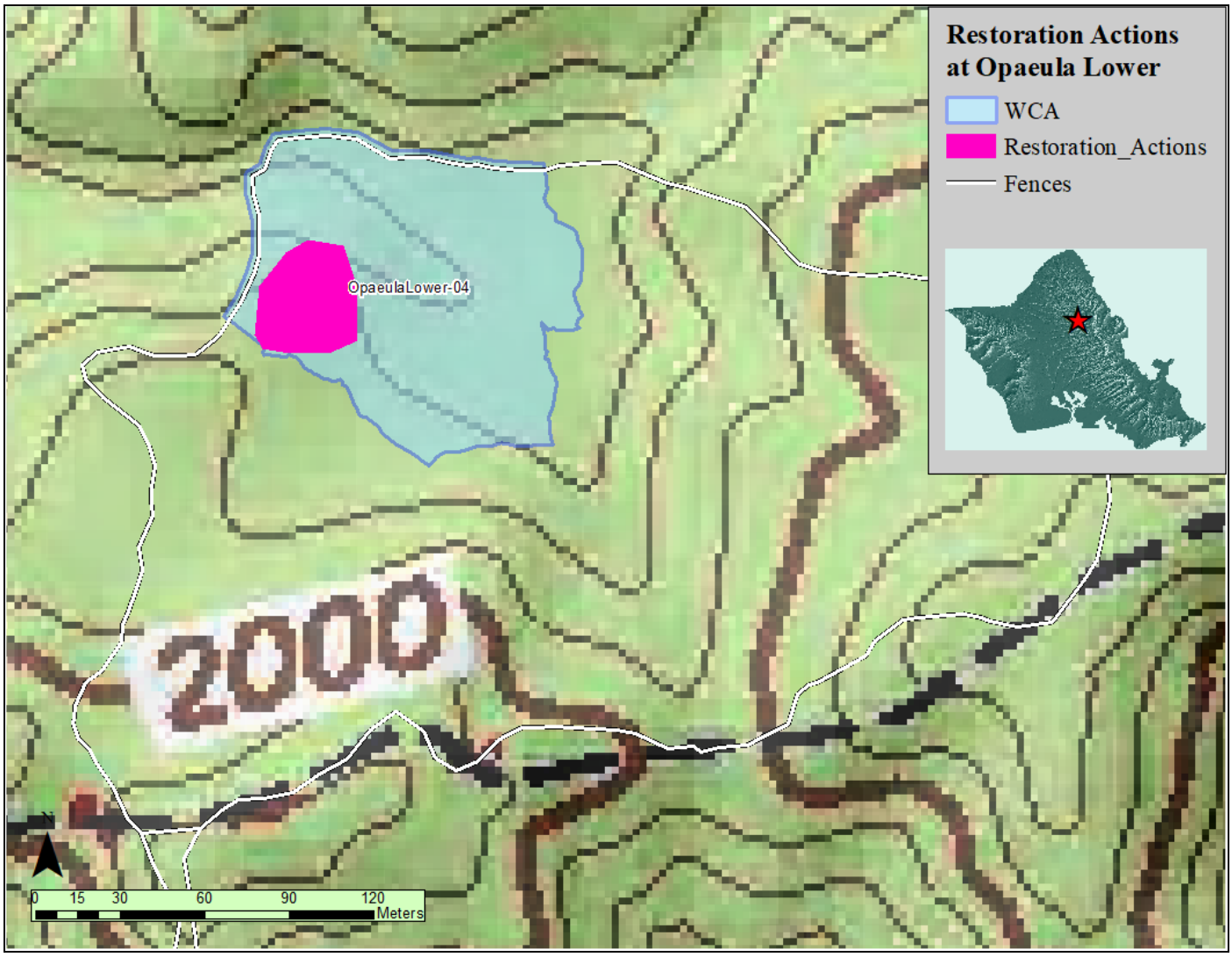

Figure 47. Map of Restoration sites in respective WCA in Opaeula Lower.

Table 30. Summary of Restoration Actions in Opaeula Lower.

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Opaeula Lower	Outplanting	38	1210	*Clermontia kakeana*	A small amount of *C. kakeana* that were the result of germination trials were planted around the area managed for *Gardenia mannii*. Future restoration is planned for this MU. See Appendix 3-3 for the ERMUP with restoration plans.

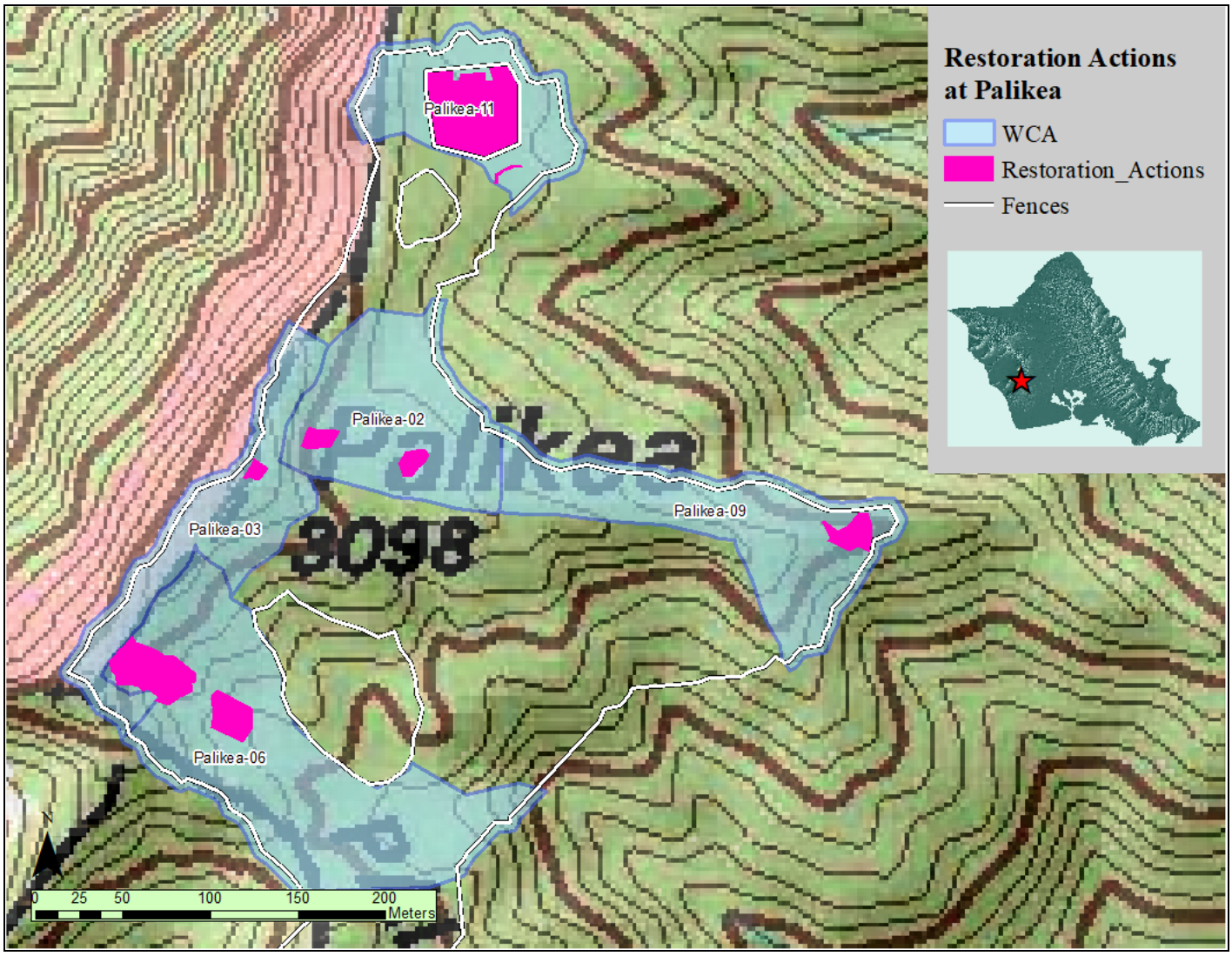

Figure 48. Map of Restoration sites in respective WCAs in Palikea.

Table 31. Summary of Restoration Actions in Palikea.

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Palikea	Outplanting-MU restoration	696	4780	*A. koa, B. torta, Cheirodendron trigynum, Coprosma longifolia, Eragrostis grandiflora, Freycenetia arborea, Ilex anomala, K. affinis, Pipturus albidus, Pisonia brunoniana, Psychotria mariniana, Santalum freycinetianum Scaevola gaudichaudiana, U. glabra, Wikstroemia oahuensis*	MU restoration outplantings were conducted at four sites. Outplantings began at 'Fern Gully' in WCA-06 for the first time following aggressive removal of alien canopy and understory this past year (Figure 49 below). Alien canopy was cleared from the gulch bottom up to native canopy boundaries on the surrounding slopes. The site is steep and challenging to work in, but when restored could be suitable for a suite of uncommon and endangered species. When complete, it is also anticipated to serve as an additional management site for *Drosophila montgomeryi.* A number of *U. glabra* were planted here as a host for *D. montgomeryi* this year. Restoration continued at the 'Guava clear-cut' site in Palikea-09 where *B. torta* and *C. wahuensis* were planted in conjunction with grass removal. *D. viscosa* were planned for outplanting, but were not ready by the scheduled outplanting date. They will be planted this coming year. Additional outplants were added to sites on the crestline and around the H-line trail in Palikea-03 and 02 respectively. At the H-line site, weed prep and outplantings were conducted by HYCC staff. Building off previous efforts in the WCA for Drosophila habitat restoration, efforts will continue in this WCA to remove canopy weeds and replace with outplants on the north side of the H-line.
	SDT- MU restoration	N/A	1300	*A. stellata*, C. wahuensis*, Cocculus orbiculatus*, D. sandwicensis*, K. affinis, Leptecophylla tameiameiae, P. albidus, U. glabra, Wikstroemia oahuensis* var. *oahuensis**	These efforts were conducted at 'Fern Gully.' Small amounts of the starred plants from the list to the left were transplanted and the rest were sown using fresh fruit collected in the MU. Three efforts of *C. chamissoi* transplants were conducted as well.

Table 31 (continued).

MU	Restoration Action	# of plants	Area (m^2)	Taxa	Comments
Palikea	Outplanting-Snail Enclosure	1467	2347	*A. koa* (24), *A. stellata* (3), *B. torta* (146), *Carex wahuensis* (20), *Cheirodendron trigynum* (168), *Coprosma longifolia* (290), *Freycenetia arborea* (3), *Ilex anomala* (12), *K. affinis* (412), *Perrotettia sandwicensis* (2), *Pipturus albidus* (12), *Pisonia brunoniana* (160), *Psychotria mariniana* (38), *Santalum freycinetianum* (4) *Scaevola gaudichaudiana* (9), *U. glabra* (131), *Wikstroemia oahuensis* (33)	Four reintroduction efforts established outplants across nearly the entire Palikea North snail enclosure, accounting for the most outplants of any site this year. In general, plants were spaced at 1 m or less, avoiding established trails. Numbers of plants per species are listed next to the taxa in the column to the left. Tree species were not planted within at least 5 meters of the wall. A handful of outplants such as *A. koa* and *C. wahuensis* were planted outside the enclosure, far from the walls. 10 *A. koa* were planted inside as well. Plant survival was high, and the wet winter likely contributed to this. The last set of plants were planted, atypically, outside the wet season, in the middle of June. However since this site is a high priority, and staff visit the snail enclosure regularly to maintain the barriers, supplemental watering was done as needed without undue extra effort. This coming year outplants will represent those taxa planted in lower numbers, and will include more snail host species such as *Antidesma platyphyllum, P. sandwicensis, Metrosideros polymorpha,* and *Myrsine lessertiana*. Additional *F. arborea* is currently in propagation in the greenhouse, but as a slow grower will likely be outplanted the following year.
	SDT- Snail Enclosure	N/A	645	*Bidens torta, Cibotium chamissoi, Pipturus albidus, Scaevola gaudichaudiana*	Several seed sows were conducted this year, and will continue in order to establish cover and connectivity between outplants. A total of 65 *C. chamissoi* stumps were relocated from outside of the MU fence and planted inside the snail enclosure. Significant time was taken to ensure that no *Euglandina rosea* were present on the fern transplants.

Figure 49. Photo of upper slopes of 'Fern Gully' site on outplanting day

Figure 50. Palikea North snail enclosure June, 2018

Table 32. 2018 Restoration Actions by MU Summary

MU	**Total # Outplants**	**Total Outplant Area** (m^2)	**SDT Total Area(m^2)**
Haili to Kealia	441	2412	
Kahanahaiki	1737	8817	4574
Kaluaa and Waieli	166	1551	
Kaluakauila	177	3066	
Keaau Hibiscus	536	1667	
Kapuna Upper	78	401	
Makaha I	408	4917	4683
Ohikilolo	432	1385	
Ohikilolo Lower	855	2872	
Opaeula Lower	38	1210	
Pahole	20	365	
Palikea	2163	4780	1945
Total:	7051	33443	11202

3.7.2 Common Native Species Collection

Utilizing genetically appropriate and ecologically adapted native plant materials is essential to successful restoration efforts. However, identifying genetically appropriate plant materials for restoration actions is rather complicated and requires the understanding of genetics of adaptation through reciprocal transplant experiments or common garden studies, used to develop empirical seed zones. A seed zone is an area within which native plants can be transferred with minimal risk of maladaptation to their new location. In many instances restoration practitioners do not have access to seed zones developed through genetic research and must try and match seed source and planting location as closely as possible. In the absence of genetic research to inform seed zones or seed transfer guidelines, provisional seed zones are a useful decision making tool for the movement and use of native plant materials. These provisional zones are delineated by integrating climate and ecological factors known to affect plant adaptation and can be used guide plant material transfer until species specific genetic research is available to delineate empirical seed zones.

OANRP has adopted the Oahu Seed Zone Map developed by Alex Loomis (Duke University) and Matt Keir (DOFAW). These provisional seed zones were initially demarcated to inform seed collections and use of *Metrosideros* spp. plant materials in response to ROD, however, they can also be applied to other common native plant species. The Oahu seed zones were delineated by overlaying Oahu moisture zones, biogeographic regions, HRPRG population reference codes, and by incorporating local expert knowledge (pers. comm., M. Keir). The map includes 14 distinct zones (Figure 51). AONRP is currently utilizing these provisional zones as a tool to guide common native seed collection goals and to inform the appropriate transfer of plant materials to restoration sites until more species specific genetic information or empirical seed zones become available.

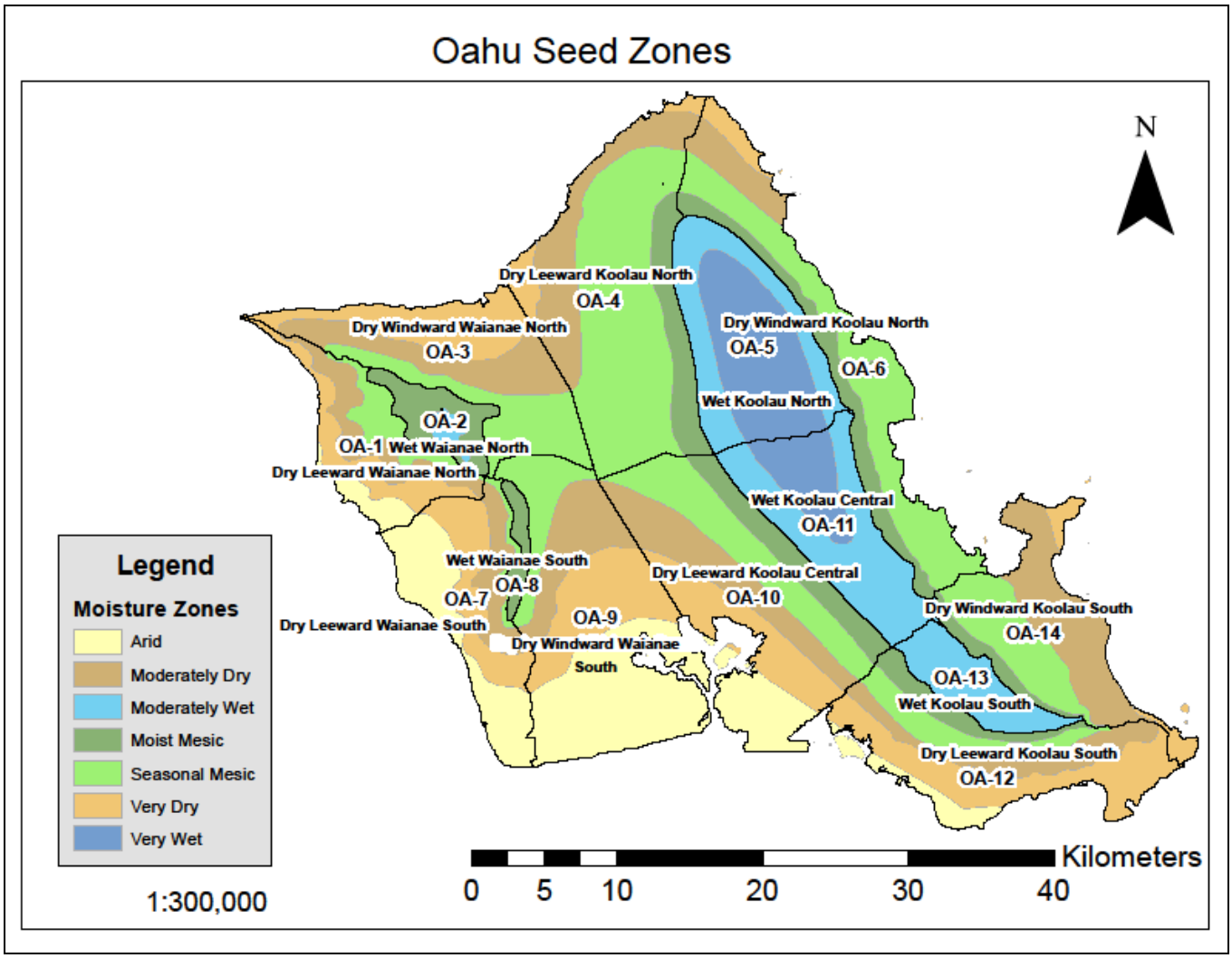

Figure 51. Map of Oahu Seed Zones

This year efforts continued 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. Collection targets were informed by the list of 57 restoration species developed in 2017 (Table 33). 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 “S” or “V” if successful protocols for seed and vegetative propagation are being used and “No” if propagation protocols are unknown.

Table 33. Summary of taxa for OANRP restoration projects

Taxa	Family	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions Collected in 2018	Seed Zones Represented
Acacia koa	Fabaceae	Yes	S	26930	22	13	OA- 1,2,5,8
Alyxia stellata	Apocynaceae	Yes	S	577	9	3	OA-1,2,8
Antidesma platyphyllum	Phyllanthaceae	Yes	S,V	1193	2	2	OA-1,2
Asplenium kaulfussii [a]	Aspleniaceae	Unknown[b]	No[c]	NA	0	0	----------
Bidens torta	Asteraceae	Yes	S	354925	16	8	OA-1,2,8
Carex meyenii [a]	Cyperaceae	Yes	No	16654	3	0	OA-2
Carex wahuensis	Cyperaceae	Yes	S	15645	9	4	OA-2,8
Cheirodendron trigynum	Araliaceae	Yes	S	11397	5	0	OA-5,8
Chenopodium oahuense	Chenopodiaceae	Yes	S	44209	5	2	OA-3
Cibotium spp.[a]	Dicksoniaceae	Unknown[b]	No[c]	NA	1	1	OA-2
Coprosma foliosa[a]	Rubiaceae	Yes	S	175	1	3	OA-2
Coprosma longifolia	Rubiaceae	Yes	S	17747	5	3	OA-2,8
Cyperus hillebrandii var. *hillbrandii* [a]	Cyperaceae	Unknown	No	0	0	0	----------
Cyperus polystachyos [a]	Cyperaceae	Unknown[b]	No[c]	1706	1	1	OA-2
Deparia prolifera[a]	Athyriaceae	Unknown	No	NA	0	0	----------
Dianella sandwicensis	Xanthorrhoeaceae	Yes	S,V	18896	5	5	OA-2,8
Diplazium sandwichianum [a]	Athyriaceae	Unknown	No	NA	0	0	----------
Dodonaea viscosa	Sapindaceae	Yes	S	200402	22	5	OA-1,2,3,8
Doodia kunthiana[a]	Blechnaceae	Unknown[b]	No[c]	NA	2	2	OA-2
Eragrostis grandis	Poaceae	Yes	S	14779	3	1	OA-2,8
Eragrostis variabilis	Poaceae	Yes	S	7088	1	0	OA-3
Erythrina sandwicensis	Fabaceae	Yes	S	1519	18	2	OA-1
Freycinetia arborea [a]	Pandanaceae	Yes	S	32294	5	1	OA-8
Gahnia beecheyi [a]	Cyperaceae	Yes	No[c]	4091	5	2	OA-1,2,8
Hibiscus arnottianus subsp. *arnottianus*	Malvanceae	Unknown	V	0	0	0	----------
Ilex anomala	Aquifoliaceae	Yes	S	7997	6	1	OA-2,5,8
Kadua acuminata	Rubiaceae	Yes	S	0	0	0	----------
Kadua affinis	Rubiaceae	Yes	S	42217	14	2	OA-2,8
Labordia kaalae	Loganiaceae	Yes	S	1515	2	0	OA-8
Luzula hawaiiensis	Juncaceae	Yes	S	158	1	0	OA-2
Machaerina angustifolia [a]	Cyperaceae	Yes	No	0	0	0	----------

Table 33 (Continued).

Taxa	Family	Seed Storage Possible	Propagation Protocol Developed	Total # of Seeds in Storage	Total Seed Accessions Currently in Storage	# of Seed Accessions Collected in 2018	Seed Zones Represented
Melicope oahuensis [a]	Rutaceae	Unknown	No	0	0	0	----------
Metrosideros polymorpha	Myrtaceae	Yes	S	2542295	59	20	OA-1,2,5,8
Microlepia speluncae [a]	Dennstaedtiaceae	Unknown	No	NA	0	0	----------
Microlepia strigosa var. *strigosa*	Dennstaedtiaceae	Unknown[a]	V	NA	1	0	OA-2
Myoporum sandwicense	Scrophulariaceae	Yes	S	2050	1	3	OA-3
Myrsine lessertiana	Primulaceae	Yes	S	183	3	1	OA-2
Nephrolepis exaltata subsp. *hawaiiensis* [a]	Nephrolepidaceae	Unknown	No	NA	0	0	----------
Nestegis sandwicensis	Oleaceae	Yes	S,V	0	0	0	----------
Perrottetia sandwicensis	Dipentodontaceae	Yes	V	0	0	0	----------
Pipturus albidus	Urticaceae	Yes	S	148432	3	2	OA-2,8
Pisonia brunoniana	Nyctaginaceae	No	S,V	0	0	2	OA-8
Pisonia sandwicensis [a]	Nyctaginaceae	No	No	0	0	0	----------
Pisonia umbellifera	Nyctaginaceae	No	Yes	0	0	0	----------
Planchonella sandwicensis	Sapotaceae	No	S	0	0	1	OA-2
Plumbago zeylanica	Plumbaginaceae	Unknown	V	0	0	0	----------
Polyscias sandwicensis [a]	Araliaceae	Yes	S	0	0	0	----------
Psychotria hathewayii	Rubiaceae	Yes	S	428	4	1	OA-8
Psychotria mariana	Rubiaceae	Yes	S	83	2	3	OA-8
Psydrax odorata [a]	Rubiaceae	Yes	S	0	0	2	OA-2
Pteris excelsa [a]	Pteridaceae	Unknown	No	NA	0	0	----------
Rumex albescens	Polygonaceae	Yes	S	4260	3	0	OA-8
Santalum spp.[a]	Santalaceae	Yes	S	106	3	4	OA-2
Scaevola gaudichaudii [a]	Goodeniaceae	Unknown	No	0	0	1	OA-8
Scaevola gaudichaudiana	Goodeniaceae	Yes	V	0	0	0	----------
Scaevola taccada	Goodeniaceae	Yes	S,V	0	0	0	----------
Sida fallax [a]	Malvaceae	Yes	S	2914	2	1	OA-3

[a] Native species targets for future restoration efforts

[b] Research underway to develop seed storage protocols

[c] Research underway to develop propagation protocols

3.7.3 Seed Production Plots Update

Outplantings of *B. torta* for the seed production plot at Kahua occurred early this year. In September 2017, 1,498 individuals representing 30 founders from the upper elevations of the southern Waianaes, seed zone OA-8 (Wet Waianae South) were planted from dibble pots. There were some minor setbacks in plot establishment and growing conditions over the year including: compacted soil, hot and dry conditions, and pest infestations. However, most plants fared well and seed collection efforts have taken place on five occasions from 4/26/18 to 7/11/18 from the plants that set fruit, totaling 51 grams of seed, approximately 25,000 seeds. Staff estimate that only 15% of the plants set flower and fruit. It is common for perennial crops to exhibit low seed yields in the first year of establishment and we anticipate that next year most plants will set fruit and harvest quantities will be much larger.

This July, in reporting year 2019, 550 *Carex wahuensis* were also planted at Kahua. Staff are hopeful to acquire seed from these plants during the fruiting season in April.

Plans are underway to establish two seed production sites within Kahanahaiki and Palikea for *Bidens torta* and *Scaevola gaudichaudiana* respectively. Degraded field sites will be cleared, prepared, and planted with those species this coming year.

Figure 52. Photos of *B. torta* production plot at Kahua. Left: photo taken September, 2017. Right: photo taken November, 2017 on day of supplemental planting.

CHAPTER 4: RARE PLANT MANAGEMENT

4.1 PROJECT HIGHLIGHTS

During this reporting period, the Army natural resource program on Oahu (OANRP) outplanted a total of 1,117 individuals of 14 MIP and OIP taxa. In the last year, the program made 526 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 longiflora* was outplanted into Pahole for the first time following the completion of full genetic seed storage for the Pahole Population Unit (PU). The outplanting was a test planting of 14 plants, but initial monitoring shows promise for expanding the site in the future.

- Between December 13, 2016 and June 20, 2018 five *Gardenia mannii* fruits have been collected from founder HEL-E-1 resulting in 3,259 viable seeds stored at the Army Seed Conservation Lab. Viability and storage testing is ongoing in order to determine preferred storage condition for this species. The greenhouse currently has 30 accessioned seedlings resulting from seed tests, with more to come, which will be used to augment outplantings at Lihue and Lower Opaeula in coming years.

- The establishment of a *Euphorbia herbstii* outplanting site in Kaluaa has shown initial success with 100% survival of outplants after two years and mature plants observed from the initial outplanting in 2017.

- *Plantago princeps var. princeps*, both in situ and reintroduced populations, have been hit with leaf pathogens and populations are in decline. We have collected seed from the North Mohiakea greenhouse stock plants and are currently germinating seeds that will be grown for testing plants with beneficial fungal inoculation. We will provide updates as this project progresses.

- An updated census for *Alectryon macrococcus var. macrococcus* was completed for the Makaha PU. While the number of mature plants remaining has decreased significantly since the last complete census in 2015, the number of founders with complete genetic storage in living collection has increased 50% due to successful air-layering of plants in the greenhouse. In addition, we have been successful in planting excess living collection individuals at inter-situ sites, with the goal of trying to collect fruit from mature trees.

- Included in the appendices are also five year plans for *Schiedea nuttallii* and *Schiedea obovata* (Appendices 4-2 and 4-3).

- Kahua Site: In 2017, founders of *Hibiscus brackenridgei* subsp. *mokuleianus* representing the Keaau PU and *Neraudia angulata* founders representing the Makua PU were outplanted at Kahua. Maintaining these founders at Kahua has reduced greenhouse space for the living collections of these two species and establish healthy plants from which seed can be collected. This will benefit field teams by reducing the amount of time invested in seed collection from wild and outplanted individuals. Outplants of both species exhibited high survivorship at Kahua and produced robust fruit crops within approximately a year of outplanting. More than 50 viable seeds were successfully collected from each of six founders of *Hibiscus brackenridgei* ssp. *mokuleianus* completing 86% of the genetic storage requirement for the Keaau PU, allowing us the option to reduce the current living collection significantly. In addition, more than 50 viable

seeds were collected from each of eight founders of *Neraudia angulata*, which represents 16% of the genetic storage requirement for the Makua PU. In March of 2018 *Dubautia herbstobatae* (MAK-B) was outplanted at Kahua. These plants have fared very well at this site and began flowering in June 2018. Taking advantage of this flowering event, we revisited past program efforts of supplemental hand pollinations intended to increase filled seed set. Due to limits on pollen availability, this year's pollination efforts focused primarily on hand pollinations between different populations and on assessing the potential for successful ambient pollination at Kahua. We will continue supplemental hand pollinations next flowering season, focusing on between and within population hand pollinations. Results of our summer 2018 efforts will be presented in next year's report.

- 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.

4.2 THREAT CONTROL SUMMARY

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

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 weeds are a threat to all taxa in all PUs. See Chapter 3 for more detailed description of weeding efforts and long term plans. Weed control status was determined by overlaying weed control efforts with IP taxa population sites in GIS. A 50 meter 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.' If only part of the buffer was weeded, it was assigned a 'Partial'. Four population sites for four different taxa meet the goals of full weed management, which is unchanged from the previous year. If none of the buffer was weeded, it was assigned a 'No'. Of the 137 MFS PU, 80 PU receive 'Partial' weed control status. This is a slight decrease of 5% 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 PUs 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 partially or fully controlled at 41% of population sites. Full rat control is considered a grid of traps that protects all the plants within a population. This is an increase of 4% from the previous year. Much of the rat threat management has included the addition of more A24 automatic resetting traps which improves 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 37% of population sites, which is an increase of 4% 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 4-5. Every year, OANRP collects propagules from IP taxa for *ex situ* genetic storage. The amount of propagules needed to meet these goals were predetermined in the MIP and OIP. In general, each wild plant (up to 100 individuals from each PU) needs either 50 viable seeds, (as estimated at the time of collection), three plants held in tissue culture, or three plants held 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 66 PUs that reached their storage goal, representing 991 plants and 27 taxa. This is an increase of twelve PUs and 501 plants from last year. There are an additional 1,413 plants that met their storage goal in 129 other PUs (where the PU genetic storage effort is not 100% complete). Two PUs experienced significant declines in genetic storage goals: *Cenchrus agrimonioides* var. *agrimonioides* Central Ekahanui PU declined by 50% between 2017 and 2018, and *Abutilon sandwicense* Makaha Makai declined by 28%. The decline of *C. agrimonioides* var. *agrimonioides* can be attributed to an aging living collection, and the horticultural staff is working to rebuild a healthy living collection. The decrease of *Abutilon sandwicense*, however, resulted from the withdrawal of seeds for the propagation of outplants for the 2018/2019 planting season. This year's increase in PU meeting storage goals is owed in part to updated recollection intervals for IP taxa. During this reporting year Army Seed Conservation Lab staff completed an analysis of viability assays of IP taxa in order to revise species re-collection intervals. Recollection intervals were increased by a minimum of five years for 26 IP taxa. For more details regarding updated recollection intervals, see Appendix 4-6.

CHAPTER 5: *ACHATINELLA MUSTELINA* MANAGEMENT

5.1 BACKGROUND

In this chapter, *Achatinella mustelina* management by the Army natural resource program on Oahu (OANRP) is outlined for the next three years: July 2018-June 2019, July 2019-June 2020, and July 2020-June 2021. 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 (PRSs). Each PRS is a discrete grouping of snails. There are many PRSs in each ESU given the fragmented status of the populations.

5.1.1 Threat Control

In PRSs designated as Manage for Stability (MFS) threats such as predators, ungulates, and weeds are controlled. Predators include black rats (*Rattus rattus*), rosy wolf snails (*Euglandina rosea*), and Jackson's chameleons (*Trioceros jacksonii xantholophus*). Tables 2, 6, 10, 13, 16, 20, 24, and 28 show the Threat Control Summary for each MFS PRS and the current status of fence construction and removal of pigs and goats from Management Units (MUs), weed, rat, *E. rosea*, and *T. jacksonii xantholophus* control. The terms "Yes," "No," or "Partial" are used to indicate the level of threat management.

Ungulate threat control and fence repairs are ongoing, and all areas known to be free of ungulates are listed as "Yes." PRSs 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 weeds are a threat to all taxa in all PUs. See Chapter 3 for more detailed description of weeding efforts and long term plans. Weed control status was determined by overlaying weed control efforts with *A. mustelina* population reference sites in GIS. A 50 meter radial buffer around PRSs were 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.' If only part of the buffer was weeded, it was assigned a 'Partial'.

Rats are considered a potential threat to most IP taxa, as they are known to prey on snails. Rat control continued around many PRSs in the last year, in large grids around entire MUs and in smaller grids targeting individual populations. Although rats potentially threaten most PRSs, they are only controlled around sites where significant damage has been observed. Much of the rat threat management has included the addition of more A24 automatic resetting traps (A24s) which improves time efficiency and control of rats.

5.1.2 Progress towards MIP Goals

OANRP has made significant progress toward these goals. At seven of the eight managed populations in the ESUs, the goal of 300 snails is met (Table 1). In ESU-E, most snails have been removed from the wild and are currently in captive rearing until they can be released into the Palikea North enclosure. Although the more than 300 snails from ESU-E are currently held in captive rearing there are less than 300 snails left in the wild, therefore the MIP goal is not met for this population. 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.

At MFS PRSs snails are monitored on a regular basis by Timed Count Monitoring (TCM) and Ground Shell Plot (GSP) surveys. TCM is used to quantify long-term population trends and assess if the population is self-sustaining over time. During a TCM, staff search a specified area for a specified number of person-hours. This will ensure that data is comparable across surveys. At the enclosures, TCM is conducted quarterly while wild PRSs are monitored once a year or once every two years. TCM data represents a subsample of the population, as not all snails are detectable at any one time. For GSP surveys, the ground is searched in a designated plot and all shells are collected and counted to detect mortality.

Construction is complete for the enclosure at Palikea North for ESU-E and is currently undergoing ecosystem restoration. Construction for a new enclosure at Makaleha West for ESU-B has begun and is set for completion in September 2018. Plans are being developed for an additional enclosure at Kaala for ESU-C and the expansion of the Kahanahaiki enclosure. With the completion of these additional enclosures and successful translocation efforts, all six ESUs will be protected from predators.

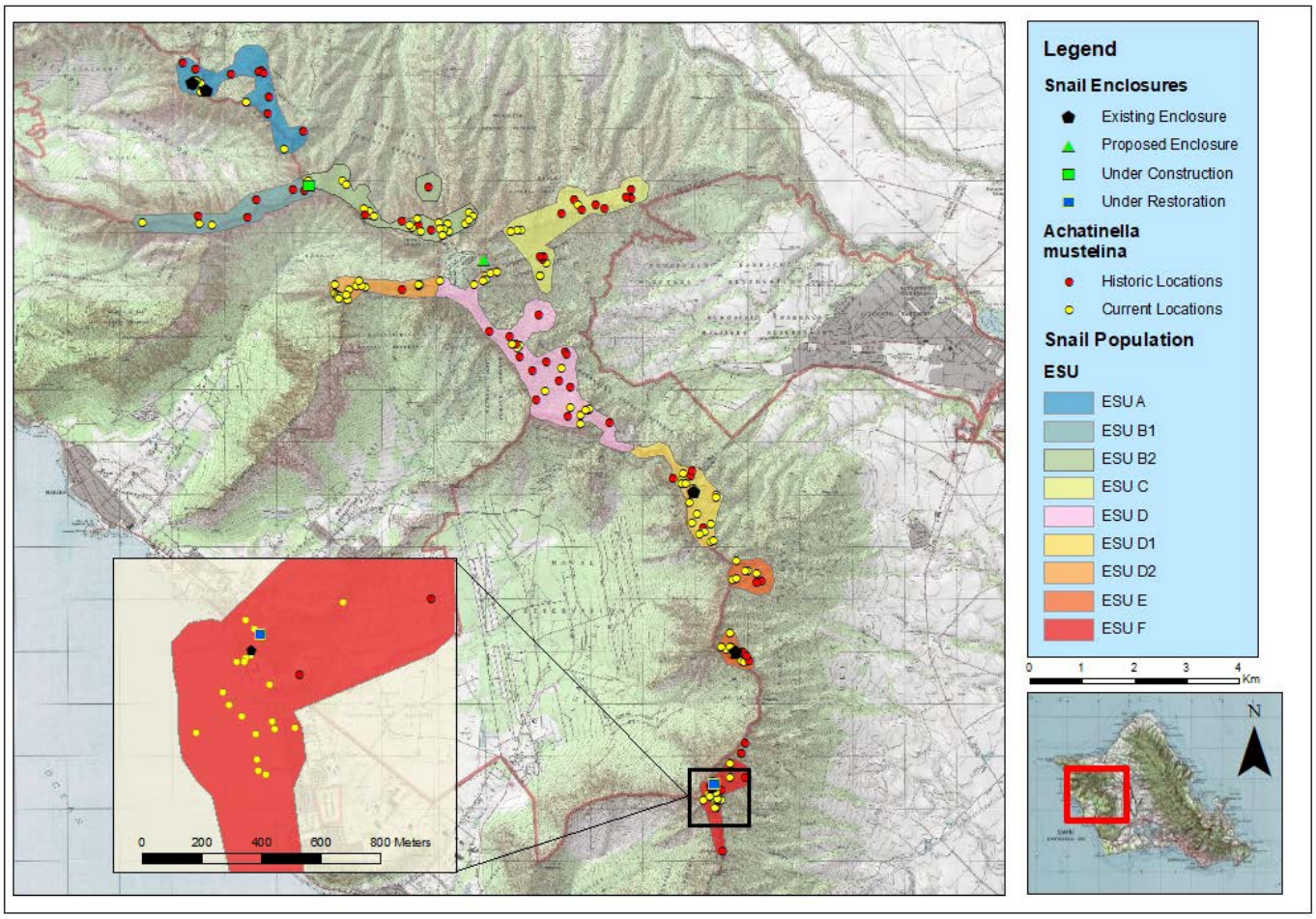

Figure 1. Map of Six ESUs, current and historic *A. mustelina* sites, and snail enclosures locations

Table 1. Recent counts of ESU wild populations and enclosure status 2018

ESU	# Snails in MFS PRS	# Snails in No Mgmt. PRS	# Total Snails	# Snails in Enclosures	Current and Future Enclosure Location
A	262	41	303	229 (Kahanahaiki) 33 (Pahole)	Kahanahaiki/Pahole
B1	309	11	320	0	West Makaleha†
B2	484	188	672	0	West Makaleha†
C	335	10	345	0	Kaala†
D1	747	49	796	747	Hapapa
D2	342	10	352	0	NONE
D*	0	392	392	0	Hapapa
E	80	21	101	0	Palikea North†
F	316	11	327	174	Palikea South

*Snails from this portion of the ESU are not managed for stability in the MIP
†Enclosure not yet constructed or not yet ready for snail introductions

5.2 ESU-A

Figure 2. *Achatinella mustelina* from ESU-A

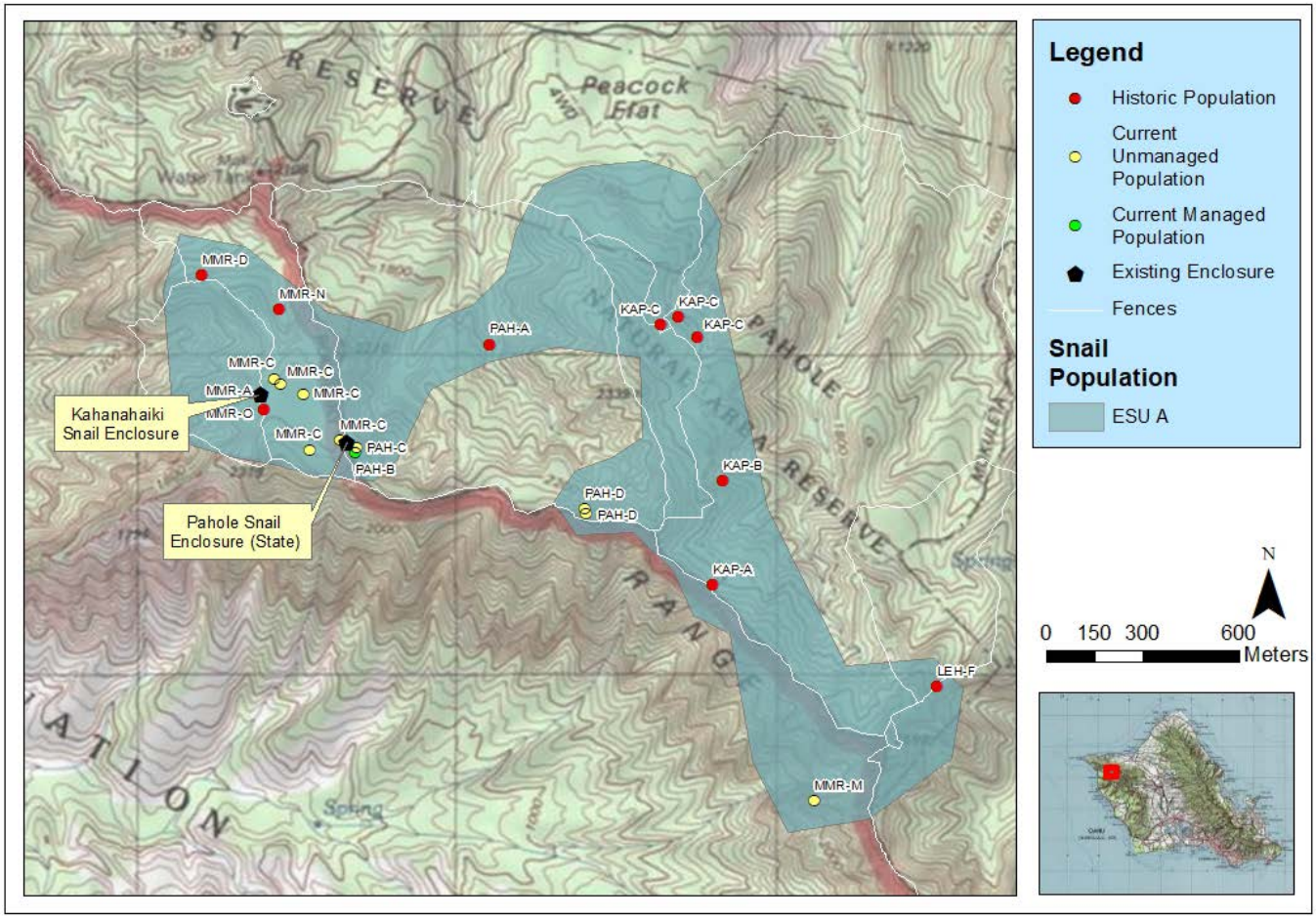

Figure 3. Map of ESU-A

5.2.1 Management History and Population Trends

Spanning parts of Kahanahaiki Gulch and Pahole Natural Area Reserve, there are 14 PRSs at ESU-A (Figure 3). Two enclosure sites (Kahanahaiki and Pahole) are designated Manage for Stability (MFS) (Table 2) and the remaining PRSs are No Management (NM) (see 2016-2017 Year End Report for a list of No Management sites). The MFS PRS have 262 counted snails and almost all the NM PRS snails have been moved into one of the two snail enclosures. OANRP manages the enclosure at Kahanahaiki (MMR-A), and the State of Hawaii's Department of Land and Natural Resources' Snail Extinction Prevention Program (SEPP) manages the Pahole enclosure (PAH-B).

Euglandina rosea are assumed to be ubiquitous across the habitat and quarterly sweeps are conducted inside the enclosure to ensure that *E. rosea* have not breached the enclosure walls. Two rat tracking tunnels and two A24s have been installed inside the Kahanahaiki enclosure and are checked three times a year. A24s and kamate snap traps are used both inside and outside of the Pahole enclosure. *Trioceros jacksonii xantholophus* have not been seen in this area.

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

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**											
MMR-A Kahanahaiki Exclosure	Manage for stability	229	2018-05-14	131	81	17	0	Yes	Partial	Yes	Yes	No
PAH-B Pahole Exclosure	Manage for stability	33	2018-03-12	22	6	5	0	Yes	Partial	Yes	Yes	No
	ESU Total:	262		153	87	22	0					

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Size Class Definitions

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

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.

5.2.1.1 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 to maximize threat protection. Monitoring of the *A. mustelina* population within the enclosure occurs quarterly, and includes timed count monitoring (TCM) and ground shell plot (GSP) monitoring. Data from quarterly monitoring (Figure 4) shows that after the large decline of *A. mustelina* inside the enclosure in early 2017 the population has remained stable.

In the past year, four snails were added to the existing population from MMR-C. The number of potential snails remaining outside of the enclosure is likely very small since translocations from this site to the enclosure began in 2011.

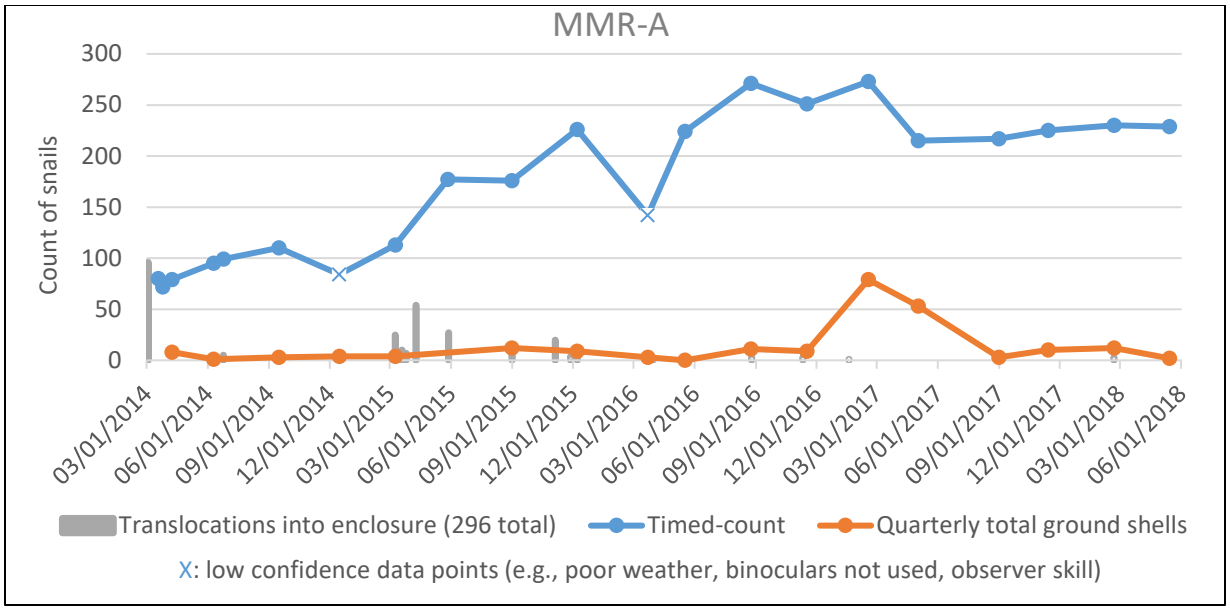

Figure 4. Quarterly timed-count monitoring (TCM) and ground shell counts for *A. mustelina* in the Kahanahaiki snail enclosure from the first quarter of 2014 to the second quarter of 2018, with numbers of snails translocated into the enclosure over time.

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. Construction is scheduled to begin in September 2018 and is expected to be completed by December 2018. During the last timed count monitoring in March of 2018 SEPP counted 33 snails inside the enclosure (Figure 5).

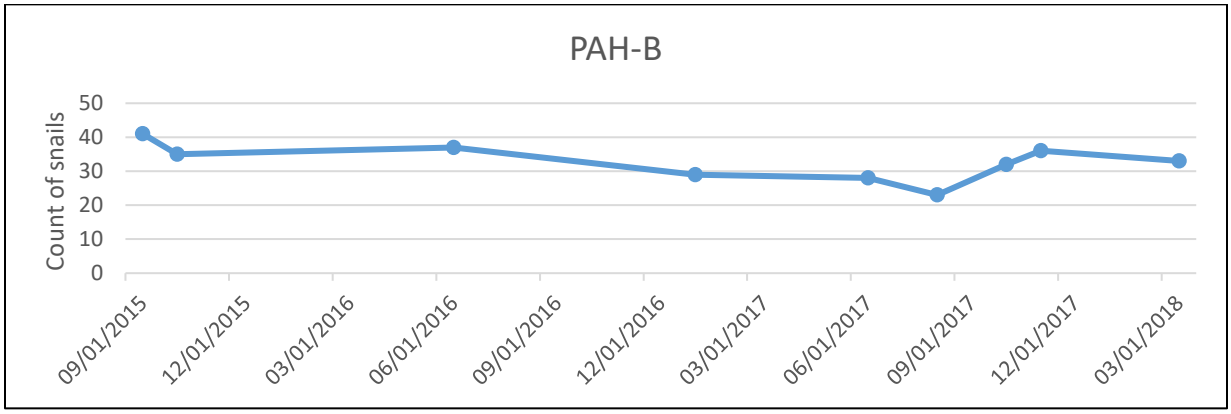

Figure 5. Quarterly timed-count monitoring (TCM) and ground shell counts for *A. mustelina* in the Pahole snail enclosure since 2015.

5.2.1.3 No Management PRSs

Snails found at NM PRSs within ESU-A have been translocated to the Kahanahaiki snail enclosure. As time allows staff will return for additional searches to find any remaining snails. Table 3 below summarizes the translocation efforts completed this year. A total of four snails were translocated from MMR-C.

Table 3. Translocations into MMR-A Kahanahaiki enclosure 2017-2018

Translocation Date	Population Reference Site	Small	Medium	Large	Total
2018-02-20	MMR-C Maile Flats	0	0	3	3
2018-05-14	MMR-C Maile Flats	0	1	0	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 inside and around the existing enclosures, including tracking tunnels and A24s 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. The size of the Kahanahaiki enclosure is less than half that of the Palikea South enclosure but has more snails (229 snails vs. 174 snails, Table 1). An expansion of the enclosure is planned for 2019 to provide more habitat for the population.

Table 4. ESU-A Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
MMR-A Kahanahaiki Enclosure	TCM	quarterly	2018, 2019, 2020	Conduct night TCM with 2 personnel 2 hours each, for 4 person-hours total; quarterly
	GSP	quarterly	2018, 2019, 2020	GSP MMR-A
PAH-B Pahole Enclosure	TCM/GSP	quarterly	2018, 2019, 2020	Assist SEPP as needed

Table 5. Three Year Action Plan for ESU-A

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
MMR-A Kahanahaiki Enclosure	• Implement monitoring plan • Rat control • Install Remote Monitoring system • 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 • Improve habitat via weed control and restoration planting • Expand enclosure	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Improve habitat via weed control and restoration planting
MMR-C Maile Flats	• Translocate remaining snails to enclosure	• Translocate remaining snails to enclosure	• Translocate remaining snails to enclosure
PAH-B Pahole Enclosure	• Assist SEPP with installation of remote monitoring system once new enclosure is complete		

5.3 ESU-B

Figure 6. *Achatinella mustelina* from ESU-B

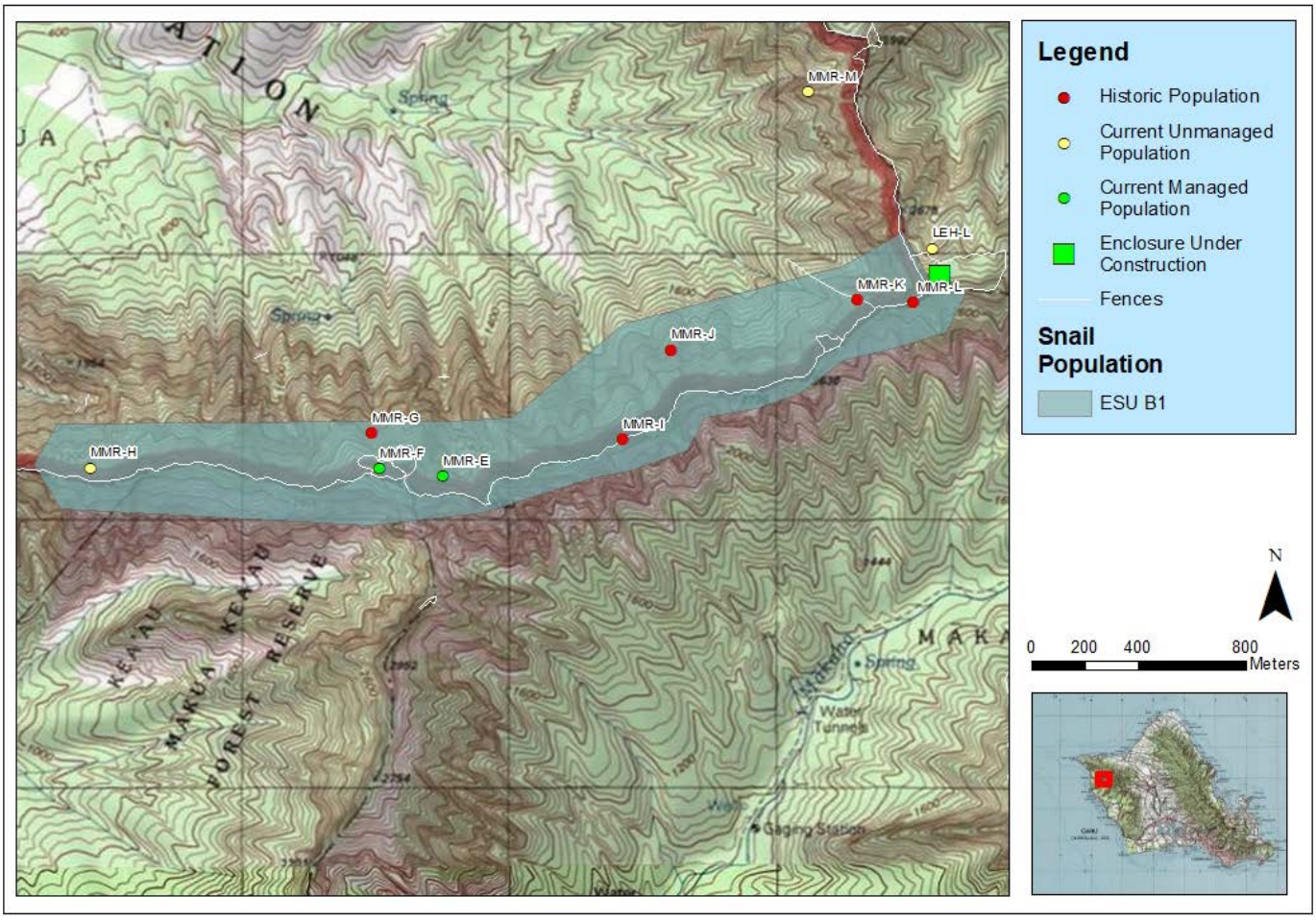

Figure 7. Map of ESU-B1

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 a genetic basis (see Makua Implementation Plan 2001). Management of ESU-B1 is focused at Ohikilolo (Figure 7). ESU-B2 includes the gulches in Makaleha (Figure 9). Management of ESU-B2 will be is focused at Makaleha West.

5.3.1 ESU-B1 Management History and Population Trends

There are two MFS PRSs within ESU-B1: MMR-E (Ohikilolo Mauka) and MMR-F (Ohikilolo Makai) (Table 6). A combined total of 309 snails were observed during the most recent TCM at these PRSs.

The Ohikilolo MU remains unique in that *E. rosea* have never been recorded in the area. *T. jacksonii xanthologus* have also never been seen. Rats are controlled across the known snail habitat with an A24 trap grid.

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

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	57	2018-05-09	37	14	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												
	ESU Total:	309		197	82	30	0					

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Size Class Definitions

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

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 conducted monitoring of the PRS in May 2018 and counted 57 live snails and found three ground shells (Figure 8).

5.3.1.2 MMR-F Ohikilolo Makai PRS

OANRP conducted a full census monitoring of the PRS in July 2016 and counted 252 live snails (Figure 6). A full census monitoring of the PRS will be conducted every four years because a 46 person-hour effort is required. A shorter eight person-hour TCM will be conducted every two years between the full census TCM to monitor for any catastrophic events.

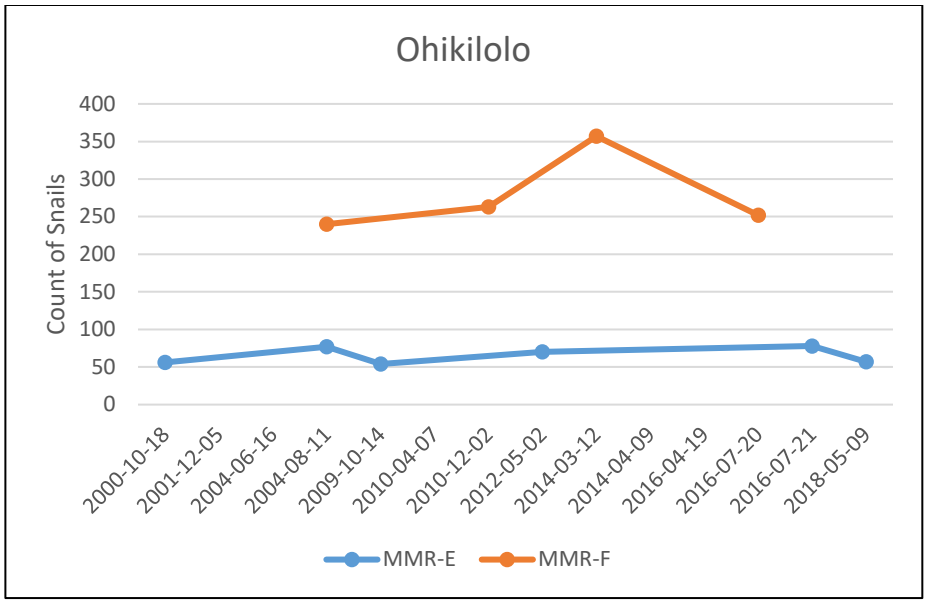

Figure 8. Timed counts of MMR-E and MMR-F during the day

5.3.1.3 No Management PRS

MMR-H was discontinued as an MFS in 2015-2016 due to declines in numbers. In 2016, staff collected and translocated 17 snails on two different trips from MMR-H to MMR-F. OANRP had planned to make only three translocation trips to move all snails found up to MMR-F, but after three snails were collected on the third trip, it was decided that an additional trip to collect remaining snails was necessary. On the fourth trip in May 2018 staff collected three snails, but one snail was unreachable and left behind. Staff plan to make a fifth and final trip next year to search for any remaining snails.

MMR-J located one ridge east of Lower Makua camp has not been surveyed since 2000 when five snails were observed. This population will be surveyed when staff can get access to the area.

All other NM PRSs are not a management priority as numbers are low and previous monitoring dates are old.

Table 7. Translocation of *A. mustelina* into MMR-F Ohikilolo Makai 2017-2018

Translocation Date	Population Reference Site	Small	Medium	Large	Total
2018-05-08	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 West Makaleha along with snails from ESU-B2 to increase the genetic diversity of the population within the enclosure.

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 during the day with binoculars.
	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 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
MMR-E Ohikilolo Mauka	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Consider moving a sample of snails to 3 Points enclosure	• 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 • Consider moving a sample of snails to 3 Points enclosure	• Implement monitoring plan • Rat control • Consider moving a sample of snails to 3 Points enclosure
MMR-H Ohikilolo Koiahi	• Survey for remaining snails • Translocate to MMR-F		
MMR-J Lower Makua camp		• Survey for remaining snails • Consider translocation to MMR-F	

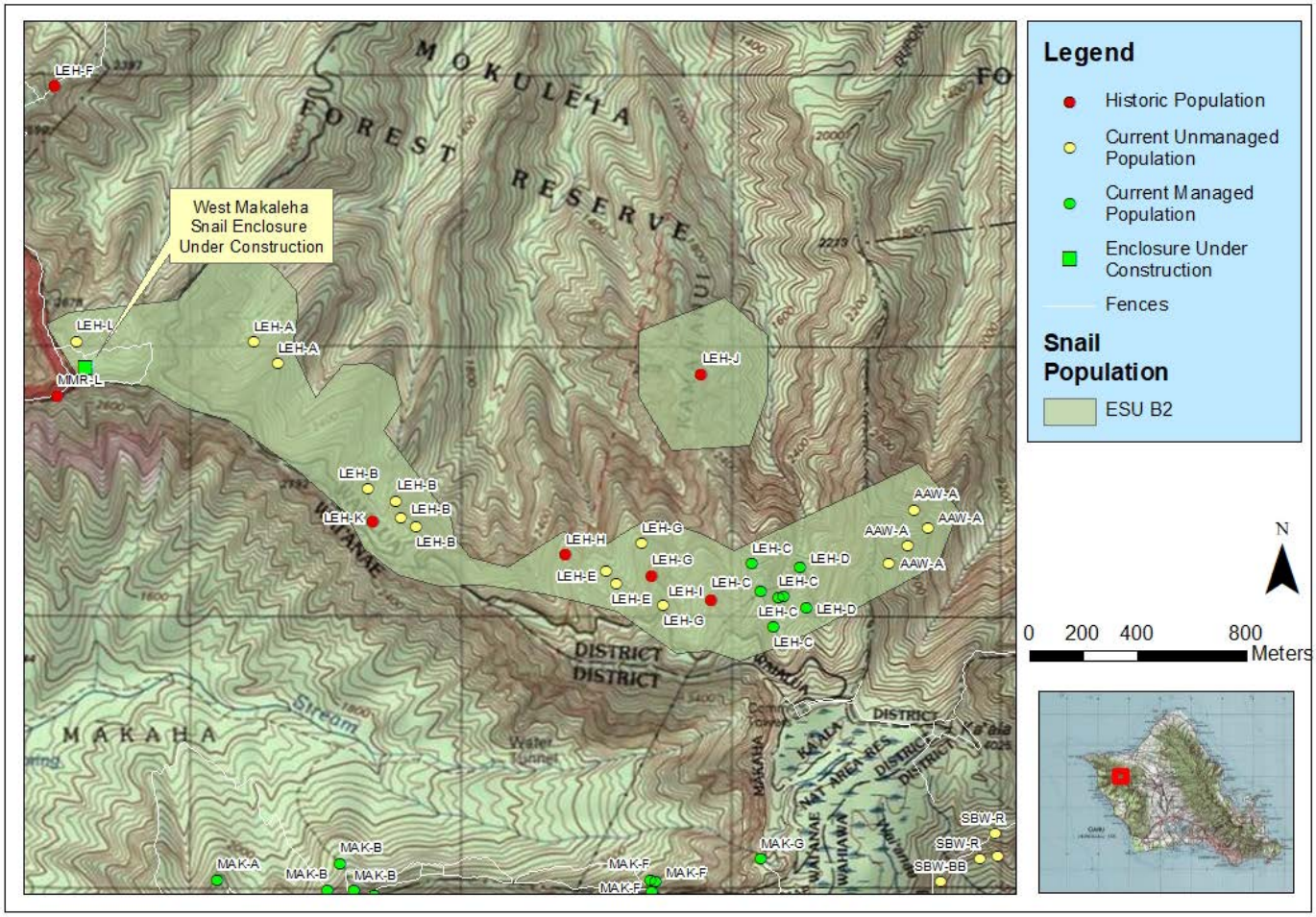

Figure 9. Map of ESU-B2.

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 484 observed snails. There are ten NM-PRS, many of which have not been surveyed for many years. Numbers have likely declined at these sites. 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 accompanying habitat damage has increased over the last several years. With the recent completion of the Kaala Road fence, and additional strategic fencing currently in construction 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 for MFS PRSs

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**											
LEH-C	Manage for stability	378	2016-12-31	267	99	12	0	No	Partial	Yes	No	No
East Branch of East Makaleha (culvert 69)												
LEH-D	Manage for stability	106	2017-12-27	76	23	7	0	No	No	Yes	No	No
East Branch of East Makaleha (culvert 73)												
	ESU Total:	484		343	122	19	0					

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Size Class Definitions

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

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 *Dicaronopteris linearis* understory and is determined to be inappropriate for GSP monitoring. TCM will be performed annually. In December 2017 a total of 106 snails were observed (Figure 10). OANRP will conduct the next TCM in Quarter 3 of 2018.

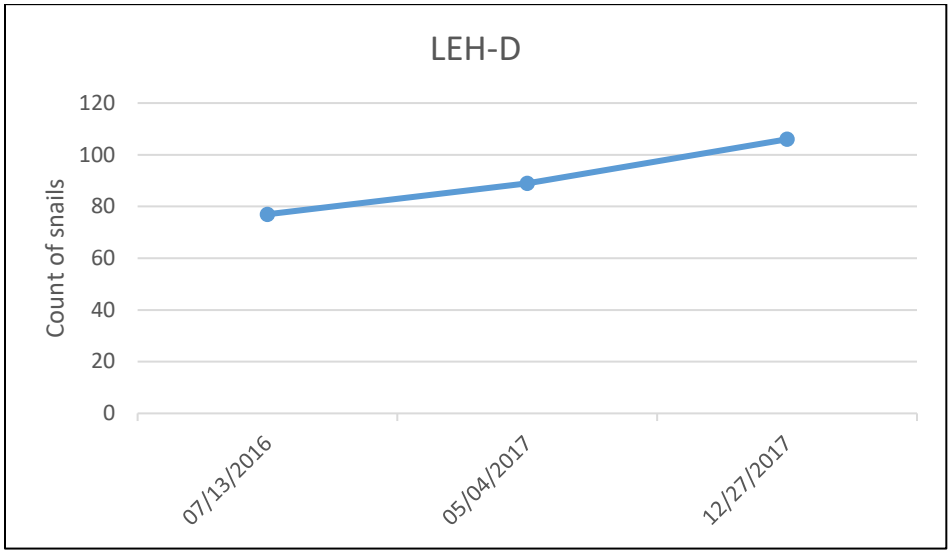

Figure 10. Timed counts at LEH-D

5.3.3.3 No Management PRS

The ten NM PRSs 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 for translocation.

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 is currently constructing an enclosure at Makaleha West to manage the snails in this portion of ESU-B. A subset of snails from the MFS PRSs will be translocated to the enclosure. All snails from NM PRSs will be translocated once the enclosure is complete. OANRP will finalize translocation plans with the IT for the 3 Points enclosure in the winter of 2018.

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	2018, 2020	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 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
LEH-C East Culvert 69	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Translocate snails to 3 Points enclosure	• Implement monitoring plan • Rat control • Translocate snails to 3 Points enclosure
LEH-D East Culvert 73	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Translocate snails to 3 Points enclosure	• Implement monitoring plan • Rat control • Translocate snails to 3 Points enclosure
NM PRS		• Translocate snails to 3 Points enclosure	• Translocate snails to 3 Points enclosure

5.4 ESU-C

Figure 11. *Achatinella mustelina* from ESU-C

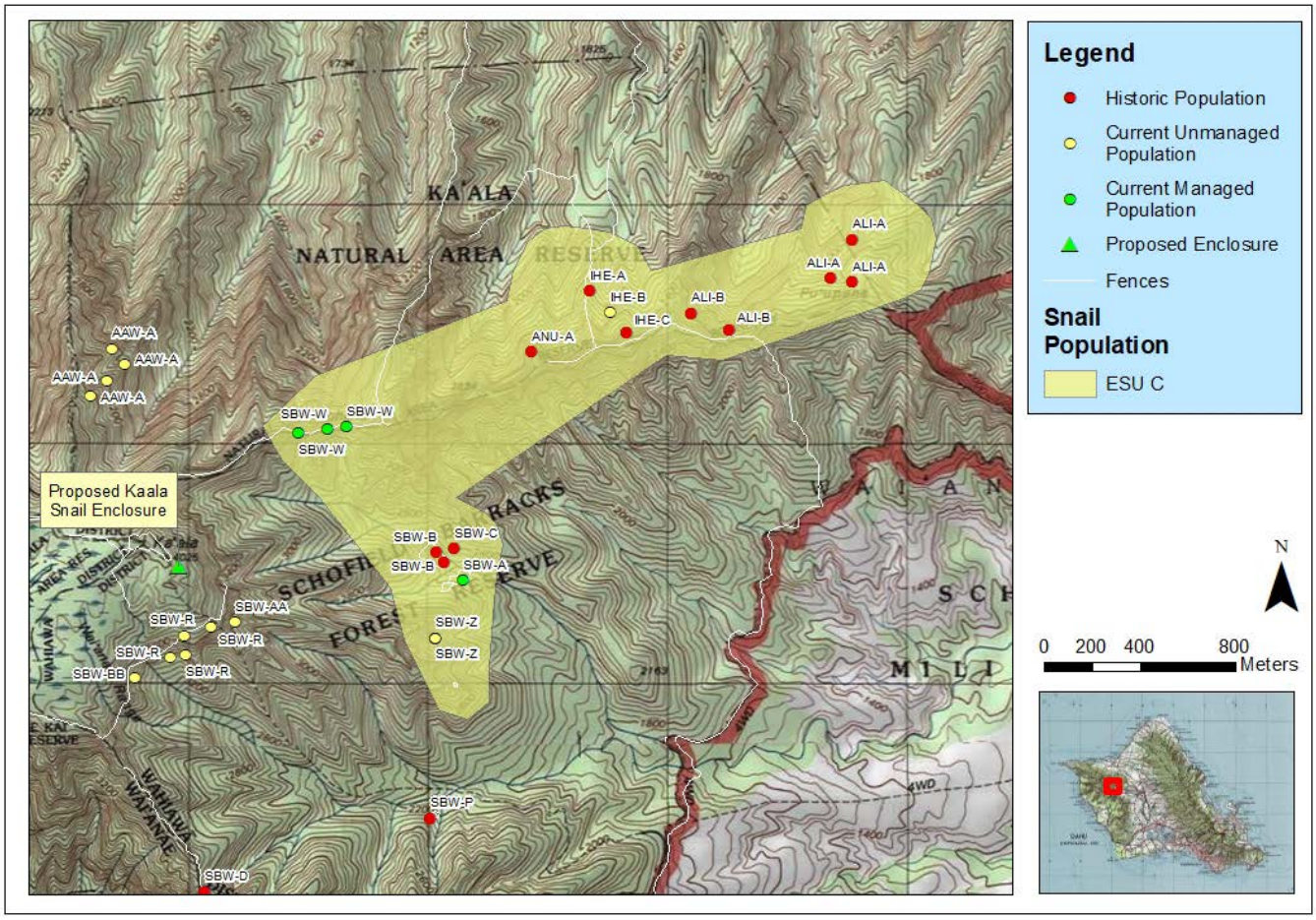

Figure 12. Map of ESU-C

5.4.1 ESU-C Management History and Population Trends

There are two MFS PRSs with 335 observed snails at ESU-C: SBW-A (North Haleauau Hame Ridge) and SBW-W (Skeet Pass) (Table 13). There are several NM PRSs that have very few total observed snails and have not been monitored recently. OANRP conducts rat control at both MFS PRSs. *Euglandina rosea* are present across the ESU. *Trioceros jacksonii xanthologus* was seen once in the lower elevation area of Lihue MU but do not seem to be common across the area, although distribution is not well known.

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

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**											
SBW-A	Manage for stability	32 *	2017-12-19	18	11	3	0	Yes	Partial	Yes	No	No
North Haleauau Hame Ridge												
SBW-W	Manage for stability	303	2014-08-27	190	89	24	0	Partial	Partial	Yes	No	No
Skeet Pass												
	ESU Total:	335		208	100	27	0					

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Size Class Definitions

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

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 (Figure 13) and will begin to translocate the remaining snails to SBW-W where there is more consistent rat control and more snails (see Appendix 5-1 2017 Status Report for the Makua and Oahu Implementation Plans available online at http://manoa.hawaii.edu/hpicesu/DPW/2017_YER/default.htm for translocation plans).

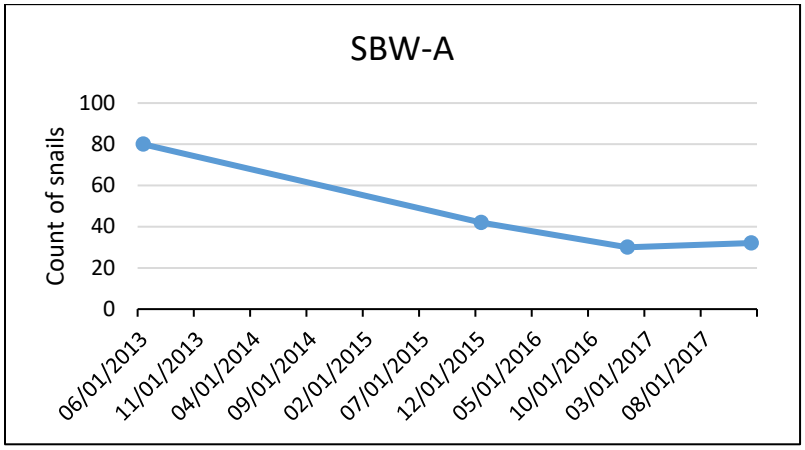

Figure 13. Timed counts at SBW-A show a decline in the population since 2013

5.4.1.2 SBW-W Skeet Pass PRS

On September 20, 2017, 231 snails were counted while surveying. Because a slightly different monitoring style was used compared with the 2014 survey when 303 snails were counted, not as many snails were counted and we continue to use 303 snails as the current census of the PRS. It is very steep habitat and ropes have been used to access some of the areas. The site will be monitored again in Quarter 4 of 2018.

5.4.1.3 No Management PRS

12 sites fall into 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 PRSs (Table 14) and construction of the enclosure at Kaala will be pursued as outlined below (Table 15). Searches for *E. rosea*, and *T. jacksonii xantholophus* in the course of other work will also continue. Weed and ungulate control will also be ongoing.

OANRP plans to construct an enclosure on the slopes of Kaala (Figure 9) by the summer of 2019. This enclosure will be geographically closer to the ESU-D *A. mustelina* than the ESU-C snails because of limited gently sloping terrain. 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 fence and Lihue MU near the historic snail populations. Low numbers of pigs are still present in the Lihue fence.

Table 14. ESU-C Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
SBW-A North Haleauau	TCM	annual	2018, 2019, 2020	Conduct night TCM for 6 person-hours.
SBW-W Skeet Pass PRS	TCM	every 2 years	2018, 2020	Conduct night TCM for 9.25 person-hours

Table 15. Three Year Action Plan for ESU-C

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
SBW-A North Haleauau	• Implement monitoring plan • Rat control • Translocate to Skeet Pass	• Implement monitoring plan • Rat control • Translocate to Skeet Pass • Begin construction of enclosure at Kaala	• Implement monitoring plan • Rat control
SBW-W Skeet Pass PRS	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control • Begin 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

Figure 14. *Achatinella mustelina* from ESU-D

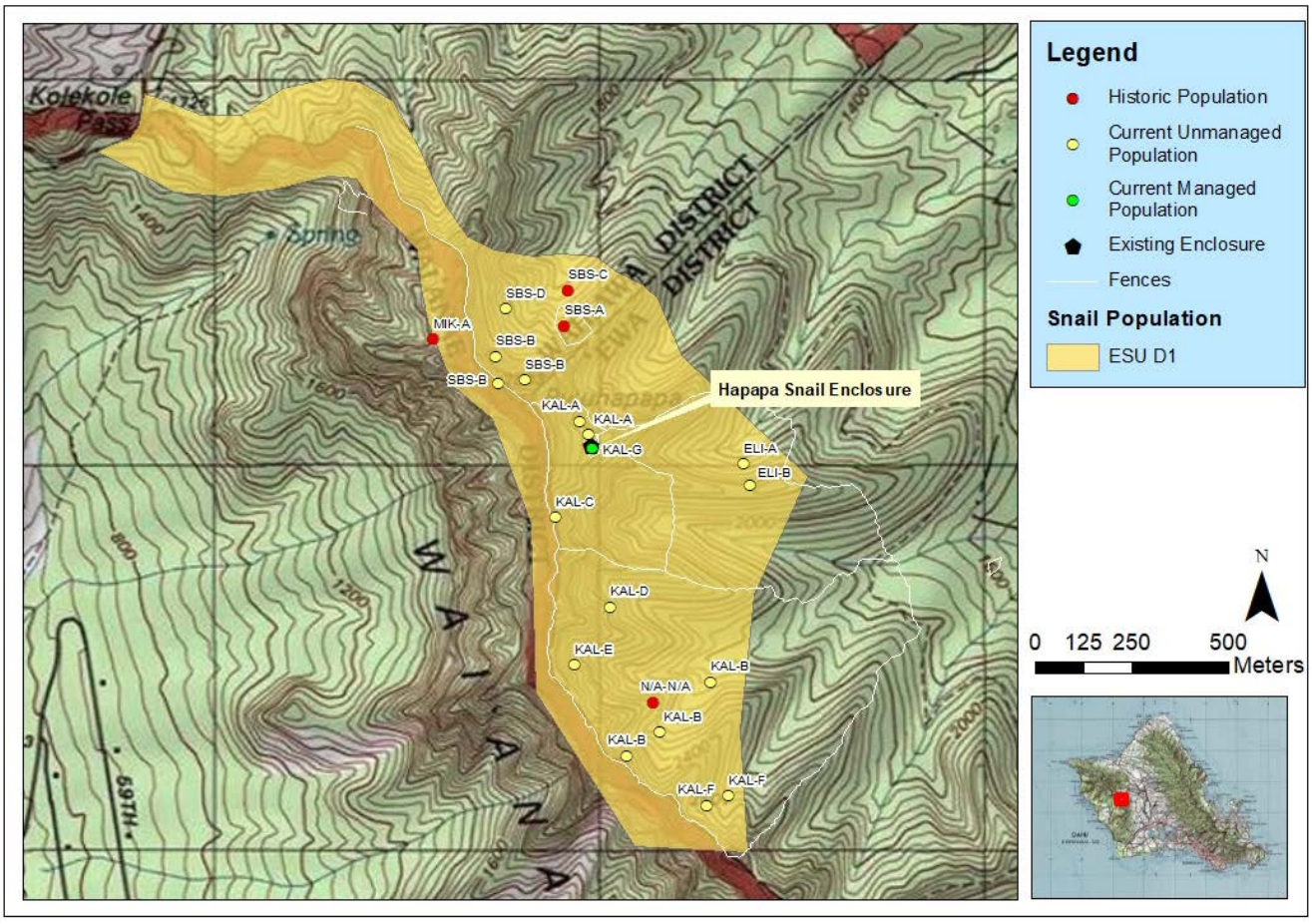

Figure 15. Map of ESU-D1

ESU-D covers a large geographic area and is therefore divided into three units: ESU-D1 in the Kaluaa area (including Hapapa) (Figure 15), ESU-D2 in Makaha (Figure 17), and ESU-D (Figure 18) in the Lihue area. ESU D1 and D2 have MFS PRSs, 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, D2, and D.

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, 747 snails were observed and the population appears to be stable or increasing. 12 NM PRSs contain few to no snails as most 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. Weed control is ongoing. Staff will continue to opportunistically survey the ten NM PRSs, and if found, translocate snails into the Puu Hapapa Snail Enclosure. 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

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**											
KAL-G	Manage for stability	747 *	2018-05-22	456	204	87	0	Yes	Partial	Yes	Yes	Yes
Puu Hapapa snail enclosure												
	ESU Total:	747		456	204	87	0					

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Size Class Definitions

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

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 747 snails were observed during TCM on May 22, 2018 (Figure 12). Though TCM counts oscillate, the population appears to be generally increasing. This trend 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 at Hapapa 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.

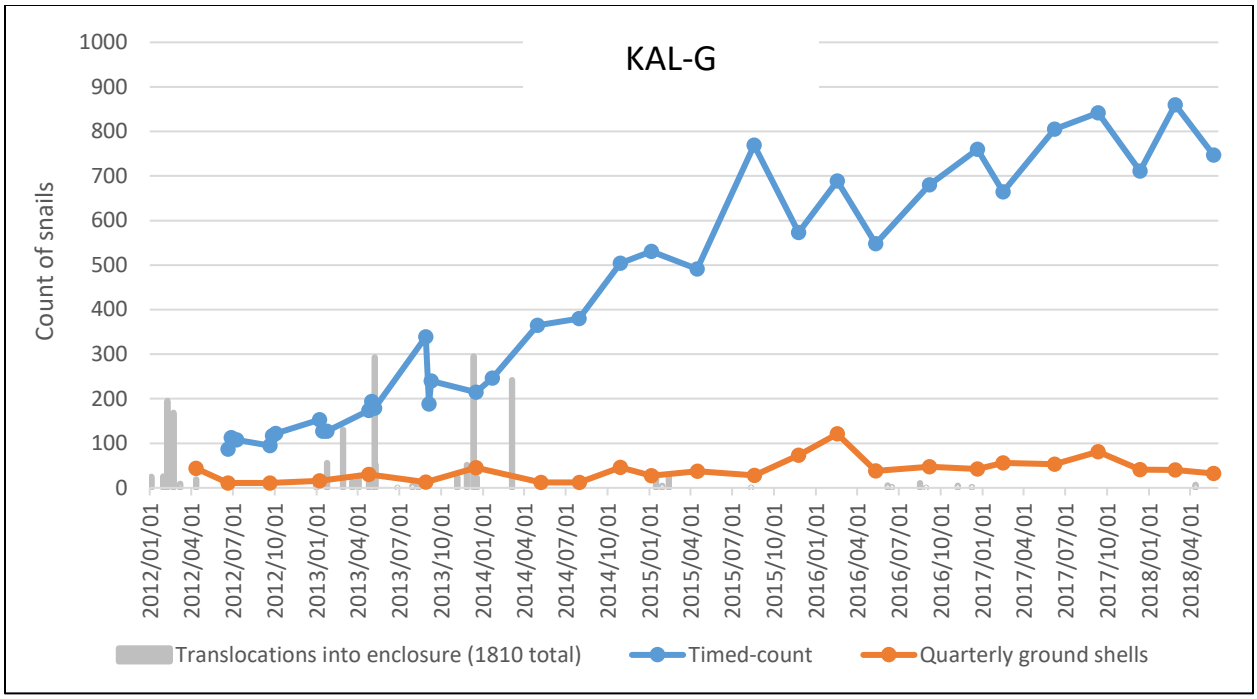

Figure 16. Timed-counts and ground shell counts for *A. mustelina* in Hapapa snail enclosure from June 2012 to April 2018, with numbers of snails translocated into the enclosure over time.

5.5.1.2 No Management PRS

The 12 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
2018-04-12	SBS-B Puu Hapapa	0	2	5	7

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 and A24s for *R. rattus*, and searches for *E. rosea*, and *T. jacksonii xantholophus*. Weed control and habitat improvements will continue. 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.

Two non-managed PRSs, ELI-A and SBS-D, will be surveyed again within the next year. Both sites were last surveyed in 2016 and a few remaining snails were observed. These PRSs will be surveyed and translocated to the Puu Hapapa enclosure.

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 8 person-hours total.
	GSP	quarterly	all	GSP KAL-G-1

Table 19. Three Year Action Plan for ESU-D1

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
KAL-G Puu Hapapa Snail Enclosure	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators • Re-wire enclosure and build cross-over	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators
ELI-A South Waieli Gulch North Branch	• Survey for remaining snails • Translocate to Hapapa enclosure		
SBS-D Two gulches west of Moho gulch enclosure	• Survey for remaining snails • Translocate to Hapapa enclosure		

5.5.3 ESU-D2

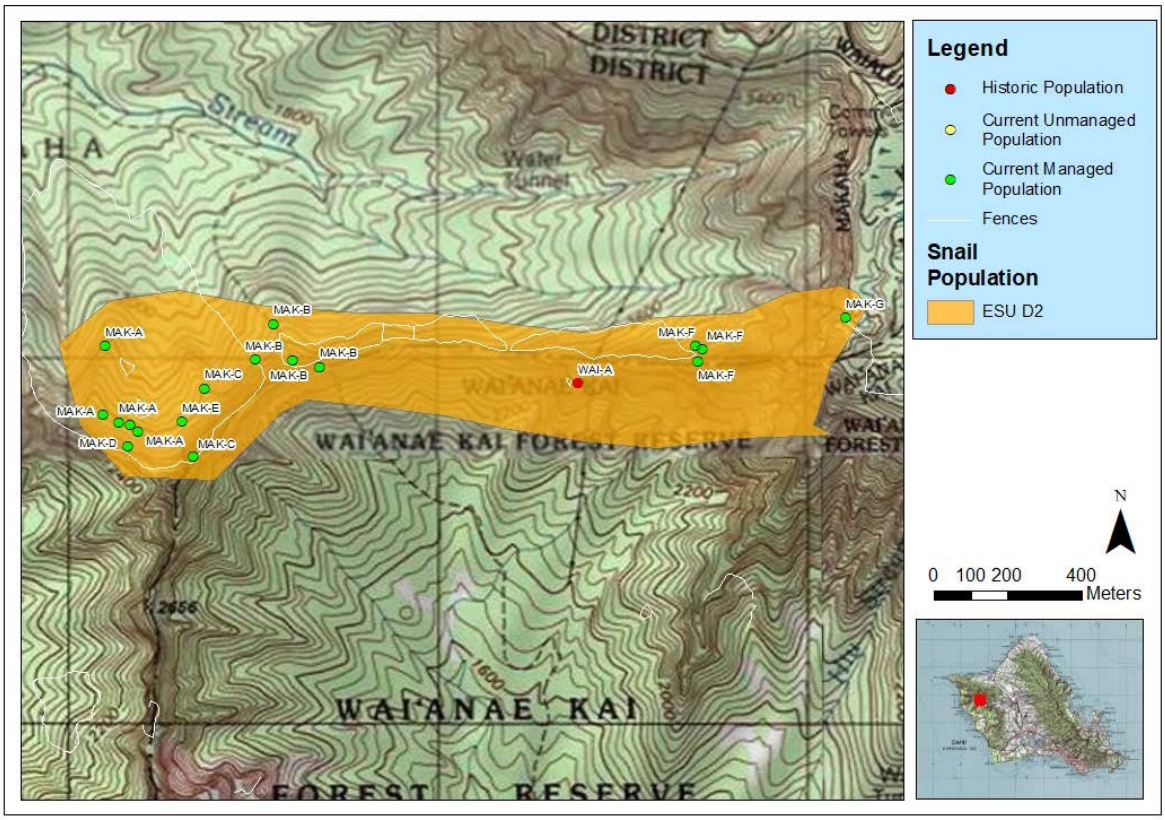

Figure 17. Map of ESU-D2

5.5.3.1 ESU-D2 Management History and Population Trends

There are seven MFS PRS in ESU-D2 with a total of 342 observed snails (Table 20). Rat control occurs at all PRS except MAK-F and MAK-G. *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 A24s are maintained in the Makaha Unit I fence area.

Table 20. ESU-D2 Population Structure and Threat Control Summary

Population Reference Site	Management Designation	Total Snails	Date of Survey	Size Classes				Threat Control				
				Large	Medium	Small	Unk	Ungulate	Weed	Rat	Euglandina rosea	Jackson's Chameleon
Achatinella mustelina												
ESU: D2 Makaha												
MAK-A Isolau ridge	Manage for stability	9 *	2016-09-19	4	4	1	0	Yes	Partial	Yes	No	No
MAK-B Kumaipo ridge crest	Manage for stability	14	2017-02-01	11	1	2	0	Yes	Partial	Yes	No	No
MAK-C Near pinnacle rocks. Includes Hesarb ridge.	Manage for stability	11	2017-10-16	7	3	1	0	Yes	No	Yes	No	No
MAK-D On ledge below ridge crest above MAK-A site.	Manage for stability	34	2016-09-19	15	18	1	0	Yes	Partial	Yes	No	No
MAK-E Ridge east of Cyasup exclosure	Manage for stability	63	2017-10-16	47	14	2	0	Yes	No	Yes	No	No
MAK-F Waianae Kai trail to Kaala	Manage for stability	145	2016-09-19	101	37	7	0	No	Partial	No	No	No
MAK-G Upper Makaha 3850 ft.	Manage for stability	66	2017-11-02	57	4	5	0	No	No	No	No	No
	ESU Total:	342		242	81	19	0					

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Size Class Definitions

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

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.

5.5.3.1.1 MAK-A Kumaipo Isolau Ridge PRS

This PRS was last surveyed on September 19, 2016 when nine snails were counted. Incidental observations indicate that there have been declines since the last TCM. This PRS will be monitored again in Quarter 3 of 2018.

5.5.3.1.2 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 previous survey on January 19, 2010 a total of 21 snails were counted and most of these were on the main ridge trail. This PRS is not a priority due to the low number of snails but will be surveyed again in Quarter 3 of 2018.

5.5.3.1.3 MAK-C Near Pinnacle Rocks PRS

During the survey on October 16, 2017 a total of eleven snails were counted. The next survey will be conducted in 2019.

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

This PRS was last surveyed on September 19, 2016 and 34 snails were counted. The most recent TCM indicates that there have been declines since the last TCM in 2014 when 127 snails were counted. OANRP has observed a decline in the number of host trees. This PRS will be surveyed again during Quarter 3 of 2018.

5.5.3.1.5 MAK-E Ridge East of Cyasup Exclosure PRS

During the survey on October 16, 2017 a total of 63 snails were counted. The next survey will be conducted in 2019.

5.5.3.1.6 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. The next survey will be conducted in July 2018.

5.5.3.1.7 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 November 02, 2017 and found 66 snails (5 small, 4 medium and 57 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 46 m lower than the summit bog at 3850 ft. and is the highest elevation site for *A. mustelina*.

5.5.3.2 ESU-D2 Future Management

Rats are controlled in all but two of the MFS PRSs where control would be challenging in those steep areas. OANRP will continue to explore higher elevation areas in the next year to determine numbers and consider possible threat control options (Table 22). 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 and will formalize a translocation plan.

Table 21. 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 22. Three Year Action Plan for ESU-D2

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
MAK-A Isolau Ridge	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control
MAK-C Near Pinnacle Rocks	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control
MAK-D On Ledge	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control
MAK-E Ridge East of Cyasup	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control	• Implement monitoring plan • Rat control
MAK-F Waianae Kai	• Implement monitoring plan • Assess rat control • Determine PRS extent	• Implement monitoring plan • Implement rat control	• Implement monitoring plan • Rat control
MAK-G Upper Makaha	• Implement monitoring plan • Assess rat control • Determine PRS extent	• Implement monitoring plan • Implement rat control	• Implement monitoring plan • Rat control

5.5.4 ESU-D No management PRS

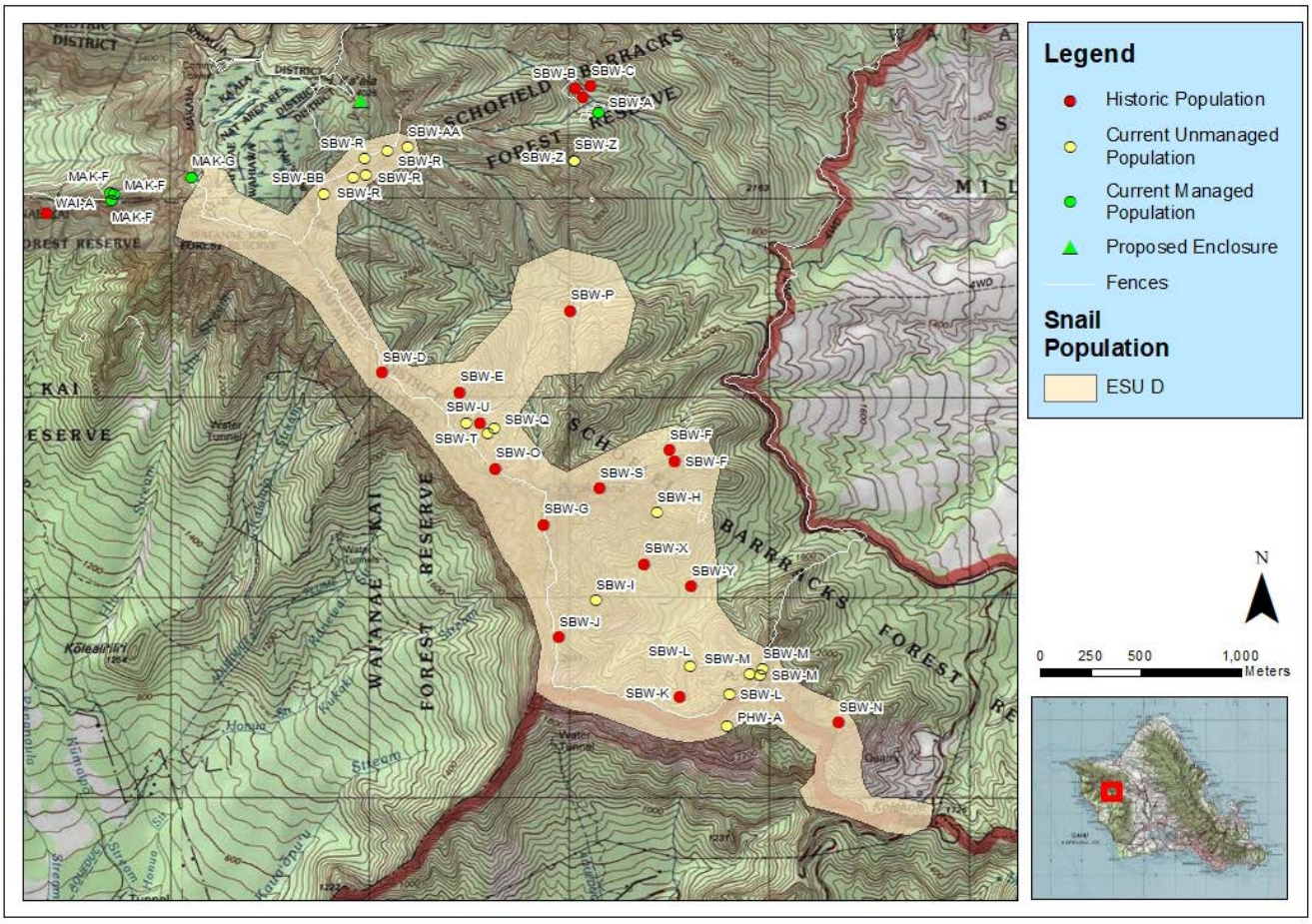

Figure 18. Map of ESU-D

None of these populations are being managed and many have not been surveyed recently. OANRP plan to survey SBW-K, L, and M in the coming year to move some of these snails into the Puu Hapapa snail enclosure given the high level of *T. jacksonii xantholophus* in the area (see Appendix 5-2 in the 2017 Status Report for the Makua and Oahu Implementation Plans).

Table 23. Three Year Action Plan for ESU-D

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
SBW-K Kumakalii-Kalena Ridge-"TR" gulch on the map by "Wahiawa District"	• Survey for remaining snails • Translocate to Puu Hapapa enclosure		
SBW-L Kalena-Kumakalii Ridge- Dike rock gulch	• Survey for remaining snails • Translocate to Puu Hapapa enclosure		
SBW-M Puu Kumakalii	• Survey for remaining snails • Translocate to Puu Hapapa enclosure		

5.6 ESU-E

Figure 19. *Achatinella mustelina* from ESU-E.

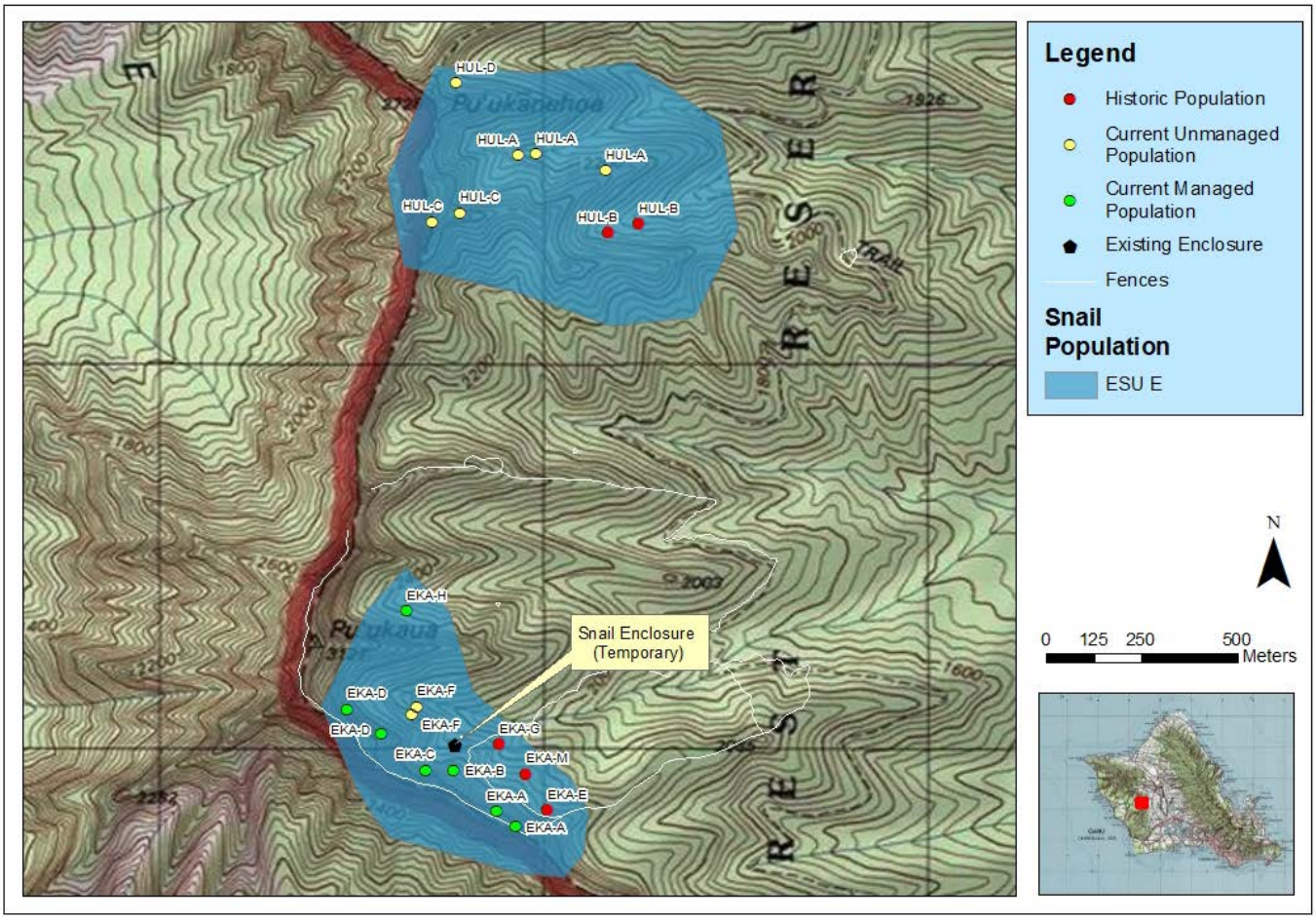

Figure 20. Map of ESU-E

5.6.1 ESU- E Management History and Population Trends

There are five MFS PRS that include 80 observed snails and eight NM PRS with 21 observed snails at ESU-E (Table 24). The larger PRS were surveyed during the past year. 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. A total of 185 snails were collected and given to the SEPP lab to rear in captivity until the Palikea North enclosure is ready.

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

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	51 *	2018-01-31	24	21	6	0	Yes	Partial	Yes	No	No
Mamane Ridge and Near Plapripri EKA-A												
EKA-B	Manage for stability	0 *	2018-01-31	0	0	0	0	Yes	Partial	Yes	No	No
Below north population of Tetlep. Between Plapri EKA-A, EKA-B and EKA-C												
EKA-C	Manage for stability	9 *	2018-02-05	7	2	0	0	Yes	Partial	Yes	No	No
At Plapripri EKA-C site												
EKA-D	Manage for stability	4	2017-08-08	4	0	0	0	Yes	Partial	No	No	No
Puu Kaua												
EKA-H	Manage for stability	16	2018-03-01	5	10	1	0	Yes	Partial	Yes	No	No
South Ekahanui North Branch												
	ESU Total:	80		40	33	7	0					

Size Class Definitions

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

*=Snails (past or current) have been Trans-Located to another wild site

= 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

Between August 2017 and January 2018 a total of 69 snails were collected and given to SEPP for captive propagation. A few remaining snails were observed after the collection in January.

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. Between August 2017 and February 2018 a total of 24 *A. mustelina* 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 August 8, 2017 a total of four *A. mustelina* were collected here and given to SEPP.

5.6.1.5 EKA-H South Ekahanui North Branch PRS

On March 1, 2018 a total of 16 *A. mustelina* were collected and given to SEPP.

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

The Mamane Ridge enclosure has been disassembled but OANRP is planning on using the Spirizona enclosure on a trial basis to house the excess sub-adult snail population that the lab can no longer accommodate beginning in the Fall of 2018 (see Appendix 5-1). A total of 50 snails from the lab will be re-introduced into the enclosure and monitored. If successful, excess lab snails will be contained here until the Palikea North enclosure is suitable for reintroduction.

5.6.1.7 No Management PRS

Most of these sites have few snails surviving but when the Palikea North enclosure is ready to accommodate all of the snails in Ekahanui, an effort will be made to survey all potential sites. Any snails found will be translocated into the enclosure.

5.6.1.8 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. Thus far the lab has been highly successful with multiple births. The number of captive snails in the lab have almost doubled (Table 25 and 26).

Table 25. Ekahanui snails collected for SEPP captive rearing lab

Date	Population	Number
4/13/2017	EKA-A, B, C	31
5/31/2017	EKA-D	5
6/29/2017	EKA-H	10
7/12/2017	HUL-A, C, D	19
7/17/2017	EKA-H	7
8/8/2017	EKA-A	18
8/8/2017	EKA-C	8
8/8/2017	EKA-D	4
1/31/2018	EKA-A	51
1/31/2018	EKA-C	7
2/5/2018	EKA-C	9
3/1/2018	EKA-H	16
TOTAL		**185**

Table 26. SEPP Lab Populations and Deaths of Ekahanui *A. mustelina,* as of June 2018

	Juvenile	Sub-adult	Adult	Total
Live snails	194	96	62	**352**
Deaths	59	9	12	**80**

5.6.2 ESU-E Future Management Plans

Future management focuses on maximizing collections from Ekahanui. OANRP will continue to closely work with SEPP to plan collections. No monitoring or ground shell plots are planned (Table 27). At the rate that the captive lab snails are reproducing, the carrying capacity at the SEPP lab will be exceeded by November 2018. At that time, the excess snails will need to be housed elsewhere until the habitat within the Palikea North enclosure is ready to support a snail population. OANRP proposes to conduct a trial reintroduction with these snails at the Spirizona Temporary Snail Enclosure in Ekahanui and at a temporary enclosure inside the Palikea North enclosure (see Appendix 5-1 for the plan).

Table 27. Three Year Action Plan for ESU-E

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
EKA-A Mamane Ridge	• Rat Control	• Rat Control	• Translocate to Palikea North enclosure
EKA-B Below Tetlep	• Rat Control	• Rat Control	• Translocate to Palikea North enclosure
EKA-C Plapri	• Rat Control	• Rat Control	• Translocate to Palikea North enclosure
EKA-D Puu Kaua	• Rat Control	• Rat Control	• Translocate to Palikea North enclosure
EKA-H South Ekahanui	• Rat Control	• Rat Control	• Translocate to Palikea North enclosure
EKA-S Spirizona enclosure	• Survey and remove any remaining snails in box • Re-introduce lab snails • Implement monitoring plan	• Re-introduce lab snails	• Translocate to Palikea North enclosure

5.7 ESU-F

Figure 21. *Achatinella mustelina* from ESU-F

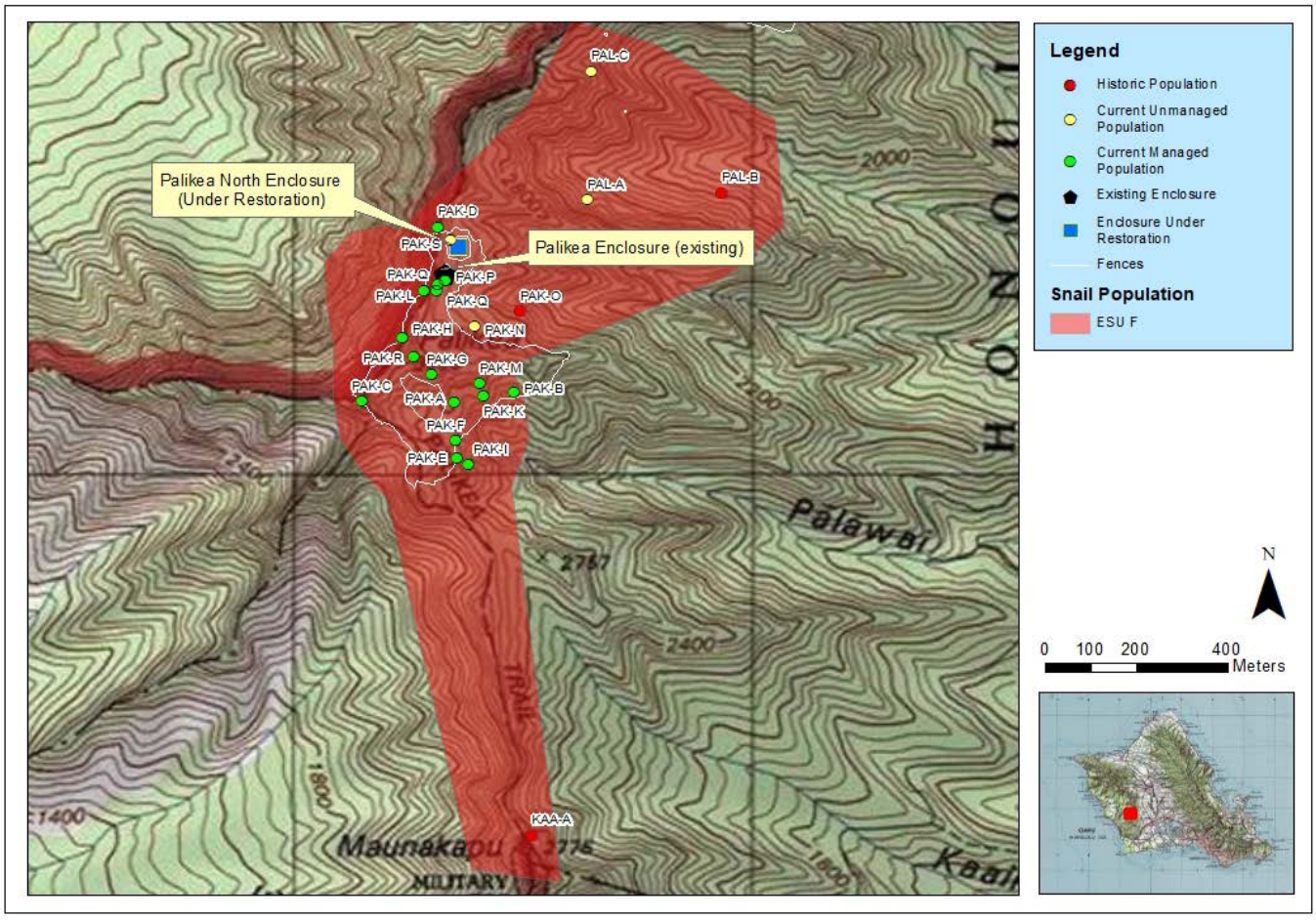

Figure 22. Map of ESU-F

5.7.1 Management History and Population Trends

295 snails have been detected by TCM in the 13 MFS PRSs in ESU-F (Table 28). Most of the snails from the NM PRSs in Palikea are listed as zero as snails from these PRS were moved into the enclosure, and no monitoring has been conducted since. There were 8 snails observed in the NM PRSs from Palawai which will likely be translocated to the existing enclosure in the near future. Small snail populations are still occasionally found within the Palikea fence and those populations have been brought into the snail enclosure due to *E. rosea* presence throughout the MU. All PRSs in the Palikea fence are within the large rat control grid. Only two *T. jacksonii xantholophus* have been observed within the MU thus far but have been observed in larger numbers along Palehua Road.

Table 28. ESU-F Population Structure and Threat Control Summary

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												
PAK-A Puu Palikea-Ohia spot	Manage for stability	9 *	2015-09-28	5	2	2	0	Yes	Partial	Yes	No	No
PAK-B Iele Patch	Manage for stability	2 *	2018-04-11	2	0	0	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 *	2017-08-01	0	0	0	0	No	Partial	Yes	No	No
PAK-E Exogau site	Manage for stability	1 *	2018-01-17	0	1	0	0	Yes	Partial	Yes	No	No
PAK-F Dodonaea site	Manage for stability	6 *	2016-10-25	4	2	0	0	Yes	Partial	Yes	No	No
PAK-G Hame and Alani site just above Cyagri fence	Manage for stability	4 *	2016-10-25	4	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	No	Yes	No	No
PAK-K Pilo site	Manage for stability	4 *	2018-04-11	4	0	0	0	Yes	Partial	Yes	No	No
PAK-L Olapa site north of Puu Palikea	Manage for stability	4 *	2018-03-28	4	0	0	0	Yes	Partial	Yes	No	No
PAK-M Middle Site	Manage for stability	106 *	2018-06-13	64	36	6	0	Yes	Partial	Yes	No	No
PAK-P Palikea snail exclosure	Manage for stability	174 *	2018-04-10	146	19	9	0	Yes	Partial	Yes	Yes	Yes
PAK-Q outside snail enclosure	Manage for stability	1 *	2018-01-17	1	0	0	0	Yes	Partial	Yes	No	No
PAK-R 4 Trail Junction	Manage for stability	2 *	2018-01-17	2	0	0	0	Yes	Partial	Yes	No	No
	ESU Total:	316		239	60	17	0					

Size Class Definitions

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

*=Snails (past or current) have been Trans-Located to another wild site

= 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 last surveyed on April 5, 2017 and no snails where found. The area is now a common restoraton site managed by the Green team.

5.7.1.2 PAK-K Pilo PRS

OANRP staff conducted TCM on August 30, 2017 and counted only three snails, however, 34 snails have been collected and translocated to the enclosure between December 2017 and April 2018.

5.7.1.3 PAK-L Olapa PRS

Four snails were found and translocated to the enclosure on March 28, 2018.

5.7.1.4 PAK-M Middle Site PRS

This was the largest PRS in the ESU, but on June 12, 2018 106 snails were counted during the TCM, which is a decline of about 66% from the June 7, 2016 total of 316 snails. As agreed by the IT, if there is a decline at a PRS that is greater than 50% then snails should be translocated out of that site (see 2015-2016 Year End Report). Since live *E. rosea* have been found on site, staff plan to return to the site as early as Quarter 3 of 2018 to collect snails and will return quarterly until all remaining snails have been translocated.

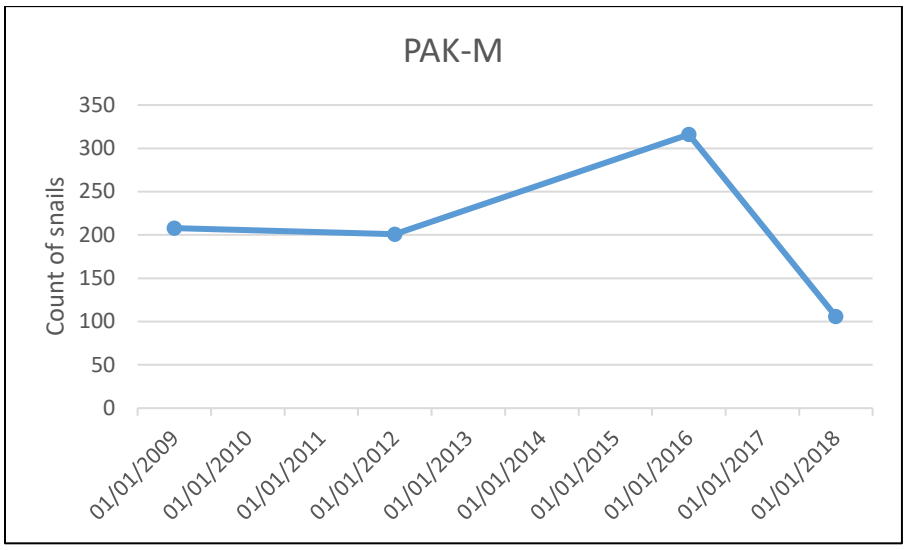

Figure 23. Timed counts at PAK-M show a large decline over the last two years

5.7.1.5 PAK-P Enclosure PRS

OANRP staff continue to translocate snails into the Palikea snail enclosure and have begun TCM on a quarterly basis (Figure 24). On April 10, 2018 TCM was performed during the day with two person-hours spent in each of two separate plots within the enclosure for a total of 72 snails counted. Once a year, a night TCM is performed for 4-person hours covering the entire enclosure, and on April 10, 2018 staff counted 170 *A. mustelina* (9 small, 19 medium, and 142 large). Future translocations from PAK-M will occur due to the sharp decline in the population observed in the last two years.

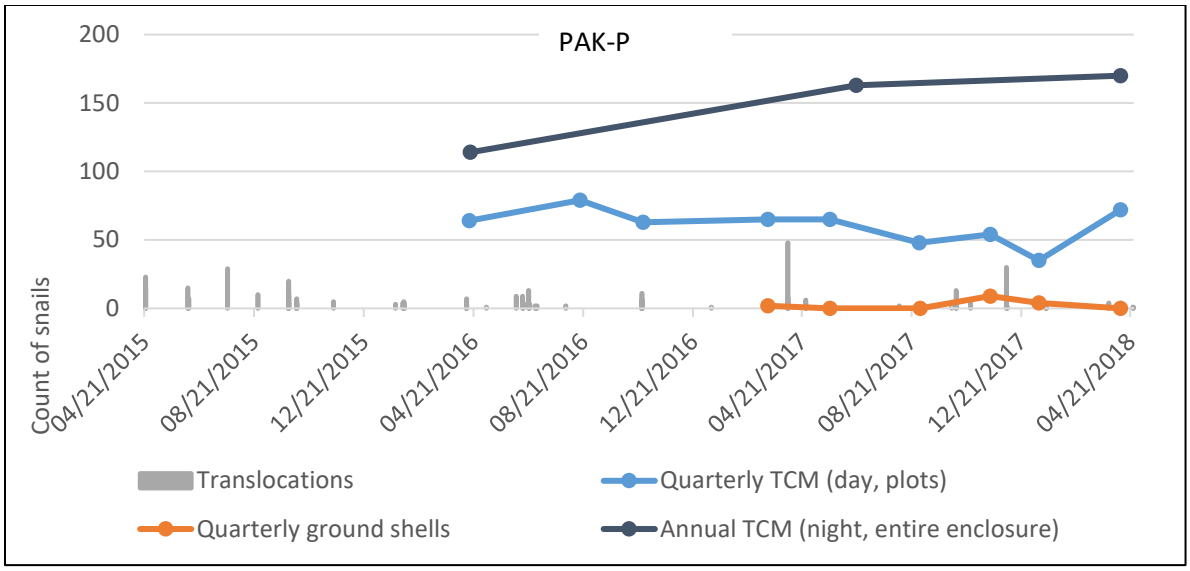

Figure 24. Quarterly and annual timed-counts and quarterly ground shell counts for *A. mustelina* in Palikea South snail enclosure from April 2016 to April 2018, with numbers of snails translocated into the enclosure over time since April 2015. Note: Snail detection is much greater at night than during the day.

No *E. rosea* have been found inside the enclosure in the past year. The last *E.rosea* found inside the enclosure was in June 2017. Quarterly sweeps for *E. rosea* of the enclosure will continue.

5.7.1.6 PAK-S Palikea North Enclosure Site PRS

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

No *E. rosea* have been found inside the enclosure in the past year. Quarterly sweeps for *E. rosea* of the enclosure will continue.

5.7.1.7 No Management PRS

These sites have historically had very few snails and declining numbers. Translocations completed in 2017-2018 are outlined below (Table 29). All snails that were found were translocated in the Palikea South Snail Enclosure.

Table 29. Translocations of *A. mustelina* into PAK-P Palikea South Snail Enclosure in 2017-2018

Translocation Date	PRS Translocation Source	Small	Medium	Large	Total
2017-08-07	PAK-R	0	1	1	2
2017-10-04	PAK-E	0	1	0	1
2017-10-10	PAK-Q,R	1	1	14	16
2017-10-25	PAK-Q	1	0	3	4
2017-12-04	PAK-K	1	2	27	30
2017-12-05	PAK-Q	0	0	1	1
2018-01-17	PAK-E,Q,R	0	1	3	4
2018-03-28	PAK-L	0	0	4	4
2018-04-10	PAK-Q	0	0	4	4
2018-04-11	PAK-B, K	0	0	4	4
2018-04-24	PAK-Q, R	0	1	1	2
Total		**3**	**7**	**62**	**72**

5.7.2 ESU-F Future Management

OANRP will continue monitoring and managing as described in Tables 30 and 31. PAK-M was the largest population within Palikea, but due to recent decline and the live *E. rosea* found on site, the population will be translocated to the enclosure. 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 PRSs listed below (Table 31) require additional visits. After each site has been visited three times with no live snails observed its status will be changed from Manage For Stability to No Management. Unlisted NM PRS have already been visited three times.

As mentioned earlier, small snail populations are still occasionally found in the Palikea MU. Threat control will continue in the MU, including quarterly tracking tunnels for *R. rattus*, and searches for *E. rosea*, and *T. jacksonii xantholophus* are focused around snail enclosures. 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 30. ESU-F Monitoring Plan for MFS PRS

PRS	Monitoring Type	Monitoring Interval	Survey Years	Comments
PAK-P Palikea Enclosure	TCM	quarterly	2018, 2019, 2020, 2021	Conduct day TCM in plots for 4 person-hours.
PAK-P Palikea Enclosure	TCM	annual	2018, 2019, 2020, 2021	Conduct night TCM across entire enclosure and perform

Table 31. Three Year Action Plan for ESU-F

PRS	MIP YEAR 15 July 2018 – June 2019	MIP YEAR 16 July 2019 – June 2020	MIP YEAR 17 July 2020 – June 2021
PAK-B Ieie Patch	• Translocate to enclosure • Rat Control	• Rat Control	• Rat Control
PAK-G Hame	• Translocate to enclosure • Rat Control	• Rat Control	• Rat Control
PAK-K Pilo	• Translocate to enclosure • Rat Control	• Rat Control	• Rat Control
PAK-L Olapa	• Translocate to enclosure • Rat Control	• Rat Control	• Rat Control
PAK-M Middle	• Translocate to enclosure • Rat Control	• Rat Control	• Rat Control
PAL-A Palawai next to Pri sp.	• Survey for remaining snails • Translocate to enclosure		
PAK-P Palikea Enclosure	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators	• Implement monitoring plan • Rat control • Maintain enclosure and monitor for predators
PAK-I One Ridge Truck side of E and F	• Translocate to enclosure • Rat Control	• Rat Control	• Rat Control
PAK-F Dodonea Site	• Rat Control	• Rat Control	• Rat Control
PAK-S Palikea North	• Rat Control	• Rat Control	• Rat Control

5.8 SNAIL ENCLOSURES IMPROVEMENTS

In the past year, the enclosure at Palikea North for ESU-E was completed and is now undergoing ecosystem restoration. Construction on the Makaleha West (3-Points) enclosure is currently underway and is set for completion in September 2018. OANRP continues to improve the electronic barrier system and monitoring system at the enclosures. Efforts to design a new debris alarm for the enclosures are ongoing. See Appendix 3-1 in the 2013 Status Report for the Makua and Oahu Implementation Plans available online at http://manoa.hawaii.edu/hpicesu/DPW/2013_YER/default.htm for original design specifications of barriers.

5.8.1 *EUGLANDINA ROSEA* ENCLOSURE ELECTRICAL BARRIER

The high density polyethylene (HDPE) wall at Palikea North expands and contracts throughout the day due to heat/cooling which caused the electric wires to sag during parts of the day making it ineffective as a barrier to *E. rosea*. The electric wires were relocated to a 2”x 1.5” plastic lumber board mounted just

under the rat hood and the size of the copper wire increased to 12 gauge from 16 gauge. The copper wires run through brass screws mounted in the board (Figure 25). The wires at Palikea North appear to be more robust than those at the other enclosures and have had no breaks in the wires, so all enclosures will be changed over to the new wiring system.

Figure 25. Copper wires held in place by stringing through holes drilled in brass screws.

5.8.1.1 Positive Temperature Coefficient (PTC) Fuses

OANRP volunteer electrician Roy Kikuta suggested the use of polymeric positive temperature coefficient (PTC) fuses, which, in the event of a short circuit, would save the battery from draining and the fuse will reset itself after the wires were fixed. A PTC fuse functions by limiting the overcurrent to protect the battery. The excess current is dissipated through internal heating resulting in increased resistance. Once the cause of the short is removed from the circuit, the PTC will cool down and resistance decreases. Unlike a traditional fuse, the PTC fuse resets itself. This fuse allows up to 750mA of current all day long but if a short circuit occurs, the current will quickly exceed 1.3A, causing the PTC fuse to operate.

The initial intent of the circuit board was to save battery power by pulsing on and off, however the circuit board itself was consuming power to operate the timing chip and the LED lamp. Now that the circuit board has been removed, the PTC fuse becomes critical.

5.8.2 INTELESENSE

All enclosures except for Kahanahaiki are actively monitored by the Intelesense system. Palikea North and Palikea South Intelecells send data to a base station Intelecell located in Mililani (direct line of site of ~5 miles). Data transmission was irregular until the omni-directional antenna at the Mililani base station was switched to a uni-directional antenna to improve signal strength. The Intelecell at Puu Hapapa sends its data to the basestation Intelecell located at the Schofield Barracks baseyard.

Kahanahaiki is the only enclosure not connected to the Intelesense monitoring system and is a priority for the upcoming year. Due to its remoteness, a relay system of Intelecells will be set up. An Intelecell will be set up on the Makua rim at the southwest end of the Kahanahaiki fenceline and will act as a relay between the Kahanahaiki and the Makaleha West Intelecells (see Figure 26). OANRP is currently awaiting approval from the Army before installing the relay Intelecell on the Makua rim. The basestation Intelecell for Kahanahaiki and Makaleha West will be stationed in Waialua.

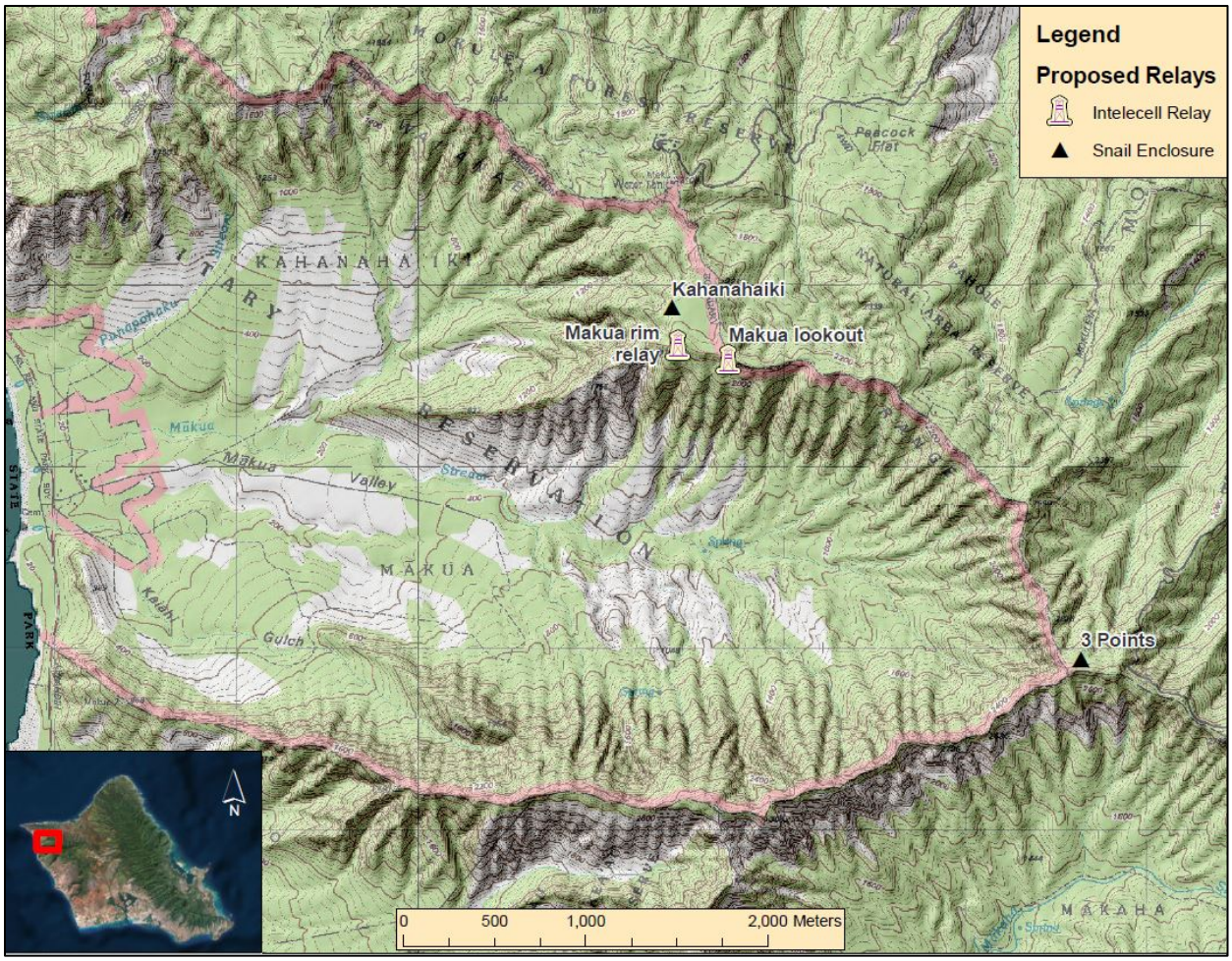

Figure 26. Map of proposed Intelecell relay system with two potential relay sites

5.8.3 ENCLOSURE CROSS-OVERS

Palikea North and Palikea South have permanent cross-overs built into the enclosure. The stationary platform sits above the enclosure wall and a removable ladder is used to get to the platform (Figure 27). When not in use, the ladder is stored on top of the platform and kept off the ground preventing *E. rosea* from getting onto the ladder. All enclosures will have cross-overs by the end of Quarter 4 of 2018.

Figure 27. Built-in crossover at Palikea South enclosure reduces the risk of *E. rosea* getting into the enclosure from the ladder.

5.8.4 KAHANAHAIKI ENCLOSURE

The perimeter of the existing enclosure (mostly eastern and southern perimeter) have been cleared in preparation for the future expansion of the enclosure. Transplanting and outplanting will be needed to replace the weeds that were previously removed. Materials are on order and will be stored at the baseyard until construction begins.

An Intelesense system will be installed in Quarter 4 of 2018 which will give a better idea of any recurring problems with the electric wires. It may be necessary to re-wire the enclosure before the expansion project to maintain the integrity of the electric barrier.

5.8.5 PUU HAPAPA ENCLOSURE

The erosion control project is ongoing at Hapapa and will be completed within the next year. The steps will be completed and filled in with gravel. Weed geotextile will be laid in some areas to hold the soil in place. This project will be completed in Quarter 2 of 2019.

During heavy rains, pools of water at the base of the wall have been observed on the western side of the enclosure. The trench that runs along the side of the wall will need to be widened to prevent pooling of water and premature rotting of the enclosure wall.

The electric wires at Hapapa experience a daily drop in voltage. Various tests were run at Hapapa to determine the cause of the voltage drops, such as testing the 12V battery capacity, checking for resistance in the wires, and replacing troublesome sections of wire. The cause of this voltage drop is still undetermined at this time, but this problem should be resolved when the enclosure is re-wired in Quarter 3 of 2018.

5.8.6 PALIKEA SOUTH ENCLOSURE

In June 2018, re-wiring with 12 gauge copper wire began at Palikea South. The electronics now connect to the fence wires from inside the enclosure which makes troubleshooting easier because the wire voltages can now be checked from inside the enclosure. A cross-over was built near the electronics.

Rotting at the base of the galvanized aluminum walls was observed on the South side of the enclosure (Figure 28). The walls will need to be reinforced within the next year to protect the integrity of the wall.

Figure 28. Corrosion at base of Palikea South enclosure wall

5.8.7 PALIKEA NORTH ENCLOSURE

Construction of the enclosure was completed in September of 2017 and is now undergoing ecosystem restoration (see Appendix 5-5 of the 2017 Status Report for the Makua and Oahu Implementation Plans). 1,350 plants were outplanted inside the enclosure between December 2017 and June 2018 by the Green team, Foundational staff, volunteers, and HYCC (see the Restoration section of Chapter 3). Table 34 summaries the outplanting efforts by date.

Table 32. Outplanting summary inside Palikea North enclosure

WCA Restoration Outplanting Summary

Between

WCACode	Restoration Date	Restoration Goa:	Taxon	Imm.	Mat.	Grand Total	Total Outplant Area	Hours
MU Name: Palikea								
Palikea-11		**North Extension Palikea**						
	2017-12-05	Snail Stabilization					2310	70
			UreGla	52				
			PsyMar	37				
			PisBru	60				
			KadAff	375				
			FreArb	3				
			CopLon	134				
			CheTri	18				
			BidTor	140				
	2018-01-25	Snail Stabilization					2347	9
			UreGla		12			
			PsyMar	1				
			PisBru		1			
			PerSan		2			
			KadAff	29				
			CopLon	24				
			CheTri	17				
			BidTor	6				
			AcaKoa	24				
	2018-04-11	Snail Stabilization					2444	44
			WikOahOah	33				
			UreGla	14	39			
			ScaGaua	9				
			PisBru	58	41			
			KadAff	8				
			IleAno	4				
			CopLon	92				
			CheTri	83				
			CarWah	20				
	2018-06-27	Snail Stabilization					1363	24
			UreGla		14			
			SanFreFre	4				
			PipAlb	12				
			IleAno					
			CopLon	40				
			CheTri	50				
			AlySte	3				
			Palikea-11 Total:	**1350**	**109**	**1459**	**8464**	**147**

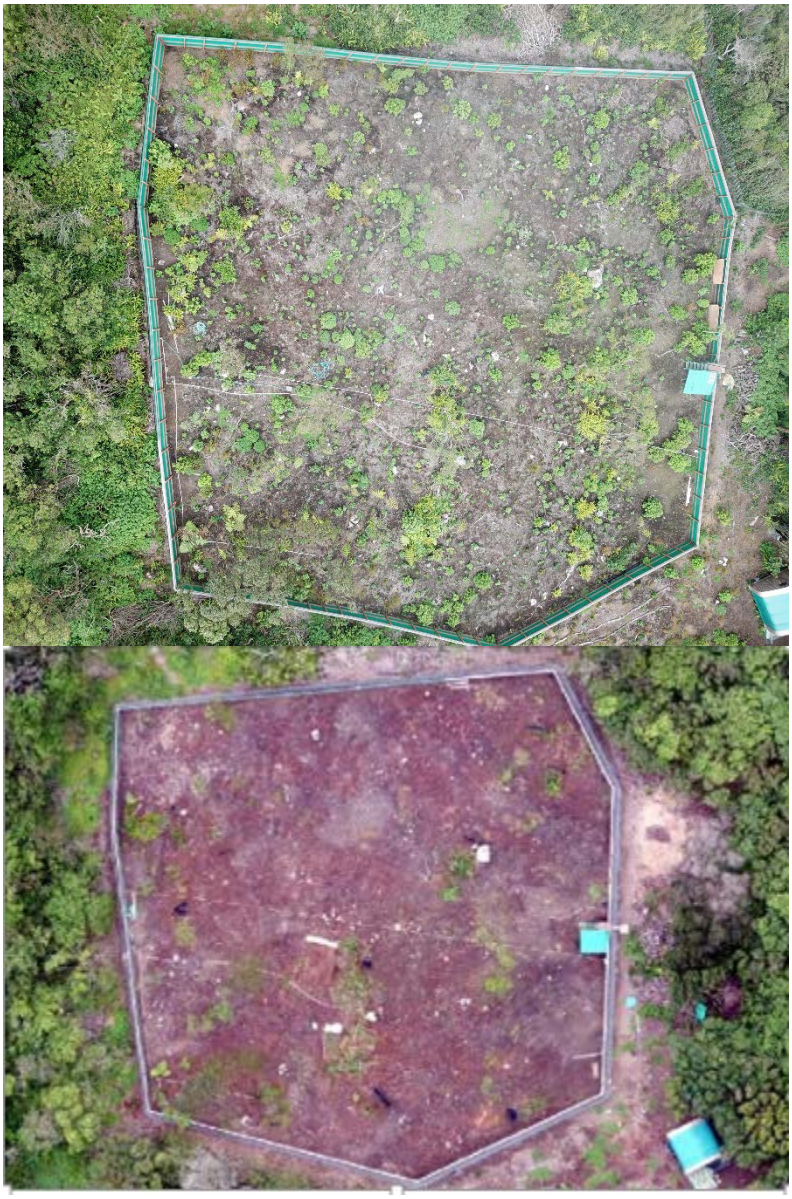

Figure 29. Aerial imagery of Palikea North's current vegetation (top) compared to September 2017 (bottom).

5.8.8 MAKALEHA WEST/3 POINTS ENCLOSURE

Construction on the 3 Points enclosure began on May 29, 2018 and will be completed in September 2018. Removal of the native *Dicranopteris linearis* and other native vegetation is necessary to thoroughly search the area for *E. rosea.* Once construction is completed and all barriers installed (including electric wires, which will be done by OANRP staff) the enclosure will be rigorously swept for *E. rosea*. Sweeps will be more rigorous than at Palikea North due to the amount of native vegetation that will be left inside the enclosure. During *E. rosea* sweeps, staff will also survey for *A. mustelina* and *T. jacksonii xantholophus*. An effort to remove all *Rubus argutus* inside the enclosure will be attempted prior to snail introductions and control will be ongoing. The Blue team will assist with snail translocations to the enclosure because snails are coming from their management areas in Central and East Makaleha. The

Orange team will be responsible for the long-term maintenance of the enclosure. Ecosystem restoration will begin in January of 2019 (see Appendix 5-2).

5.8.9 KAALA ENCLOSURE

Construction for the Kaala enclosure is planned for the summer of 2019. A site on the margin of the Kaala Plateau within Schofield Barracks West Range was selected as a potential enclosure location, however, the transect trail will be scouted for an additional suitable site. In Quarter 1 of 2019, a snail IT sub-committee will visit both sites and decide on the best location for the enclosure.

CHAPTER 6: RARE VERTEBRATE MANAGEMENT

The Army natural resource program on Oahu (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 2018

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, 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. 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. OANRP has conducted rodent control and Elepaio monitoring at SBW (1998-present), Ekahanui Gulch in the Honouliuli Forest Reserve (2005-present), Moanalua Valley (2005-2017), Palehua (2007-present), Palikea (2018), 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

There were some changes in the Management Units (MU) monitored this year and the intervals at which they were visited. At SBW, monitoring was limited to eleven days for the entire breeding season as the threats of and OANRP's response to unexploded ordnance were reassessed. OANRP was also unable to manage the territories at Moanalua Valley due to road construction that occurred during the Elepaio breeding season. The construction did not affect the Elepaio, but made accessing the territories very difficult. Management at Moanalua will resume when construction is complete. To make up for the loss of pairs at Moanalua, OANRP monitored a small population of birds at the Palikea MU. Territories at Palikea, along with Ekahanui and Palehua, were monitored throughout the nesting season, from early January to late July. 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, 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.

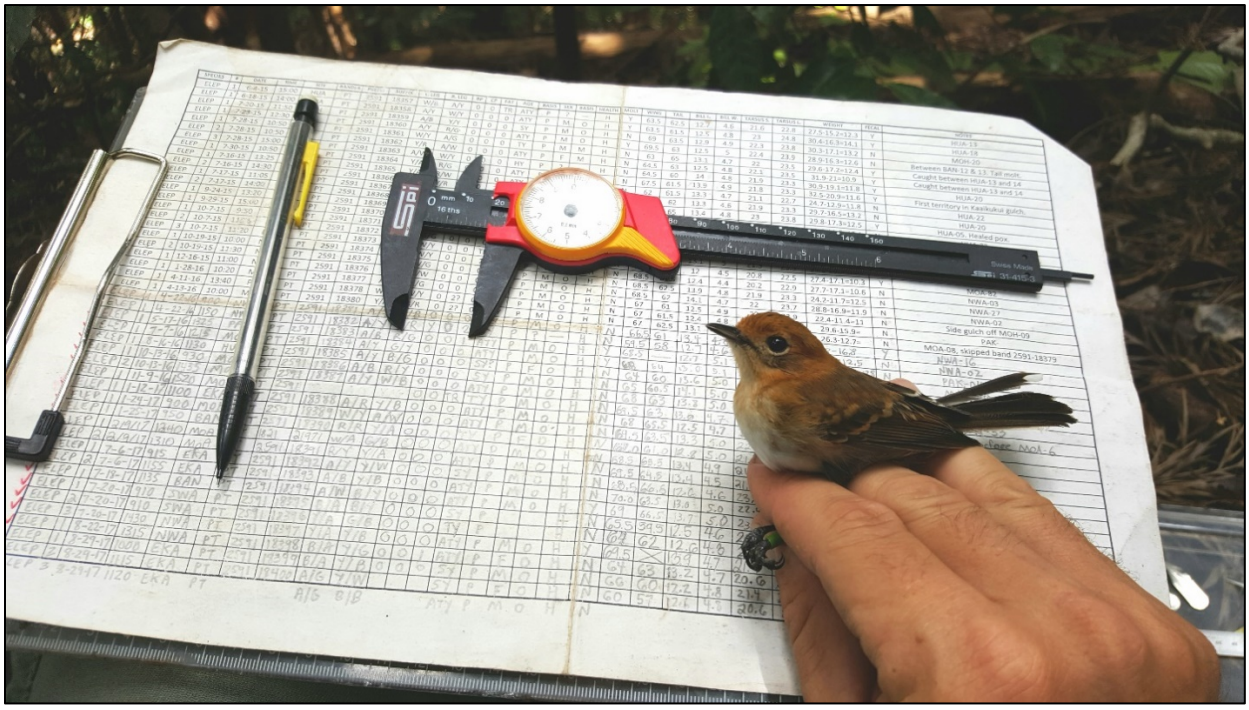

Figure 1. A young female Oahu Elepaio is processed after having been captured in a mist-net. After the bird is given leg bands, various measurements and information are recorded in the field and later entered in a database. Every bird captured helps create a more detailed picture regarding the conservation status of this species on Oahu.

Rodent Control

OANRP also explored newer and more cost efficient methods of rodent control for the 2018 breeding season. OANRP abandoned all use of Victor® snap traps at its sites, which required the assistance of an outside contractor to conduct weekly visits for rebaiting the traps. At SBW, OANRP conducted a wide scale aerial rodenticide broadcast to reduce the amount of rat activity over the MU, as opposed to just within each managed territory. Over half of the MU area (430 ha/746 ha) was treated with two applications just prior to the start of the Elepaio breeding season in December (See Chapter 8: Rodent Management for details). This innovative method of rodent control allowed OANRP to protect 95%-99% of the known territories in SBW. During previous breeding seasons only 30%-45% of the known territories could be protected from rodents. Since access to this MU was restricted for much of the breeding season, this method provided the birds with the best possible protection from rodent predators.

There was also a change in the way OANRP controls rodents at Palehua and Ekahanui. The 192 large scale Victor® snap trap grid at Palehua was replaced with a 92 unit A24 trapping grid. The 600 snap traps at Ekahanui were replaced with 306 A24 traps. These traps were installed along the previously established transects running throughout each MU. At Moanalua, once road construction is complete OANRP will install small scale A24 trapping grids consisting of nine traps in each paired territory. Rodent control will be conducted in a minimum of ten territories. The A24's only have to be monitored/rebaited every three

months, which will provide year-round protection from rodents without increasing costs. Lastly, with the temporary loss of the Moanalua MU, OANRP was able to manage Elepaio pairs at Palikea in its place. This MU already was protected by a large scale A24 trapping grid originally installed to protect rare snails, which provides year-round rodent control for the resident eight Elepaio pairs.

Figure 2. Senior Natural Resource Management Technician, Kelly Tschannen, with a juvenile Elepaio in Moanalua Valley. Younger solitary birds, like this male, sometimes occupy "temporary territories" before seeking out areas more suited for breeding. For several months this subadult utilized a stream bed surrounded by an impenetrable hau tree forest, as seen behind Kelly.

6.1.3 Results

With rodent control occurring in 151 Elepaio pair territories during the 2018 breeding season, the OANRP fulfilled the required 75 pairs for species management. The results of management conducted for each area during the 2018 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 managed. 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

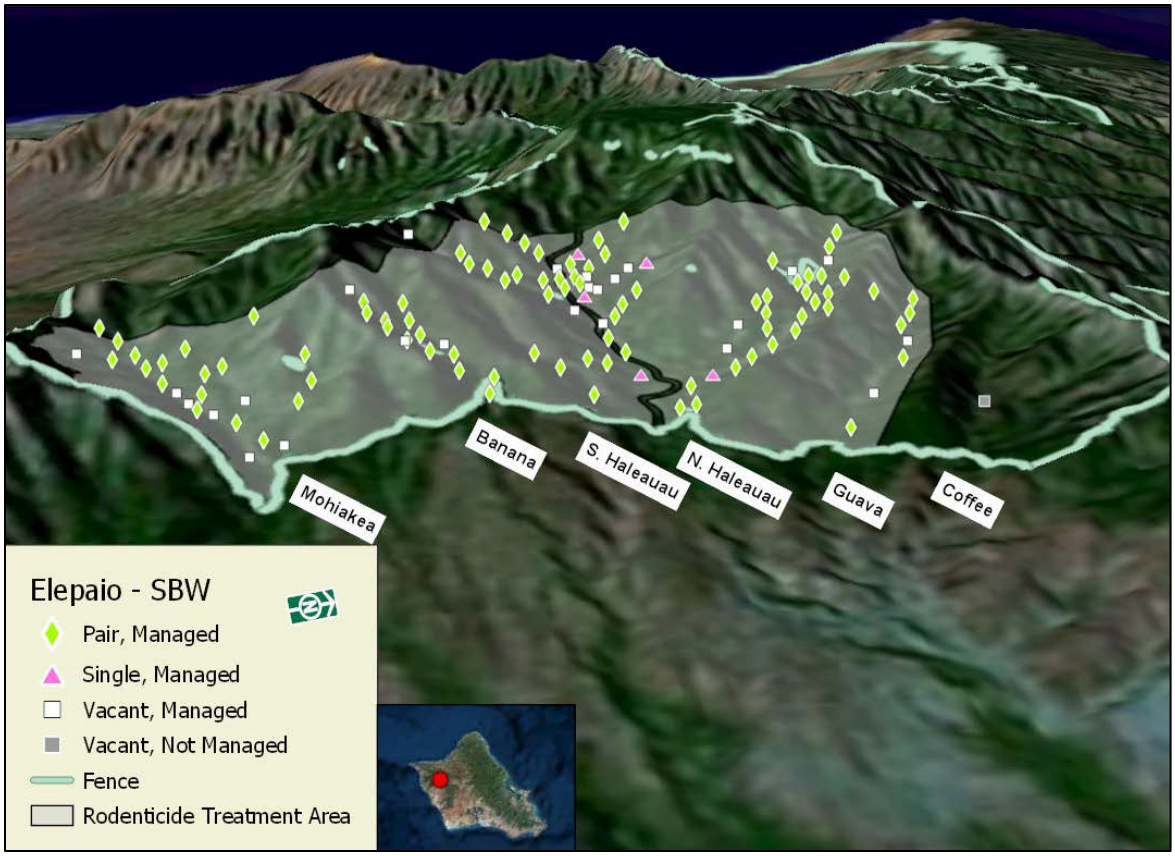

Figure 3. Schofield Barracks West Range Territory Occupancy Status and Rat Control 2018

Table 1. Schofield Barracks West Range Site Demographic Data

SBW	2018	2017	2016	2015	2014	2013	2012	2011
Singles	0*	9	16	16	17	18	16	15
Pairs	31*	81	66	58	57	60	58	56
Pairs with Rat Control	31*	27	28	26	22	29	28	31
Active Nests[1]	7	18	16	14	16	18	23	34
Successful Active Nests[2]	1/4=25%	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]	6	4	2	2	3	0	0	0
Failed Active Nests	0	4	4	4	5	9	7	12
Family Groups Found[4]	7	8	7	5	8	15	11	11
Fledglings Observed[5]	9	19	21	14	20	28	28	46
Fledglings/Managed Pair[6]	0.29	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. (2018 ratio is inaccurate due to limited time allowed for monitoring)
*Number includes monitoring data from Mohiakea and Banana gulches only.

Reproductive Results

Monitoring nesting activity in SBW became a challenge this year due to such a limited amount of time that we were allowed to access the MU. Due to this restricted access we were unable to conduct any monitoring in North Haleauau. Pairs within Mohiakea and Banana gulches were only monitored intermittently during the 2018 breeding season. In both of these gulches only one active nest was found to be successful, which produced one fledgling. Six active nests had unknown outcomes as too much time had lapsed between locating nests and determining fledgling success. Another eight fledglings were found with seven managed pairs where no nesting had been observed (family groups). A total of nine fledglings were observed in territories benefiting from rodent control management in Mohiakea and Banana.

Figure 4. This male in SBW now holds the record for oldest Elepaio ever known in the state of Hawaii. With a sighting in late August 2018, we confirmed the bird to be 23 years, 4 months old. The previous record holder was a Hawaii Elepaio at Hakalau NWR on the Big Island. Notice the head of this bird, which has turned almost completely white with old age.

Summary

Access in SBW this season was limited to eleven days of monitoring. The majority of that time was spent in Mohiakea and Banana gulches. Increased Army training and modified UXO procedures restricted monthly access and limited our ability to monitor all areas of the MU. Therefore, Table 1 population numbers for 2018 for singles and pairs only includes birds observed in Mohiakea and Banana. With the aerial rodenticide drop an estimated 90 pairs had rodent control implemented within their territories. This estimate includes pairs observed during surveys in 2016 in South Haleauau and Guava gulches, as well as, pairs normally monitored each year in Mohikea, Banana, and North Haleauau through the 2017 breeding season. While access to each of these areas did not occur this year, two aerial rodenticide drops were conducted before the start of the breeding season that provided almost all territories in SBW with rodent suppression. While we weren't able to determine the breeding success of pairs in SBW, most territories presumably benefited from the aerial rodenticide application (see Rodent Management chapter for details).

Honouliuli Forest Reserve – Ekahanui

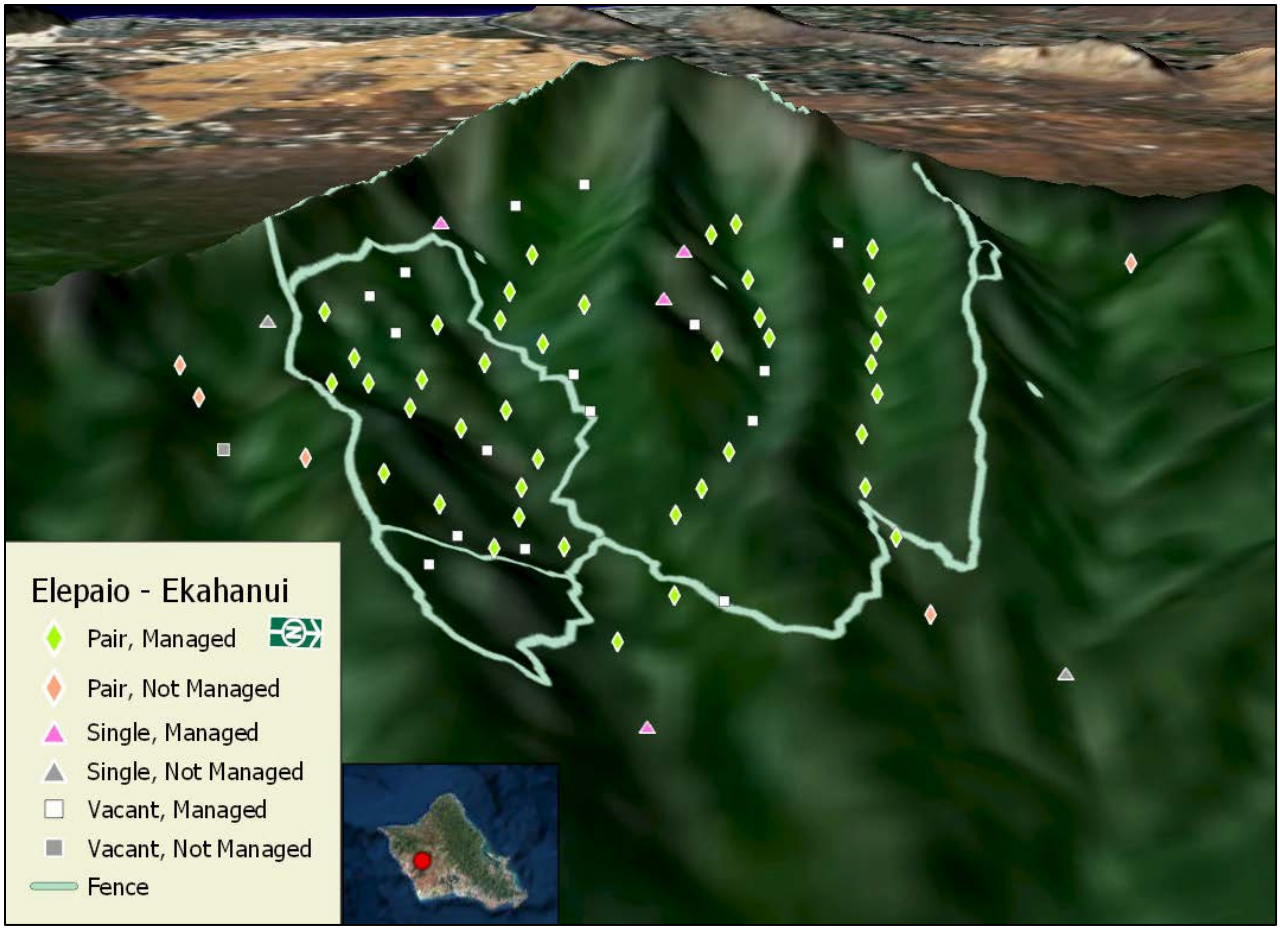

Figure 5. Ekahanui Territory Occupancy Status and Rat Control 2018

Table 2. Ekahanui Site Demographic Data

EKA	2018	2017	2016	2015	2014	2013	2012	2011
Singles	5	4	2	0	5	1	11	14
Pairs	46	42	40	39	30	39	31	30
Pairs with Rat Control	42	37	37	37	28	36	29	30
Active Nests[1]	25	11	12	24	14	28	21	15
Successful Active Nests[2]	12/25=48%	6/11=55%	7/12=58%	14/24=58%	7/14=50%	17/28=61%	9/21=43%	8/15=53%
Unknown Nest Outcome[3]	0	0	1	4	1	2	0	1
Failed Active Nests	13	5	4	6	6	9	12	6
Family Groups Found[4]	11	25	22	6	12	8	6	15
Fledglings Observed[5]	25	36	36	24	21	29	18	26
Fledglings/Managed Pair[6]	0.6	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, 48% (12/25) were successful, producing thirteen fledglings, and 52% (13/25) of active nests failed. Twelve fledglings were found in eleven managed pairs where no nesting had been observed (family groups). A total of twenty-five fledglings were observed in territories benefiting from rodent control management. Another two fledglings were observed in territories not protected from rats.

Summary

Despite a high number of failed nests and fewer fledglings than the previous two years, the population at Ekahanui reached its peak in 2018. With limited access to SBW this season, more time was spent monitoring in Ekahanui, leading to the most active nests found since 2013. Unfortunately, slightly more than half of these failed during the egg or nestling stage. It's difficult to determine why each nest failed, but harsh weather conditions appear to be a likely cause. Seeing an increase in the population was not just limited to within the management unit. We continued with our biennial surveys north of the Ekahanui MU and after a 3-day survey of North Ekahanui and Huliwai drainages we observed a 73% increase in the number of birds detected over the previous survey, as well as, a 64% increase in breeding pairs. This is extremely encouraging and suggests fledglings from inside the managed unit are helping to repopulate areas outside the managed unit with suitable habitat that are capable of sustaining breeding pairs of Elepaio.

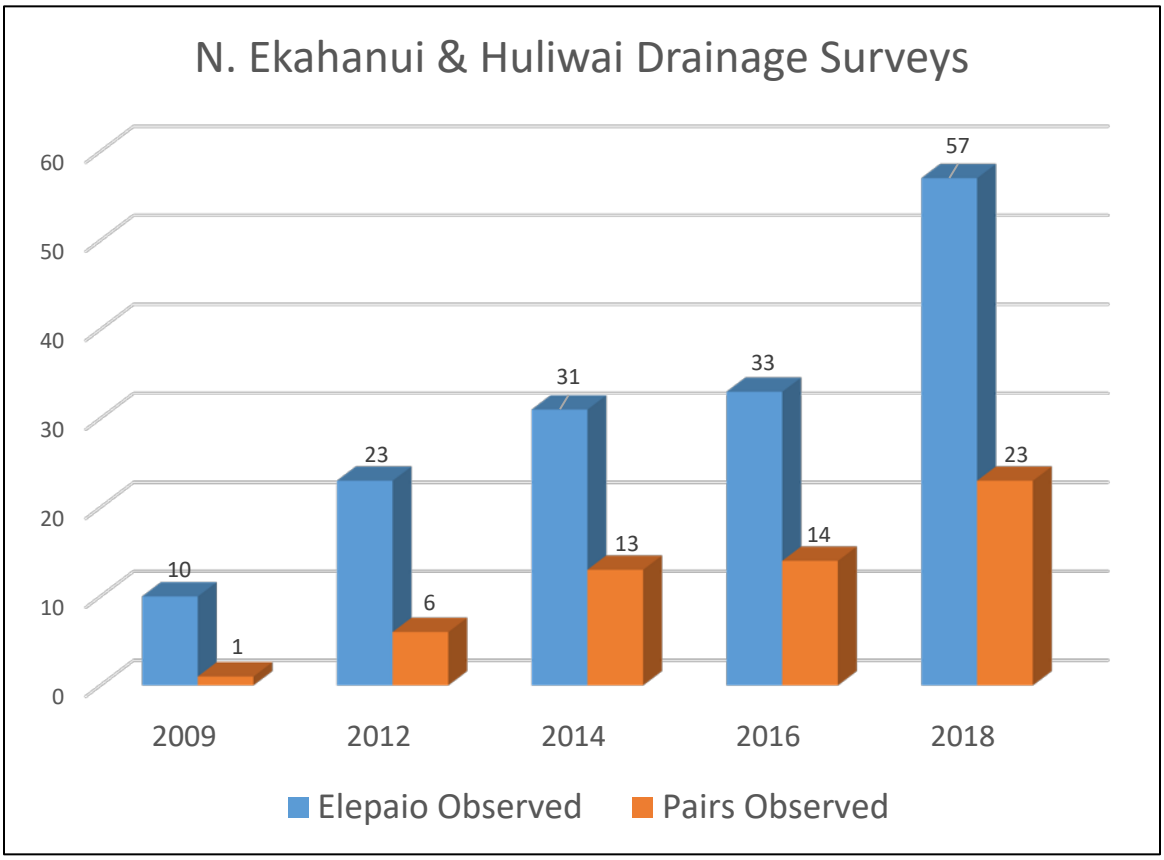

Figure 6. Results of surveys conducted in non-managed drainages north of Ekahanui

Palehua

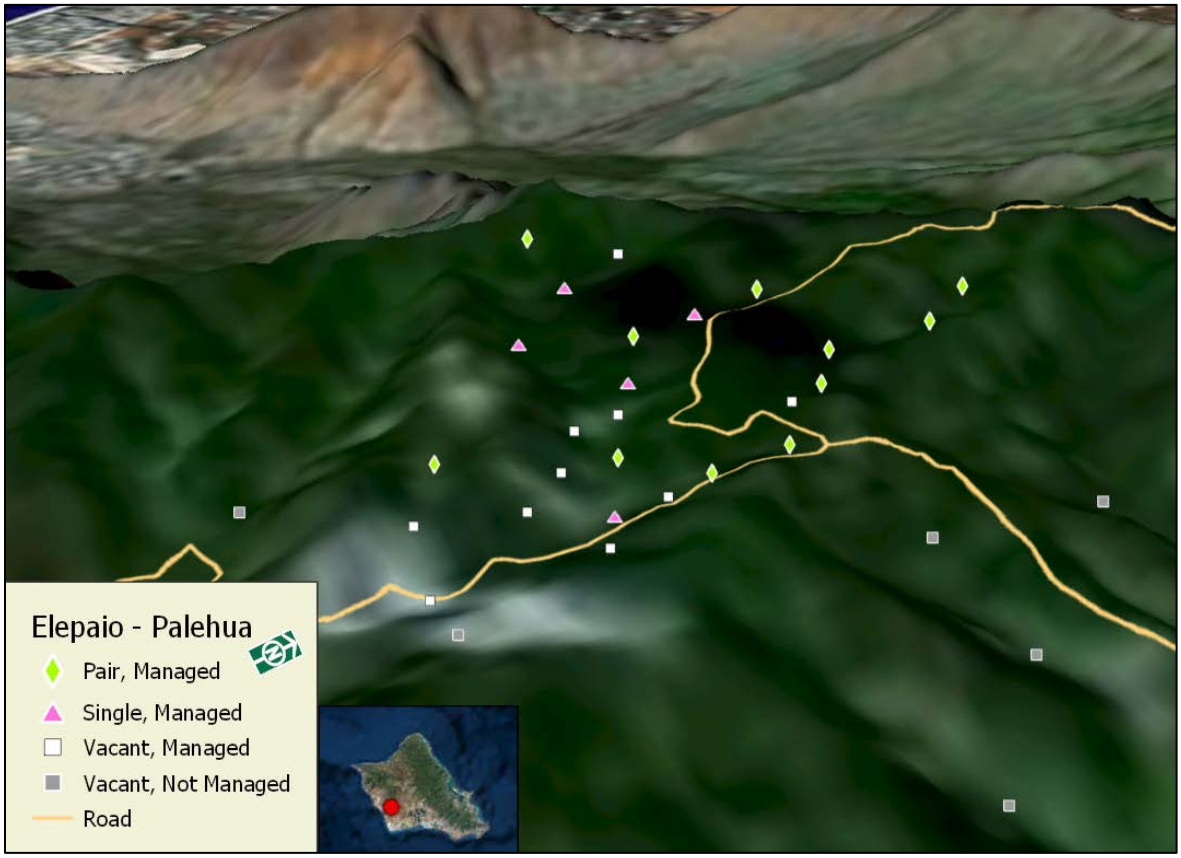

Figure 7. Palehua Territory Occupancy Status and Rat Control 2018

Table 3. Palehua Site Demographic Data

HUA	2018	2017	2016	2015	2014	2013	2012	2011
Singles	5	5	2	1	2	0	0	0
Pairs	11	12	11	15	11	17	16	17
Pairs with Rat Control	11	12	11	15	10	17	16	17
Active Nests[1]	8	6	6	6	8	16	8	13
Successful Active Nests[2]	4/8=50%	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	0	2
Failed Active Nests	4	2	4	3	4	5	5	1
Family Groups Found[4]	3	5	5	1	4	5	3	5
Fledglings Observed[5]	10	12	8	5	10	21	6	16
Fledglings/Managed Pair[6]	0.91	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, 50% (4/8) were successful and produced a total of six fledglings, while 50% (4/8) of the nests failed. Four fledglings were found with three managed pairs where no nesting had been observed (family groups). A total of ten fledglings were observed in territories benefiting from rodent control management.

Summary

Palehua had a positive breeding season this year. Before nesting began all Victor® snap traps were replaced with A24 traps to improve rodent control. Unfortunately, 2018 slightly underperformed compared to the previous year. There was one fewer resident pair and two fewer fledglings observed. Palehua had four failed nests, one of which was confirmed to have been lost due to bad weather and high winds. It's likely the other failed nests suffered the same fate due to unfavorable weather conditions. Despite the four failed nests, this small population was able to produce ten fledglings from eleven pairs.

Figure 8. An adult Oahu Elepaio incubating eggs. Male and female Elepaio incubate in shifts during the day, swapping places with quick, stealthlike flights in and out of nest trees as to not attract attention from predators and OANRP biologists.

Palikea

Figure 9. Palikea Territory Occupancy Status and Rat Control 2018

Table 4. Palikea Site Demographic Data

PAK	2018
Singles	1
Pairs	8
Pairs with Rat Control	8
Active Nests[1]	4
Successful Active Nests[2]	3/4=75%
Unknown Nest Outcome[3]	0
Failed Active Nests	1
Family Groups Found[4]	1
Fledglings Observed[5]	6
Fledglings/Managed Pair[6]	0.75

[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, 75% (3/4) were successful in producing five fledglings, and 25% (1/4) failed. One fledgling was found in one managed pair where no nesting had been observed (family groups). A total of six fledglings were observed in territories benefiting from rodent control management.

Summary

Palikea is a site known for its management of endangered plants and tree snails. This small fenced unit is also one of the few places on the island where it's possible to see all of Oahu's remaining native forest birds, even the elusive Iiwi. It's an area where years of rodent control has greatly benefited many native species, as well as, a small population of Elepaio. With the temporary halt of management in Moanalua Valley, Palikea became a focus for monitoring Elepaio during the 2018 breeding season. While Palikea does not support as large a population as Moanalua, it was an easy site to manage since rodent control is already taking place and locations of breeding pairs are well known. While monitoring the eight pairs this season, six fledglings were observed. One of these fledglings is from a pair whose territory was heavily impacted by the construction of a new endangered snail enclosure at Palikea. Fortunately, the birds were able to utilize what habitat remained and successfully nested at the edge of the cleared forest within view from the Palikea cabin, giving staff and volunteers the opportunity to witness Elepaio nesting behavior. With management at Moanalua expected to return for the following 2019 breeding season, monitoring of Elepaio at Palikea may have been short lived. While we won't have the benefit of knowing the outcomes of future breeding seasons, this population will continue to be provided with year-round rodent control.

Figure 10. Introducing young conservationists to the Oahu Elepaio. While many people associate the "Elepaio" as one of Hawaiian Airlines' Boeing 717 aircraft that flies passengers between islands, they are surprised to see the small flycatcher up close, as it is an endangered forest bird not easily seen on the island of Oahu.

6.1.4 OIP Summary

Management Action Highlights 2018

- Conducted rodent control in a total of 151 territories with pairs at four management sites.
- Protected the largest number of territories in the OANRP's history, due to the aerial rodenticide drop at SBW.
- Completed the 5th survey since 2009 of the two drainages north of the Ekahanui MU. Since that time, the number of Elepaio observed has increased from 10 to 57 birds with the number of breeding pairs increasing from 1 to 23.
- Table 5 below summarizes the number of managed pairs and reproductive output since 2006. In 2018, a large number of paired territories at SBW were baited and not able to be monitored for breeding activity. This is reflected in the unusually low fledglings/managed pairs.

Table 5. Summary of Elepaio Management

Year	Managed Pairs	Success Active Nests	Family Groups	Fledglings	Fledglings/ Managed Pair
2018[1]	151	20	22	50	0.33
2017[2]	89	26	36	73	0.82
2016[2]	88	21	36	68	0.77
2015[2]	97	27	20	50	0.52
2014[2]	81	24	28	62	0.77
2013[2]	105	51	38	95	0.90
2012[2]	97	38	22	65	0.67
2011[2]	94	47	34	96	1.02
2010[2]	87	18	15	39	0.45
2009[3]	81	29	24	60	0.74
2008[4]	74	25	20	56	0.76
2007[4]	78	18	26	46	0.59
2006[5]	69	11	17	33	0.48

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

Management Actions 2019

- 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.
- Now that road improvements at Moanalua have been completed we will return to the management unit and install A24 traps within paired territories in preparation for the 2019 breeding season.
- Access into SBW is expected to be extremely limited and aerial bait drops will not be an option as a method of rodent control. We will take advantage of every opportunity we have to monitor Elepaio territories and utilize A24 traps to minimize rat predation.
- 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.*

[On September 19, 2017 a fire burned 0.25 acres of Elepaio critical habitat at Schofield Barracks, West Range. A second fire on September 22, 2017 burned 0.33 acres of Elepaio critical habitat at Schofield Barracks, South Range. Surveys conducted before and after the fires revealed no resident Elepaio.]

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 11. The helicopter conducting aerial rodenticide drops over SBW. During the 2-day application 26,000 pounds of bait pellets were released over 430 hectares to help control rodent predators during the Elepaio breeding season. This is the first time this method of control has been attempted on the main Hawaiian Islands.

6.2 MIP ELEPAIO MANAGEMENT 2018

6.2.1 Background

The initial Biological Opinion (BO) that triggered the development of the Makua Implementation Plan (MIP) was issued in 1999. At that time, the Oahu Elepaio (*Chasiempis ibidis*) was not listed as an endangered species, but the 1999 BO did include recommendations related to Elepaio. These included conducting complete surveys of the Makua Action Area (AA) for Elepaio presence, monitoring of all known Elepaio within Makua Military Reservation (MMR) and installing and maintaining predator control grids around nesting pairs within MMR. In 2000, the U.S. Fish and Wildlife Service (USFWS) granted the Oahu Elepaio endangered species status under the Federal Endangered Species Act and in 2001 designated critical habitat on Oahu for the Elepaio. In the *Supplement to the Biological Opinion and Conference Opinion for Proposed Critical Habitat for Routine Military Training at Makua Military Reservation* issued in 2001, the recommendations from the 1999 BO became requirements. In September 2004, the USFWS issued another BO that covered newly designated critical habitat within the Makua AA for plants and Elepaio. This BO outlined additional requirements related to this critical habitat. The most recent BO issued in 2007 required the protection of all Elepaio pairs within the Makua AA. 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.

6.2.2 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 12. A nestling Oahu Elepaio at Ekahanui awaiting a meal from its parents foraging nearby. Over the next two weeks the young bird will remain in the nest and rely heavily on the adults for food and protection from harsh weather and tree climbing rats.

Makua

Figure 13. Makua Territory Occupancy Status and Rat Control 2018

Table 6. Makua Site Demographic Data

Makua	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Single Males	N/A	2	2	N/A	0	2	2	2	2	1	1	2	4
Single Females	N/A	0	0	N/A	0	0	0	0	0	0	1	1	1
Pairs	N/A	0	0	N/A	0	0	0	0	0	2	2	2	1
Pairs with Rat Control	N/A	0	0	N/A	0	0	0	0	0	2	2	2	1
Active Nests[1]	N/A	0	0	N/A	0	0	0	0	0	1	1	0	0
Successful Active Nests[2]	N/A	0	0	N/A	0	0	0	0	0	0	0	0	0
Unknown Active Nests[3]	N/A	0	0	N/A	0	0	0	0	0	1	0	0	0
Failed Active Nests	N/A	0	0	N/A	0	0	0	0	0	0	1	0	0
Family Groups Found[4]	N/A	0	0	N/A	0	0	0	0	0	0	0	0	0
Fledglings Found[5]	N/A	0	0	N/A	0	0	0	0	0	0	0	0	0
Fledglings/Pair[6]	N/A	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

Unfortunately, due to safety concerns regarding UXO, we were unable to access Makua Valley in 2018. Last year 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.

6.2.3 MIP Summary

Management Actions 2018

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

Management Actions 2019

- If the OANRP is allowed access we hope to continue with yearly territory occupancy surveys at all territories and surrounding gulches within the Makua AA, as well as, monitoring and banding.

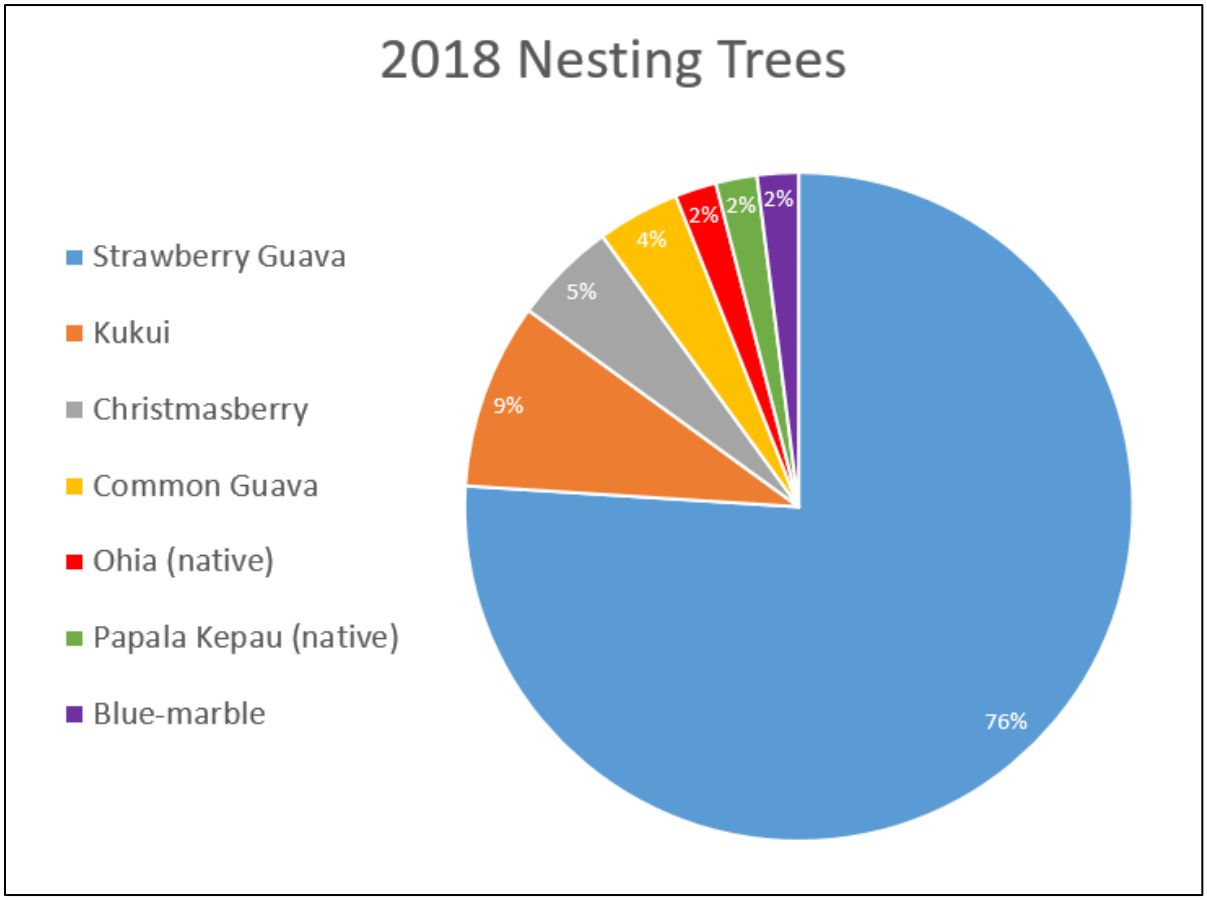

Figure 14. These are the seven tree species used for nesting during the 2018 breeding season. Strawberry guava (*Psidium cattleianum*) is the dominant tree occupying gulch bottoms and valleys where Oahu Elepaio are found, therefore they are utilized the most.

6.3 OPEAPEA MANAGEMENT 2018

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.).

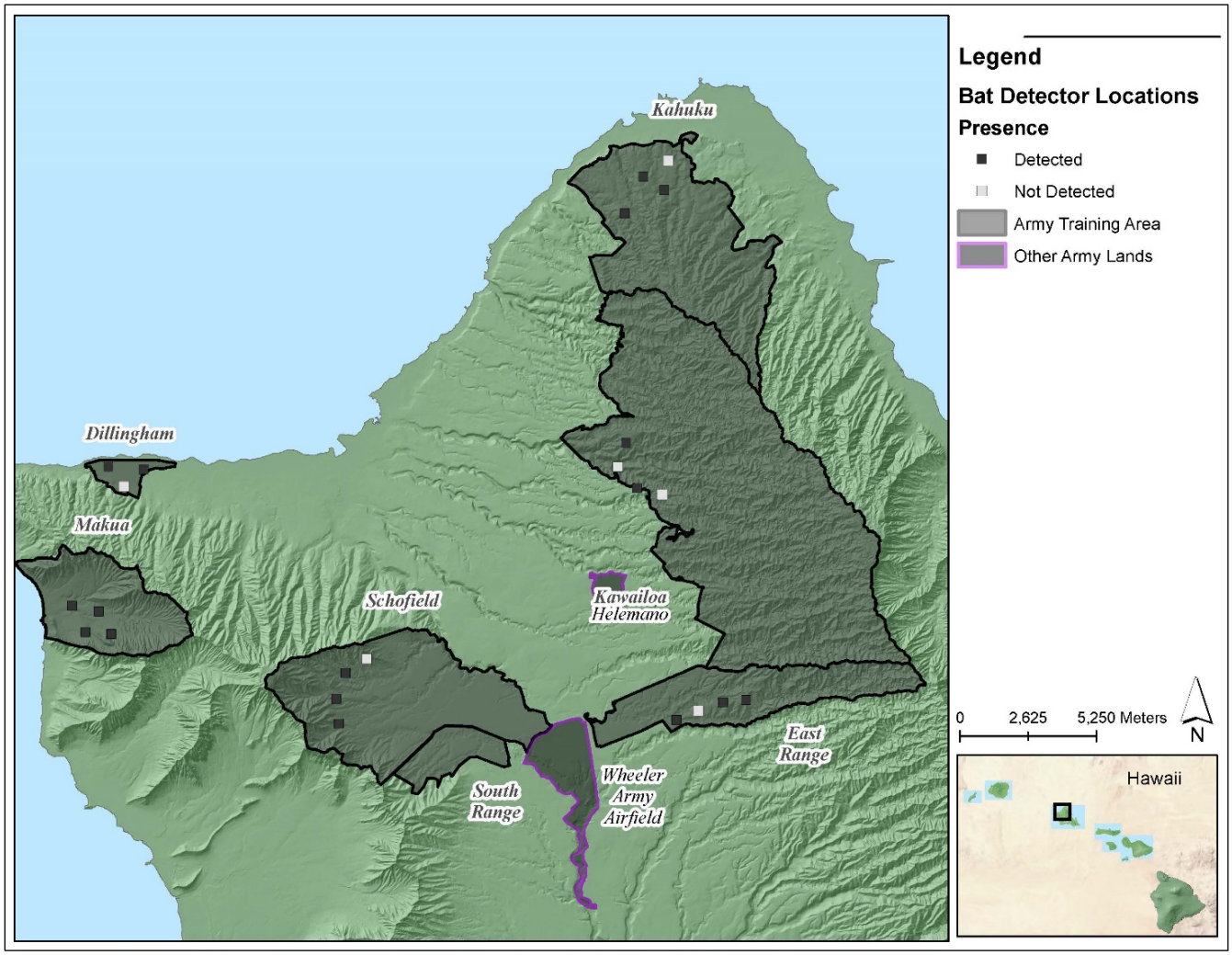

Figure 15. OANRP bat survey sites on Army Training lands from 2010-2013

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 Pacific Island Ecosystem Research Center of the U. S. Geological Service were contracted to conduct these intensive surveys. 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 16). The highest detection rates were at a station in Dillingham Airfield (0.05) and at the stations spread across West Range (0.04 up to 0.355). All other stations had much lower detection, 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.

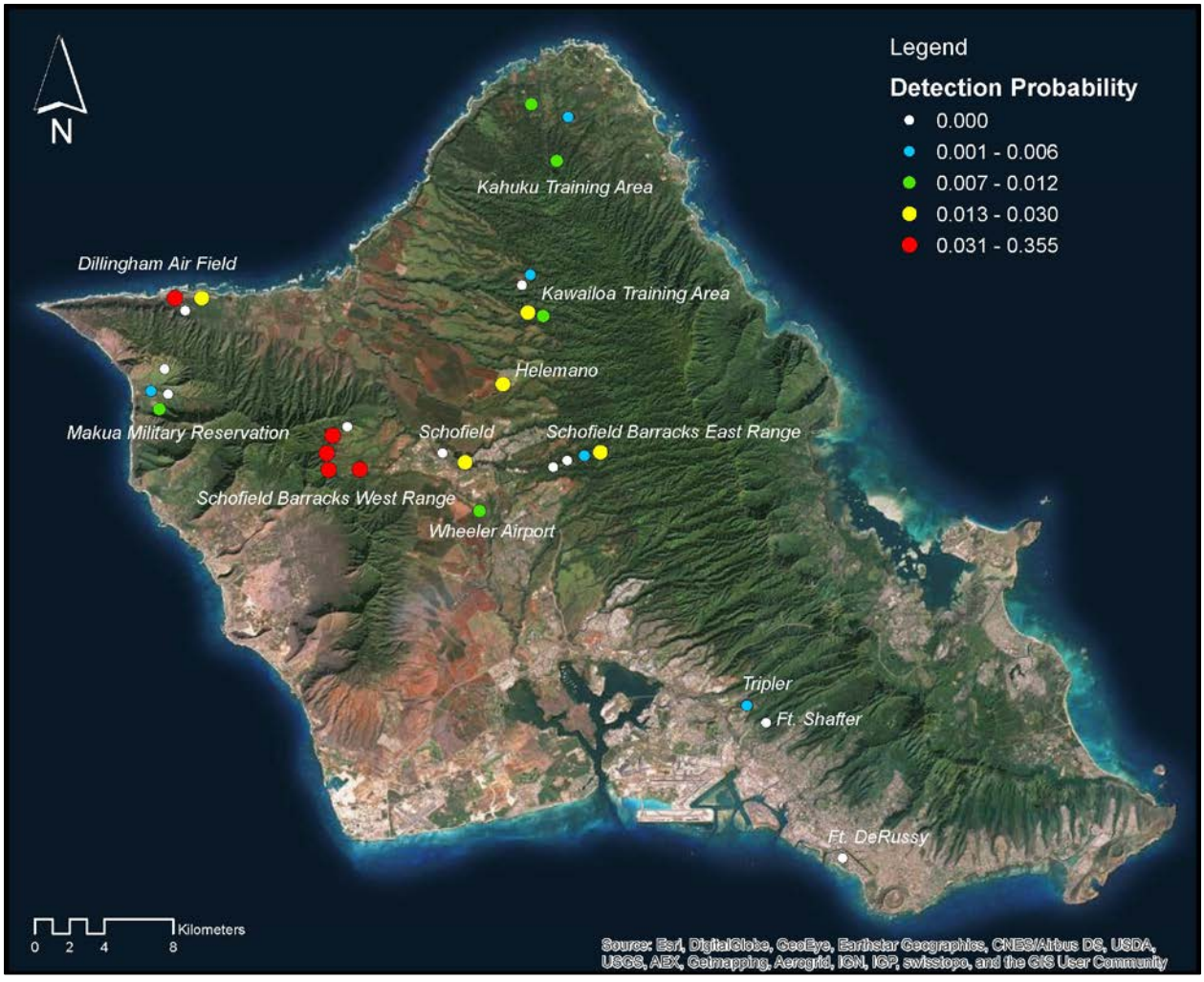

Figure 16. USGS survey sites for Opeapea on Army controlled lands from 2015-2016

OANRP continues to abide by tree cutting limits 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. This is a difficult situation as Federal contracts for grounds maintenance are executed using year-end funding just prior to the pupping season restrictions (1 June-15 September). This makes it impossible to get all tree trimming and removal projects completed prior to 1 June. During the 2018 pupping season, natural resource staff were inundated with requests for bat pup surveys. There were 40 separate tree trimming/removal projects of varying sizes throughout the pupping season that were supported by bat survey teams. The Army's contract officer representative was able to locate a contractor, Tree Solutions and Environmental Consulting Services that had training in bat pup surveys to help alleviate the burden. The Contractor employed the use of a FLIR Scout thermal imager to conduct its surveys. OANRP continued to employ 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. Both the Contractor and OANRP recorded whether any other wildlife was observed during the surveys. Survey reports produced by OANRP and the contractor are included as Appendix 6-1 and 6-2, respectively. Table 7 shows that a total of 39 surveys were conducted by both OANRP and the Contractor before the end of this pupping season. One of the tree trimming/removal projects is continuing through the end of the pupping season and will be reported on in the 2019 Year End Report. All totaled, ~38 hours were spent conducting these surveys (not including transportation time) in 137 trees (19 different species). Zero roosting or flying bats were detected during the course of the thermal surveys.

The Opeapea Acoustic/Thermal Survey summary table below shows the total number of roosting bat surveys throughout the 2018 pupping season. From the left, column 1 shows the date of each survey. Column 2 lists the surveyor, either OANRP or Tree Solutions and Environmental Consulting Services (TSECS). Column 3 is the type of survey. Column 4 shows the time of the survey. Columns 5 and 6 show whether there were any detections, bat or other wildlife. Column 7 lists the Army installation. Finally, columns 8-20 present the different species of trees that were surveyed.

Table 7. 2018 Opeapea Acoustic/Thermal Surveys, showing number of trees by species surveyed

Date	Surveyor	Thermal or Acoustic Survey	Time	Bat Detected (T/A)	Wildlife Detected	Army Installation	*Albizia* spp.	*Spathodea campanulata*	*Ficus* sp.	*Schefflera actinophylla*	*Mangifera indica*	*Araucaria columnaris*	*Persea americana*	*Enterolobium cyclocarpum*	*Jumiper* spp.	*Pterocarpus indicus*	*Eucalyptus* spp.	*Syzygium malaccense*	*Casuarina equisetifolia*	*Handroanthus chrysotrichus*	*Cassia fistula*
04-Jun	TSECS	Thermal	05:00-06:00	No	Yes	FSMR			2												
13-Jun	TSECS	Thermal	05:15-06:00	No	Yes	FSMR			1												
14-Jun	TSECS	Thermal	05:45-06:20	No	Yes	FSMR			1												
14-15 June	OANRP	Both	05:00-06:30	No	Yes	SBMR	7										3				
18-Jun	TSECS	Thermal	05:45-06:45	No	Yes	TAMC	1		3												
18-Jun	TSECS	Thermal	05:30-09:00	No	Yes	WAAF		1		2											
19-Jun	TSECS	Thermal	05:20-06:00	No	Yes	TAMC	4														
19-Jun	TSECS	Thermal	05:45-08:30	No	Yes	WAAF		3													
20-Jun	TSECS	Thermal	05:45-06:20	No	Yes	WAAF		2		1											
21-Jun	TSECS	Thermal	05:30-06:30	No	Yes	WAAF		2			1										
21-22 Jun	OANRP	Both	05:00-06:30	No	Yes	SBMR		2	2									1			
25-Jun	TSECS	Thermal	05:00-06:30	No	Yes	WAAF						6									
26-Jun	OANRP	Both	05:45-06:30	No	Yes	SBMR														1	1
27-Jun	OANRP	Both	05:00-06:00	No	Yes	SBMR	3														
28-Jun	TSECS	Thermal	05:15-06:00	No	Yes	WAAF			1												
29-Jun	TSECS	Thermal	05:30-06:30	No	Yes	WAAF							1								
02-Jul	TSECS	Thermal	05:30-06:30	No	Yes	WAAF		2		1											
11-Jul	TSECS	Thermal	05:30-06:00	No	Yes	TAMC	1		1												
18-19 July	OANRP	Both	05:00-06:30	No	Yes	SBMR	1										7				
19-21 July	OANRP	Both	05:00-06:30	No	Yes	SBMR											11				
21-Jul	TSECS	Thermal	05:30-06:45	No	Yes	TAMC	6		1												
26-Jul	TSECS	Thermal	05:30-06:15	No	Yes	WAAF													1		
27-Jul	TSECS	Thermal	06:00-07:00	No	Yes	SBMR					1			2							
29-Jul	TSECS	Thermal	05:45-06:00	No	Yes	SBMR									1						
30-Jul	TSECS	Thermal	05:30-06:15	No	Yes	WAAF			1												
01-Aug	TSECS	Thermal	05:30-06:30	No	Yes	SBMR					1			2							
09-Aug	TSECS	Thermal	05:30-07:00	No	Yes	SBMR	5		1												
10-Aug	OANRP	Both	05:00-06:30	No	Yes	SBMR											4				
10-Aug	TSECS	Thermal	05:30-07:00	No	Yes	SBMR	2									4					
14-Aug	TSECS	Thermal	06:00-07:30	No	Yes	SBMR	3									4					
21-Aug	TSECS	Thermal	05:45-06:45	No	Yes	SBMR	3														
23-Aug	TSECS	Thermal	05:15-06:00	No	Yes	FSMR	1														
08-Sep	TSECS	Thermal	05:15-06:30	No	Yes	WAAF	9														
11-Sep	OANRP	Both	05:00-06:00	No	Yes	SBMR								1							
15-Sep	TSECS	Thermal	05:00-06:30	No	Yes	SBMR	9														

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 and are managed by the Army natural resource program on Oahu (OANRP). OANRP work on *Drosophila* began in March 2013, focusing on monitoring known populations, surveying for new ones, and restoring habitat.

After several years of poor conditions and low population of both rare and common species, winter and spring 2018 saw a return to higher numbers in wet-mesic forests not seen since 2015. Those in drier forests remained low, possibly due to a continued shortage of breeding material. Many of the host trees outplanted in previous years are now reaching the size where they can support *Drosophila* breeding.

The endangered damselfly *Megalagrion xanthomelas* is also currently being managed. Its sole Oahu population is monitored monthly and has been stable for approximately 20 years. Efforts to reintroduce it to another site are ongoing and we expect to report on results next year.

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 Management Unit (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 there 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.

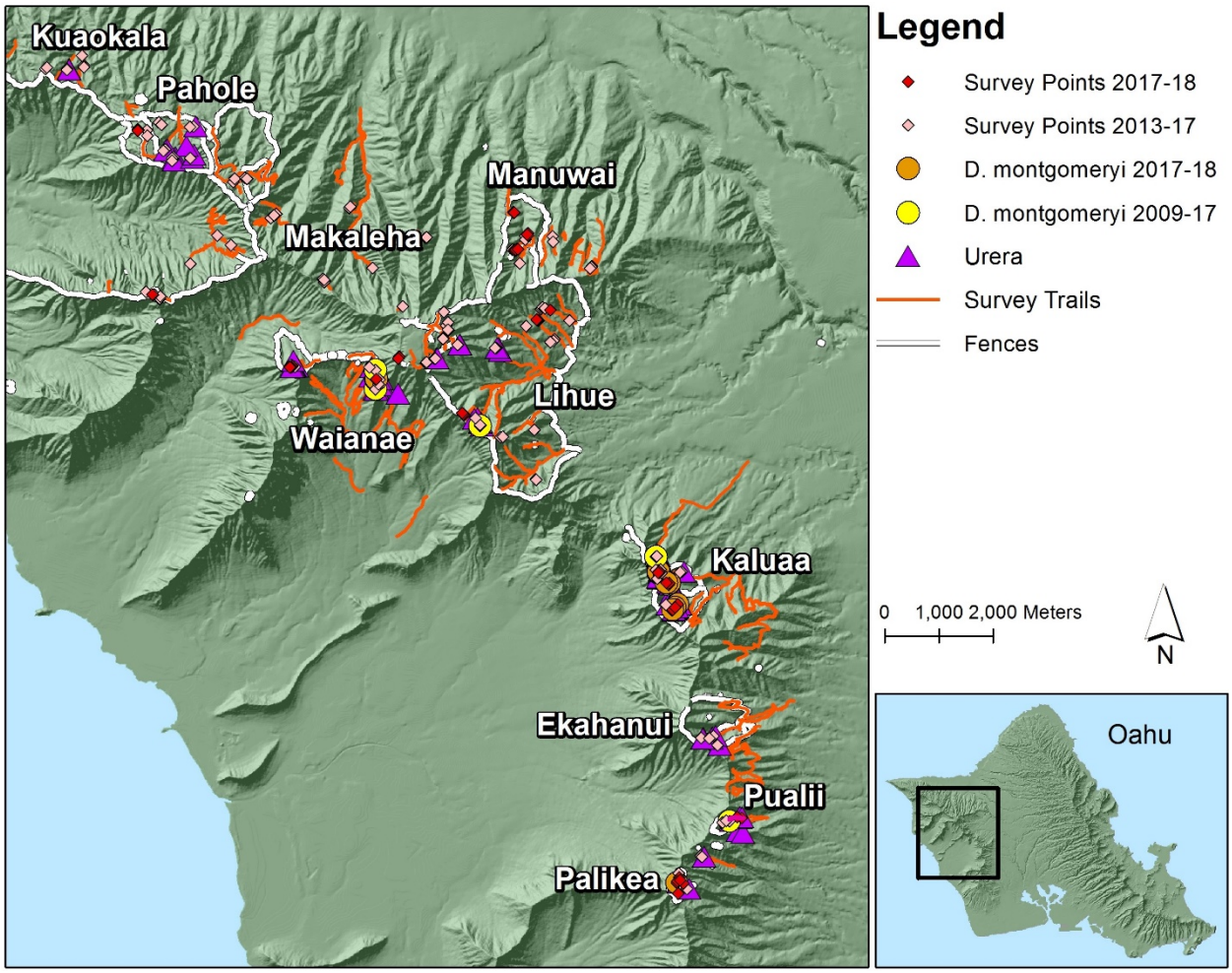

Figure 1. Distribution of *Drosophila montgomeryi* observations in the 2017-18 reporting year (including sites where it was previously found) and earlier records from 2009-17, with known *Urera* spp. sites and all survey points in the Waianae range. Labels indicate major *Drosophila* survey areas.

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 one or a few individuals, 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) (discussed individually below, except Lihue), effectively covering nearly its entire historic range in the Waianae Mountains (Figure 1). It has not been found at the Pualii PU in over two years, and the Lihue PU has not been surveyed recently due to access issues. However, one individual was found this year at Palikea PU, two and half years after the previous sighting. 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

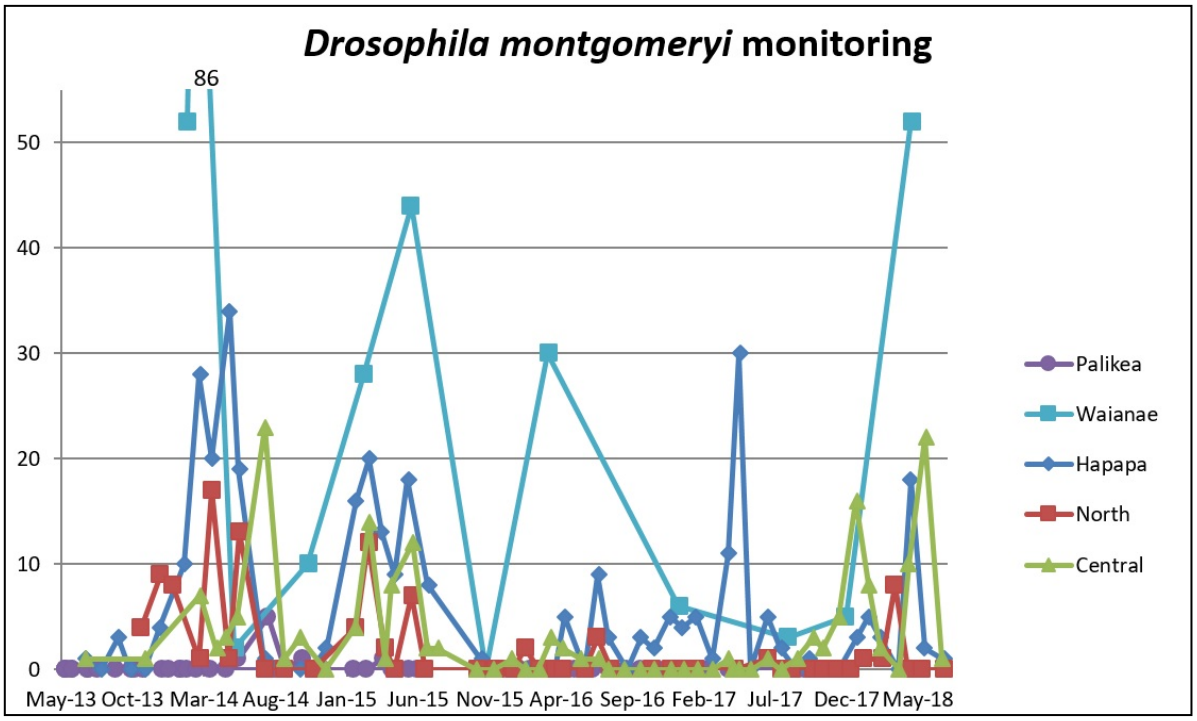

Figure 2. *Drosophila montgomeryi* numbers during monthly monitoring at three sites in Kaluaa PU (Puu Hapapa, North Kaluaa, and Central Kaluaa) and Palikea, and quarterly monitoring at Waianae. Y axis is the maximum number observed across the entire site on the survey day (see Survey Methods, section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

Three sites in this PU – 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 150 survey days. Abundance of *D. montgomeryi* generally follows a distinct seasonal pattern, increasing dramatically over the winter months to a peak between January and May, more or less in synchrony with several common *Drosophila* species (Figure 2). 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 aside from a brief late spring spike at Puu Hapapa in 2017.

Table 1. Survey effort for *D. montgomeryi* across all potential sites in 2017-18 reporting period, in survey days. "Max No." is the highest number of flies observed in a single day.

Site	Days	Max No.
Kaluaa - Central	12	22
Kaluaa - North	12	8
Puu Hapapa	12	18
Palikea	13	1
Waianae	3	52
Pualii	1	0
Makaha	1	0
Kahanahaiki	1	0

Pualii PU

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 *D. montgomeryi* reintroduction site after additional host plant restoration.

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. Over the past year, ant control has been successfully implemented, first across the entire population and then targeting remnants. Currently only one small patch of *Pheidole* remains in the gulch bottom above the fence.

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. Four of the five records here have been of single individuals, indicating that the population remains low. After a year of occasional sightings it disappeared, possibly due in part to drying of the site from canopy clearing needed to allow the plants to thrive; survival and growth of *Urera* are dramatically reduced under alien canopy. However, there are other patches of *Urera* around the Palikea MU that may also harbor small or transient 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

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.

population. Outplanted *U. glabra* here have done exceptionally well – many of them are 6–8 feet tall after only 18 months. *Urera kaalae* have also been planted here by Oahu PEPP, and are 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*. In October 2017, *D. montgomeryi* was resighted at the outplant site for the first time in two and a half years.

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 over the past several years. Although still degraded from the condition it was originally discovered in, numbers of *D. montgomeryi* were found to have rebounded to their previous high level during the most recent survey (Figure 2). 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 fourth year of active habitat management for *D. montgomeryi*. Since fall 2014, approximately 300 *U. glabra* and 300 *U. kaalae* have been planted at North Kaluaa, Central Kaluaa, Pualii, and Palikea, achieving the goals set out in the 2014 three-year plan (summarized in the 2017 Year

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.

End Report). This year, an additional 32 *U. glabra* and 10 *U. kaalae* were planted at North Kaluaa, where a large treefall opened up a light gap and killed some of the previous *U. kaalae* outplants. All sites are exhibiting high survivorship (87–100%) and good growth, especially Kaluaa and Palikea (Figure 3), with some already at the size where they can support *D. montgomeryi* breeding. Observations of some individuals 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 as they mature. *Urera glabra* is also being used in general restoration plantings, including in snail enclosures, that are near existing *D. montgomeryi* populations, so these may also become breeding sites. This year, 47 *U. glabra* were planted at a new restoration site at Palikea; hopefully these will eventually become breeding locations. 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 *U. kaalae* (Figure 4), and positively identified by HDOA. Two years on, it does not appear to be causing significant effects on *U. kaalae* despite some plants having very heavy infections. While other native Urticaceae such as *Pipturus albidus* and *Boehmeria grandis* can be infected, *U. glabra* apparently is not.

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*

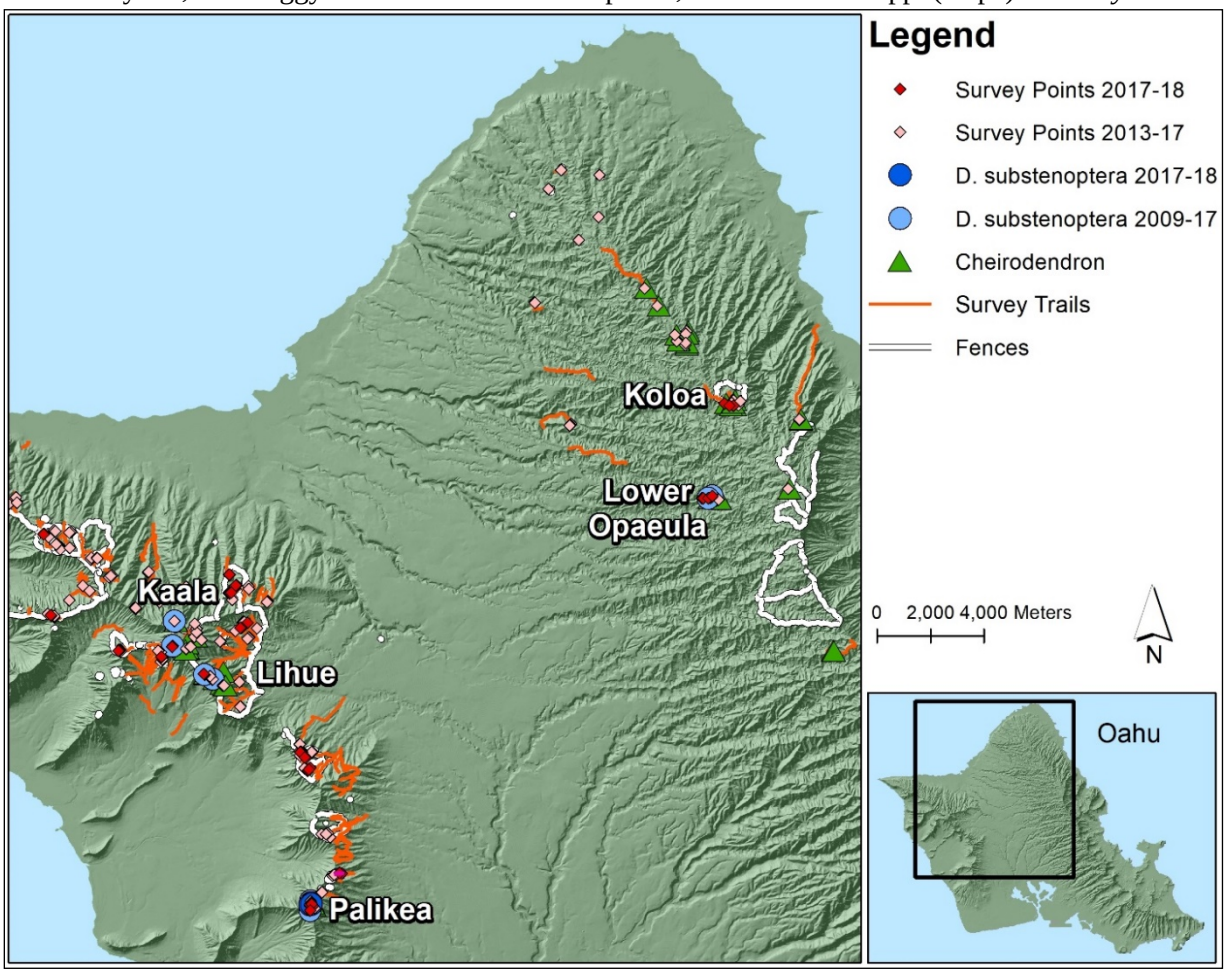

Figure 5. Distribution of *Drosophila substenoptera* observations in the 2017-18 reporting year and earlier records from 2009-17, with selected *Cheirodendron* spp. sites and all survey points.

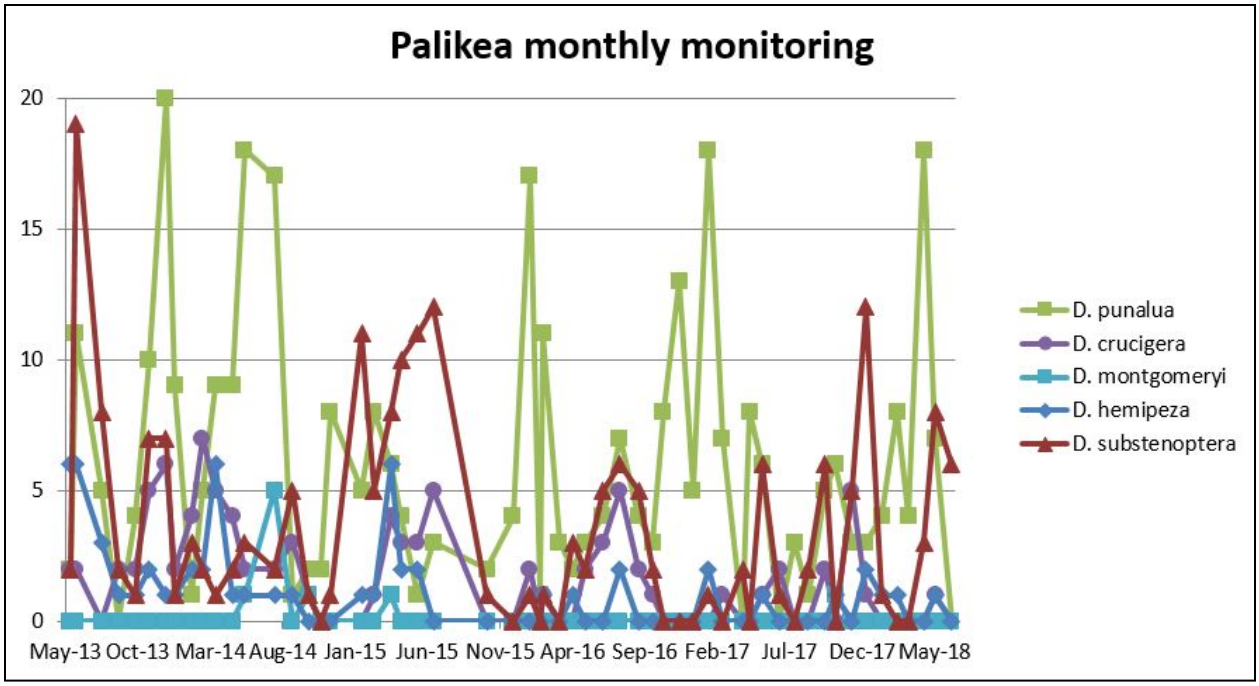

Figure 6. Monthly monitoring results for all picture-wing *Drosophila* species at Palikea, from May 2013 to June 2017.

(=*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 Lower Opaeula (Figure 5). PU trends are 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.

Table 2. Survey effort for *D. substenoptera* and number of flies found across all potential sites in the 2017-18 reporting period, in survey days. "Max No." is the highest number of flies observed in a single day.

Site	Days	Max No.
Palikea	12	12
Kaala	3	0
Lihue	1	0
Lower Opaeula	6	0
Koloa	2	0

Waianae Range

Monthly monitoring in the northern portion of Palikea MU has been ongoing since May 2013 (57 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. *Cheirodendron trigynum* is being used for restoration at sites across Palikea, so habitat can be expected to increase in the future. At the Kaala-Kalena PU, two sites were surveyed (Kalena summit ridge and Kaala west face). No flies were found in this area.

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 in the Koolaus 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 2017-18, Lower Opaeula was visited three times for a total of six 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.

Table 3. Survey effort for *D. obatai* across all potential sites in 2017-18 reporting period, in survey days.

Site	Days	Max No.
Manuwai	6	1
Lihue – Pulee	3	0
Ohikilolo	5	0

7.3.3 *Drosophila obatai*

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

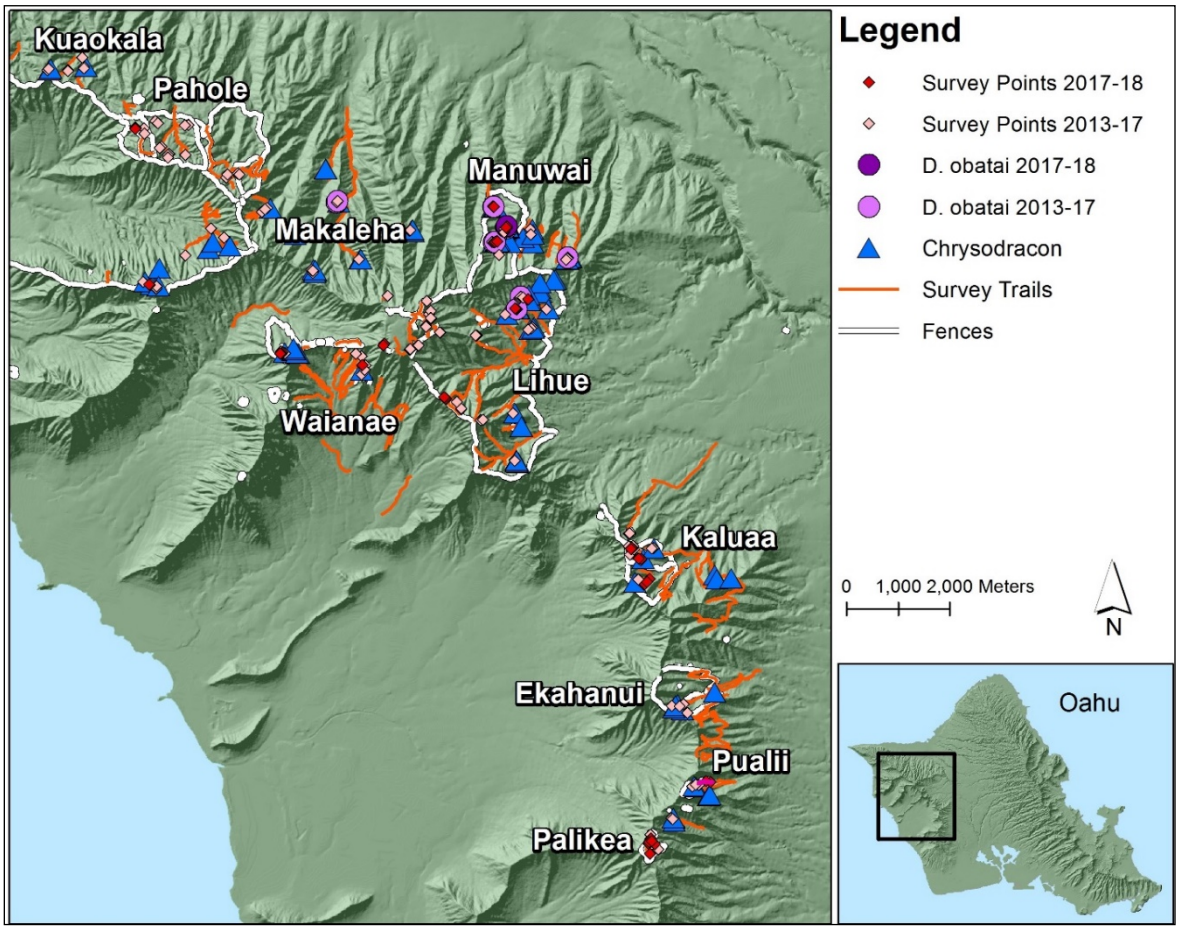

Figure 7. Distribution of *Drosophila obatai* observations in the 2017-18 reporting year and earlier records from 2013-17, with known *Chrysodracon* spp. sites and all survey points in the Waianae range.

Palikea Gulch, and Pulee), although three of these are within 1,200 m of each other and could potentially form one 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. However, more *Chrysodracon* plants exist than are mapped, due to their tendency to grow on steep, difficult to access slopes.

Surveys for *D. obatai* in 2017–18 were few due to difficulty accessing SBW and Manuwai, limited survey time available, and focus on monitoring *D. montgomeryi* (Table 3). Three sites at Manuwai, two in Pulee (SBW), and one at Ohikilolo were visited; only a single *D. obatai* was seen, at Manuwai (Figure 7). The lower elevation site at Manuwai was visited for the first time since 2015 and found to be overrun by yellow crazy ants (*Anoplolepis gracilipes*), attracted by invading lobate lac scales (*Paratachardina pseudolobata*, Kerriidae) on lama trees (Figure 8). One picture wing *Drosophila* was still found there, but it is likely that the high abundance of ants has or will render this site inhospitable for *D. obatai*. The facilitation of ant invasions by other invasive insects also reveals another threat to *Drosophila* populations, which may become more significant as the scale spreads.

Between November 2017 and February 2018, A24 rat traps were set up around concentrations of *Chrysodracon halapepe* where *D. obatai* has been found. Six traps were installed at Manuwai east, seven at Guava Gulch in Pulee, and ten at Coffee Gulch in Pulee. The former was covered by the aerial rodenticide broadcast, while the latter was not (see Chapter 8). All of these sites have not had recruitment of *Chrysodracon* in many years, while older trees continue to die. Trapping will hopefully reduce rat

Figure 8. Lobate lac scale, *Paratachardina pseudolobata* Kondo & Gullan, a serious new pest of both agricultural and native plants. The thick waxy shell protects it from most predators and parasites, while the mobile nymphs (small red spots on the branch) allow for rapid dispersal.

predation on seeds and seedlings and allow them to increase. Rebaiting at Pulee has been limited due to access restrictions in SBW, but only trapping during the fruiting season is critical to success.

Chrysodracon grows extremely slowly, limiting the usefulness of outplanting as a management tool for *D. obatai*. Plants grown from seed in the wild are often under two feet tall after five years under good conditions, and may remain small seedlings after that time when suppressed by shade. The seed lab is currently working on techniques to better propagate *Chrysodracon* and store seeds.

7.3.4 Other Rare *Drosophila*

During the course of surveys, eight additional rare but non-listed *Drosophila* were found in management units where *D. montgomeryi*, *D. obatai*, and *D. substenoptera* occur (Table 4). Many of the rare species that had been found as of 2014 (*D. kinoole*, *D. paucicilia*, *D. reynoldsiae*, *D. sobrina*, *D. spaniothrix*, and *D.* n. sp. nr. *truncipenna*) were not seen this year, despite the improved conditions and overall higher insect populations.

Table 4. Non-target rare *Drosophila* observed during surveys, July 2017–June 2018

Species	Sites	Total Observed	Max. No.
D. craddockae	Lower Opaeula, Ohikilolo	7	2
D. divaricata	Kaluaa, Hapapa	31	7
D. flexipes	Manuwai	1	1
D. hemipeza	Palikea, Hapapa	6	2
D. hexachaetae	Manuwai, Waianae	3	2
D. nigribasis	Kaala	1	1
D. oahuensis	Kaala, Koloa, Lower Opaeula	10	5
D. pilimana	Manuwai	2	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 tends to be found only sporadically at widely separated localities. It was found during both trips to Ohikilolo and Lower Opaeula this year, both sites where it had been found previously.

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. As last year, it was moderately abundant at both North and Central Kaluaa during the months of the winter and spring peak.

Drosophila flexipes breeds in fermenting sap fluxes of *Sapindus oahuensis* (lonomea, Sapindaceae). Although this tree is relatively common in remnant mesic and dry forest, it often occurs at lower elevations where ants prevent *Drosophila* from persisting. After a significant number were found in Manuwai in 2014, none were observed aside from a single fly this year. It was also previously observed at Pualii.

Drosophila hemipeza is the only listed endangered species on Oahu that is known to be extant but does not occur on Army lands or OIP/MIP action areas, although it historically occurred at Kahuku Training Area and West Makaleha Gulch adjacent to Makua. The primary host is probably *Cyanea*, like related species. It has been consistently found at Palikea MU for several years but always in low numbers; in

2014–2015 occasional individuals showed up at Puu Hapapa as well. It was only seen five times (total of six individuals) at Palikea in the past year's monthly monitoring, and none at Hapapa.

Drosophila hexachaetae is a small species similar in appearance to *D. montgomeryi*, but not closely related. It breeds in *Charpentiera* spp. (papala, Amaranthaceae) and *Pisonia* spp. (papala kepau, Nyctaginaceae). Although moderately common prior to 2013, it has been rare since then. Three individuals were seen, at Waianae Kai and Manuwai, the first sightings in nearly two years.

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. Only one was seen this year, but surveys in those areas were fewer than previously.

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. Surveys at its preferred sites were relatively few this year, but a total of ten were still found this year, from multiple sites.

Drosophila pilimana is the Oahu representative of a species group with a number of species on Maui Nui and one on Kauai. Host plants are unknown for the entire group. It was formerly one of the more abundant picture wing species on Oahu, found widely across mesic and wet habitats, but its range has contracted dramatically since the 1970s, and it is apparently now found only in the northern Waianae range. Two were found this year at Manuwai, the most consistent site for it.

Figure 9. *Drosophila craddockae*, widespread but extremely rare and sporadic.

Figure 10. *Drosophila divaricata*, restricted to Honouliuli in the southern Waianae range.

Figure 11. *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. Traps were replaced with a different style in February 2017, which may mean the numbers for 2017 may not be directly comparable to those for 2015–16. *Vespula* numbers were similar at the two sites in 2015, but have increased at Palikea every year since while Hapapa has not had any since that time (Figure 12). Even numbers at Palikea are relatively modest compared to upper elevations of Hawaii or Maui. Still, they show a significant number of *Vespula* are usually present during the summer, coinciding with the low period of *Drosophila* numbers. It is unclear if there is any causal relationship; in 2015 and 2016 the ramp up of *Vespula* numbers at Palikea corresponded with a drop in *D. substenoptera*, but there was not the same correlation in 2017 (in part because *D. substenoptera* was less common overall). This suggests that the benefit to each from weather or other conditions outweighs the negative effect on *Drosophila* from *Vespula* predation. No *Vespula* have been seen so far in 2018, but the spike occurs in the late summer and fall, and this too has shifted later each year.

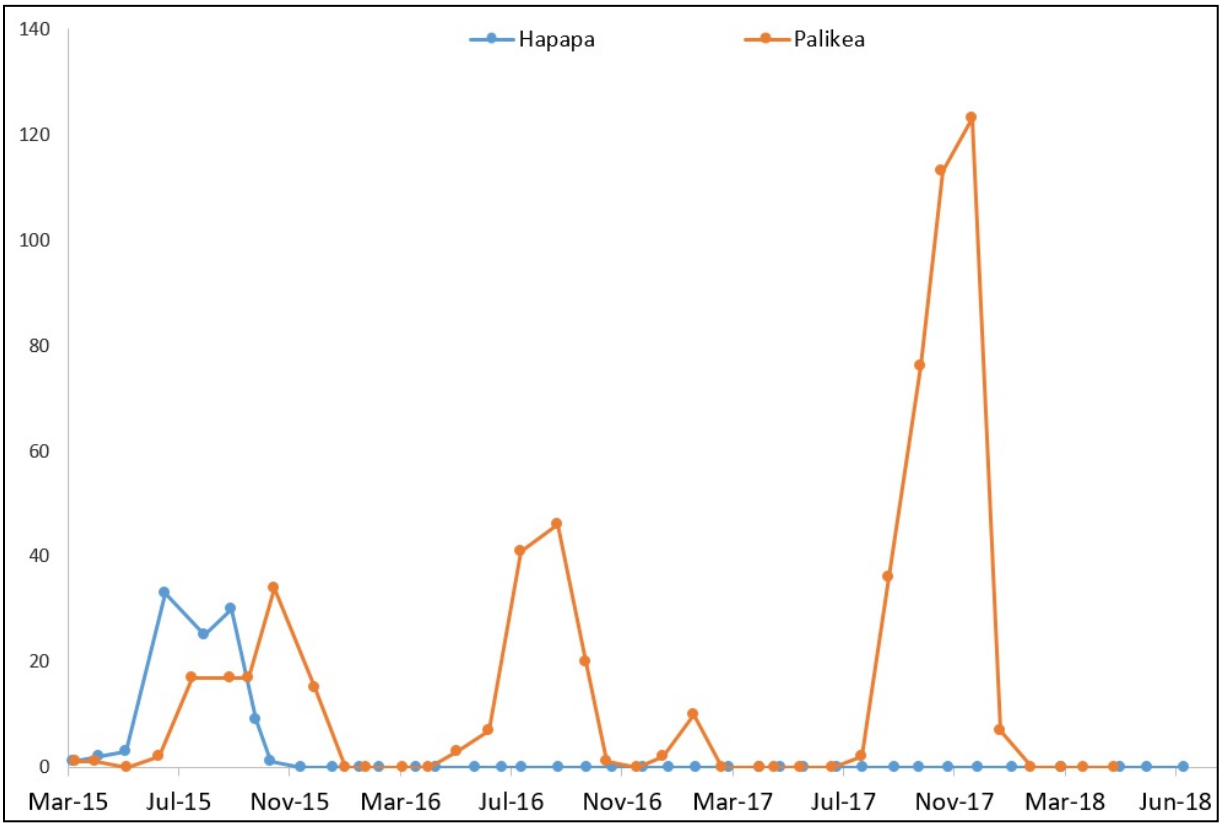

Figure 12. *Vespula pensylvanica* numbers at Palikea and Puu Hapapa (monthly total across 10 traps at each site).

We plan to continue monitoring at Palikea and Hapapa, since 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. Control methods have been developed but are labor-intensive.

CHAPTER 8: RODENT MANAGEMENT

The Army natural resource program on Oahu (OANRP) has managed Makua Implementation Plan (MIP) and Oahu Implementation Plan (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 results for an aerial broadcast of rodenticide at Lihue Management Unit (MU); Section 8.4 discusses a trial with the rodent birth control product ContraPest; and Section 8.5 lays out future plans for rodent control.

8.1 RODENT CONTROL PROGRAM SUMMARY

OANRP has traditionally managed rats seasonally or year-round, depending on rare taxa protection needs. For example, *Chasiempis ibidis* (Oahu Elepaio) were only protected during the nesting season, while *Achatinella mustelina* are protected from predation year-round. Other grids were 'rapid response' to address threats to endangered plant resources. In the history of our program methods of rodent control that OANRP has utilized 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 (including ramik), ContraPest birth control used for trials, and predator-proof fences.

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. The old bait system used a "static" lure that would only last from one to four weeks at our MUs. GoodNature has now produced an Automatic Lure Pump (ALP) baiting system that provides continuous attractive bait for up to 6 months.

In 2017-2018 our program transitioned all trapping grids from older methods to A24s with Automatic Lure Pumps (ALPs). OANRP now has 25 rodent control areas consisting of 1,030 A24s managed year-round (Table 1). Because of the success of the ALP, the standard re-baiting interval for all grids is now every 4 months. We have also been working to optimize trap spacing. Currently, we are deploying traps in larger areas with 100 by 50 meter grids but will continue to investigate this design. This method of control is now our primary way to reduce rodents for the benefit of our managed species. We plan to limit changes to the grids for the next three years while we evaluate this approach.

Table 1. Rat control areas in 2017-2018

MU (Area)	Primary Spp. Protected	Description	# A24 Traps
Ekahanui	*Chasiempis ibidis, Achatinella mustelina, Cyanea grimesiana, Schiedea kaalae, Delissea waianaeensis*	Large-scale grid	306
Kaala Army	*Labordia cyrtandrae*	One small grid	33
Kahanahaiki	*A. mustelina*	Predator-proof fence	2
Kaluaa & Waieli	*A. mustelina*	One small grid	12

Table 1 (continued).

MU (Area)	Primary Spp. Protected	Description	# A24 Traps
Kaluaa & Waieli	*D. waianaeensis, C. grimesiana*	One small grid	30
Kaluaa & Waieli (Hapapa)	*A. mustelina*	Predator-proof fence	4
Kamaohanui (in Lihue)	*A. mustelina*	One small grid	25
Keawapilau (in Kapuna Upper)	*Hesperomannia oahuensis, Schiedea nuttallii, Cyanea longiflora*	One small grid	17
Lihue (Coffee and Guava)	*Drosophila obatai*	Two small grids	17
Lihue (Haleauau)	*A. mustelina*	Two small grids	24
Lihue (Mohiakea)	*D. waianaeensis*	One small grid	10
Makaleha East	*A. mustelina*	Two small grids	20
Makaleha West	*C. grimesiana*	One small grid	15
Makaha I	*A. mustelina, H. oahuensis, C. superba*	Large-scale grid	113
Makaha I	*H. oahuensis*	One small grid	6
Makaha II	*C. grimesiana, C. longiflora, H. oahuensis, S. nuttallii*	Many small grids	51
Manuwai	*D. waianaeensis*	One small grid	8
Manuwai	*D. obatai*	One small grid	6
Ohikilolo	*A. mustelina, Pritchardia kaalae*	Large-scale grid	61
Opaeula Lower	*Cyrtandra dentata*	One small grid	50
Palehua	*C. ibidis*	Large-scale grid	92
Palikea	*A. mustelina*	Predator-proof fence	4
Palikea	*A. mustelina*	Large-scale grid	108
Palikea North	*A. mustelina*	Predator-proof fence	4
Pualii North	*H. oahuensis*	One small grid	12
Total:			**1,030**

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 1-4). 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 Upper MU where no rodent control is being conducted. At other grids, we collected control data for a nearby location where no rodent supression was conducted for

one year after the grid was installed. At Makaha MU, there were monitoring tunnels within the A24 grid. We compared these to tunnels that were outside of the trapping grid, however in May 2018 the grid expanded and there will no longer be a control site for this grid. The goal of OANRP rat control is to keep tracking levels at 10% or less throughout the year. This number is based on goals developed in New Zealand.

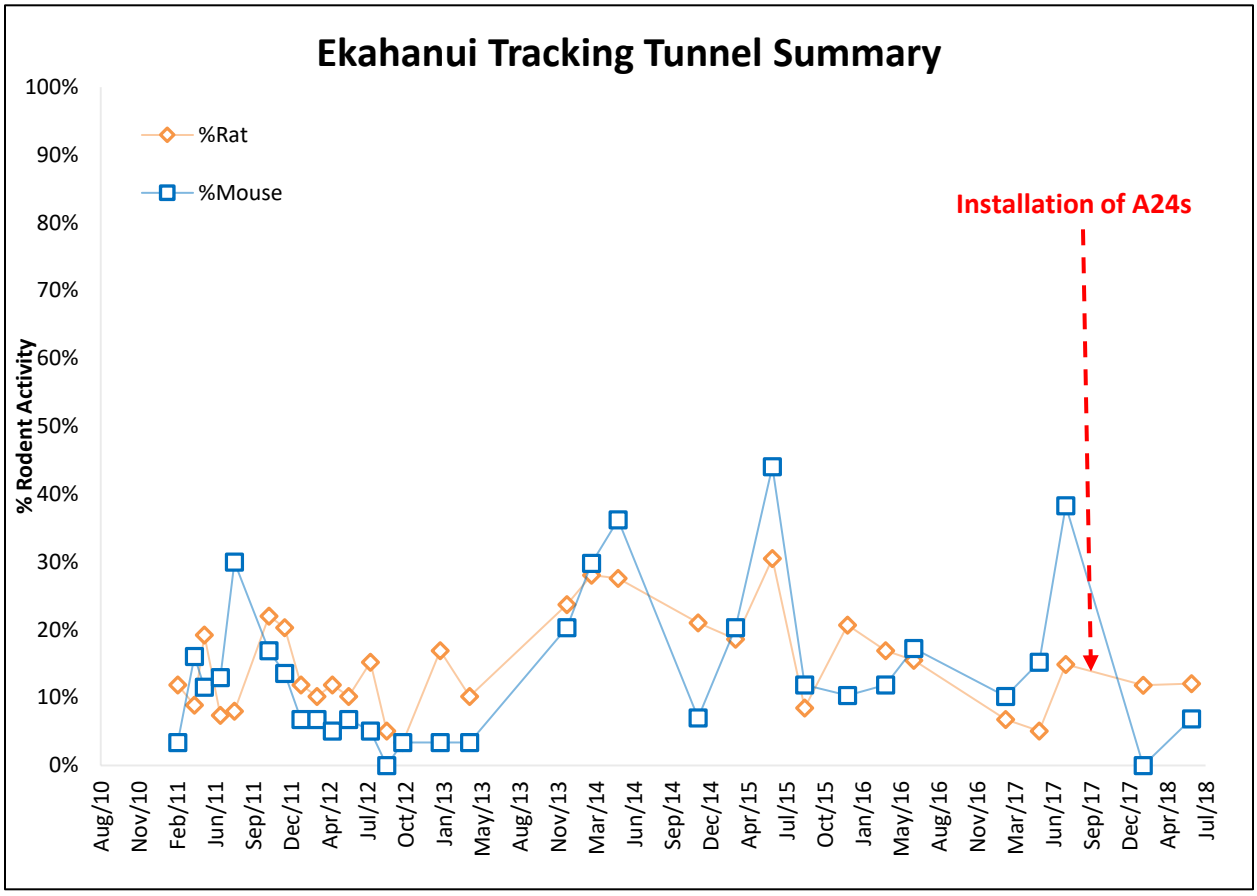

Figure 1. Percent of rodent activity at Ekahanui

The Ekahanui grid formerly consisted of ~600 Victors with a few A24s installed around snail areas from February 2011 to September 2017. Rat tracking has a relatively stable trend with a high of 30% in June 2015. Most tracking events show rates around the 10% goal (Figure 1). This grid was very labor intensive with a two week re-baiting interval that control was only conducted during the elepaio breeding season (December to June). Because of advancements in the performance of the GoodNature A24s the Victor grid was removed and 306 A24s were installed at a 100 by 50 meter spacing in September 2017.

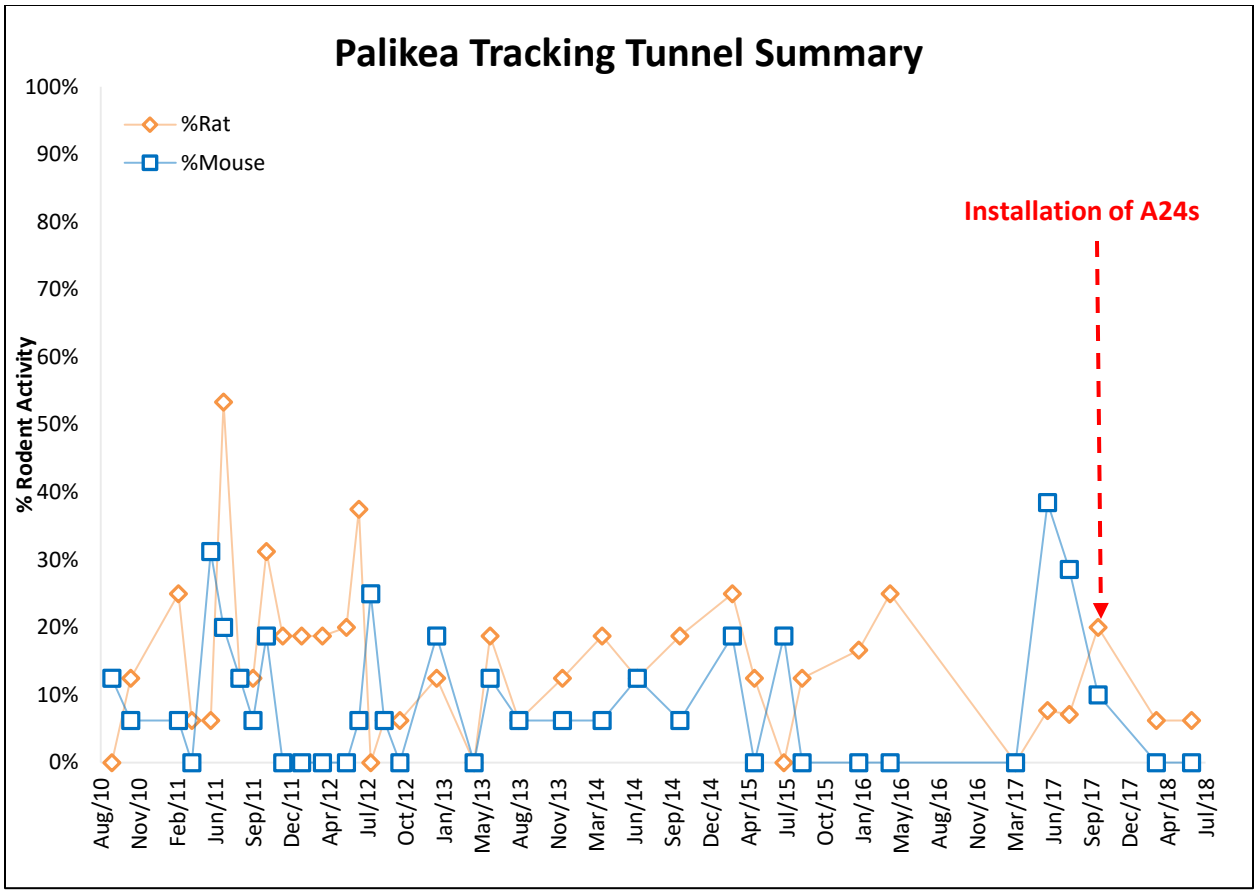

Figure 2. Percent of rodent activity at Palikea

The Palikea grid consisted of ~200 KaMate traps from August 2010 to October 2017. Rat 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 2). In October 2017 all KaMate traps were removed and 108 A24s were installed. Since installation rat tracking has been below 10%.

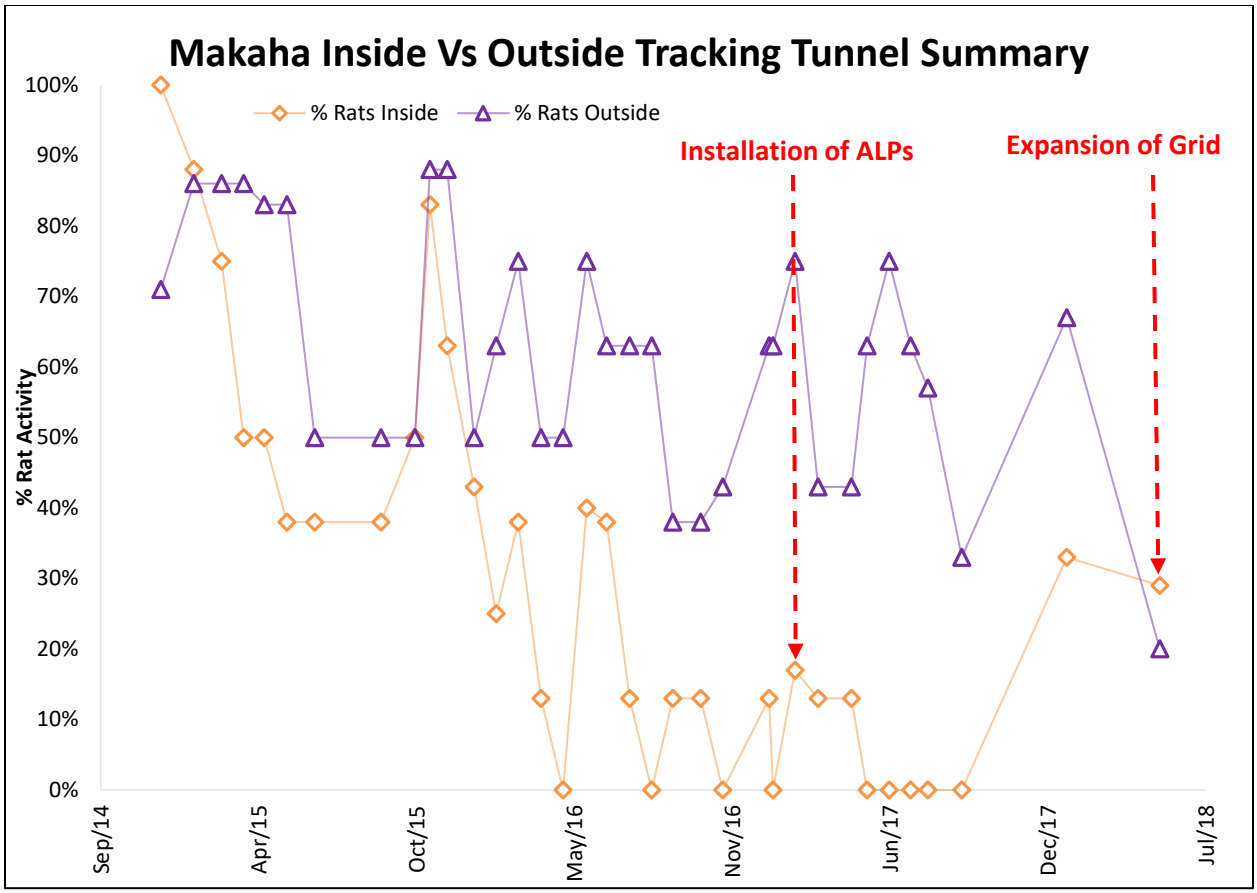

Figure 3. Percent of rodent activity at Makaha inside and outside of the A24 grid

The Makaha grid is all A24s with ALPs. Tracking within the grid has been very impressive with six 0% tracking events in 2016 and most other events close to the 10% goal following the installation of ALPs (Figure 3). In May 2018 the grid was modified due to concerns that the grid was small and did not protect all resources within the MU. The entire MU is now gridded with 113 A24s at a 100 by 50 meter spacing. The grid expanded into the area previously used to track activity outside the grid. From now on all tunnels will be within the trapping grid.

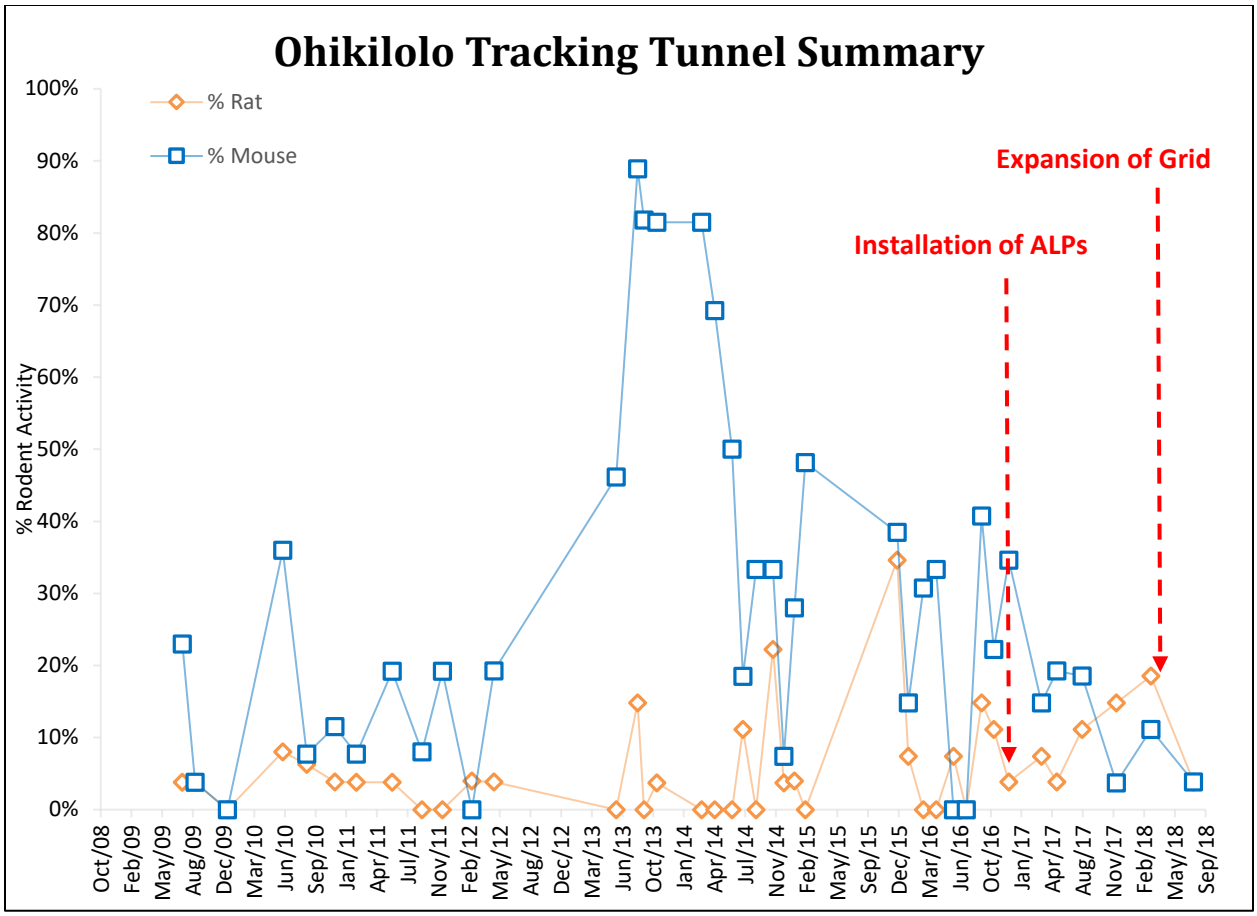

Figure 4. Percent of rodent activity at Ohikilolo

Management tools at the Ohikilolo MU have varied through the years including bait stations, hand broadcast, victor snap traps and A24s. In April 2018 the A24 grid was expanded for a total of 61 traps. The tracking trends generally indicate successful rodent suppression over the past year with all events under 20% (Figure 4).

8.3 Lihue Aerial Broadcast

In December 2017 we conducted an aerial broadcast of Diphacinone-50 over 430 hectares (ha) at the Lihue MU for the protection of the Oahu Elepaio. This action was covered by a Supplemental Environmental Assessment and Finding of No Significant Impact and includes a summary of the project, purpose & need, description of the action and affects to the environment (Appendix 8-1).

The goal of the operation was to reduce the rat activity on a management unit scale to less than 10% tracking and improve survival rates of Oahu Elepaio within Lihue MU. Standard methods of control that have been implemented include Victors, A24s, and bait stations. These methods have been very labor intensive and inconsistent due to the area only being available for re-baiting 5 days per month during range maintenance weeks.

To conduct this operation we entered into a cooperative agreement with The National Wildlife Research Center (NWRC) under the direction of Aaron Shiels. Objectives for the NWRC component of the study were to: determine the density and fate of bait from the applications, document non-target effects through

trail cameras and sample the water from the stream to test for diphacinone residues. More information can be found in Appendix 8-2. Results should be made available by the end of the year 2018.

According to the Diphacinone-50 label two applications were to be made 5-7 days apart (weather dependent). We completed the first application over two days, November 28th- 29th, due to contractual issues and weather delaying the initial start time. For the second application we were able to complete the entire area in one day on December 3rd (Figure 5). Bait was applied at a target application rate of 13.8kg/ha.

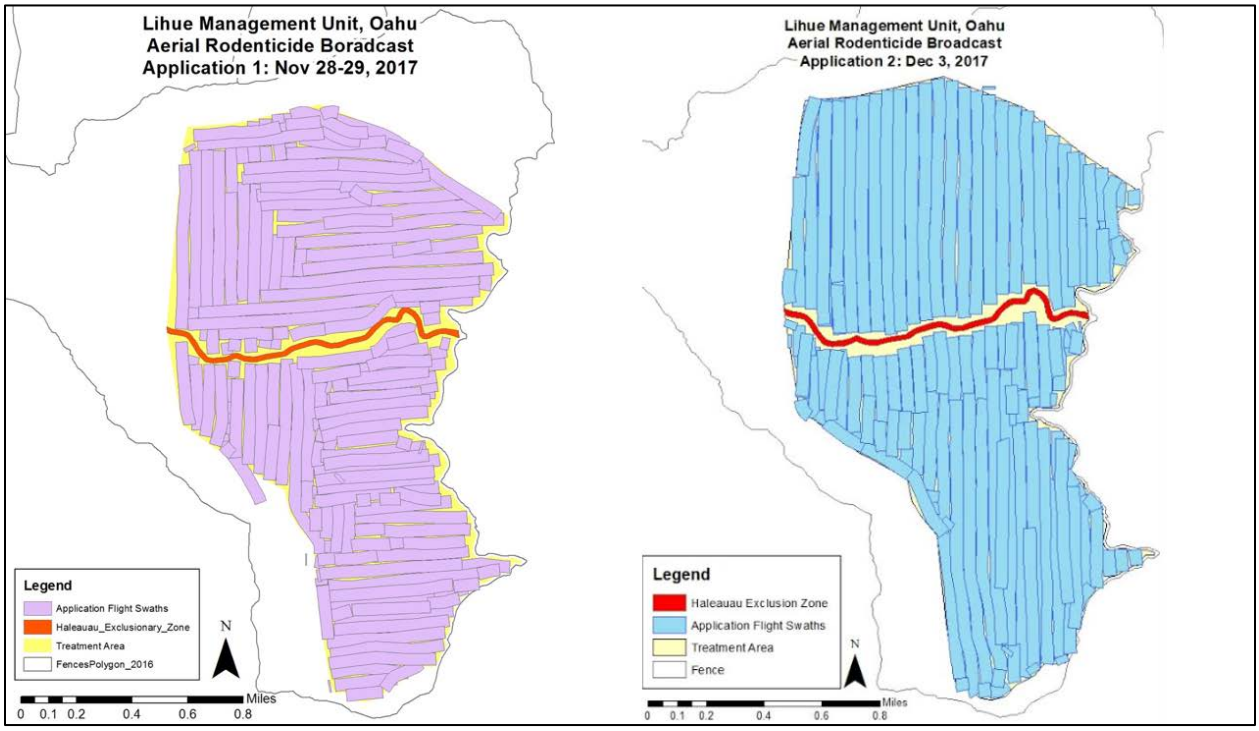

Figure 5. Aerial broadcast flight swaths for both applications showing nearly continuous coverage of the treatment area, and avoidance of the exclusion zone along the Haleauau stream bed.

A total of 120 tracking tunnels within the treatment site and 30 tracking tunnels in the reference site were installed in November 2016 (Figure 6). Tunnels were monitored every two months until the broadcast in December and then ran monthly. Access to the Lihue MU was restricted due to a UXO stand-down from March to April 2018. Limited access was restored in May allowing us to resume tracking tunnel monitoring in three of the eight gulches that we were previously monitoring, including 60 of 120 tunnels within the treatment site.

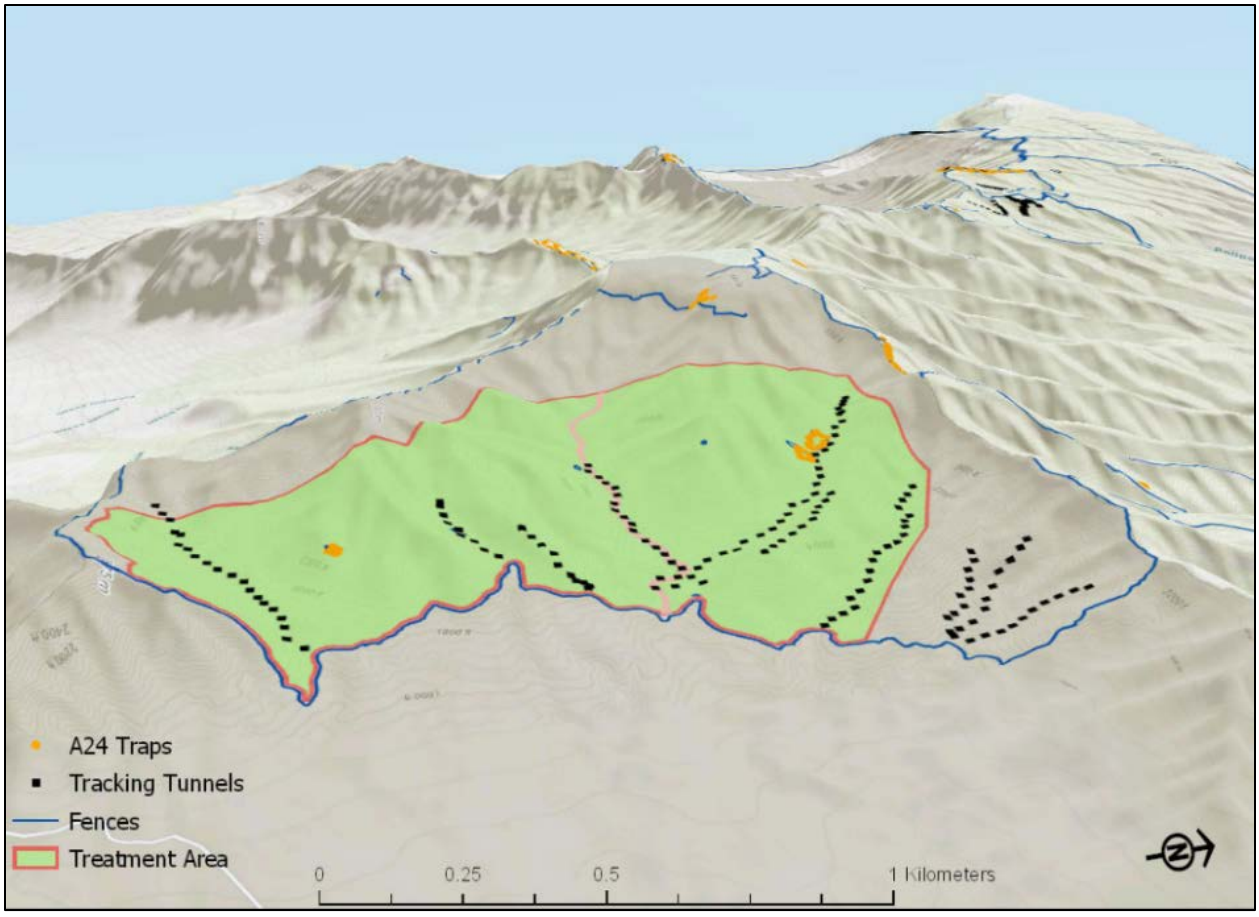

Figure 6. Tracking tunnel placement within the control and treatment sites

Rat activity was very similar at both the treatment and reference sites prior to the broadcast. Upon implementation, activity levels at the treatment site went from 49% to 6%, while levels remained high at the control site (Figure 7). Rat activity remained below or near our 10% tracking goal throughout the entire Oahu Elepaio breeding season. This is probably the best Oahu Elepaio rat threat protection that our program has conducted over our twenty year history. It will be very interesting to see how long suppression continues to be low. Unfortunately we were not able to get much Oahu Elepaio monitoring done this season due to the UXO stand-down. Access to this site should be made a priority and Oahu Elepaio monitoring should be increased. It is possible that aerial broadcasts could be conducted yearly and offer excellent protection. A cost benefit analysis between aerial application and a grid of A24s will be evaluated, as well as site access issues, in determining the future direction of rodent control within this MU.

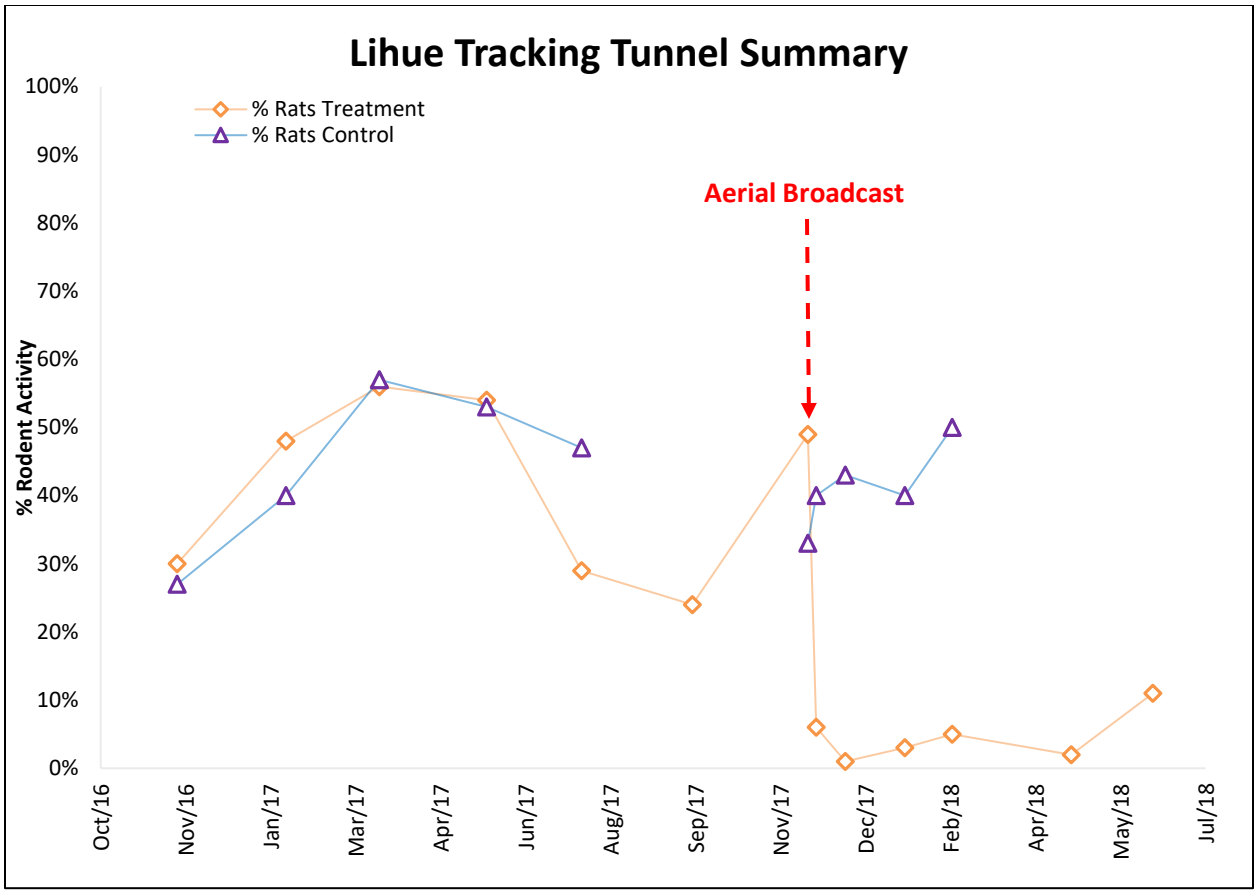

Figure 7. Percent of rat activity at Lihue

8.4 CONTRAPEST TRIAL

From August 2017 to August 2018 we conducted a trial with the 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 received an Experimental Use Permit (EUP) to trial ContraPest in a forest environment at Kahanahaiki MU. The treatment site was a 4 ha area within the gulch and an associated 4 ha control site at Maile Flats (Appendix 8-3). An additional off-site control area was established at Kapuna Upper MU for comparison, given the potential for a spill-over effect of the treatment into the nearby control site at Kahanahaiki.

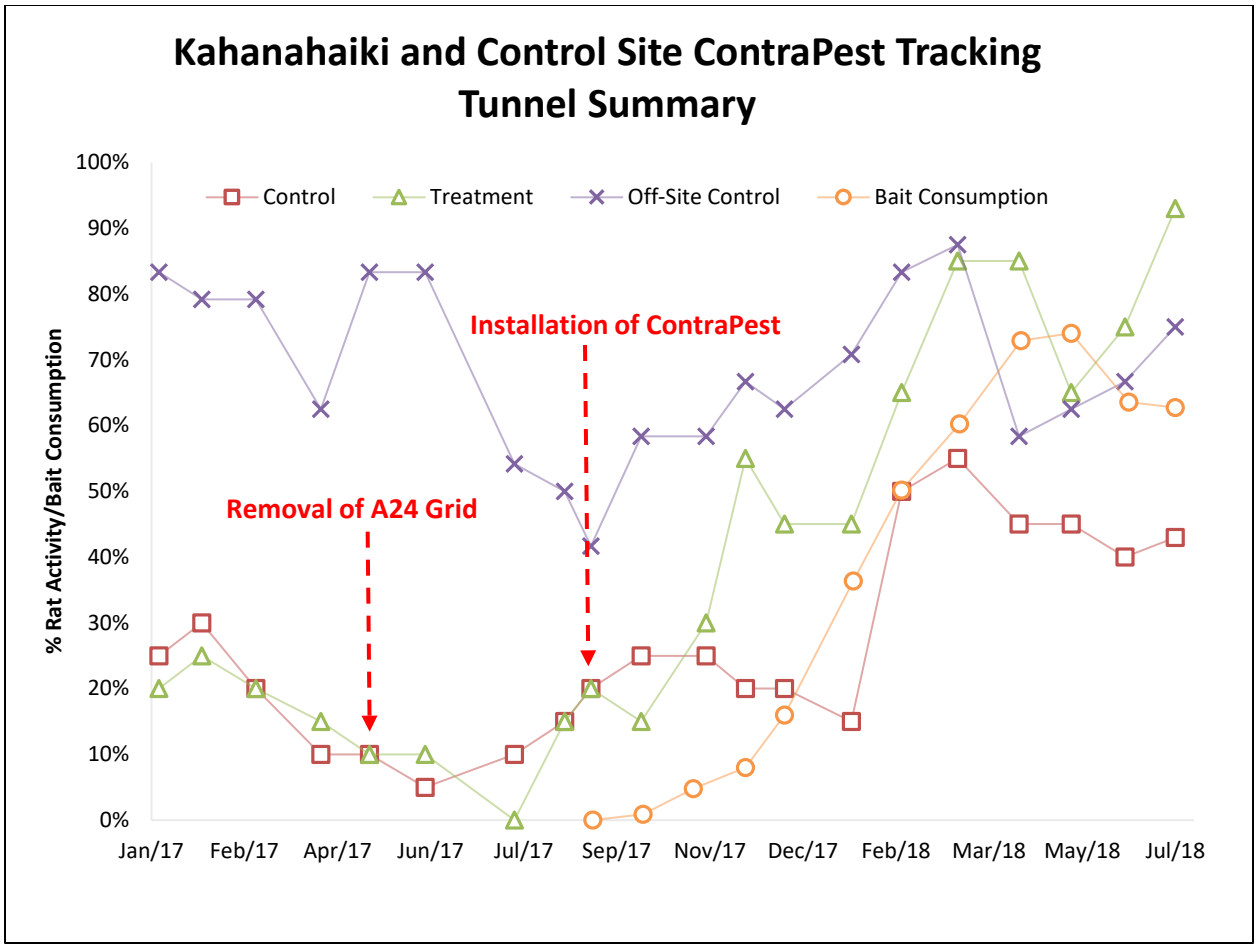

Figure 8. Percent of rat activity in the treatment and control sites at Kahanahaiki and Kapuna in relation to bait consumption

Prior to the trial, the treatment and control sites at Kahanahaiki had similarly low rodent activity in association with a large-scale A24 grid. In comparison, activity at the Kapuna off-site control, where no rodent control occurs, was considerably higher. A24 baiting ceased in May months prior to initiating the trial. Tracking tunnels were run monthly at all sites for the duration of the trial. The rat activity increased in both the treatment and control areas and was unacceptably high from February-July 2018 (Figure 8). These results indicate that ContraPest was not successful at reducing rat activity. It is presumed that this was likely due to the small size of the treatment area, resulting in a confounding influence of rat ingress from the surrounding areas, if not due to an outright failure of the treatment itself to cause infertility. More definitive results of the potential efficacy of ContraPest may be determined from histological analyses. Tracking tunnels may not be the best monitoring method for a small area and for a suppression method that keeps rats alive

Bait consumption was low for the first several months. It is believed that the presence of abundant strawberry guava fruits from September to December contributed to the delay in consumption and decrease in associated tracking activity. Consumption generally increased from December to July.

In August 2018, rats were collected from snap traps at both the control and treatment sites for histological examination. Future findings will include what percentage of rats captured in the area were consuming ContraPest, how far from the treatment area rats traveled, and information about rat densities within the

sites. A total of 130 rats were necropsied and samples will be analyzed at the SenesTech facility. Results will be in next year's report.

8.5 FUTURE PLANS

We will continue to work with the A24 trap and bait to maximize its full potential. Trials with citric acid bait ALPs (used as a slug deterrent) have begun and will be checked every four months for the next year. Hopefully results from these trials will show that adding citric acid to the bait will extend the checking interval to 6 months at all sites. Now that the checking interval is every 4 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 Elepaio territory-based grids.

We will 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 will be baited and the cameras set to take pictures for one day. We will 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 will be conducted to see how results from cameras compares to results from tracking tunnels. We have purchased 80 relatively cheap game cameras (<$100each). The number of cameras will be the key limiting factor, as equipment costs could be high for this type of project.

CHAPTER 9: INVERTEBRATE CONTROL PROGRAM

This chapter outlines alien invertebrate control actions by the Army natural resource program on Oahu (OANRP). This year's control efforts included the expansion of the number of rare plants receiving slug control, the development of a protocol to prevent accidental exposure of native snails to molluscicide, as well as surveys for, and treatment of invasive ants at several high traffic areas (primarily helicopter landing zones).

9.1 SUMMARY OF SLUG CONTROL ACTIONS JULY 1, 2017 – JUNE 30 2018

Hawaii has no native slugs. Two temperate species are well established at elevations above 1,500 feet: the marsh slug, *Deroceras laeve* and the leopard slug, *Limax maximus*. 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 rare plant species (Kawelo *et al*. 2012) in particular those within the Campanulaceae.

This year the number of plant populations protected from slug depredation increased 17% over previous levels and the associated area receiving treatment increased by 14%. The increase was made cost effective by transitioning to a longer lasting slug control product, FerroxxAQ (EPA Reg. No. 67702-49) which, in prior field trials (Joe 2017) was shown to be effective for up to 6 weeks. In contrast, the product we had been using since 2010, Sluggo (EPA Reg. No. 67702-3-34704) required reapplication monthly. This savings is reflected in the total annual staff time spent conducting slug control last year (July 2016-June 2017) compared to time spent this year (July 2017-June 2018). Despite the increase in treated area, the time spent by staff remained flat (Figure 1). In fact, since 2013 staff time has increased 180% while the number of plant species protected has increased 250%.

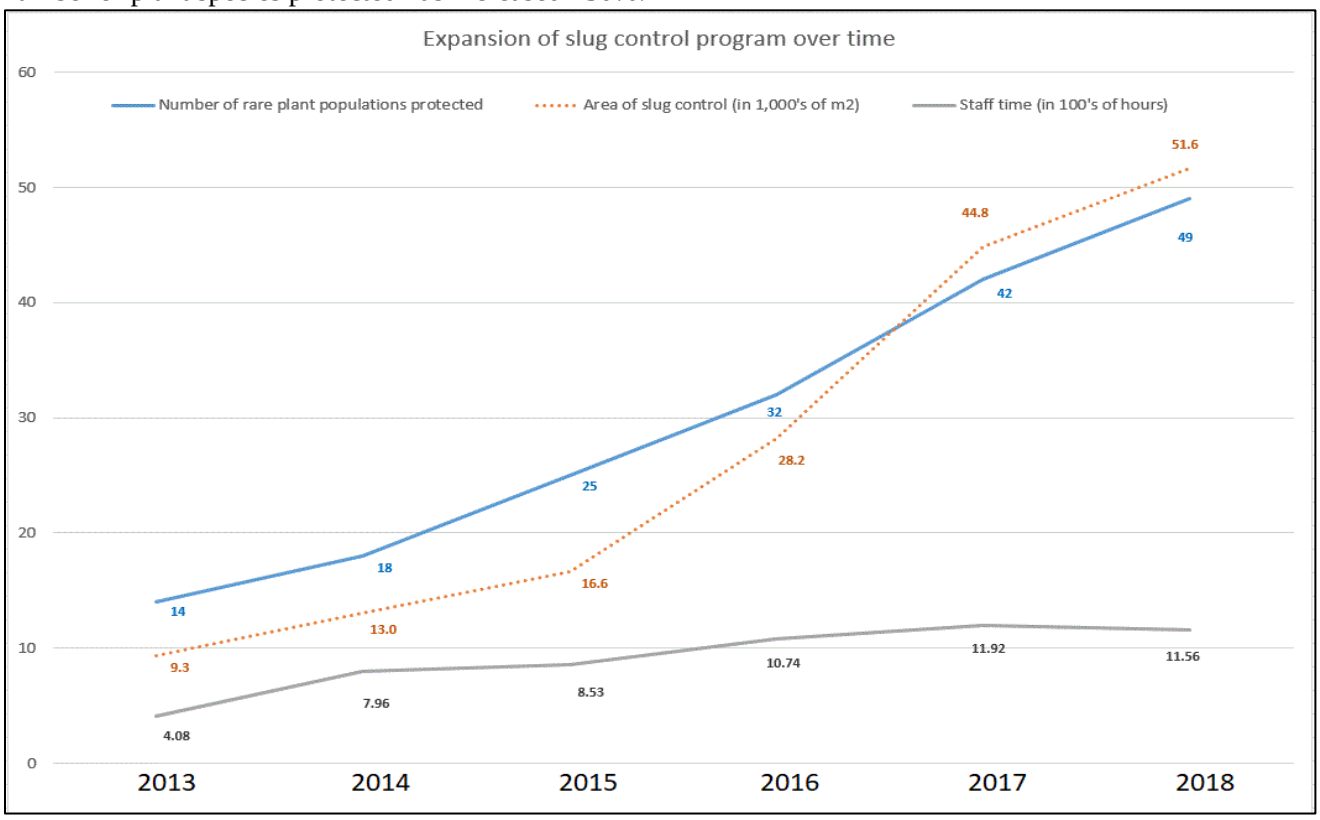

Figure 1. Line graph showing growth of slug program over time and staff effort.

Currently all high priority, vulnerable plant populations are protected from slugs with the exception of seven populations (Table 1) where the presence of rare snails precludes the use of molluscicide and at one plant population in Manuwai where treatment will begin in 2019. Due to its longer field efficacy, FerroxxAQ is the molluscicide used in all of our MUs except for Makaha where the landowner (Board of Water Supply) has approved only the use of Sluggo (Table 2).

At present, 49 rare plant populations spanning a 12.75 acre area receive slug control. Forty six percent of this treated area falls within Pahole MU which accordingly has the highest number of treated plant populations (Table 2).

Table 1. List of rare plant species exempt from slug control due to the presence of native snails

Rare plant species	Population reference code (PRC)	Snail species present	Note
Cyanea superba subsp. *superba*	MMR-H, MMR-G, MAK-A, PAH-A	*Leptachatina* spp., *Achatinella mustelina*	
Cyanea grimesiana subsp. *obatae*	PAH-C, PAK-C	*Achatinella mustelina*	PAK-C has partial slug control
Scheidea obovata	PAH-D	*Achatinella mustelina*	

Table 2. List of rare plant species undergoing slug control. Bold underlined text indicates additions for the year 2017-2018. An Asterisk (*) marks remote plant populations which, due to the difficulty of access, receive slug control at a reduced rate.

MU	Plant species treated (PRC in brackets)	Treatment area (m^2) 2017-2018	Product used/rate of application
Ekahanui	*Cyanea grimesiana* subsp. *obatae* (EKA-C) , *Delissea waianaeensis* (EKA-D), *Schiedea kaalae* (EKA-D)	3,000	FerroxxAQ/6 weeks
Kahanahaiki	*Cyanea superba* subsp. *superba* (MMR-E & MMR-H), *S. nuttallii* (MMR-E), *S. obovata* (MMR-C & MMR-G)	2,300	FerroxxAQ/6 weeks
Kaluaa & Waieli	*Delissea waianaeensis* (KAL-C), *S. kaalae* (KAL-B)	3,500	FerroxxAQ/6 weeks
Lihue	***Labordia cyrtandrae* (ALA-S), *Phyllostegia hirsuta* (ALA-A)**	2,800	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)	1,500	FerroxxAQ/12 weeks*

Table 2 (continued).

MU	Plant species treated (PRC in brackets)	Treatment area (m^2) 2017-2018	Product used/rate of application
Pahole	*Cyanea longiflora* (PAH-A, PAH-I, PAH-J), C. *grimesiana* subsp. *obatae* (PAH-D), *Delissea waianaeensis* (PAH-C), *Euphorbia herbstii* (PAH-G, PAH-R & PAH-S), *Schiedea kaalae* (PAH-C), *S. nuttallii* (PAH-A, PAH-D, PAH-E,), *S. obovata* (PAH-E),	23,630	FerroxxAQ/6 weeks
Palikea	*Cyanea grimesiana* subsp. *obatae* (PAK-A & PAK-B), *C. superba* subsp. *superba* (PAK-A), *Phyllostegia hirsuta* (PAK-A), ***C. grimesiana* subsp. *obatae* (PAK-C)**	5,097	FerroxxAQ/6 weeks
Upper Kapuna	*Schiedea kaalae* (KAP-A), *Cyanea longiflora* (PIL-B, PIL-C, PIL-E & PIL-F), *S. 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), ***C. grimesiana* subsp. *obatae* (LEH-A &LEH-B)**	2,461	FerroxxAQ/6 weeks
Manuwai	*Delissea waianaeensis* (ANU-A)	1,441	FerroxxAQ/12 weeks*

9.2 NATIVE SNAIL INCURSION INTO TREATMENT AREA

Native snail monitoring within treatment areas is crucial to prevent accidental exposure to molluscicide. On the Special Local Needs label for Sluggo, the following caution appears: "Do not apply in areas where it may come into contact with known populations of endemic Hawaiian snail species from the following rare families or subfamilies: Amastridae, Achatinellinae and Endodontidae). Bait must not be applied within 20 m of any tree known to harbor endangered Hawaiian tree snails (*Achatinella* spp.)." Accordingly, all areas which currently receive Sluggo have been extensively searched by our rare snail conservation specialist for one day and one night. Though the FerroxxAQ label contains no such stipulation, we nonetheless expect it to have a similarly adverse impact on native snails should they consume the bait. Our commitment to conserving native species led us to adopt these recommendations for the application of FerroxxAQ. Due to these precautions, on four occasions we have discontinued molluscicide application after repeated applications because of the discovery of a rare native snail. Here we describe these discoveries and outline our response.

A thorough daytime and nighttime survey does not guarantee snail detection. Snails can be hidden deep in foliage, move into or out of an area, or occur in such low numbers that an encounter would be improbable. In addition, treated areas are, generally speaking, more pristine and contain greater native plant species cover. This may prove attractive to native snails drawing them in from nearby marginal habitat. Regular, periodic monitoring is necessary to ensure native snails are not present and do not move into areas where they would be exposed to molluscicide. Prior to 2015, *Achatinella mustelina,* (family: Achatinellinae) were found in a treated area in Makaleha West and an unknown *Leptachatina* species

(family: Amastridae) inhabited the gulch at Kahanahaiki. At Makaleha West we resumed treatment after moving the snails to better habitat (Joe 2014), while in Kahanahaiki we discontinued treatment indefinitely because the snails were too ubiquitous to translocate. Since that time, *A. mustelina* has been found at two additional sites, one in Palikea (October, 2016) and one in Pahole (March, 2017) (Figure 2). In each of these cases, we discontinued molluscicide treatment immediately and the Rare Snail Conservation Specialist relocated both snails into predator-proof enclosures. We eventually resumed treatment after one daytime and nighttime search yielded no additional snails. Thus, we currently treat three sites where there is a high risk of snail incursion (defined below).

Given that snails may migrate into areas undergoing treatment or be missed during the initial survey, we recommend the following protocol for areas which both receive molluscicide treatment *and* are at 'high risk' for snail occupation (a 'high risk area is one where snails have been found historically or is adjacent to areas where snails are currently found).

1. If a rare native snail is discovered, discontinue molluscicide application
2. If a subsequent day time and night time search yields no snails, *and* if the discovered snails have been relocated, then molluscicide application may resume
3. For the duration of molluscicide application, areas must be searched for native snails a minimum of once per year (daytime)
4. For two consecutive years following a rare snail find, the areas must be searched annually for at least one night in addition to the annual daytime surveys.

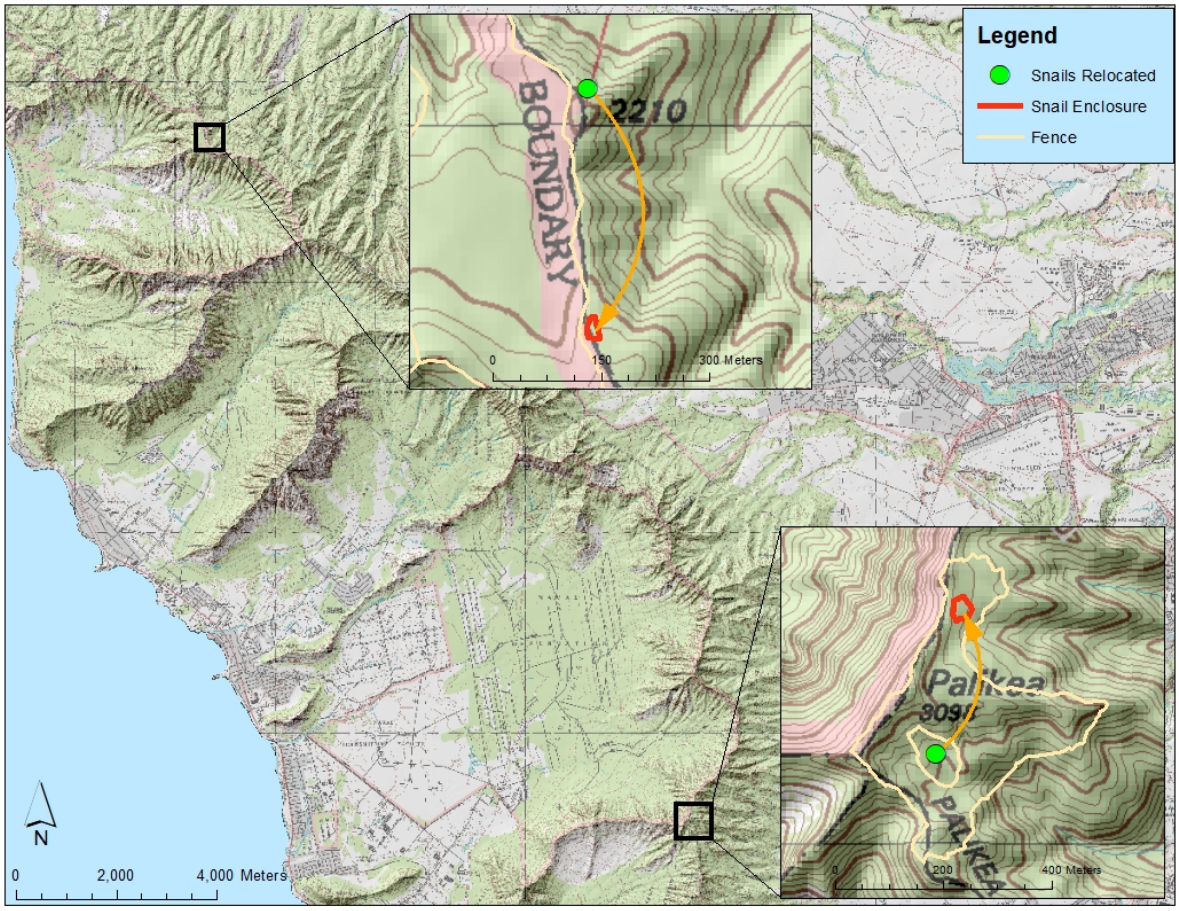

Figure 2. Map showing location of Palikea and Pahole snail finds and locations of predator-proof enclosures

9.3 INVASIVE ANT SURVEYS AND MANAGEMENT

Background: There are no native ants in Hawaii. Of the approximately 45 species present, all were accidental introductions by humans. The result has been widespread colonization of disturbed and occasionally pristine areas by generalist ants that can utilize a number of resources (Krushelnycky *et al*. 2005). Ants can damage managed resources directly or indirectly. They consume rare native insects directly, as is the case where *Solenopsis papuana* was found to reduce picture wing fly (*Drosophila*) survival by 58% (Krushelnycky *et al.* 2017). Ants affect plants indirectly by reducing pollinators (Sahli *et al.* 2016) and by farming plant pests such as scales and aphids.

Methods: Our program aims for early detection of problem species, delineation of infestations of those species, and when possible, eradication. In order to accomplish this, we have carried out annual standardized surveys since 2004 across areas with a high risk of ant introduction (outhouses, out planting sites, *Drosophila* sites, campgrounds, fence lines, helipads, and roads). Ants in these areas are sampled using baited index cards left out for one hour. Counts of foraging ants at these cards also are used to measure treatment efficacy. Our methodology is outlined in Joe 2010.
Treatment of an ant infestation is only considered when one or all of the following criteria are met:
1. The infestation is <3 acres
2. The ant species present is not widespread in adjacent locations
3. The ant species present is known to harm native species.
4. The site is an area of high traffic where materials are staged prior to transport into a pristine area.

These characteristics were true of the Nike Site high elevation nursery where we eradicated *Anoplolepis gracilipes* or the yellow crazy ant (YCA) in 2011 (Joe 2012) and *Solenopsis geminata* from Peacock Flats campground (Joe 2011). Neither of these species have been detected at those sites in over 5 years. At Pualii MU we control *Pheidole megacephala* (the big headed ant) because the infestation is less than three acres. Only the fourth criteria is true for six areas where we currently conduct regular ant control: Nike Site Landing Zone (LZ), East Baseyard (Wahiawa), West Baseyard (Schofield Barracks), Kaala Road Landing Zone (Culvert 37 LZ, FAA Road), the Waianae Mountains Watershed Baseyard LZ (WMWB LZ) (Palehua) and Kaluaa LZ (Figure 5). Regular ant control is necessary at all sites to prevent transport of ants into pristine areas, however, as adjacent areas remain infested, ants inevitably recolonize over time. These sites as well as other ant sampling locations are shown in Figure 5. Four baits are used in rotation: AmdroPro (EPA Reg. No. 241-322), Provaunt (EPA Reg. No. 100-1487), MaxForce (EPA Reg. No. 432-1262) and Terro PCO (EPA Reg. No. 149-8-64405). Note that Terro is used only around buildings.

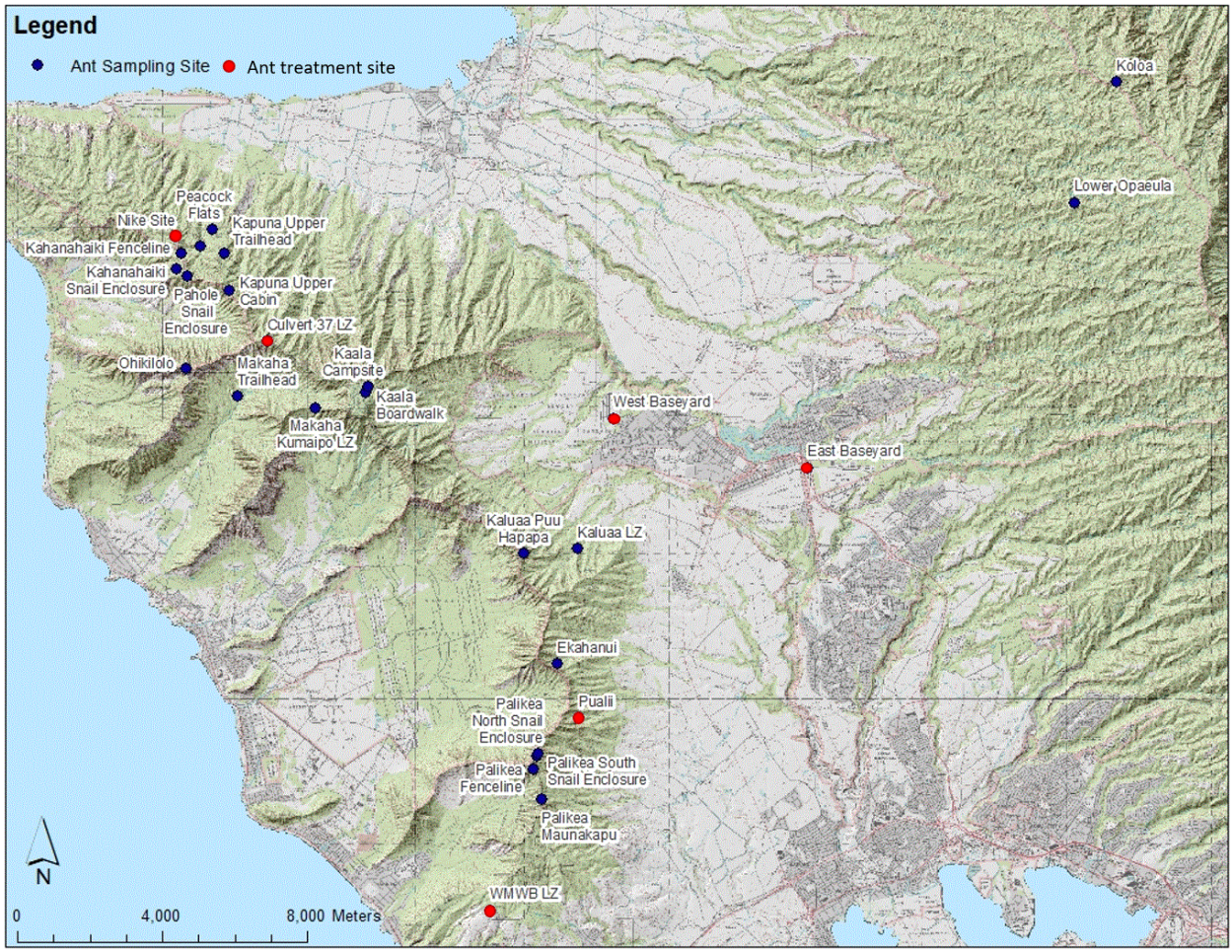

Figure 3. Map showing locations of ant control as well as ant sampling sites

Results ant treatment: After failing to control YCA using a variety of insecticides, we were successful at eradicating them at Nike Site and suppressing YCA at WMWB LZ and using Provaunt. At WMWB LZ, we reduced foragers counted at baits 90% on average (Figure 4). Additionally, the number of baits with any ants fell from 89% to 20% post-treatment (Figure 5). Ants did not recover fully from the Provaunt treatment for five months.

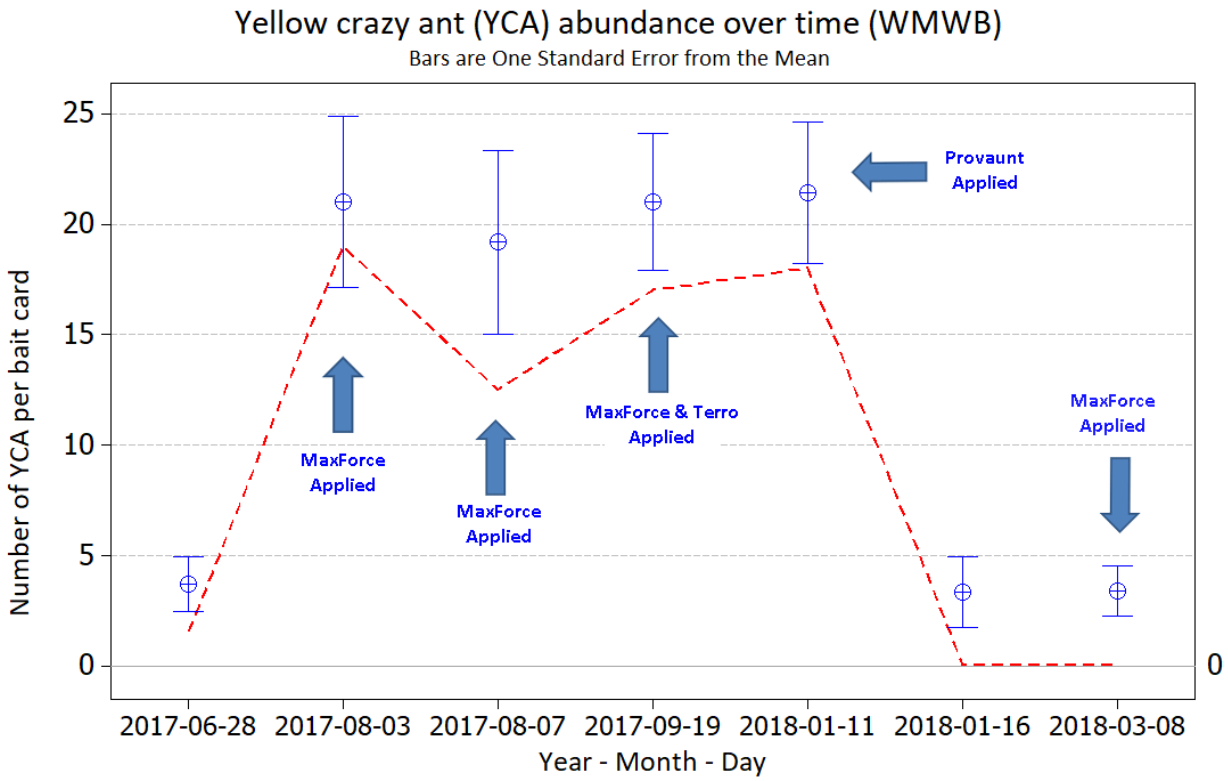

Figure 4. History of YCA treatments at WMWB showing a reduction in ants after Provaunt application. The red dotted line shows the median number of ants at each sampling station (n=53) while the blue circle shows the mean.

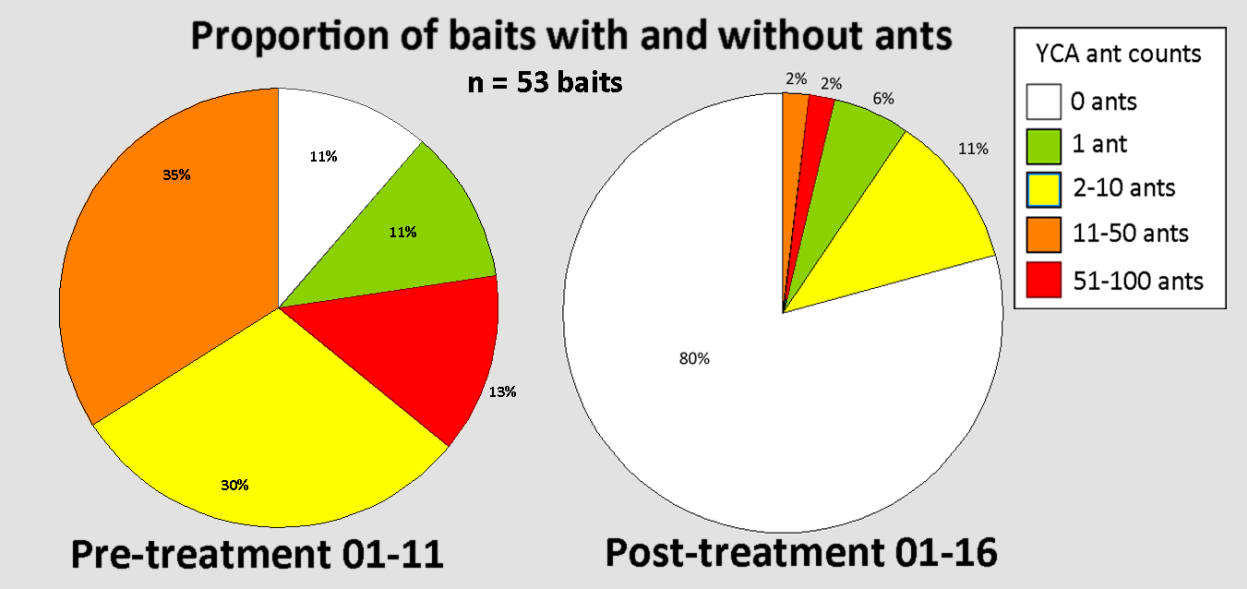

Figure 5. Proportion of bait stations with and without ants pre and post treatment at WMWB LZ

Results ant surveys: Annual ant surveys took place across 12 MUs (Figure 3). Ants both presently and historically recorded at 12 MUs are shown in Table 3. We consider any species discovered over the past

three years as being present since multiple ant surveys are needed to confirm a given species is, in fact, absent. A species is considered eradicated if treatment takes place and the target is not detected for five years. Species that are among the 100 worst invaders globally are highlighted in red (Invasive Species Specialist Group [ISSG] 2018). These are defined as "recognized globally as a major threat to biodiversity (the collected wealth of the world's species of plants, animals and other organisms) as well as to agriculture and other human interests."

It is clear from Table 3 that ants are ubiquitous throughout most of the MUs sampled. Of the 14 MUs surveyed, 12 or 86% are known to have ants. Though not included here because it was discovered outside of the reporting period, the thief ant (*Solenopsis papuana*) *is* present in Opaeula Lower bringing the number up to 93%. The thief ant (a threat to *Drosophila*) is also most commonly encountered ant (Table 4). AmdroPro is known to be effective against the thief ant, however, as it is an insecticide, when used to mitigate threats to *Drosophila*, it may have unintended impacts. Research is currently underway to determine its effect on non-target insects (P. Krushelnycky *pers. comm.*). Currently we do not apply insecticides where there are endangered *Drosophila*. This precludes treatment at Puu Hapapa, Opaeula Lower and Palikea. Treatment for the big-headed ant can and will take place in 2019 at Ohikilolo and at Upper Kapuna. There are no approved insecticides safe to use near water so ants at Makaha cannot be treated at this time. Staff are instructed to be vigilant about inspecting gear at the Makaha trailhead (*i.e.* not setting food or backpacks on the ground) so as not to transport *Anoplolepis gracilipes* to higher elevations.

Table 3. Table showing recent and historical ant occurrence in 13 Management Units (MUs). Species in red are considered a high threat by ISSG (2018)

Management Unit (MU)	Current species (detected within the last 3 years)	Species detected prior to Jan. 2015
Ekahanui	*Solenopsis papuana*	*Plagiolepis alluaudi, Technomyrmex albipes*
Kaluaa (Trailhead & Puu Hapapa)	*Pheidole megacephala, Plagiolepis alluaudi, Solenopsis papuana*	*Pheidole fervens, Technomyrmex albipes*
Kaala (Boardwalk & Campsite)	*Cardiocondyla kagutsuchi, C. venustula, Plagiolepis alluaudi, Solenopsis papuana, Tetramorium simillimum*	*Cardiocondyla minutior, C. wroughtoni, Ochetellus glaber*
Kahanahaiki (Snail Enclosure & Fenceline)	*Ochetellus glaber, Pheidole megacephala, Plagiolepis alluaudi, Solenopsis papuana*	*Anoplolepis gracilipes, Cardiocondyla emeryi, C. kagutsuchi, C. obscurior, C. venustula, C. wroughtoni, Leptogenys falcigera, Solenopsis geminata*
Koloa	No ants	
Opaeula Lower	No ants	
Makaha (Trailhead & Kumaipo LZ)	*Anoplolepis gracilipes*, Solenopsis papuana*	*Technomyrmex albipes*
Ohikilolo	*Pheidole megacephala, Plagiolepis alluaudi, Solenopsis papuana*	*Anoplolepis gracilipes, Ochetellus glaber*
Pahole (Snail Enclosure)	*Ochetellus glaber, Plagiolepis alluaudi, Paratrechina bourbonica, P. vaga, Technomyrmex albipes, Tetramorium bicarinatum, Tet. simillimum, Solenopsis papuana*	*Anoplolepis gracilipes, Leptogenys falcigera, Cardiocondyla emeryi, C. obscurior, Solenopsis geminata*
Palikea (Snail Enclosures, Fenceline & Maunakapu)	*Cardiocondyla kagutsuchi, Pheidole megacephala, Solenopsis papuana*	*Cardiocondyla venustula*
Pualii North	*Pheidole megacephala, Solenopsis papuana*	
Kapuna Upper (Trailhead & Cabin)	*Pheidole megacephala, Solenopsis papuana*	

*Only present at the parking lot, not in the forested area

Table 4. Ant species occurrence (not including species that occur in only 1-2 Units) by number of Management Units 2004-2018

Species	Number of MUs with species	Proportion of MUs sampled, positive for species
Solenopsis papuana	10	71%
Plagiolepis alluaudi	8	57%
Anoplolepis gracilipes	7	50%
Pheidole megacephala	7	50%
Ochetellus glaber	6	42%
Technomyrmex albipes	4	28%
Leptogenys falcigera	3	21%

Results *Wasmannia auropunctata* surveys: Since its first record on Oahu in December 2013, we have surveyed areas on base (Schofield Baracks and Wheeler Army Airfield) as well as pesticide and soil providers to prevent *Wasmannia auropunctata* (the Little Fire Ant or LFA) from establishment. No LFA was detected during any of these surveys (Table 5).

Table 5. Table showing LFA survey details July 2017-June 2018

Location	Date surveyed	Ants detected
BEI Chemicals and Fertilizers 311 Pacific St # B, Honolulu	July 27, 2017	No ants
New housing area on junction of Lyman and Iolani Road, Schofield Barracks	July 27, 2017	*Anoplolepis gracilipes, Pheidole megacephala*
Garden store PX, 903 Cadet Sheridan Road, Schofield Barracks	July 27, 2017	*Pheidole megacephala*

9.4 RAPID OHIA DEATH DETECTION

Rapid Ohia Death (ROD) is a disease caused by two fungal pathogens. *Ceratocystis lukuohia* and *Ceratocystis huliohia*. Both of these fungal pathogens kill ohia, (*Metrosideros polymorpha*) Hawaii's most abundant native tree. Both fungi are widespread on the Big Island and *C. huliohia* was found on Kauai in early 2018. It threatens to establish on Oahu. Following recommended decontamination guidelines (CTAHR 2018), we took samples from three ailing trees in Makaha and sent them to USDA in Hilo for testing. All tested negative for the disease. We assist the Oahu Invasive Species Committee to conduct aerial surveys for ROD twice yearly on Schofield Barracks West Range. We remain vigilant to the threat ROD poses and our staff have been briefed on the signs and symptoms of ROD.

9.5 COCONUT RHINOCEROS BEETLE (CRB) DETECTION AND TRAPPING

CRB was first detected on Oahu in December 2013. Adults attacks palms, agave, sugarcane, banana and pineapple (USDA 2018). It is therefore a threat to agriculture and to the endangered palm *Pritchardia kaalae*. OANRP currently maintains 18 CRB traps spread throughout Wheeler, Schofield and Wahiawa, with a single trap at Dillingham (Figure 6). 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 February 2014. No CRB have been detected at any traps during these period. All information is relayed to HDOA and integrated into CRB distribution maps on Oahu.

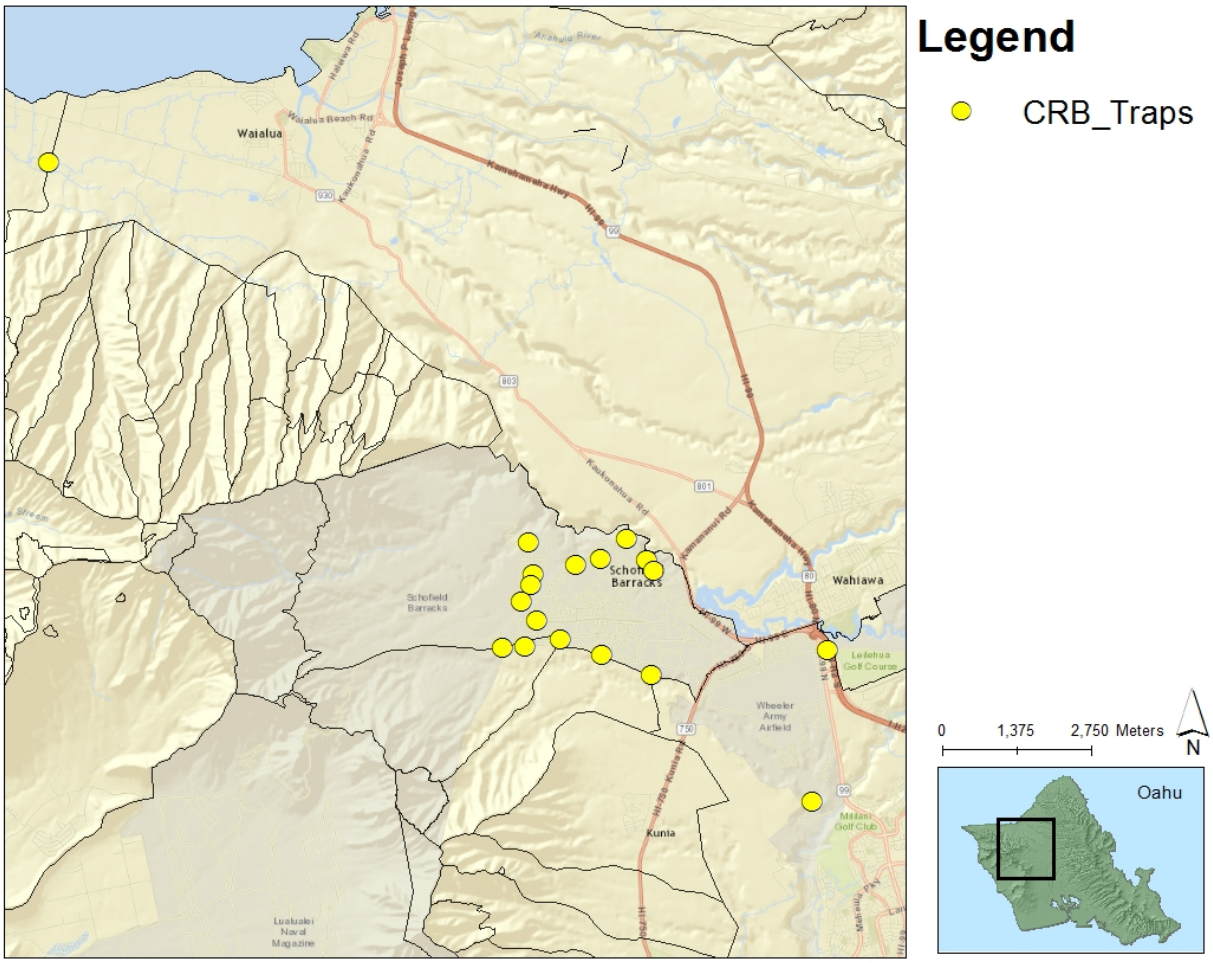

Figure 6. Map of CRB traps maintained by our program

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